AMERICAN COLLEGE of SPORTS MEDICINE®
LEADING THE WAY

ACSM'S Resources for the Personal Trainer

Sixth Edition

Wolters Kluwer

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Preface

Overview

This sixth edition of *ACSM's Resources for the Personal Trainer* is based on *ACSM's Guidelines for Exercise Testing and Prescription*, eleventh edition. In this sixth edition, the editors and contributors have continued to respond to the needs of practicing Personal Trainers. This edition has expanded on the previous edition in that content was updated with the latest scientific evidence, the functional movement assessments were integrated into the chapter on client fitness assessments, and the chapter on special populations was expanded into two chapters to individually cover apparently healthy populations across the lifespan and populations with metabolic/cardiovascular disease risk factors.

ACSM's Resources for the Personal Trainer, sixth edition, continues to recognize the Personal Trainer as a professional in the continuum of creating healthy lifestyles. This text provides the Personal Trainer with both the tools and scientific evidence to help build safe and effective exercise programs for a variety of clients. The book is divided into six distinctly different parts, ranging from an introduction to the profession of Personal Training to considerations of how to run your own business. In between are chapters dedicated to the foundations of exercise science which include anatomy, exercise physiology, biomechanics, behavior modification, and nutrition. The science-and evidence-informed approach provides a way for the transfer of knowledge from the Personal Trainer to the client, allowing for the opportunity for success from a business standpoint, as well as for the individual clients. The middle chapters include establishing goals and objectives for clients and a “how-to” manual for preparticipation screening guidelines as well as assessing body composition, cardiovascular fitness, muscular fitness, and flexibility. The last sections of chapters are dedicated to developing various training programs, addressing special populations and advanced training program options, and providing the basics on business and legal concerns facing Personal Trainers.

Organization

The chapters are divided into six parts designed for ease of navigation throughout the text. Using this approach, usefulness will be maximized for every Personal Trainer.

Part I: Introduction to the Field and Profession of Personal Training. Two introductory chapters are designed to introduce the new and aspiring Personal Trainer to the profession. Chapter 1 provides insight into why the health and fitness professions are some of the fastest growing industries in the world and how the Personal Trainer can capitalize on this growth. Chapter 2 provides a career track for the Personal Trainer, helping prospective Personal Trainers to examine their own interest in Personal Training and how to make Personal Training a viable career.

Part II: The Science of Personal Training. In Part II, Chapters 3–6 provide the scientific foundations for Personal Training. Every Personal Trainer, regardless of experience, will find these chapters helpful. For the Personal Trainer just starting out, these chapters introduce the scientific basis for physical activity. For the advanced Personal Trainer, these chapters serve as a foundational resource for specific lifestyle modification programs. These four chapters include anatomy and kinesiology, applied biomechanics, exercise physiology, and nutrition.

Part III: Behavior Modification. The next section of this book is dedicated to learning how and why people are either willing or unwilling to change their behavior. One of the most challenging aspects of Personal Training is when a client struggles to change a deleterious habit or even is unable to follow recommendations between training sessions. Chapters 7–9 include discussions of the concept of "coaching" — a new way of looking at and creating your relationship with a client. These chapters will forever change your approach to Personal Training.

Part IV: Initial Client Screening. Part IV comprises Chapters 10–12 and walks the Personal Trainer through the first client meeting to a comprehensive health-related physical fitness assessment. Capitalizing on the learning objectives of Part III, this section establishes a framework for developing client-centered goals and objectives. Although certainly not an exhaustive list of physical fitness assessments, Chapter 12 provides critical techniques to evaluate a client both in the field and in the laboratory. This section includes many tables, figures, and case studies that will assist with placing clients into various fitness categories.

Part V: Developing the Exercise Program. Chapter 13 introduces the concept of developing a comprehensive exercise program. On the basis of the goals established by the client and the Personal Trainer, Chapters 14–16 (resistance training, cardiorespiratory, and flexibility programs, respectively) are specific "how-to" manuals. Chapter 17 is dedicated to the proper sequencing of exercises within a given Personal Training session, whereas Chapter 18 has been written for the Personal Trainer who works with individuals who desire more advanced training options. Finally, Chapters 19 and 20 provide expanded coverage about working with clients throughout the lifespan and with clients who have medical conditions. As more people decide that being active is beneficial, Personal Trainers will encounter these populations. These chapters discuss the scope of a Personal Trainer's knowledge, skills, and abilities when it comes to working with these "special populations."

Part VI: The Business of Personal Training. Although seeing clients improve is rewarding, one goal of a successful business is to be profitable financially. Chapters 21 and 22 introduce the professional Personal Trainer to common business practices and provide information about how to avoid some of the common mistakes beginners typically make in the development of their practices. Chapter 22 deals specifically with legal issues. This chapter encourages each Personal Trainer to take their responsibility seriously by getting the necessary training and experience.

Features

Specific elements within the chapters will appeal to the Personal Trainer. A list of objectives precedes each chapter. **Key points** highlight important concepts addressed in the text and boxes expand on material presented. **Case Studies** present common scenarios that allow for application of concepts covered within the chapters. **Icons** are provided in selected chapters directing the reader to updated videos found at the book's companion Web site. Numerous four-color tables, figures, and photographs will help the Personal Trainer understand the written material. A **chapter summary** concisely wraps up the content, and **references** are provided at the conclusion of each chapter for easy access to the evidence.

Additional Resources

ACSM's Resources for the Personal Trainer, sixth edition, includes additional resources for students and instructors that are available on the book's companion Web site at http://thepoint.lww.com. See the inside front cover of this text for more details, including the passcode you will need to gain access to the Web site. Any updates made in this edition of the book prior to the publication of the next edition can be accessed at https://www.acsm.org/get-stay-certified/get-certified/prepare-for-exams/acsm-book-updates.

Students

- Video clips

Instructors

Approved adopting instructors will be given access to the following additional resources:

- Test bank
- PowerPoint presentations
- Image bank
- Lesson plans

Acknowledgments

The sixth edition of *ACSM's Resources for the Personal Trainer* continues to build on previous editions to make it a go-to resource for Personal Trainers. As with the previous editions of this text, this edition would not be the quality resource that it is without the many volunteer contributors who wrote the chapters. Additionally, the editors would like to thank the many dedicated reviewers who also volunteered their time to carefully review each chapter to ensure the content was current and established guidelines were accurately presented. This text is a team effort of volunteer editors, contributors, and reviewers.

Thank you to the staff at the American College of Sports Medicine (ACSM), specifically the Editorial Services, Publications, and Marketing departments for their support and assistance. The staff at ACSM work tirelessly to make projects like this happen and ensure consistency among all ACSM-related publications.

Personally, I would like to thank Angie Chastain for the constant support, encouragement, and confidence that you have shown in me for the past 3 years. Your constant help and wisdom has been invaluable. I also want to thank the associate editors, Elizabeth, Anthony, and Katrina. This text would not be what it is without their tireless work that they have put into this edition. I would also like to express my gratitude to my family who have supported me throughout this process. Your love and encouragement mean the world to me.

And last, but certainly not least, thank you to the many dedicated Personal Trainers that make this work so rewarding. We hope that this text helps you in

your endeavors, and we wish you continued success in a career that influences so many people to improve their health and fitness.

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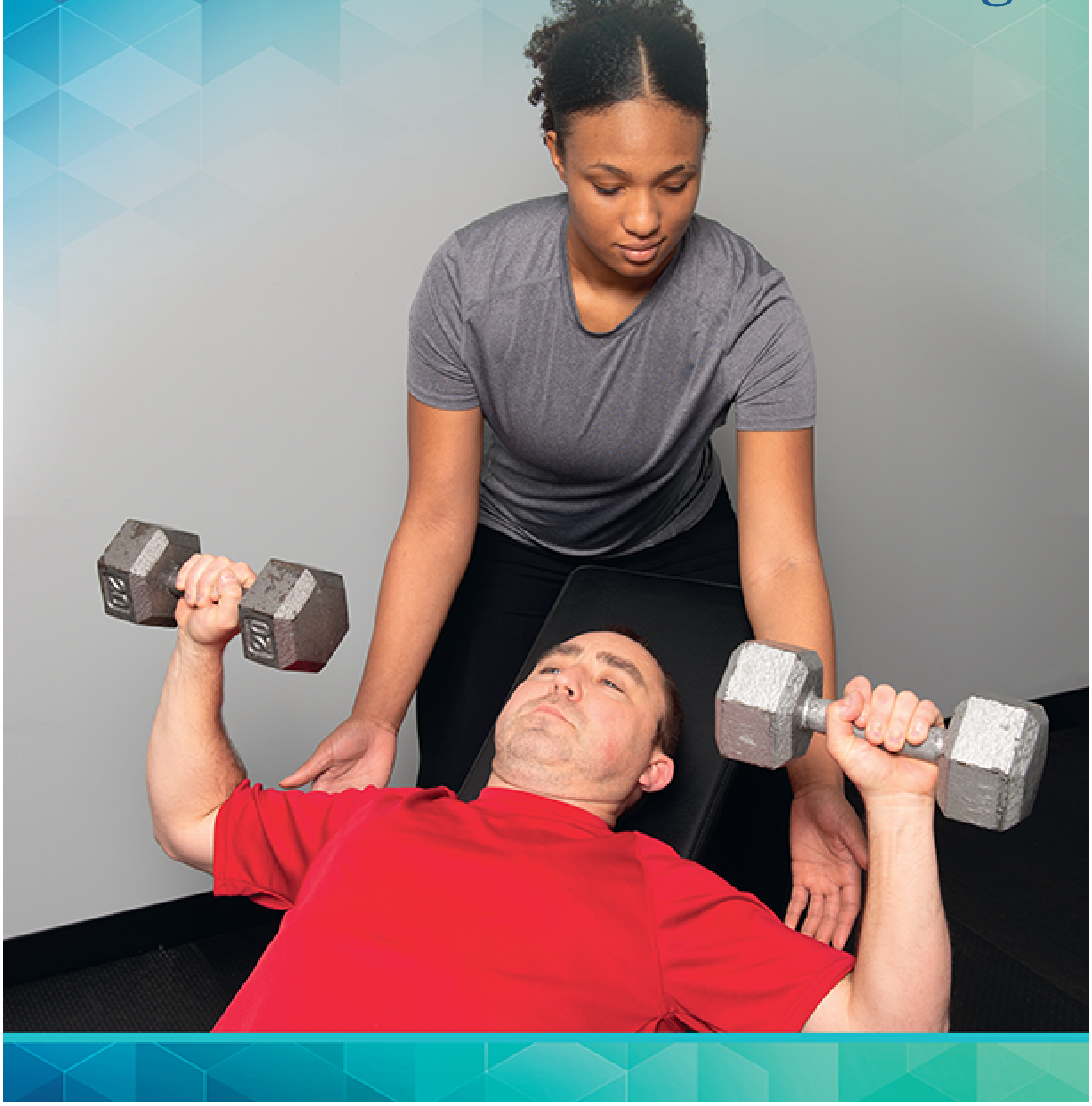
PART VI: The Business of Personal Training

PART
I

Introduction to the Field and Profession of Personal Training



CHAPTER 1

Importance of the Field and Profession of Personal Training

OBJECTIVES

Personal Trainers should be able to:

- Recognize the need for a Personal Trainer.
- Describe the scope of practice of a Personal Trainer, including the background and experience needed to become a Personal Trainer.
- Discuss professional career environments and other educational opportunities for Personal Trainers.
- Identify future trends that will affect the fitness industry and Personal Training.

INTRODUCTION

Personal Training (practiced by one referred to in this book as the "Personal Trainer" but often described as a "fitness trainer," "personal fitness trainer," "fitness professional," or "weight trainer") continues to be a fast-growing profession in the United States. According to the U.S. Bureau of Labor Statistics, the job outlook for this profession is projected to grow "much faster than the average" for all occupations between 2018 and 2028, which is further defined as an increase of 13% during this decade (1). The increased emphasis on health and fitness, diverse clientele interested in and in need of health and fitness programming, and recent links between sedentary activities and risk for chronic disease development and all-cause mortality (2) provide multiple opportunities for Personal Trainers.

Consider some groups for whom Personal Training may be of increased interest. Baby boomers (approximately 78 million Americans born from 1946 to 1964) are the first generation in the United States that grew up exercising, but obesity, hypertension, hypercholesterolemia and diabetes are higher among their generation than the previous generation (3). Baby boomers have now reached retirement or are approaching retirement age, and although they are less active than the previous generation, they have the time and desire to begin or continue exercising in their 70s and beyond and the potential to achieve more optimal health outcomes (3). Life expectancy has also increased to an average age of 80 years (4). In addition, an increasing number of businesses are recognizing the many cost-related benefits that health and fitness programs provide for their employees (5). The recent emphasis and reliance on technology in the office and home has led to an increased time spent in sedentary-type activities (*e.g.*, sitting and working at a computer) (6,7). This increased sedentary time is associated with obesity, diabetes, and cardiovascular disease (2).

Older adults and working adults are not the only potential clients for Personal Trainers. A growing concern about childhood obesity (8) and the reduction in number of physical education days in schools (9) will also contribute to the increased demand for fitness professionals. Personal Trainers are increasingly being hired to work with children in nonschool settings, such as health/fitness facilities. Because of the increased concern for fitness, the number of weight-training centers for children and health/fitness center membership among young adults is expected to continue to grow steadily (10,11).

The Fitness Industry: An Overview of the Landscape

Interestingly, although the population is highly physically inactive (12), the health/fitness center industry has never been in better "shape." Consider the following information reported by the United States from the International Health, Racquet & Sportsclub Association (IHRSA), a trade association serving the health/fitness facilities industry (11) and the U.S. Bureau of Labor Statistics (1):

38,477	Number of U.S. health clubs
62.4 million	Number of U.S. health club members
$32.3 billion	Total U.S. fitness industry revenues for 2018 California, New York, Texas, Illinois, and Florida have the highest employment rates for fitness trainers/aerobics instructors
37.1%	Increase in total health club members since 2008
308,470	Number of U.S. fitness trainers/aerobics instructors

Although these numbers may seem impressive, consider how many people actually live in the United States compared to the number that are health club members. It is likely that only 16% of the population has a membership to a fitness center. Although there are certainly a variety of avenues to engage in physical activity, data suggest adults are not meeting the recommendations for physical activity. According to the Centers for Disease Control and Prevention (CDC), only 20.3% of adults achieve both the recommended aerobic and muscle strengthening guidelines (Fig. 1.1) (13). Additionally, only 24.2% of adults perform no leisure-time activity, and the southeastern part of the United States not only has low leisure-time activity but also reports the highest rates of obesity (Figs. 1.2 and 1.3).

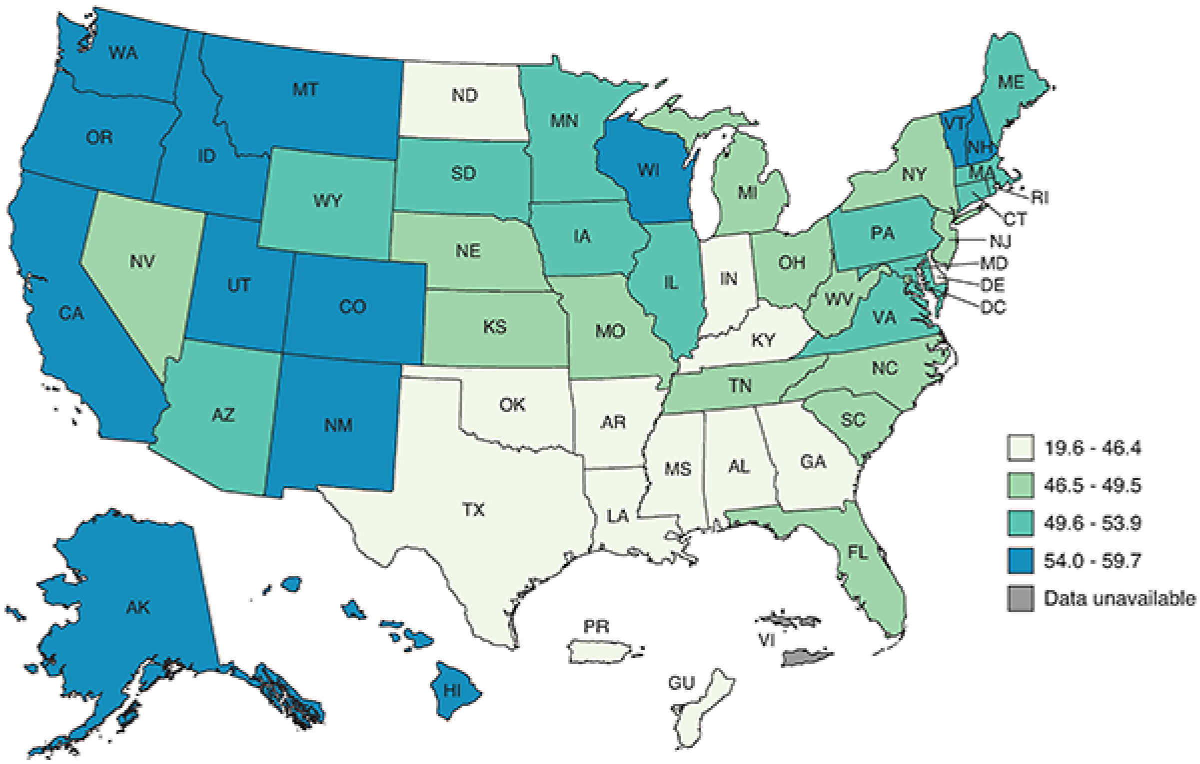


FIGURE 1.1. Percentage of adults who achieve at least 150 minutes a week of moderate-intensity aerobic physical activity or 75 minutes a week of vigorous-intensity aerobic physical activity and engage in muscle-strengthening activities on 2 or more days a week. (Centers for Disease Control and Prevention. Data, trend and maps [Internet]. Atlanta [GA]: Centers for Disease Control and Prevention. Available from: https://www.cdc.gov/nccdphp/dnpao/data-trends-maps/index.html.)

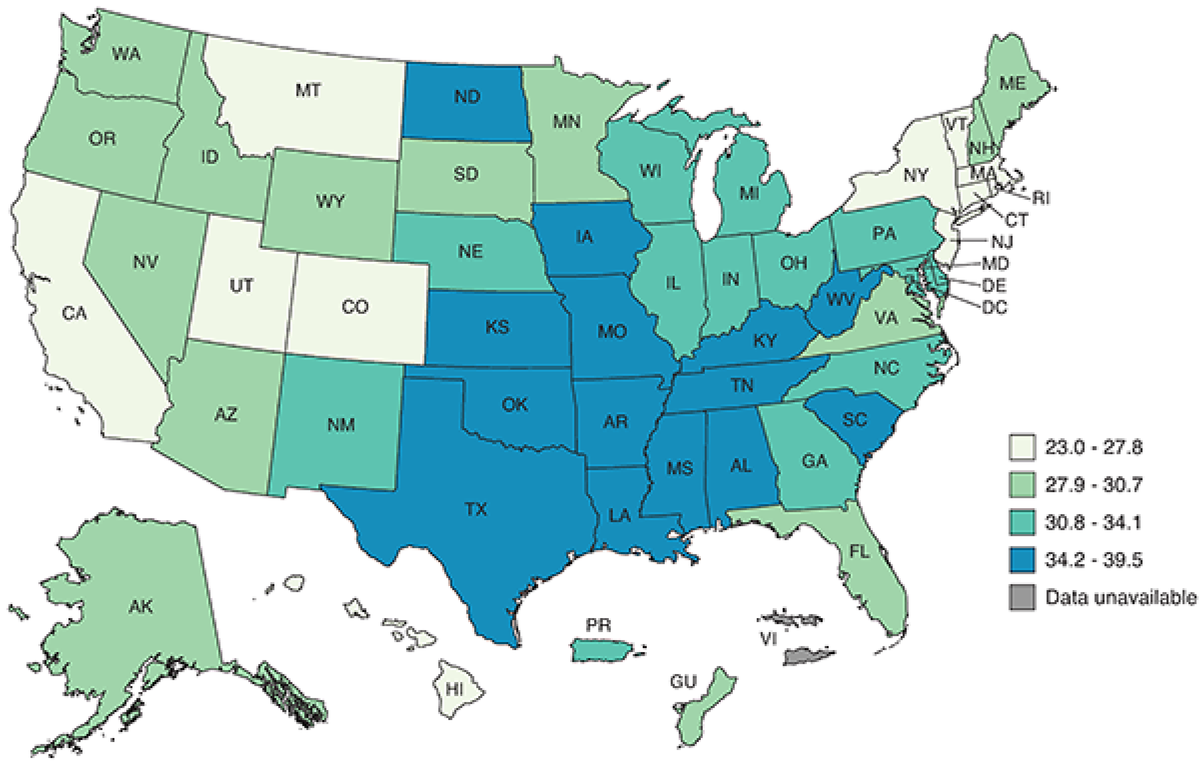


FIGURE 1.2. Prevalence of obesity in percentage (body mass index ≥30) in U.S. adults in 2018. The data shown in these maps were collected through the CDC's Behavioral Risk Factor Surveillance System (BRFSS). Each year, state health departments use standard procedures to collect data through a series of monthly telephone interviews with the U.S. adults. Prevalence estimates generated for the maps may vary slightly from those generated for the states by the BRFSS as slightly different analytic methods are used. (Centers for Disease Control and Prevention. Data, trend and maps [Internet]. Atlanta [GA]: Centers for Disease Control and Prevention. Available from: https://www.cdc.gov/nccdphp/dnpao/data-trends-maps/index.html.)

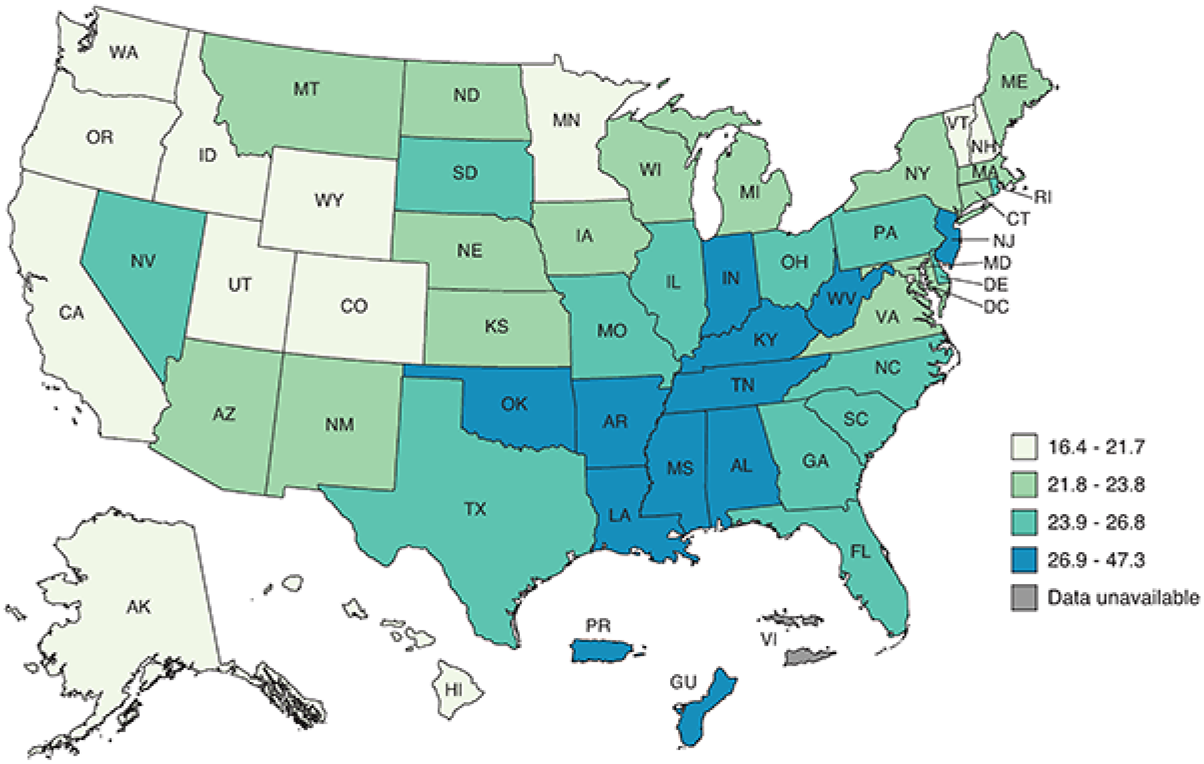


FIGURE 1.3. Percentage of adults who engage in no leisure-time physical activity, 2017. (Centers for Disease Control and Prevention. Data, trend and maps [Internet]. Atlanta [GA]: Centers for Disease Control and Prevention. Available from: https://www.cdc.gov/nccdphp/dnpao/data-trends-maps/index.html.)

According to the U.S. Bureau of Labor Statistics, the job outlook for this profession is projected to grow "15% from 2019 to 2029, much faster than the average" for all occupations between 2018 and 2028, which is further defined as an increase of 13% during this decade.

A large proportion of the population could benefit from involvement in some type of regular physical activity as part of a healthy lifestyle, whether as a member of a health/fitness facility or on their own. Personal Trainers are well positioned to influence the greater scope of public health in this regard. As the health/fitness facility industry continues to grow, so too will the demand for highly qualified and certified fitness professionals to serve the needs of their members (1).

Despite the growth of the fitness industry and emerging opportunities for physical fitness, high inactivity rates among Americans remain, with only 1 in 5 adults meeting the recommended amounts of physical activity and fewer than 3 in 10 high school students achieve at least 60 minutes of physical activity every day (13). Currently, there are only six states that require physical education in every grade (14). At the elementary school level, six states require schools to follow the nationally recommended 150 minutes per week of physical education and only 16% of states require elementary schools to provide daily recess (14). For middle schools and high school, only three states require the recommended 225 minutes per week of physical education (14).

Health care costs are rising exponentially as the medical field continues to focus more on treatment than on prevention. Food portion sizes are increasing (15). According to the CDC, obesity has become a problem in every state. No state reported that less than 20% of adults were obese in 2018, and only 3 states report obesity levels lower than 25% (13). The data also show that at least 30% of adults in 31 states and Puerto Rico were classified as obese in 2018 (see Fig. 1.2) (13). This is quite a change from 2000 when no states reached that level of obesity and in 2010 and 2015 when 12 and 21 states, respectively, were at that level. The data also indicate how obesity impacts some regions more than others. For example, states in the South have the highest obesity rate at 33.6%, the Midwest had an obesity rate of 33.1%, the Northeast had a rate of 28%, and the West had a rate of 26.9% (16).

> Despite the growth of the fitness industry and emerging opportunities for physical fitness and the recommendations provided in the *Physical Activity Guidelines for Americans*, 2nd edition (17), the rates of adults meeting the physical activity recommendations and rates of adults who engage into leisure-time physical activity has not changed substantially over the last several years (18).

According to the most recent National Health and Nutrition Examination Survey, in 2015–2016, 39.8% of adults and 18.5% of children aged 2–19 years in the United States are classified as obese (19). A recent Mott Poll Report examining the top 10 health concerns for children found that issues related to childhood obesity, not enough exercise and unhealthy eating, were concerns numbers 2 and 3, respectively (20). With so much to be done to improve the current health status of Americans, the time is right for highly qualified Personal Trainers (with the help of health care providers) to lead the charge toward a healthier nation. Participation in physical activity can lead to higher quality of life by decreasing risk factors associated with morbidity and mortality (21). Therefore, one role of the Personal Trainer is to encourage and motivate others to be more active.

Definition of a Personal Trainer

American College of Sports Medicine's (ACSM) job definition/scope of practice for ACSM Certified Personal Trainer® (ACSM-CPT®) is:

> The ACSM Certified Personal Trainer (ACSM-CPT®), possessing a high school diploma or GED at minimum, works primarily with apparently healthy individuals to enhance fitness. The ACSM-CPT® also works with individuals who have stable health challenges and are cleared to exercise independently. The ACSM-CPT® conducts basic preparticipation health screenings, lifestyle inventories, and fitness assessments for health and skill-related components of fitness. The ACSM-CPT® assesses behavior adaptation readiness and offers guidance in the development of realistic, client-centered goals related to health, fitness and wellness. The ACSM-CPT® develops and administers programs designed to promote optimal cardiorespiratory fitness, muscular strength, muscular endurance, flexibility, and body composition, as well as agility, balance, coordination, power, speed, and reaction time. The ACSM-CPT® facilitates client motivation and adherence and honors client

confidentiality. The ACSM-CPT® adheres to all agreed-upon terms with each client and stays within the scope of practice of the ACSM-CPT® credential. The prudent ACSM-CPT® makes referrals to appropriate allied health professionals when clients' needs exceed the ACSM-CPT's scope of practice (22).

It is crucially important to understand that a certified Personal Trainer's (CPT) scope of practice does not include meal planning or diagnosing injuries or other medical conditions, or can Personal Trainers work with individuals who cannot currently exercise independently.

As mentioned previously, the health/fitness industry is unique in that there are a wide variety of certifications available to the potential fitness professional. In addition to the ACSM-CPT certification, ACSM also offers several other health fitness certifications and a clinical certification (Box 1.1).

Box 1.1 ACSM Certification Names and Acronyms

Certification Name	Certification Acronym
ACSM Certified Group Exercise Instructor®	ACSM-GEI®
ACSM Certified Personal Trainer®	ACSM-CPT®
ACSM Certified Exercise Physiologist®	ACSM-EP®
ACSM Certified Clinical Exercise Physiologist®	ACSM-CEP®
ACSM/NCHPAD Certified Inclusive Fitness Trainer	ACSM/NCHPAD-CIFT
ACSM/ACS Certified Cancer Exercise Trainer	ACSM/ACS-CET
ACSM/National Physical Activity Society (NPAS) Physical Activity in Public Health Specialist	ACSM/NPAS-PAPHS

Organizations that offer certifications are commercial (for-profit) as well as nonprofit. Some have services and benefits that facilitate professional development, such as publications and conferences. Before committing to a specific certification, Personal Trainers should review each one for its relevance to their individual situation (see Tables 1.1 and 1.2 for more information).

Table 1.1 Specialty Certifications

	Scope of Practice	Minimum Requirements

Exercise is Medicine® (EIM)	■ Has three levels that range from those with low or moderate risk and cleared for independent activity to those at high risk and need to be monitored
	■ Level 1
	  ■ Patient population: individuals at low or moderate risk who have been cleared for independent exercise
	■ Level 2
	  ■ Patient population: individuals at low, moderate, or high risk who have been cleared for independent exercise
	■ Level 3
	  ■ Patient population: individuals at low, moderate, or high risk including those requiring clinical monitoring
		■ The EIM Credential contains three levels, designed to serve clients and patients depending on their health status. The eligibility requirements for the three credential levels vary, based on the following:
		  ■ Your current fitness professional certification must be an NCCA- or ANSI/ISO 17024–accredited certification.
		  ■ The level of your current NCCA- or ANSI/ISO 17024–accredited certification and your education level determine the EIM Credential level you can obtain. Those with bachelor's or master's degrees in exercise science qualify for higher level credentials.
		  ■ Level 1
		    ■ Credential requirements
		      ■ NCCA- or ANSI/ISO 17024–accredited fitness professional certification
		      ■ Successful completion of the EIM Credential online course and examination
		    ■ Level 1 exemption

            - To be exempt from the online course and exam, you must answer YES to both of the following:
                - I have a bachelor's degree or higher in exercise science, exercise physiology, or kinesiology.
                - I have a current NCCA- or ANSI/ISO 17024–accredited fitness certification.
- Level 2
    - Credential requirements
        - Approved bachelor's degree in exercise science, exercise physiology, or kinesiology
        - NCCA- or ANSI/ISO 17024–accredited fitness professional certification
        - Successful completion of the EIM Credential online course and examination
    - Level 2 exemption
        - To be exempt from the online course and exam, you must answer YES to both of the following:
            - I have a bachelor's degree or higher in exercise science, exercise physiology, or kinesiology.
            - I have a current NCCA- or ANSI/ISO 17024–accredited certification with an emphasis on special populations (ACSM-

		EP, ACSM-CEP, ACE Certified Medical Exercise Specialist). ■ Level 3 ■ Credential requirements ■ Approved master's degree in Exercise Science, Exercise Physiology or Kinesiology OR approved bachelor's degree in Exercise Science, Exercise Physiology or Kinesiology with 4,000 hours of experience in a clinical exercise setting ■ NCCA- or ANSI/ISO 17024–accredited clinical exercise certification (ACSM-CEP) ■ To obtain your Level 3 EIM Credential, you must fill out the EIM exemption application form.
ACSM/NCHPAD Certified Inclusive Fitness Trainer (ACSM/NCHPAD-CIFT)	■ Works with people with a disability who are healthy or have medical clearance to exercise and were referred or currently under the care of a physician or health care professional ■ Leads and demonstrates safe, effective, and adapted methods of exercise ■ Writes adapted exercise recommendations, understands precautions and contraindications to exercise for people with disabilities, and is aware of current ADA policy for recreation facilities and standards for accessible facility design	■ Current ACSM certification or current NCCA-accredited, health/fitness-related certifications (*e.g.* ACE, NCSF, NASM, NFPT, NSCA, Cooper Institute) OR ■ Bachelor's degree in exercise science, recreation therapy, or adapted physical education ■ Adult CPR/AED certified (with hands-on practical skills component)

ACSM/ACS Certified Cancer Exercise Trainer (ACSM/ACS-CET)	■ Trains individuals who were recently diagnosed with cancer and have not yet begun treatment, are receiving treatment or have completed treatment, and are apparently healthy or have the presence of known stable cardiovascular disease with low risk for complications with vigorous exercise and do not have any relative or absolute contraindications for exercise testing ■ Performs appropriate fitness assessments and makes exercise recommendations while demonstrating a basic understanding of cancer diagnoses, surgeries, treatments, symptoms, and side effects	■ An ACSM- or NCCA-accredited exercise/fitness certification ■ Adult CPR/AED certified (with hands-on practical skills component), bachelor's degree (in any field), 500 h of experience training older adults or individuals with chronic conditions OR ■ 10,000 h of experience training older adults or individuals with chronic conditions[a]
ACSM/NPAS Physical Activity in Public Health Specialist (ACSM/NPAS-PAPHS)	■ Conducts needs assessments; plans, develops, and coordinates physical activity interventions provided at local, state, and federal levels ■ Provides leadership; develops partnerships; and advises local, state, and federal health departments on all physical activity–related initiatives	■ A bachelor's degree in a health-related field[b] from a regionally accredited college or university OR ■ A bachelor's degree in any subject and 1,200 h of experience in settings promoting physical activity, healthy lifestyle management, or other health promotion[c]

ACE, American Council on Exercise; NCSF, National Council on Strength & Fitness; NASM, National Academy of Sports Medicine; NFPT, National Federation of Professional Trainers; NPAS, NSCA, National Strength and Conditioning Association; CPR, cardiopulmonary resuscitation; AED, automated external defibrillator; ANSI, American National Standards Institute; ISO, International Organization for Standardization.

[a]Hours of experience with older adults or individuals with chronic conditions include exercise testing, exercise prescription, group or individual training, group or individual client education, academic coursework and/or continuing education (relating to older adults or individuals with chronic conditions), internships or observational hours in an oncology setting, and/or cancer rehabilitation program.

[b] Examples: exercise science, exercise physiology, kinesiology, physical education, sports management, athletic training, recreation, nutrition, health education, health promotion, public health, community health, and health care administration.

[c] Examples: education; community/public health setting; YMCA, parks and recreation, after-school programs; worksite health promotion; community health; health education or health promotion; federal, state, or local government; health care or health plan; academia or university; nonprofit organization; commercial health clubs; and corporate fitness centers.

Table 1.2 ACSM Certification Requirements

	Education	Age	Additional Requirements
Health/Fitness Certifications			
ACSM Certified Personal Trainer® (ACSM-CPT®)	High school diploma or equivalent	18 y of age or older	Adult CPR/AED certification (with practical hands-on skills component)
ACSM Certified Group Exercise Instructor® (ACSM-GEI®)	High school diploma or equivalent	18 y of age or older	Adult CPR/AED certification (with practical hands-on skills component)
ACSM Certified Exercise Physiologist® (ACSM-EP®)	Minimum of a bachelor's degree in exercise science, exercise physiology, or kinesiology		Adult CPR/AED certification (with hands-on practical skills component)
Clinical Certification			
ACSM Certified Clinical Exercise Physiologist® (ACSM-CEP®)	Master's degree in clinical exercise physiology or equivalent and 600 h of hands-on clinical experience OR Bachelor's degree in exercise science, exercise physiology, or equivalent and 1,200 h of hands-on clinical experience		Basic life support provider or CPR for the professional rescuer certification (with hands-on practical skills component)

	Examples: exercise science, kinesiology, kinesiotherapy, physiology, and exercise physiology	

AED, automated external defibrillator; CPR, cardiopulmonary resuscitation.

Some certification organizations recognize other certifications for the purposes of continuing education. Most legitimate certifications will require their respective certified professionals to pursue educational opportunities, commonly referred to as *continuing education units* (CEUs) or *continuing education credits* (CECs). These CEUs/CECs are required in an ongoing fashion for a certified professional to maintain his or her certification status and as one way to maintain professional competence. Some certifications are complementary to others, and again, multiple certifications could make you more valuable to a potential employer. Currently, ACSM-CPTs need to obtain 45 CEUs every 3 years. There is a nominal administrative fee associated with recertification. You can find more information on recertification at http://www.acsm.org/get-stay-certified/stay-certified.

ACSM-CPTs need to obtain 45 CEUs every 3 years. There is a nominal administrative fee associated with recertification.

Personal Trainers' Scope of Practice

As mentioned previously, the profession of Personal Training is rapidly evolving, and employment opportunities are wide-ranging and will continue to increase. But what does a Personal Trainer do? Depending on the work setting, Personal Trainers have a wide range of potential activities, including, but not limited to, the following tasks:

- Screen and interview potential clients to determine their readiness for exercise and physical activity. This may involve communicating with the clients' health care team (especially for clients with special needs): physicians, physician assistants, nurse practitioners, registered dietitian nutritionists, physical therapists, occupational therapists, and others.
- Perform fitness tests or assessments (as appropriate) with clients to determine their current level of fitness.
- Help clients set specific, measurable, and realistic goals; modify goals as needed; and provide motivation for adherence to the program.
- Develop exercise regimens and programs (often referred to as an "exercise prescription") for clients to follow and modify programs as necessary based on progression and goals.
- Demonstrate and instruct specific techniques to clients for the safe and effective performance of various exercise movements.
- Provide clients with safe and effective exercise techniques or training programs as well as educate them about exercises that may be contraindicated.
- Supervise or "spot" clients when they are performing exercise movements.
- Maintain records of clients' progress or lack thereof with respect to the exercise prescription.
- Be a knowledgeable resource to accurately answer clients' health and fitness questions.
- Educate clients about health and fitness and encourage them to become independent exercisers (provided they have medical approval to do so).
- Provide referrals to other professionals when appropriate, including but not limited to registered dietitian nutritionists, physical therapists, and others.

Other responsibilities not directly involving a client may be assigned or performed as needed. These usually include administrative paperwork, maintenance of equipment, and cleaning of equipment and facilities as required.

Many Personal Trainers also obtain additional education or specialty certifications in areas such as group exercise instruction, kickboxing, yoga, aquatic exercise, wellness coaching, indoor cycling, cancer exercise training, and inclusive fitness (Fig. 1.4). These specialties should not be confused with "core" or primary certifications, such as ACSM-CPT. Additional specialty certifications are valuable and allow Personal Trainers to have a wider variety of responsibilities, such as teaching group exercise classes.

FIGURE 1.4. A trainer working with a client who has a physical disability.

> Many Personal Trainers also obtain additional education or specialty certifications in areas such as group exercise instruction, kickboxing, yoga, aquatic exercise, wellness coaching, studio cycling, cancer exercise training, and inclusive fitness.

Becoming a Personal Trainer

Because of the large number of certification organizations, the prerequisites and eligibility requirements for becoming a Personal Trainer vary widely. Some are stand-alone certifications, whereas others, such as those offered by ACSM, are part of a progressive professional development pathway in which the scope of practice increases in both depth and scope as the prerequisites and eligibility requirements increase.

There are two tracks of ACSM certification (health/fitness and clinical) with four main certifications (not counting specialty certifications). The health/fitness certifications include (a) Group Exercise Instructor® (ACSM-GEI®), (b) ACSM-CPT, and (c) Certified Exercise Physiologist® (ACSM-EP®), whereas the clinical track certifications includes Certified Clinical Exercise Physiologist® (ACSM-CEP®). Each certification level has minimum requirements (see Table 1.2).

Personal Trainers should consider current career plans as well as future professional goals when determining what educational preparation and certification(s) are needed. Background and interests will combine in determining how fast and by what process a Personal Trainer can develop a career. One should ensure that the certifying agency is accredited by the National Commission for Certifying Agencies (NCCA). The NCCA is the accreditation body of the National Organization for Competency Assurance. The NCCA is a widely recognized, independent, nongovernmental agency that accredits professional certifications in a variety of professions. The NCCA comprehensively reviews the certification organization's procedures, protocols, and operations and determines if the certification properly discriminates between those who are qualified and those who are not qualified to be awarded the respective credential.

The Backgrounds of Personal Trainers

The Committee on Accreditation for the Exercise Sciences (CoAES) was established in April 2004 under the auspices of the Commission on Accreditation of Allied Health Education Programs (CAAHEP). The primary role of the CoAES is to establish standards and guidelines for academic programs that facilitate the preparation of students seeking employment in the health, fitness, and exercise industry. The secondary role of the CoAES is to establish and implement a process of self-study, review, and recommendation for all programs seeking CAAHEP accreditation.

Programmatic accreditation through the CAAHEP is specifically intended for exercise science or related departments (physical education, kinesiology, etc.), with a professional preparation tract designed for students seeking employment opportunities in the health, fitness, and exercise industry.

The CAAHEP is the largest programmatic accrediting body in the health sciences field; it reviews and accredits more than 2,100 educational programs in 32 health science occupations such as personal fitness trainer. See http://www.coaes.org and https://www.caahep.org for more information or to find a CAAHEP-accredited academic institution in your state.

> The Committee on Accreditation for the Exercise Sciences (CoAES) was established in April 2004 under the auspices of the Commission on Accreditation of Allied Health Education Programs (CAAHEP).

It is important to possess a certification from an NCCA-accredited certifying agency; because of the many different types of certifications that exist, the background of today's Personal Trainer varies significantly with respect to educational preparation and work-related experience. Some individuals commit to the profession early and pursue a related course of study in college. Many of these individuals actually begin working part-time at a local health club or at the university student recreation center, gaining valuable "hands-on" practical experience to complement their academic studies. Other Personal Trainers enter the profession later in life as a new career or as a second career on a part-time basis while maintaining their primary career pursuit (Fig. 1.5). Ideally, the Personal Trainer will have a good combination of education, work-related experience, and even first-person perspective experiences as either an athlete or a former client.

FIGURE 1.5. A trainer and a client have reached a goal.

Educational Background

As the profession of Personal Training continues to evolve and grow, more and more educational opportunities become available. Many certification organizations offer workshops and online examination preparation opportunities. From a formal academic training perspective, there are certificate, associate's, bachelor's, master's, and doctoral degree programs available for fitness professionals. Typically, certificate programs (both in-person and online) range from 12 to 18 months in duration. Associate degree programs range in length from 18 months to 2 years. Bachelor's degree programs are usually 4 years in duration. Master's degree programs are typically 18 months to 2 years beyond a bachelor's degree. Finally, a doctoral degree program is usually 3–4 years beyond a master's degree and involves a research project. Also, internships, practicums, or student cooperative work experiences (typically unpaid opportunities to work under the direct supervision of an experienced fitness professional) may or may not be part of these different types of programs. Common names for these academic programs include, but are not limited to, exercise science, exercise physiology, kinesiology, sport science, and physical education. Currently, the CAAHEP accredits academic programs for personal fitness trainer (certificate and associate degrees), exercise science (bachelor's degree), and clinical exercise physiology and applied exercise physiology graduate programs.

The CAAHEP accredits academic programs for personal fitness trainer (certificate and associate degrees), exercise science (bachelor's degree), and clinical exercise physiology and applied exercise physiology graduate programs.

Increasingly, more fitness programs require Personal Trainers to have college degrees. Long-term employment and management advancement often require a degree. Most fitness directors, those individuals who have management/supervisory responsibilities over the floor staff (Personal Trainers), often have master's degrees and/or extensive experience in training staff.

Work-Related Background

It is possible for Personal Trainers to obtain employment without a related degree, especially if they have one or more certifications and prior industry-related work experience. For many individuals who want a career change, pursuing a second degree or even a first degree later in life may not be possible. Some health/fitness facilities have formal training paths and processes for their employees that may include assigning a more experienced Personal Trainer as a mentor or scheduling periodic staff training sessions, sometimes referred to as "in-services." Some health/fitness centers may even pay for continuing education opportunities for their staff as one benefit of employment. If not, look for an experienced Personal Trainer with an exemplary reputation who would consider taking on an apprentice. Many certification organizations have educational opportunities, such as workshops and webinars, which can also provide a good review of the various areas of content, especially as they relate to preparing for a certification examination. It is always advisable for all professionals working in this environment to seek a college degree whenever possible.

Experiential Background

Some Personal Trainers pursue this field as a result of previous positive experiences. Examples would include those who were once high school, college, professional, elite athletes, or former Personal Training clients who had a significant positive or transformational experience. Like those who are changing careers, some may not have a related academic degree, and some may have no college degree at all. However, their passion for a particular activity or a love of exercise in general usually motivates them sufficiently to fill in knowledge gaps they may have as they begin their Personal Training career. Commitment to the profession is shown by obtaining one or more certifications from reputable organizations, such as ACSM, as well as obtaining relevant, work-related experience under the mentorship of a proven, experienced (preferably degreed) CPT. By being proactive from a self-study perspective, obtaining one or more certifications and combining these with work-related experience, individuals can become competent professional Personal Trainers over time. If the opportunity arises to enhance your knowledge in the area of exercise science by a reputable organization or institution, take advantage of this opportunity.

Regardless of one’s background, starting down the career path as a Personal Trainer does not have to be complicated. Consider current status and then professional goals for 1, 2, and 5 years in the future. Reflect on the following questions:

- Do I have an exercise science–based college degree, and is it from a CAAHEP-accredited academic institution?

- If not, is it feasible for me to go back to obtain a certificate or degree on either a part-time or full-time basis?
- Was I ever a client of a Personal Trainer, and did I have a positive experience in achieving my goals?
- Do I have experience as a high school, college, professional, or elite athlete that provides me with some first-person experiences?
- Which certifications and certifying agency are appropriate for me to pursue now and in the future? The certifying agency (such as ACSM) should be well respected, provide peer-reviewed materials, and be NCCA accredited.
- Which certifications have study materials and/or workshops to help me accumulate a core body of knowledge?
- Where can I begin obtaining the necessary skills, either by observing a more experienced CPT or by volunteering at a local health/fitness facility?
- Which certifying organizations and, specifically, which level of certification do potential employers in my city expect to see when hiring Personal Trainers for their facilities?

Certifications

ACSM currently offers four specialty credentials (see Table 1.1 for details; https://www.acsm.org/get-stay-certified/get-certified). These additional credentials can assist the Personal Trainers in their continued education as well as provide them with opportunities to add skills and increase potential client base by offering diversity.

ACSM Exercise is Medicine®

Exercise is Medicine® (EIM) offers a credential program that recognizes exercise professionals who possess the education and skills to work closely with the health care community and referred patients, including those with common chronic diseases and health conditions. Certified exercise professionals or individuals with a qualifying university degree can earn the

EIM credential. The credential signifies that an exercise professional is part of the EIM initiative and can safely and effectively guide patients who need specialized fitness programming to change their health behaviors and improve health outcomes. The EIM credential currently features three levels (https://www.acsm.org/get-stay-certified/get-certified/specialization/eim-credential).

ACSM/NCHPAD Certified Inclusive Fitness Trainer

Created in collaboration with the National Center on Health, Physical Activity and Disability (NCHPAD), ACSM/NCHPAD Certified Inclusive Fitness Trainers (ACSM/NCHPAD-CIFT) are uniquely qualified to work with people who have health risks and/or physical limitations. With an understanding of current Americans with Disabilities (ADA) policy, ACSM/NCHPAD-CIFTs create adapted programming that promotes safe and effective training while also providing motivational support for a healthy lifestyle (https://www.acsm.org/get-stay-certified/get-certified/specialization/cift).

ACSM/ACS Certified Cancer Exercise Trainer℠

Created in collaboration with the American Cancer Society (ACS), ACSM/ACS Certified Cancer Exercise Trainers (ACSM/ACS-CETs) design and administer fitness assessments and exercise programs specific to a person's cancer diagnosis, treatment, and current recovery status (https://www.acsm.org/get-stay-certified/get-certified/specialization/cet). The ACSM/ACS-CET performs appropriate fitness assessments and makes exercise recommendations while demonstrating a basic understanding of cancer diagnoses, surgeries, treatments, symptoms, and side effects.

ACSM/NPAS Physical Activity in Public Health Specialist℠

ACSM/National Physical Activity Society Physical Activity in Public Health Specialist (ACSM/NPAS-PAPHS) is a professional who promotes physical activity in public health at the national, state, and/or local level. The

ACSM/NPAS-PAPHS engages and educates key decision makers about the impact of, and need for, legislation, policies, and programs that promote physical activity. Additionally, the ACSM/NPAS-PAPHS provides leadership and develops partnerships with private and public associations to catalyze the promotion of population-based physical activity (https://www.acsm.org/get-stay-certified/get-certified/specialization/paphs).

These additional specialty credentials can assist the Personal Trainer in continued education as well as to provide opportunities to add skills and increase potential client base by offering diversity. The kinds of fitness facilities are diverse, with the most numerous being multipurpose, commercial, for-profit clubs, followed by community, corporate, and medical fitness centers (MFCs). Although there are many core similarities between facilities, there is also great variety in size, structure, target markets, program offerings, amenities, membership fees, contracts, staffing, and equipment. This variety is necessary to attract and serve many different populations with many different interests (Fig. 1.6). With the member retention rates varying greatly across the industry, most clubs and centers must continually recruit new members. According to the IHRSA, in competitive suburban markets, in which the automobile is the primary means of commuting to a club, the majority of a club's membership base will come from within a 10- to 12-minute drive time from home to the club; thus, clubs that are located close to one another are typically competing for the same members (11). This means that Personal Trainers are vying for the same clients as well. However, Personal Trainers, just like clubs, can differentiate themselves from the competition in a number of ways, such as focusing on a specific clientele (*e.g.*, women, children, seniors, and athletes), developing expertise in a given area, offering small-group training in addition to individual sessions, offering a more competitive price, and using multiple locations. Many trainers make themselves more marketable by obtaining more than one primary and/or specialty certification.

FIGURE 1.6. A trainer spotting a squat exercise of a client who is on a BOSU ball (with light dumbbells in each hand).

Establishing a Solid Knowledge Base

Everyone has strengths and weaknesses with respect to how much he or she knows or does not know about any given topic, including Personal Trainers. Part of the commitment to the profession is for Personal Trainers to continuously evaluate their educational foundation and expand their knowledge base. One way to focus on an action plan for specific continuing education needs is to use the job tasks outlines by the ACSM as a knowledge map.

Begin by performing a thorough review of the job tasks and corresponding knowledge, skills, and abilities for each, rating familiarity and competence against each specific job task (specific information on the job tasks for Personal Trainers can be found on ACSM Web site under Certifications; https://www.acsm.org/get-stay-certified/get-certified). Next, use this checklist to prioritize the job task knowledge and skill areas from weakest to strongest. Over the course of a year, seek out and participate in continuing educational opportunities that focus on weak content areas. Personal Trainers should do this on a yearly basis, at a minimum, as content areas that were once weak may become stronger over time, especially for those who devote additional study to these areas and, more importantly, develop a client base in which some content areas are relied on more than others. By doing this consistently 1 year to the next, recertifying becomes a pleasure as opposed to a chore. Some Personal Trainers procrastinate, waiting until the last minute to accumulate the required number of CEUs/CECs. Not only does this create a great deal of stress but also it is not a very effective way to expand one's knowledge base as a Personal Trainer.

The Exercise Sciences

The competent Personal Trainer should have a strong knowledge foundation in the exercise sciences combined with leadership and coaching training. *Exercise science* is a broad term that includes multiple disciplines. These disciplines often include but are not limited to anatomy and physiology; exercise physiology; motor learning/motor control; nutrition (dietetics); biomechanics/applied kinesiology; exercise prescription; fitness testing; wellness coaching; and sport, exercise, and health psychology. Good-quality educational programs (workshops or online opportunities offered by certification organizations or curriculums offered by academic institutions) may offer a course of study that includes content or courses dedicated to helping the Personal Trainer develop an understanding of these more specific disciplines.

ACSM has a number of resources available to help individuals prepare for the ACSM-CPT certification examination. These include in-person workshops, online webinars, online practice questions, online study groups, book bundles for purchase, and an exam content outline to help guide your preparation. Details about each of these preparation approaches can be found at https://www.acsm.org/get-stay-certified/get-certified/health-fitness-certifications/personal-trainer.

> The competent Personal Trainer should have a strong knowledge foundation in the exercise sciences.

Developing Your Tool Kit

In addition to a strong knowledge foundation in the exercise sciences, effective Personal Trainers are constantly developing and adding skills to their "tool kit." Essential tools include the following:

- Effective communication skills (in-person, phone, and written such as e-mail)
- Ability to motivate appropriately
- Ability to influence behavior change
- Effective interviewing and screening
- Effective use of goals and objectives
- Effective and safe exercise program design
- Ability to demonstrate, instruct, spot, and supervise appropriate exercise movements
- Effective use of up-to-date technology in order to obtain continuing educational opportunities via webinars and other online resources
- Obtaining new primary or specialty certification skills
- Effective use of social networking sites, Web sites, blogs, e-mail blasts, and so on, for marketing and monitoring purposes
- Using a sound business model

These are, at the minimum, the tools Personal Trainers should include in their tool kit and also master using effectively, either individually or in combination with others. Nonetheless, effective Personal Trainers continuously add tools and improve their skills throughout their professional career.

Communication Skills (Motivating and Influencing Behavioral Change)

Perhaps, the most overlooked yet important skill for the Personal Trainer tool kit is that of communication. Communication is more than just verbal because it includes nonverbal elements such as visual (what is observed) and kinesthetic (what is felt). Additionally, effective communication involves much more than information exchange. Communication also relies on the emotional state of both individuals. For example, is the client "ready" to accept information, or is there temporary resistance to the new information being provided? Likewise, Personal Trainers can be effective motivators when they create an optimal emotional environment for clients, so they not only are ready to take in the information provided but also are able to put it to good use. As a complex and important skill, communication is discussed throughout this book, particularly in Chapter 9.

Screening, Assessment, and Referrals

Another set of tools required for the Personal Trainer includes interviewing, screening, and recognizing when to refer a client to a medical health care provider such as a physician, physical therapist, sport psychologist, or registered dietitian. When health screening forms are used appropriately, these tools help establish a foundation of trust that facilitates the development of the trainer–client relationship. Combined with effective communication skills, these tools further improve the possibility of achieving the client's goals.

Typically, a Personal Trainer conducts an initial interview with a potential client in which basic demographic information is obtained, along with the client's health history. Two types of forms are used at a minimum: the health history form and the Physical Activity Readiness Questionnaire (PAR-Q) form. The ACSM also recently developed a preparticipation screening form for exercise professionals for use with ACSM's preparticipation screening algorithm, which can be found in *ACSM's Guidelines for Exercise Testing and Prescription*, 11th edition (23). Examples of these and other forms are available in Chapter 11. In addition, it is appropriate during this initial interview to ask clients about their specific expectations for working with a Personal Trainer and what initial goals they may have as well as any other lifestyle information they can share. Examples include the following:

- Recent and past history of physical activity (if any)
- History of previous injuries (if any)
- Level of social support from family and friends
- Potential stressors/obstacles that may impose challenges on their exercise regimen, such as excessive work hours, physically demanding work, and multiple recurring commitments within the community or with family
- Types of physical activity the participant feels that they may enjoy engaging in

Finally, this initial consultation should be used to synchronize the Personal Trainer–client expectations, obtain or request any medical clearance forms (if required) as well as obtain signatures on required waivers, informed consent forms, and/or other contractual forms and agreements as required by your employer.

Assessing risk of your new client is the next step. It is important to note that Personal Trainers should not diagnose or treat disease, disorders, injuries, or other medical conditions under any circumstance. The presence of specific and/or multiple risk factors requires that the Personal Trainer refer the client to the appropriate health care professional for additional guidance and/or a medical release before designing and implementing an exercise program. Also, even if the client fails to initially disclose information that becomes known at a later time, the Personal Trainer still has a legal obligation to refer the client to a health care provider before additional training guidance can be provided. Personal Trainers who provide services outside their scope of practice place both themselves and their clients at risk. If in doubt whether or not a client should be referred to another health care professional before working with the client, be cautious and refer the client first. The old saying still holds true, "If in doubt, refer out."

Assessments are tests and measurements that Personal Trainers use with their clients to evaluate their current physical and functional status. Assessments may include the following:

- Resting and exercise heart rate
- Resting and exercise blood pressure
- Body weight and height
- Body composition estimates
- Circumference measurements of limbs, hips, and waist
- Calculation of body mass index
- Calculation of waist-to-hip ratio
- Measurements of flexibility
- Tests for muscular strength/muscular endurance
- Tests for cardiorespiratory fitness

Assessments provide a current snapshot of the functional ability of a client. When combined with the data from the PAR-Q and other health-related questionnaires, the Personal Trainer can begin developing a draft of a customized exercise program for the client.

Professional Work Environments

Employment opportunities for Personal Trainers are available in more diverse settings than ever before and include (but are not limited to) the following:

- Commercial (for-profit) fitness centers
- Community (not-for-profit) fitness centers
- Corporate fitness/wellness centers
- University wellness/fitness centers

- Owner/operator (self-employed) studios, fitness centers, and in-home businesses
- MFC
- Municipal/city recreation/public parks/family centers
- Governmental/military fitness centers
- Activity centers/retirement centers/assisted living communities for older adults
- Worksite health promotion (WHP) programs
- Cruise ships, resorts, and spa fitness centers

For-Profit

Commercial (for-profit) fitness centers dominate the fitness landscape and include independently owned businesses, chains, studios, licensed gyms, and franchises. Opportunities for gainful employment exist within the commercial club industry. Most commercial fitness centers advertise employment opportunities locally or regionally, whereas some also post them on their corporate Web sites, blogs, or social networking sites. It is wise to thoroughly investigate a company's policies concerning compensation, benefits, policies, and opportunities for advancement before accepting a position.

> Commercial (for-profit) fitness centers dominate the fitness landscape and include independently owned businesses, chains, studios, licensed gyms, and franchises.

Licensed gyms and franchises are popular choices when establishing new commercial fitness centers (Fig. 1.7). The benefits of choosing a franchise include brand recognition, access to proven operational systems, logo usage, marketing templates, in-depth training, and ongoing support. Franchisers then retain the right to dictate most aspects of the facility, including colors, layout, décor, equipment, programs, and product sales. Initial fees for fitness franchises can range widely from $10,000 to more than $100,000, and equipment may or may not be included in the cost. There is also a monthly franchising fee, which is either a set amount or a percentage of gross revenue (typically about 5%). Licensed gyms operate on a much simpler model. A fee is paid to use (license) the name and logo. Licensees typically have much more flexibility in how they operate the facility than do franchisees, but they also do not receive as much operational support.

FIGURE 1.7. A trainer demonstrating a fly motion with an inclined bench press.

Not-for-Profit

Not-for-profit (or nonprofit) organizations with fitness centers make up a large proportion of the total market. Some examples of the larger nonprofit organizations in which fitness professionals can find relevant employment include the Young Men's Christian Association (YMCA), Jewish community centers, hospital-based clubs, municipal and military fitness facilities, and college/university recreation centers.

Personal Trainers may find that some nonprofit organizations may not have rates of pay comparable with those of their for-profit counterparts but, at the same time, may provide better benefits. Nonprofit work (regardless of the industry) creates a strong sense of mission throughout the organization and carries a significant commitment to service with respect to their specific members or constituents. Nonprofit fitness centers fill a significant role in the fitness professional job market, and it is ultimately up to the individuals to determine the most appropriate place of employment for their personal and professional goals.

Medical Fitness Centers

The growing relationship between the fitness industry and the health care field is evidenced by the steady growth of MFCs and the establishment of the Medical Fitness Association (MFA; http://www.medicalfitness.org/). The MFA is a nonprofit organization that was established to assist with medically integrated health and wellness. These types of fitness facilities tend to see older adults and focus on clients with chronic diseases and multiple risk factors. Although these centers do provide access to hospital employees, over half of the membership is typically composed from community members.

> The growing relationship between the fitness industry and the health care field is evidenced by the steady growth of MFCs and the establishment of the Medical Fitness Association (MFA; http://www.medicalfitness.org/).

A central mission of many MFCs is integration of services for both the "sick" and the "healthy." It is not uncommon for patients in cardiovascular rehabilitation or physical therapy programs to exercise next to healthy community members. Using the same space and equipment saves on overhead, space, and staffing needs. Although there currently are not any specific guidelines for hiring Personal Trainers with specific degrees or certifications in these facilities, the focus on transitional programs (*i.e.*, working with former hospital patients) may require that a Personal Trainer has higher qualifications than usual.

Corporate

The largest purchaser of health care in the Unites States is employers, and providing health care coverage for employees and their dependents can be a large portion of their budget. As a result, businesses and industries are naturally concerned about today's rising medical costs and what they can do to decrease this liability (24). Therefore, one possible cost-containment strategy is to implement WHP programs. WHP can be defined as "a combination of educational, organizational, and environmental activities and programs designed to motivate and support healthy lifestyles among a company's employees and their families" (24). The goals of WHP programs are to

- Reduce modifiable risk factors
- Improve a person's overall health status
- Reduce demand for health care costs to the worksite

A recent survey assessing workplace health in the United States found that on average, 46% of U.S. worksites with 10 or more employees offered some type of WHP program. The percentage of worksites with a WHP program was lower among worksites with a smaller number of employees (39% of worksites with 10–24 employees, to 60% of worksites with 50–99 employees, to 92% of worksites with 500 or more employees) (25). It is encouraging to see that the number of worksites with a comprehensive WHP program has grown to 17% from 7% in 2004 (25).

The kinds of fitness-specific offerings vary greatly in WHP programs, ranging from steps-based walking programs to group exercise classes to fully equipped health/fitness facilities. One of the primary determinants of facility and program size is the number of employees. Companies with more than 1,000 employees working in a central location (building or campus) are much more likely to offer traditional fitness facilities because they have the financial means to do so, and it makes economic sense. Smaller companies with a smaller employee base are much less likely to offer a WHP, especially one that includes fitness facilities.

> WHP can be defined as "a combination of educational, organizational, and environmental activities and programs designed to motivate and support healthy lifestyles among a company's employees and their families."

Many corporate fitness programs are outsourced to companies that specialize in facility and program management. This makes it somewhat easier for the corporation because it can rely on someone else's expertise instead of having to develop it from within. Some choose to avoid development and management altogether by setting up a corporate account with an existing local fitness facility. A reduced membership fee is negotiated, and the company reimburses employees a portion or all of the fees. It is common, though, for the company to dictate that an employee must visit the facility a certain number of times per month to qualify for reimbursement.

Corporate fitness opportunities exist for Personal Trainers within both large and smaller companies. For larger companies, the typical route is to work as a traditional employee or independent contractor in the fitness center. For smaller companies, a more entrepreneurial approach is usually taken. Personal Trainers will typically need to approach the management about offering on-site services to the employees, with the employer absorbing some of the cost. Because employers are often very cost conscious and are typically unsure about investing in preventive programs, Personal Trainers will need to educate them about the benefits of their services to the health and well-being of their employees. Reporting an overall view of client results, such as weight loss, reductions in blood pressure, and other health factors, also has a positive impact on their thinking and decision making. Because individual sessions are the most expensive option, small-group training sessions may be potentially more appealing to the employer.

Ethics and Professional Conduct

Ethics can be described as standards of conduct that guide decisions and actions based on duties derived from core values. Specifically, core values are principles used to define what is right, good, and/or just. When a professional demonstrates behavior that is consistent, or aligned, with widely accepted standards in their respective industry, that professional is said to behave "ethically." On the other hand, "unethical" behavior is behavior that is not consistent with industry-accepted standards. As a fitness professional, Personal Trainers have obligation to stay within the bounds of the defined scope of practice for a Personal Trainer as well as to abide by all industry-accepted standards of behavior at all times. Furthermore, individuals certified or registered through ACSM must be familiar with all aspects of ACSM's Code of Ethics for certified and registered professionals (https://www.acsm.org/get-stay-certified/policies-procedures).

Code of Ethics for ACSM Certified and Registered Professionals

Purpose

This code of ethics is intended to aid all certified and registered ACSM Credentialed Professionals (ACSMCPs) to establish and maintain a high level of ethical conduct, as defined by standards by which ACSMCPs may determine the appropriateness of their conduct. Any existing professional, licensure, or certification affiliations that ACSMCPs have with governmental, local, state, or national agencies or organizations will take precedence relative to any disciplinary matters that pertain to practice or professional conduct.

This code applies to all ACSMCPs, regardless of ACSM membership status (to include members and nonmembers). Any cases in violation of this code will be referred to the ACSM Committee on Certification and Registry Boards (CCRB) Executive Council and the CCRB Ethics Subcommittee and, if appropriate, the ACSM Committee on Ethics and Professional Conduct as well Principles and Standards.

Responsibility to the Public

- ACSMCPs shall be dedicated to providing competent and legally permissible services within the scope of the knowledge and skills of their respective credential/certification. These services shall be provided with integrity, competence, diligence, and compassion.
- ACSMCPs provide exercise information in a manner that is consistent with evidence-based science and medicine.
- ACSMCPs respect the rights of clients, colleagues, and health care professionals and shall safeguard client confidences within the boundaries of the law.
- Information relating to ACSMCP–client relationship is confidential and may not be communicated to a third party not involved in that client's care without the prior written consent of the client or as required by law.
- ACSMCPs are truthful about their qualifications and the limitations of their expertise and provide services consistent with their competencies.

Responsibility to the Profession

- ACSMCPs maintain high professional standards. As such, an ACSMCP should never represent himself or herself, either directly or indirectly, as anything other than ACSMCP unless he or she holds other license/certification that allows him or her to do so.
- ACSMCPs practice within the scope of their knowledge, skills, and abilities. ACSMCPs will not provide services that are limited by state

law to provision by another health care professional only. An ACSMCP must remain in good standing relative to governmental requirements as a condition of continued credentialing.

- ACSMCPs take credit, including authorship, only for work they have actually performed and give credit to the contributions of others as warranted.
- Consistent with the requirements of their certification or registration, ACSMCPs must complete approved, additional educational course work aimed at maintaining and advancing their knowledge and skills.

Principles and Standards for Candidates of ACSM Certification Examinations

Candidates applying for a credentialing/certification examination must comply with candidacy requirements and, to the best of their abilities, accurately complete the application process. Candidates applying for a credentialing examination must comply with all eligibility requirements and, to the best of their abilities, accurately complete the application process. In addition, the candidate must refrain from any and all behavior that could be interpreted as “irregular.”

Discipline

Any ACSMCP may be disciplined or lose his or her certification or registry for conduct that, in the opinion of the executive council of the ACSM CCRB, goes against the principles set forth in this code. Such cases will be reviewed by the ACSM CCRB Ethics Subcommittee, which will include a liaison from the ACSM CCRB Executive Council, as appointed by the CCRB chair. The ACSM CCRB Ethics Subcommittee will make an action recommendation to the executive council of ACSM CCRB for final review and approval.

Using Your ACSM Certification Title

Any ACSMCPs may disclose their affiliation with ACSM certification in any context, oral or documented, provided it is currently accurate. Individuals who are certified by ACSM may not imply ACSM endorsement unless expressively authorized by the college. Disclosure of affiliation in connection with a commercial venture may be made provided the disclosure is made in a professionally dignified manner; is not false, misleading, or deceptive; and does not imply licensure or the attainment of specialty or diploma status. ACSMCPs may disclose their credential status.

ACSMCPs may list their ACSM certification on business cards without prior authorization (see Box 1.1). ACSMCPs and the institutions employing an ACSMCP may inform the public of an affiliation as a matter of public discourse or presentation.

National Campaigns to Promote Physical Activity

Many national organizations associated with physical activity and health are actively involved promoting the benefits of physical activity. In addition, these organizations launch national campaigns, produce recommendations and guidelines, and serve as advocates for legislation related to physical activity. Discussed in the following text are examples of the ways organizations are helping to promote physical activity.

Exercise is Medicine®

In 2007, ACSM in partnership with the American Medical Association launched EIM, a program designed to encourage America's patients to incorporate physical activity and exercise into their daily routine. EIM encourages doctors to assess and review every patient's physical activity program at every visit. For those patients not already exercising, the physician is asked to prescribe exercise to their patients and to record physical activity as a vital sign during patient visits.

ACSM has developed a system to credential exercise professionals for EIM designation. The EIM certificate contains three levels based on the health status of the patient referrals and the educational status and certifications of the candidate. Individuals who are currently certified by an NCCA accrediting organization (this would include individuals with ACSM Personal Trainer certification) and who successfully complete an EIM certification course and exam will meet Level 1 requirements; Level 1 includes working with individuals at low or moderate risk. For more information about the levels and the certification and educational requirements, please see https://www.acsm.org/get-stay-certified/get-certified/specialization/eim-credential.

EIM has a user-friendly Web site (https://www.exerciseismedicine.org) providing many helpful resources for health care providers, health and fitness professionals, members of the media, as well as the general public (Fig. 1.8). CPTs should become familiar with and regularly use the continually updated tools provided to them on the EIM Web site to educate themselves as well as their clients on the importance and best implementation of regular physical activity according to the most recent evidence-based research.

FIGURE 1.8. A trainer and a client doing an initial client consultation.

Research suggests that physical activity counseling provided by primary care physicians can be a powerful motivator for patients to adopt and maintain a more physically active lifestyle (26), and the American Heart Association recently released a scientific statement on routine assessment and promotion of physical activity in health care settings (27). Many physicians are beginning to refer patients directly to certified fitness professionals, thanks in part to the EIM initiative.

EIM has reached far beyond doctor's offices. In 2008, EIM month (May) was launched in order to recognize, emphasize, and celebrate the valuable health benefits of exercise on a national scale. The "Exercise is Medicine on Campus" initiative was launched in 2009 as a call to action for educational institutions around the country to make a commitment supporting EIM and the benefits of physical activity. The Inaugural World Congress on EIM was held in Baltimore, Maryland, in 2010 where the U.S. Surgeon General, Vice Admiral Regina Benjamin spoke to a standing-room-only crowd on the consequences of a sedentary population and the dire need for Americans to incorporate regular physical activity into their lifestyles. Finally, EIM has a global outreach program that includes six regional centers in North America, Latin America, Africa, Australia, Europe, and Asia. The EIM initiative continues to gain momentum, so Personal Trainers will benefit by keeping up on its most recent accomplishments.

American Fitness Index

Another public health initiative is the ACSM American Fitness Index (AFI) (28). The AFI is a program to help cities understand how the health of their residents and community assets that support active, healthy lifestyles compare to that of other cities nationwide. The overall goal of the AFI program is to improve the health, fitness, and quality of life of the nation through promoting physical activity. The AFI uses three primary means to achieve their task: (a) collection and dissemination of city health data, (b) provision of resources, and (c) community assistance to connect with health promotion partners.

The AFI reflects a composite of community indicators for preventive health behaviors, levels of chronic disease conditions, access to health care, and community support and policies for physical activity. In addition, demographic and economic diversity and levels of violent crime are shown for each metropolitan area. Cities with the highest scores are considered to have high *community* fitness, a concept akin to an individual having high *personal* fitness. In 2020, the top five cities were Arlington, Virginia; Seattle, Washington; Minneapolis, Minnesota; Madison, Wisconsin; and San Francisco, California. These communities had many strengths that supported healthy living and few challenges that hindered their choices. The AFI provides ideas and goals for other cities to initiate and become healthier. Understanding and learning about these national initiatives may assist a Personal Trainer in proving support to community members concerning healthy lifestyles. Other organizations that are taking active roles in promoting healthy lifestyles include the IHRSA (https://www.ihrsa.org), American Council on Exercise (https://www.acefitness.org), and the National Strength and Conditioning Association (https://www.nsca-lift.org).

> The AFI is one example of a national initiative to help local officials, community groups, health organizations, and individual citizens to assess factors contributing to their city's fitness, health, and quality of life. For further information, visit www.americanfitnessindex.org.

Other Recent Releases of Which Personal Trainers Must Be Aware

- The *Physical Activity Guidelines for Americans*, 2nd edition, is an update of the first guidelines released by the U.S. government in 2008 (17). The Physical Activity Guidelines for Americans recommend that preschool-age children aged 3–5 years should be physically active throughout the day and caregivers should encourage a variety of activity types when engaging in active play. Children and adolescents aged 6–17 years should do 1 hour or more of moderate to vigorous physical activity every day and vigorous activity should be encouraged on at least 3 days per week. They are also encouraged to do muscle-strengthening activities and bone-strengthening physical activity at least 3 days per week. Adults ages 18–64 years should reduce sedentary time and sit less throughout the day. Adults are recommended to engage in 150 minutes (2 h and 30 min) to 300 minutes (5 h) per week of moderate-intensity or 75 minutes (1 h and 15 min) per week of vigorous-intensity aerobic physical activity or an equivalent combination of both. Additional health benefits are associated with activity levels greater than 5 hours per week of moderate-intensity physical activity. It is also recommended that adults engage in 2 or more days per week of muscle-strengthening activities for all of the major muscle groups at a moderate or great intensity. The recommendations for older adults aged 65 years and older are the same as adults. Additionally, older adults should incorporate multicomponent exercises to maintain or improve balance. If older adults are unable to meet the adult recommendations, they should be as physically active as possible given their fitness level, abilities, and chronic conditions (17).

- The 2015–2020 Dietary Guidelines for Americans has five overarching themes: (a) Follow a healthy eating pattern across the lifespan; (b) focus on variety, nutrient density, and amount; (c) limit calories from added sugars and saturated fats and reduce sodium intake; (d) shift to healthier food and beverage choices; and (e) support healthy eating patterns for all. Decreasing consumption of some foods such as those with added sugars, saturated fats, and sodium are recommended (29). More information on dietary choices is found in Chapter 6 and at https://www.myplate.gov/.
- Healthy People 2030 was released by the U.S. Department of Health and Human Services in 2020 (see https://www.healthypeople.gov/). Healthy People includes the nation’s 10-year goals and objectives for health promotion and disease prevention. The Healthy People initiative is grounded in the principle that setting national objectives and monitoring progress can motivate action. The Healthy People goals related to physical activity are focused on reducing the number of people who do

not engage in any leisure-time activity and to increase the number of children and adults meeting the recommendations for aerobic and muscle-strengthening activities in the Physical Activity Guidelines for Americans (30).

ACSM's Role and the Educational Continuum

ACSM is a professional member association headquartered in Indianapolis, Indiana, and composed of a multidisciplinary mix of more than 50,000 exercise science researchers, educators, and medical practitioners in more than 90 countries. More specifically, member categories include exercise physiologists, physicians, nurses, athletic trainers, registered dietitian nutritionists, and physical therapists as well as many other allied health care professionals with an interest in sports medicine and the exercise sciences. ACSM promotes and integrates scientific research, education, and practical applications of sports medicine and exercise science to maintain and enhance physical performance, fitness, health, and quality of life.

ACSM was founded in 1954, was the first professional organization to begin offering health and fitness certifications (in 1975), and continues to deliver the most respected NCCA-accredited certifications within the health and fitness industry. Because of the multidisciplinary nature and diversity of its members, ACSM has evolved into the unique position of an industry leader for creating evidence-based best practices through the original research of its members as well as disseminating this information through its periodicals, meetings and conferences, position stands and consensus statements, and certification workshops and webinars. ACSM's respect has earned them numerous health-initiative partnerships and collaborative efforts with groups such as the American Heart Association, American Medical Association, NSF International, ACS, CDC, IHRSA, National Intramural-Recreational Sports Association, National Academy of Sports Medicine, the

CAAHEP, the NCCA, the National Collegiate Athletic Association, the NCHPAD, and many others.

ACSM was founded in 1954, was the first professional organization to begin offering health and fitness certifications (in 1975), and continues to deliver the most respected NCCA-accredited certifications within the health and fitness industry.

Identification of a Core Body of Knowledge

Shortly after ACSM began offering certifications, the first edition of *ACSM's Guidelines for Exercise Testing and Prescription* (23) was published along with its companion publication *ACSM's Resource Manual for Guidelines for Exercise Testing and Prescription* (31). These publications included, for the first time anywhere, the consensus of subject matter experts and so defined the core body of knowledge with respect to standards and guidelines for assessing fitness and prescribing exercise. Generally, all professions, regardless of the industry, have a core body of knowledge that provides guidance and clarity and also helps establish a specific profession's scope of practice. This initial publication proved so effective for practitioners that periodic review and revision of this book now takes place every 4 years. The year 2021 marked the publication of the 11th edition of *ACSM's Guidelines for Exercise Testing and Prescription* as well as the 6th edition of the *ACSM's Certification Review*.

Continuous Revision of Knowledge and Skills

In the past, included in the appendices of every edition of *ACSM's Guidelines for Exercise Testing and Prescription* was a comprehensive list of knowledge, skills, and abilities relative to each ACSM certification. These categories are now called Performance Domains for each ACSM Certification Level and can be found on ACSM Web site (https://www.acsm.org/get-stay-certified/get-certified). Each domain has a percentage attached to it that expresses the relative importance or weighting of that particular domain in the workplace and on the certification exam as well (see Table 1.3 for the current domains).

Table 1.3 ACSM Certified Personal Trainer Performance Domains

Domain	Content Areas	Percentage
I	Initial client consultation and assessment	25
II	Exercise programming and implementation	45
III	Exercise leadership and client education	20
IV	Legal and professional responsibilities	10

All certification examination candidates are encouraged to visit the American College of Sports Medicine Certification Web site (https://www.acsm.org/get-stay-certified). Follow the links through certification to view the latest certification examination blueprint and job tasks.

ACSM-CPT certification domains contain several job tasks, each requiring knowledge and skills statements. These job tasks represent the specific attributes necessary for success as a practitioner (practicing Personal Trainer). The general process for the ongoing revision and/or addition to the job tasks follows industry-accepted best practice models for ongoing quality assurance. Box 1.2 describes the development of the knowledge and skills required of the Personal Trainer.

Box 1.2 Description of the Development of the Personal Trainer Skills

1. A group of subject matter experts, including practitioners, academicians, and potential employers, review the current set of job tasks for a particular occupation (*i.e.*, Personal Training).
2. Updated job tasks from the review are evaluated through a "job task analysis," in which a large sample of randomly selected practitioners and employers further comment on the importance, frequency, and relevance of each specific job task compared with the typical job demands and requirements in the real-world setting.
3. Subject matter experts then revise the job tasks as needed based on the results and comments from the job task analysis.
4. The job tasks are assigned to their appropriate performance domain, the necessary knowledge and skills to accomplish each job task are determined, and each performance domain is weighted, representing the combined work of the content experts and the results of the job task analysis.
5. The weighted domains serve as the certification exam blueprint for the creation of legally defensible exam questions. The exam has multiple-choice questions delivered in a computer-based testing format.

SUMMARY

The rapidly expanding fitness industry offers Personal Trainers many potential work environments in which they gain experience and develop a career, including commercial (for-profit) fitness center, not-for-profit fitness centers, university recreation centers, corporate fitness centers, MFCs, and more. Although compensation varies greatly for trainers, they are overall very satisfied with their career choice and see opportunities for advancement and growth. With a nation on the verge of a health care crisis due primarily to the prevalence of lifestyle-related conditions, highly qualified and motivated Personal Trainers are needed now more than ever to lead individuals down the road to good health and well-being. As the fitness industry grows and the demographics/characteristics of the population continue to change, it is likely that the role of Personal Trainers will change, too. This changing role will likely be an expansion of Personal Trainers' scope of practice so that Personal Trainers may soon be seen as allied health care professionals. Personal Trainers are beginning to be more commonplace in areas where they were seldom seen in the past, such as medical clinics, with a role of helping low-risk individuals capable of independent exercise to become more active, as the medical profession turns to the prevention of disease and not just the treatment of it. As an emerging professional in this rapidly growing field, Personal Trainers can contribute to this expanding sphere of influence by being the utmost professional at all times for clients and in acting in the best interests of the profession.

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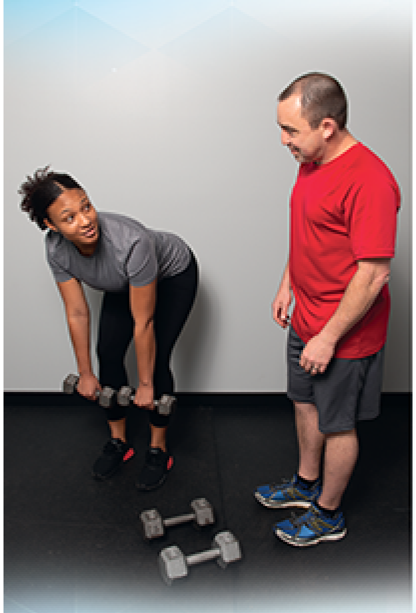
CHAPTER 2

Career Track for Personal Trainers



OBJECTIVES

Personal Trainers should be able to:

- Discuss common client expectations of a Personal Trainer.
- Examine potential career starting points and career paths.
- Highlight options for continuing education and career development.
- Understand the expectations of a career as a Personal Trainer.

INTRODUCTION

The iconic Jack LaLanne was undoubtedly one of the first professional Personal Trainers to bring Personal Training to the masses through television. He created the identifiable persona as an expert and motivated millions of people to exercise through the power of television. He then parlayed that success into a 74-year career that spanned from health clubs to jump ropes and juicers.

Although popularized in the late 1970s with the advent of celebrity Personal Trainers for stars of movie screens and tennis courts, Personal Training gained notoriety as a stand-alone business through the work of pioneers in New York City and Hollywood, California. These pioneers founded Personal Training studios that provided strength and endurance workout sessions in 30- or 60-minute bouts. They catered to the elite, including movie stars, tennis pros, television news anchors, business leaders, and ballerinas. The personal approach to fitness was so successful that professional athletic teams employed strength coaches (leading to the formation of the National Strength and Conditioning Association [NSCA] in 1978). Movie stars hired Personal Trainers to work with them on location. Financial firms brought trainers in-house to push their corporate athletes.

At the same time, in health clubs, training facilities, gymnasiums, and sporting arenas around the world, people were seeing and feeling the benefits of having an educated and dedicated fitness professional (1). Personal Training evolved into a career that was waiting to happen. A career that allowed exercise experts, cajoling coaches, tenacious teachers, and master motivators to make a living by guiding their clients to a specific set of goals and objectives that would eventually lead to a better body but more importantly better health.

Client Expectations of a Personal Trainer

Most evaluations of service professionals use the concept of how the individual performs in relation to expectations. If Personal Trainers do not know what clients expect from them, it is virtually impossible to meet, much less exceed, those expectations. The following are categories and examples of reasonable client expectations. The scope and scale of the service-level agreement with the client should clearly describe goals and an acceptable "range of results." Chapters throughout this book provide background and information on how to assist clients to achieve great results (Fig. 2.1).

FIGURE 2.1. A Personal Trainer and client meeting for the first time.

Know the Goal

As defined by James Prochaska's transtheoretical model of behavior change (2), Personal Training clients typically arrive in the "action" stage (see Chapter 7 for more information on the stages of change, processes of change, and decisional balance). They have decided that they will take their physical activity behaviors to a new level, and they are employing the Personal Trainer as the expert to guide them to their vision of success. This is an important assignment and a very difficult one. Implementing lasting behavior change is difficult even under the best circumstances.

The first step of the intake process involves goal setting because this serves as the foundation for the development of exercise program objectives. Once identified, these goals should be memorialized in a contractual business agreement, which also details the following:

- Number of sessions
- Cost per session or per multisession package
- Length of each session
- Length of agreement
- Cancellation and no-show policies
- Refund policies
- Session expiration dates
- Unsupervised training requirements outside of each session
- Client lifestyle commitments to support the training program
- Performance guarantees

After protecting the safety and well-being of the client, the attainment of client goals is the next most important priority in a Personal Trainer–client relationship. Identifying the client's goals helps reinforce the client-centered approach to training as well as provides the priorities of the exercise program. As a general best practice, fitness programs should always be "reverse engineered" by the Personal Trainer, backing into any key dates by which a particular goal should be achieved. For example, if the Personal Trainer is training a client to compete in a marathon, a schedule should be created in reverse from the day of the race to the start of the training. In this case, one-to-one sessions may be more frequent in the beginning, at critical mileage differentiators, at low points in the client's motivational cycle, or at whenever both parties agree are appropriate. By comparison, training for a 20-lb weight reduction for an upcoming life event (*e.g.*, wedding, high school reunion) might require a more regimented schedule that includes nutritional check-ups, weekly weigh-ins/measurements, and disciplined combinations of supervised high-intensity training with partially supervised aerobic exercise bouts. In other words, the specifics of each plan will be dictated by the requirements and time lines of the goal.

Many clients have a goal (or set of goals) in mind when they hire a Personal Trainer. Due to unrealistic messages prevalent in the media, clients often hire a Personal Trainer with an unrealistic and unfounded expectation of what they can reasonably achieve in a defined period of time. The Personal Trainer must educate the client on appropriate goals and timelines for the achievement of those goals. Part of this involves education on the unrealistic (and frequently digitally manipulated) images portrayed in the media. The Personal Trainer needs to ensure all communication promotes the attainment of a healthy body image for that client with a focus on health and fitness over aesthetics alone. For a much broader and in-depth description of goal setting and the achievement of goals, please see Chapter 7.

The client's goals must be translated by the Personal Trainer into achievable objectives and outcomes. By breaking the overarching goals into a thought-out plan with quantifiable milestones, the Personal Trainer demonstrates a thorough understanding of a client's aspirations and mastery of the professional skills required to drive success. These milestones are a way to chart a client's progress and measure success over time. It is important to acknowledge that goal setting and behavior change in general are dynamic, individualized processes that vary from client to client and even from day to day.

Although client goals serve as a motivator for adherence, setbacks should be anticipated because they are a natural part of the training process. A key aspect of the Personal Trainers role is to work with clients to consistently adjust the initial training plan in light of client behavior, commitment, changes in health status, lapses in training, and the like. The Personal Trainer should always keep the client motivated and engaged by reframing any perceived setback as normal and to be expected from time to time. Key to this is coaching the client that improvement is rarely a linear process, and deviations and modifications of the initial program are to be expected as the training plan meets the inevitable realities of a client's day-to-day life.

Another long-term objective for the Personal Trainer is to work toward empowering clients to exercise independently. The underlying, unspoken question "When will you be able to maintain your goals without me?" is often not addressed. Good teachers teach their students to succeed without supervision. Good coaches teach players to perform successfully with little or no supervision because the player becomes his or her own coach. A client may remain with a Personal Trainer for a long period of time (from months to years), but that relationship should not be based on dependence. In many ways, Personal Trainers combine the characteristics of a good teacher and a good coach. Personal Trainers can (and should) bolster their clients' self-efficacy by providing them with a high level of mastery of skills regarding their exercise habits. For more information regarding self-efficacy and behavior change, see Chapter 7.

Be Knowledgeable and Experienced

In 2002, commercial health club's largest trade organization, the International Health, Racquet & Sportsclub Association (IHRSA) persuaded the industry into rethinking how Personal Trainers would be certified for the safety of their clients and the betterment of their careers. Faced with literally hundreds of certification options, Personal Trainers and their clients were unsure which certification processes were well designed, unbiased, valid, and reliable. IHRSA, in concert with most of the certifying organizations, crafted a position statement in 2004. This statement recommended that by January 2006, member clubs hire only the Personal Trainers who hold certification from an organization that was in the process of obtaining third-party accreditation of its certification procedures and policies from an independent and nationally recognized accrediting body (see "Additional Resources" for more information). The goal was to ensure that the certificate held by Personal Trainers accurately and appropriately measured their competence and provided the industry with a means toward improving the growing business of Personal Training. With the new standard of accredited certification taking hold, certifying agencies felt comfortable establishing the high school diploma (or its equivalent) and cardiopulmonary resuscitation (CPR)/automated external defibrillator (AED) training as the prerequisite for their entry-level Personal Training certificate (1) (Box 2.1).

Box 2.1 For More Information

For the most up-to-date list of accredited Personal Training certification programs, go to the Institute of Credentialing Excellence (ICE [3]; https://www.credentialingexcellence.org). Note that ICE was formerly the National Organization for Competency Assurance.

Gaining experience as a Personal Trainer requires time that is well spent. The process of discovering a specialty, obtaining a degree, completing internship hours for certification, performing volunteer work, and actual employment will provide the Personal Trainer with many learning and professional opportunities. Experience is meaningful if the Personal Trainer is successful in documenting the outcomes, acquiring references from employers and clients alike, and building a resume connected to a stated career objective. Sometimes, these experience-based opportunities require the Personal Trainer to work for little or no compensation and seek situations that may be outside of the typical comfort zone. For example, a Personal Trainer may lack experience working with an older population. However, the demographic trends point toward a larger number of clients who are older and who may possess orthopedic and metabolic conditions as a result of their age. Therefore, the Personal Trainer may search out opportunities to work in retirement homes or assisted living facilities as most offer exercise therapy for their residents. Some of these facilities feature well-equipped fitness centers with robust programming, giving the Personal Trainer an opportunity to gain valuable experience and professional connections to begin working with this market segment.

Present a Clear and Concise Plan

Football coach Vince Lombardi once said, “Plan your work and work your plan.” This strategy may sound simple but it conveys one of the most important qualities for success in the art and science of Personal Training. The pretraining assessment, screening, and goal discovery phase with a client provides the foundation for the exercise prescription.

Once the mode, frequency, duration, intensity, and general components (*e.g.*, warm-up, flexibility, balance, agility, power, strength, endurance, energy system development [ESD], specific skills, and cool-down) of the exercise prescription are determined, a written plan is presented to the client. The plan includes the various phases of the training and the goals for each phase, exercise session date(s), primary goal(s) for each individual session, exercise modes, the order of exercises, the name of the exercises, duration (in repetitions, sets, exercise time), and intensities (target heart rate, rating of perceived exertion, amount of resistance).

The last line of each completed exercise prescription plan should be the Personal Trainer's signature. It is a sign that the Personal Trainer has developed the plan and has incorporated any pertinent observations, notes, adjustments, and comments from the client and the session for future reference. This can also be helpful in case another Personal Trainer works with that client in the future.

The Personal Trainer should meet privately with the new client prior to the initial session to share the overall strategy, confirm client alignment, and answer questions or concerns. In addition to the exercise prescription, the Personal Trainer should discuss the logistics of how the Personal Trainer and client will work together. This should include information on policies for late, no-showed, cancelled, or abbreviated sessions. The Personal Trainer should also underscore the importance of keeping him or her informed of any changes in the client's health status that could impact training. Some changes in health status may require modifications in the training plan or and/or referrals to other health professionals. Information on referring when needed is covered in Chapter 22.

Ongoing communication with the client is another essential part of the Personal Trainer–client relationship. Prior to each session, the Personal Trainer should inquire about the client's general level of readiness for the day's exercises. Factors to discuss include overall energy level, sleep quality, nutrition and hydration status, stress levels, soreness as well as any minor aches, or pains that may impact the plan. This information can help the Personal Trainer make any necessary last-minute adjustments to the day's plan and sets the stage for a safe and effective workout.

Lastly, the Personal Trainer should educate the client on the importance of healthy lifestyle behaviors that will support the overall training plan. These should include smoking cessation (if necessary), proper nutrition, proper hydration, adequate sleep, stress management, and intrasession recovery techniques (*e.g.*, self-myofascial release [SMR], massage, and stretching). It is beneficial for a Personal Trainer to develop a network of other health care professionals that may serve as resource for these latter behaviors.

Be Innovative, Creative, and Resourceful

Effective Personal Trainers demonstrate both innovation and creativity (1). An innovator is defined as one who continually introduces new methods and techniques. The Personal Training experience provides many opportunities for such innovation in ways that are simple to execute. That said, it is imperative the Personal Trainers acquire competence with any new method or technique prior to using it with their clients. As always, client safety should be the first (and most important) consideration for any modality used or exercise prescribed.

Creativity is another behavioral trait of effective Personal Trainers. The opportunity for the Personal Trainer to be creative frequently comes when a piece of equipment is out of order or when a particular area of the facility is in use. A creative Personal Trainer will always ensure session efficiency by having a backup exercise ready to substitute to accomplish the same exercise objective. An example of this would be substituting a free-weight or body-weight movement for a machine-based exercise (Box 2.2). It is also important to use creativity to incorporate variety into the training program. Variety can keep the client engaged and reduce the boredom that can be associated with a repetitive routine.

Box 2.2 Manual Resistance

One technique that seems to demonstrate creativity is when a Personal Trainer substitutes his or her strength to provide resistance to the client's exercise movement. This technique is called "manual resistance." The client can push against a trainer, but a trainer should avoid pushing against a client. Another innovation is to manipulate speed of movement. Speed of contraction is as relevant a variable as reps, sets, and weight in the completion of a strength training exercise, so manipulating the speed of the pushing or pulling (or both) phase of a movement is an effective way to change the stimulus for the muscle complex and surprise the client in regard to his or her expectations of what action is coming next at the same time.

A competent Personal Trainer is also resourceful. The addition of new or cutting-edge equipment can help the Personal Trainer tailor the session to the client's needs while also providing an interesting, novel component to the training session. Examples of Personal Trainer resourcefulness include using an AIREX pad or BOSU to improve balance and reduce fall risk in older individuals or using upper body ESD devices (such as a MARPO rope trainer or battle ropes) to provide a safe ESD option to an individual recovering from a lower body injury. Such modifications indicate the Personal Trainer is considering the unique needs of each individual well in advance of the session (Fig. 2.2). Program enhancements such as these will convey to clients that the Personal Trainer is current with the profession and leveraging the latest industry developments to help the clients achieve their specific goals.

FIGURE 2.2. A Personal Trainer demonstrates the use of resistance bands.

Educate

Good health is a lifelong journey. An important goal for any Personal Trainer is to teach clients the basic tenets of safe and effective physical activity, so they can apply these principles for themselves. These concepts include understanding the components of a well-balanced workout; these include proper warm-up and cool-down, flexibility/stretching, balance, agility, power, strength, endurance, and ESD. For example, when learning the progression of a properly designed program for developing muscular fitness, the client should learn progression from large muscle groups to small muscle groups. They should be familiar with the need to balance movement patterns (such as pushing and pulling), proper breathing, effective stretching techniques, how to determine appropriate exercise intensity (*e.g.*, training heart rate, rating of perceived exertion, or amount of resistance), various modes of exercise, and proper program progression (intensity, duration, and frequency of workouts) in accordance with established exercise goals. Choice of an appropriate and safe exercise mode is of importance to maximize the effectiveness of a training session while minimizing any risk of injury.

A working knowledge of human anatomy, kinesiology, and physiology is essential for a Personal Trainer to describe what is happening inside the body through the bout of exercise and during the overall course of a training program. The Personal Trainer also needs the ability to translate the science of exercise into simple lay terminology that the clients will understand and can apply in the service of their own goals.

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Effective Personal Trainers are patient, professional, and prepared. They understand the specific goals and knowledge level of each client and continue to educate them by providing appropriate handouts, reference materials, and credible online sources. They check for understanding by encouraging questions and ongoing communication. The topics of interest can range from motor learning, to hydration, to the symptoms of overtraining. The Personal Trainer should choose material that meets the client at his or her current level of understanding and based on the client's specific interest and the relevance to the client's individual goals.

Inspire

For many laypeople, exercising regularly, making optimal programming choices, and working out at an intensity sufficient to yield visible results can be difficult. A Personal Trainer's value is largely in providing his or her clients with both accountability; expert guidance; and real-time coaching, motivation, and feedback.

Clients often assume that Personal Trainers have always embodied a healthy lifestyle. A Personal Trainer's willingness to share the story of his or her own fitness journey, especially any struggles and learnings gleaned along the way, can make the training process more relatable and less intimidating. If Personal Trainers have overcome a physical challenge themselves, the empathy they can convey to clients who are in similar situations can be a powerful source of inspiration for prospective clients and clients in training especially when the compassion is delivered at just the right moment of need (Box 2.3). This oftentimes happens when a client is stuck at a certain training level or cannot easily attain the goals he or she seeks.

Box 2.3 Further Reading

Simon Sinek (4) describes in his video "Start with Why — How Great Leaders Inspire Action" that although most people can deftly describe what they do and how they do it, what compels people to work with others the most is the conviction, passion, and dreams of *why* a person chooses a particular profession. Most Personal Trainers enter the profession because they have had a transformational experience in their own health and fitness journey and want to share that gift with others. Sharing the truth of this internal motivation with potential clients sends a powerful message that you are a caring and committed professional.

Every training client is motivated to succeed for very different reasons. Personal Trainers should take the time needed to discover what motivates each individual client and then leverage those drivers to customize the approach and accelerate the client's success. For example, some clients like the competitive challenge and respond to the desire to excel over and above others. In this case, the Personal Trainer might assemble a group of clients, categorized by gender, weight, and training experience and provide each member of the team with unique identifiers to protect each client's privacy (often referred to in experimental settings as blind coding). The Personal Trainer could then rank the clients by a select category of performance, for example, a personal record (PR) on a bench press one repetition maximum. At periodic intervals or when the client needs a "competitive" push, the Personal Trainer posts the team rankings and, thus, uses the client's internal competitive spirit as a motivator to work harder to achieve a new PR (Fig.

2.3). Knowing that a client is motivated by competition and using a competitive game to leverage that knowledge to help that client succeed is an example of how Personal Trainers can tailor their approach to engage and motivate each individual.

FIGURE 2.3. A Personal Trainer using a team ranking chart to show the client her latest position after the last posting of her PR.

Individual activity preferences are another important consideration. This is especially true for training programs that are long in term and duration. Clients are more likely to be consistent when engaging in experiences that they enjoy. Mixing in specialty classes, sports, and/or leisure-time activities matched to the preferences of the individual can complement the overall program while also providing welcome relief, novelty, and motivation to endure (and eventually succeed) in the long-term training objectives. This is especially important in activities that involve considerable time commitment and repetitive (and therefore potentially drudgerous) activities over a sustained period of time, such as training for endurance events such as triathlons, half marathons, or marathons. More about motivation and adherence is discussed later in Chapter 8.

Focus

One of that hallmarks of professional excellence in Personal Training is a commitment to unwavering, individualized attention. This requires undivided, undistracted, unencumbered, and sustained focus on a client's form, speed, posture, grip, stance, breathing, and even facial expressions. Consistent attention to a client's nonverbal cues can help differentiate whether a particular exercise is too hard or too easy. Undistracted monitoring of form and technique ensures client safety and exercise efficacy.

Presession preparation is the first step in creating a client-focused experience. The Personal Trainer should plan the session well in advance, thinking through the individual elements and sequence of activities, so there is no time spent deciding "what's next." This allows the Personal Trainer to concentrate solely on the client's performance. "Now and how" (*i.e.*, "*now* we are doing this and this is *how* you do it") is a great mantra to replay because preparations are made mentally to introduce each new set of exercises for the client.

The Personal Trainer should also set the ground rules for clients on distractions during the session. Alert clients that the Personal Trainer will not answer their questions while training another client. Personal Trainers should give clients their contact information (*e.g.*, e-mail, phone number), so clients can easily contact them if they have questions. The client being trained should also be restricted from taking phone calls, texting, checking e-mail, or excessive socializing, especially during key sets/reps in the training session. Unnecessary distractions can result in injuries at worst and minimally can reduce the efficiency of the session.

The Personal Trainer should have all equipment necessary set up in advance as part of the overall session preparation. This includes items such as client charts, stopwatches, small exercise equipment (*e.g.*, bands, tubing), towels, and water. Going to gather items during a training session is an unnecessary waste of a client's valuable session time.

Personal Trainers should work to cultivate proactive awareness and be able to anticipate a client's needs. Hospitality will become a part of the unique selling proposition, the feature that makes individuals different from the competition and that provides added value (Box 2.4). Additionally, Personal Trainers can make their services distinctive from their peers by specializing in one (or several) niche markets. Examples of this could include specializing in training female triathletes or people looking to improve their golf game or older adults new to fitness. Focusing on a unique market within an overall business model can establish a Personal Trainer as an expert in a particular area, distinguishing him or her from other professionals and generating referral from clients and other professionals alike.

Box 2.4 Service and Hospitality

As a Personal Trainer, you are asking people to invest a significant amount of their time and money with you. That said, the experience should always be positive and client focused from start to finish. This requires an understanding of best practices in service and hospitality. The Personal Trainer should study service organizations that are known for consistently delivering a high-level end-to-end customer experience. Hotels, restaurants, and Internet retailers are some examples of organizations that thrive as a result of the highest standards when it comes to servicing their customers. Successful examples of organizations that have achieved legendary levels of customer service and best practices are well documented in *The New Gold Standard: 5 Leadership Principles for Creating a Legendary Customer Experience Courtesy of the Ritz-Carlton Hotel Company* (5) and *Delivering Happiness: A Path to Profits, Passion, and Purpose* (6).

Track and Recognize Progress

A Personal Trainer determines all the appropriate metrics of success for each and every individual client in the intake process. As described in the Specific, Measurable, Attainable, Realistic, Time-bound (SMART) goal concept (see Chapter 7 for more details), while establishing key success metrics, the Personal Trainer sets critical benchmarks used to evaluate whether or not the training programs are effective. These metrics are also used to motivate the client to forge ahead toward these very important goals. Clients are often after "big-impact" results (*e.g.*, lose 20 lb [9 kg], reduce body fat by 7%, serve a tennis ball at 75 mph [121 kph], or hit a golf drive 300 yd [274 m]). The Personal Trainer's challenge is to lead clients toward their long-term goals through attainment of several smaller ones. The Personal Trainer's job is to make clients aware of the small advances they are achieving and how they all contribute toward their desired endpoint.

Simple charts and graphs are very effective in demonstrating client progress toward a desired goal. The simplest example of how this works is usually seen when working with clients who have a weight loss goal. Most clients set weight loss goals that are too large and too fast. Safe and effective weight loss strategies typically recommend 1–2 lb (0.5–1 kg) of weight loss per week, although this can vary depending on the initial body weight of the client. If a client wants to lose 20 lb (9 kg), this may take up to 20 weeks and that does not account for any muscle weight gain that may occur as a result of the training regimen. Twenty weeks equals 5 months. Because clients read advertisements on the Internet and listen to late night television that claims weight loss of 20 lb (9 kg) in 1 month without exercise, getting clients to acknowledge a 5-month wait for a weight loss goal is a challenge. Moreover, most clients are often focused solely on scale weight, not understanding the concept of body composition. It is important to educate clients on the safety of slow fat loss and the concept of sparing and increasing lean body mass. Scale weight may or may not indicate fat loss and could potentially increase as a concomitant increase in lean body mass occurs. For this reason, it is important to focus on other measures such as body girth measurements or body fat percentage. Presenting metrics that track numerous "small wins" on a regular basis can reinforce clients' adherence by showing them that they are making consistent progress, albeit perhaps at a slower pace than they might have initially expected. It is also important to show changes performance metrics such as an increase in weight lifted, intensity maintained, or repetitions completed, so they understand their weight loss in the context of overall improvements in their fitness. Seeing holistic proof points that they are moving ever closer to long-range goals in a variety of ways can help keep the clients focused and motivated.

It is easy for clients to get frustrated with a perceived lack of progress or setbacks in compliance. By celebrating improvements not only in metrics but also in effort, consistency, and engagement, Personal Trainers can reframe the client's frustrations and keep the client focused on identifying the incremental improvements that may be overlooked. Awareness of these small successes is critical to building a client's confidence and increasing his or her belief in his or her own self-efficacy, both of which are essential to keeping the client committed to his or her program (Box 2.5).

Box 2.5 Client Appreciation

It is important to have a small budget for appreciation gifts for your clients. These rewards could be given for achieving certain milestones (*e.g.*, completing their first 10K) or for referring a new client. Additionally, it is important to remember and celebrate important client's life events such as birthdays, life events (*e.g.*, engagements, marriages, births), and holidays with small tokens of appreciation. This could be anything from a book, a training diary, gift cards to a free training session, or even a thoughtful card. It needn't be expensive to be meaningful. The important thing is to let the clients know you were thinking about them and want to acknowledge and celebrate their special day or achievement.

Where Do I Start My Career?

Background

The prerequisites for employment will depend on the employer, job description, and types of clients serviced while performing the scope of work. Many employers in commercial health clubs expect a Personal Training certificate that was accredited from a third-party accrediting organization. Facilities should hire trainers with demonstrable competence as evidenced by, among others, holding certification from a recognized organization. Facilities (*e.g.*, medical wellness centers and rehabilitation clinics) that serve clients with multiple risk factors and orthopedic limitations typically require both a degree (graduate or undergraduate) in a health- or fitness-related field *and* a certificate that is related to their scope of responsibilities.

Find Your "Why"

Most trainers start their careers as a result of personal experience, direct or related. Trainers with direct experience include the athlete who has been positively affected by a coach, Personal Trainer, teacher, or even a highly regimented and effective self-imposed routine. They can be sport athletes on any level, cosmetic athletes who are performing a total body makeover, or corporate athletes who are sold on the concept that their bodies are as important as their minds for success in their business pursuits. The success (and even the disappointing failure) of those experiences often serve as the impetus for wanting to pursue a career as a Personal Trainer. Someone who works in the health, fitness, or medical field as an allied professional (*e.g.*, registered dietitian, physical therapist, clinical exercise physiologist, athletic trainer, licensed massage therapist, occupational therapist, and physical therapy aide) or a support person (*e.g.*, receptionist; maintenance person; membership sales person; or administrator, such as operations manager, office assistant, bookkeeper, accountant, or human resources administrator) can also use his or her proximity to (and familiarity with) the Personal Training profession as a springboard to his or her entrance as a career Personal Trainer.

The Personal Trainer is in a gratifying yet challenging profession. Workdays typically stretch over significantly more hours than a conventional job. Training must be done when clients are available, with sessions typically starting early in the morning before clients go to work and extending into the evening after a client's workday is over. The Personal Trainer must balance the demands of maintaining focused attention on each individual client, managing the needs of an average of 8–10 clients per day all while continuing to grow as a professional. This ongoing professional development should include reading, researching, listening to podcasts, watching webinars, and attending conferences. Additionally, the Personal Trainer should embody a healthy physical condition that meets the physical demands of the profession and serves as an inspiration for clients and prospective clients alike.

Given the rigors of the job, having clarity on the "why" of this career is an important first step for the Personal Trainer. A compelling reason for entering the profession provides a foundation that enables the Personal Trainer to persevere during the more challenging aspects of the job. Once an aspiring Personal Trainer is clear on the "why" is time to acquire some initial experiences in the field training clients while simultaneously working toward an accredited certification. The most effective strategy is multidimensional, with both experience gathering and certification studying occurring at the same time. That said, the degree of emphasis will depend on the individual's life stage, budget, and time constraints. This is also the time to try to identify and secure a mentor.

Certification

In choosing a certification, start by identifying two to three accredited certification programs and do some background research on each. Some things to consider include the following:

1. Do you meet their eligibility requirements?
2. Are their fees within your budget?

3. Are the logistics required to obtain their certification reasonable for you to achieve (*e.g.*, travel, Internet access, time, internship requirements)?
4. Does the certification match with your prospective field of training specialty (*e.g.*, kettle bells, performance training, special populations), or is it a general Personal Trainer certificate?

Whether working for a national health and fitness chain, a specialty franchise, a small privately held studio, or opening up a private practice, attaining certification is the most important first step to be accomplished.

Whether working for a national health and fitness chain, a specialty franchise, a small privately held studio, or opening up a private practice, attaining certification is the most important first step to be accomplished.

When applying for a Personal Training position, it is important to ask if the employer requires a particular certification. The requirements may have been established based on the certifications held by the employer or those recommended to him or her by others in the industry.

What if you are already certified? Maintaining one's certification is as important as getting the certification initially. Most certification bodies require some level of documented continuing education within a certain period of time to keep the certification current. This ongoing professional development ensures that the Personal Trainer is constantly evolving and upgrading his or her skill set and maintaining a high standard of professionalism. Additionally, keeping one's CPR/AED certification current is typically a prerequisite to renewing a certification as well as a standard operating policy for most facilities.

Many certifying agencies offer multiple levels of certification as well as the ability to get certified in subspecialties such as weight management, wellness coaching, health coaching, and behavior change. Great Personal Trainers are lifelong learners. They adapt to the need of the clients in the markets they serve, and they make sure to be current with the techniques required to serve those clients safely and effectively.

Find a Mentor

A mentor is someone who invests time, energy, and personal experience into another's career development. It is a volunteer role typically entered into from a desire to give back to the field and help others enter the profession. Look to find a mentor who most closely matches the background and experiences needed. A mentor can be invaluable in providing a Personal Trainer with the guidance necessary to avoid both training and business mistakes alike. If possible, try to find a mentor who is working with the types of clients in your preferred Personal Trainer practice specialty. Understand that if the mentor's business is within your catchment area, a signed nonsolicitation or noncompete agreement with the mentor may be required. In today's digitally connected world, mentorships needn't happen face to face. They can be accomplished remotely via phone text, e-mail, and videoconferencing. This capability greatly expands the universe of prospective mentors.

When approaching a mentor, be as clear as possible about the type of help you are looking for from him or her. The mentor's role is to help you navigate your career choices, not to create a path for you. At the start of the relationship, make sure that you are both aligned on your expectations. This can include (but is not limited to) the frequency of meetings, specific area of focus, and the structure of the time spent. Always be respectful of a mentor's time. Be sure to maximize the effectiveness of the session by preparing thoughtful questions well in advance of the session. Mentoring sessions should be used to ask specific questions and problem solve on identified areas of concern or interest. Come prepared and ready to maximize the available time. Mentor–mentee sessions are typically anywhere from 20 to 60 minutes and can occur on a monthly or bimonthly basis.

What Are Some Examples of Rewarding Career Paths?

There so are many types of clients, working venues, schedules, and unique opportunities in the Personal Training field today that a Personal Trainer can extend a career over many years and even more markets. The next logical step in a career path, especially if working in an environment that employs many other Personal Training professionals, is Personal Training management. This path generally can consist of two distinct elements: administration/personnel management and professional development. Administration/personnel management requires a Personal Trainer to hire and supervise staff, evaluate performance, set schedules and policies, interface with clients, and oversee the sales and financial performance of a Personal Training department. On the professional development path, Personal Trainers with specialty expertise (*e.g.*, yoga, Pilates, sports-specific training) are often responsible for the education, certification, upskilling, and programming in specific areas. In these situations, a Personal Trainer may be required to evaluate staff's professional skills, create personal development plans, and deliver (or at a minimum coordinate) the continuing education curriculum for the team.

> There so are many types of clients, working venues, schedules, and unique opportunities in the Personal Training field today that a Personal Trainer can extend a career over many years and even more markets.

Although Personal Trainers work as commissioned employees in some commercial health and fitness centers, they may also serve as independent contractors. As a result, Personal Trainers may seek the career path of an entrepreneur. Being your own boss is rewarding and has many advantages, but it also has challenges and responsibilities. Of course, the easiest way to this path is to train clients privately in public facilities, in their own homes, or even your own home gym.

To minimize some of the risks of entrepreneurship, Personal Trainers can explore the option to become franchisees. Entering into a contract with a franchise has many branding, marketing, and operating advantages, but they come with a cost and commitment to the franchise. Good legal advice is always recommended when considering this career path.

The boldest entrepreneur opens his or her own Personal Training business. Finding, renting, and renovating or, alternatively, buying the land and then building the physical location are obviously the most expensive journeys on this career path. Searching the newspaper or on the Internet for an existing business to buy and place under management is also an option worth exploring and may even come with a built-in client base. In every case, the Personal Trainer who is going to create a new business needs a very capable team of real estate agents, lawyers, construction professionals, accountants, information technology professionals, and sales and marketing consultants and a high tolerance for risk. Risk decreases and reward increases in proportion to every celebrity or professional athlete that a Personal Trainer has on a client list. It also helps to have approximately 30% more start-up cash on hand than the most conservative estimate (1).

One way that a Personal Trainers can decrease risk and minimize start-up costs is to seek to set up a business inside an existing service facility. Businesses such as a commercial health/fitness center, spa, salon, or nutritional consultation practice often have clients in need of a Personal Trainer's services. These facilities typically already have amenities such as fitness equipment, locker rooms, and showers. This enables the Personal Trainer to focus on building a business rather than investing in the creation (and ongoing investment) of a stand-alone operation.

Personal Trainers who are interested in working in health care settings may wish to obtain American College of Sports Medicine's (ACSM) Exercise is Medicine® (EIM) Credential. This designation is a component of ACSM's broader *Exercise is Medicine Global Health Initiative* and is designed to teach fitness professionals to work effectively as part of an extended health care team. The EIM Credential includes information on how to train individuals with common chronic conditions and how to provide behavioral support strategies to help clients successfully integrate regular physical activity into their daily lives. The EIM certification can open up opportunities for the Personal Trainer to work in environments, including medical offices, hospital wellness centers, and physical therapy practices.

Career paths for Personal Trainers can also take very successful detours down the related professional paths requiring higher levels of education and training. Personal Trainers who have an interest in clinical work and who are academically inclined can enter the allied health professions. The careers most closely aligned with Personal Training are physical therapy assistants, health promotion professionals, nutritional counselors, and health/wellness coaches. Other potential allied health professional paths include physician assistants, nurses, occupational therapists, clinical exercise physiologists, athletic trainers, and physical therapists. Most allied health careers require an advanced degree, additional certifications, a state license, and/or extensive internship hours.

What Are My Best Options for Continuing Education and Career Development?

The best way to a long, successful, and fulfilling career is to establish a disciplined strategy for reading, research, clinics, conferences, conventions, and course work right from the beginning.

Reading and Research

The Personal Trainer must consistently read professional journals to stay current on the research in the field. The ACSM has several publications that will provide a wide range of information, from the more practical in their *ACSM's Health & Fitness Journal*® and the *Translational Journal of the American College of Sports Medicine* and the latest peer-reviewed research published in *Medicine & Science in Sports & Exercise*. The *American Journal of Health Promotion* publishes an excellent peer-reviewed research journal every 2 months that is focused on health and wellness. The Institute for Health and Productivity Management publishes a quarterly journal that explores the effect of health on all aspects of employee productivity. Most professional organizations (*e.g.*, International Dance and Exercise Association [IDEA], the American Council on Exercise [ACE], IHRSA, the National Academy of Sports Medicine, ACSM, the National Business Group on Health, NSCA) offer frequently updated electronic publications including newsletters, articles, blogs, and national professional organization position papers (Box 2.6). Access to information varies for members and nonmembers. Many very reputable publications and organizations will provide quick and easy access to their latest articles online. The Harvard Business Review and the Centers for Disease Control and Prevention are two.

Box 2.6 Additional Resources

Learn how to use the U.S. National Library of Medicine's PubMed at https://pubmed.ncbi.nlm.nih.gov/. This free resource comprises more than 20 million citations for biomedical literature from MEDLINE, life science journals, and online books. Citations may include links to full-text content from PubMed Central and publisher Web sites. The resource also provides updates of the latest research by keyword to e-mail accounts.

Clinics, Conferences, and Conventions

There are many opportunities on the local, regional, national, and international level to attend (in person and virtually) educational sessions held over a one-to-several-day format, sponsored by professional membership organizations, certifying agencies, suppliers, customers, government agencies, and academic institutions. Membership in a relevant professional organization such as ACSM or a trade association such as IHRSA allows you to stay informed about these opportunities. Annual conferences or conventions typically provide a broad curriculum, including keynote speakers, poster presentations of research studies, topical lectures and demonstrations, and supplier trade shows to showcase products/services/software and networking/recruiting opportunities. Regional clinics are shorter in duration (from 1 h to 1 d) and are typically focused on a specific issue or topic. Many are also available remotely via teleconferencing.

Coursework

The first place to look for continuing education opportunities is the employer. Today, almost every organization has an internal training department that offers formal and informal courses that assist in performing day-to-day responsibilities and also to prepare for advancement within the company. In conjunction with maintaining a professional certification, certifying agencies require continuing education credits (CECs). To achieve the required CECs, the agencies, either directly or through affiliated suppliers, offer courses that upon completion award CECs. Identifying, planning, and scheduling the courses needed to receive the number of CECs required to maintain (or attain) a certification is the most efficient path to follow for coursework.

Specialty courses are also available from organizations that specialize in continuing education such as ACSM, IDEA, ACE, and the Cooper Clinic and even some suppliers such as Nike, adidas, and Cybex (exercise equipment). For subject matter outside of the health and fitness disciplines, continuing education courses can be found at local colleges and universities and commercial organizations that offer education.

What Can I Expect from a Career as a Personal Trainer?

The evolution of Personal Training as a career has been very rapid and dynamic. With less than 30 years of existence in the modern day, the profession experienced a major change for the better with the requirement of accredited certification. This requirement has drastically changed what a professional must expect as a result of pursuing Personal Training career. The increased requirements of certification have promoted a "better" (more qualified) Personal Trainer who can provide a safe and improved experience for clients. Although national certification has helped, there are only a few states that have attempted to mandate certification or licensing requirements. This can often be frustrating for the certified trainer if competing for positions with others without certifications.

The Satisfaction of Seeing Healthy Results

Working with a Personal Trainer has always provided clients with quicker and more effective results (1). The most satisfying part of this career is that the Personal Trainer gets to see and be an integral part of positively affecting the clients' health. Client responses vary depending on initial fitness and individual goals; structuring a regular exercise routine can promote higher energy levels, increased levels of aerobic capacity, flexibility, and muscular fitness.

Exceeding Client Expectations

The opening chapter objective delineated in detail what clients expect from a Personal Trainer. Realize these are the baseline expectations. Clients will want the Personal Trainer, and the trainer should aspire, to exceed these expectations.

If a Personal Trainer is successful in knowing the clients' goals, the likelihood of success for the client increases. Fine-tuning the program in relation to the actual results will have the most significant impact on the real reason for using a Personal Trainer in the first place — efficient, effective, and relevant attainment of individual goals. The more a Personal Trainer works with a particular client and understands the client's readiness to change and ability levels, the greater will be the potential to inspire and motivate the client.

Planning exercise sessions and documenting workouts are minimum expectations. Charting and graphing results and using them as motivational and educational presentations to clients are a plus. Expect to work long hours at either ends of the day (morning and evening) possibly with some down time in the middle of the day. Most clients train either before the start of their workday or after. In corporate fitness facilities, however, midday/lunch hours may be the peak times. Weekends, when most people have more schedule flexibility, are popular as well. Some markets can be contained to a normal daily schedule, but, typically, they will mirror the peak usage times for a health/fitness facility, fitness center, or other training facility.

Entering the World of Lifelong Learning

A higher level of knowledge and professionalism are now expected of the Personal Trainer. This will require that the Personal Trainer devote much more time and effort into reading, research, and continuing education. The Personal Trainer will be expected to put this time in on a regular and ongoing basis. As summarized earlier in this chapter, reading and research can take considerable time. Conference attendance is an effective way to stay on top of the field and earn CEC. This is typically a 2- to 4-day commitment away from clients, travel, hotel, meals, and registration expenses, all of which need to be included in the annual budget. Local conferences are another option, which can minimize travel expenses. The Personal Trainer will have to maintain a certification, and this will require a minimum amount of course work to obtain the necessary CECs. Renewal periods for most certifications are typically between 2 and 4 years.

SUMMARY

Personal Training is now well established as a viable professional career option for those interested in helping clients experience healthy results efficiently and effectively. The Personal Trainer's job description is based on a foundation of expertise that is relevant to the client's goals and on the ability to exceed the client's service expectations. Successful Personal Trainers combine the qualities of a good teacher with those of a good coach. Gaining certification and eliciting the assistance of a mentor are two important first steps. These steps are best achieved concurrently. Fortunately, the most rewarding aspect of embarking on a Personal Training career is the act of Personal Training itself. The personal satisfaction that comes with empowering clients to achieve their health goals is well worth the effort and hours required to stay up on the latest research and plan the most effective exercise prescriptions. A Personal Training career requires a strategy of lifelong learning combined with the rigors of facilitating individual behavior change.

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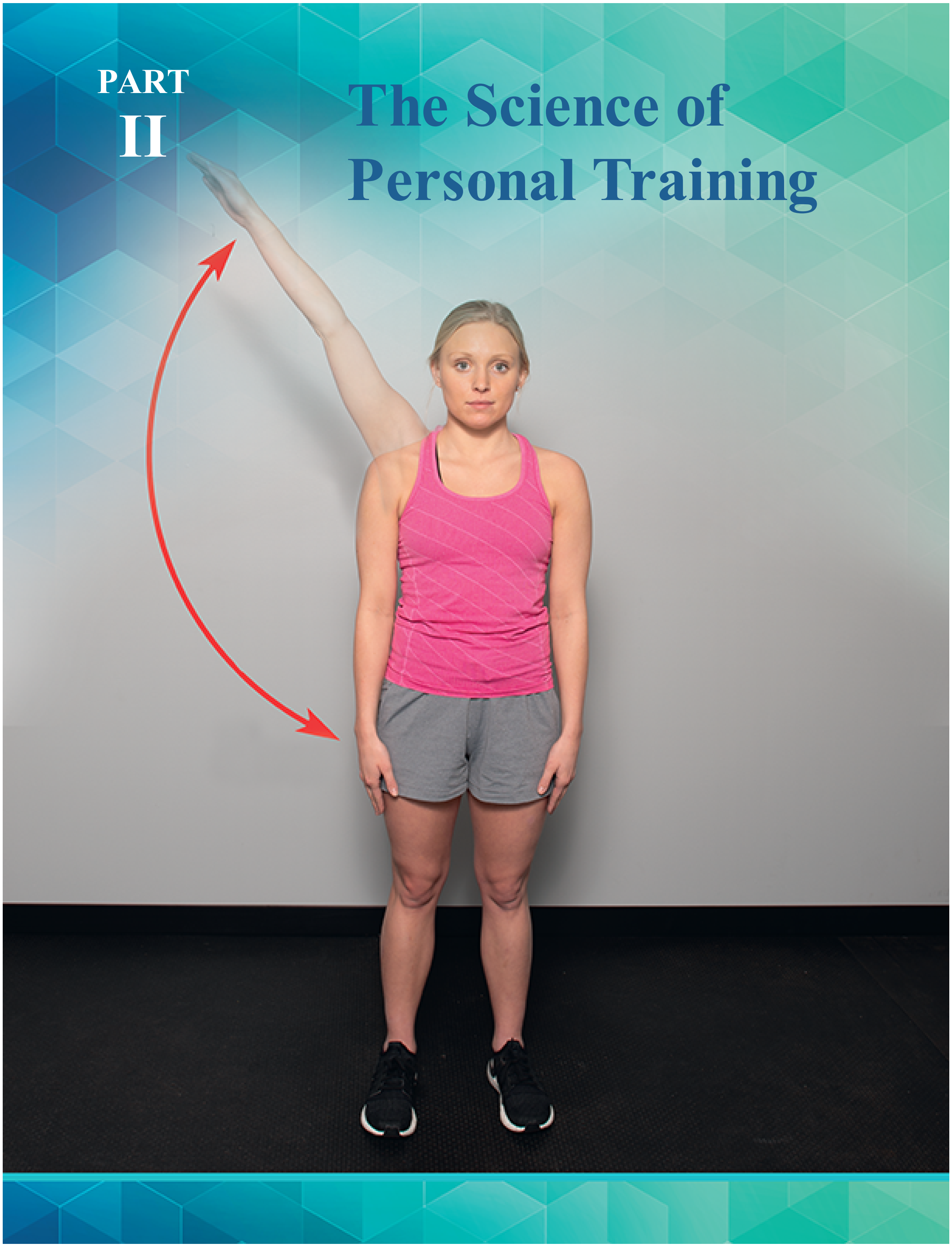
PART

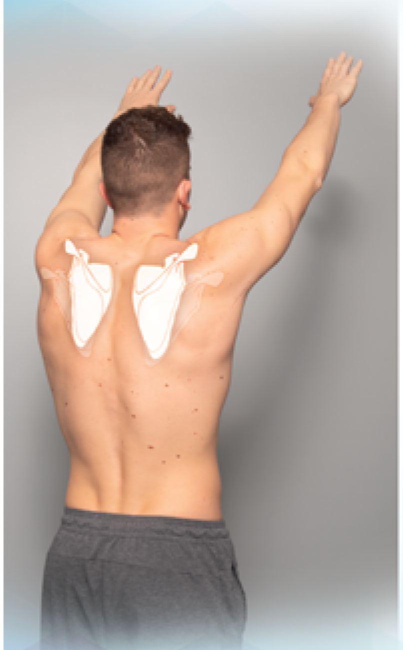
II

The Science of Personal Training



CHAPTER 3

Anatomy and Kinesiology



OBJECTIVES

Personal Trainers should be able to:

- Provide an overview of anatomical structures of the musculoskeletal system.
- Explain the underlying biomechanical and kinesiological principles of musculoskeletal movement.
- Identify the key terms used to describe body position and movement.
- Describe the specific structures, movement patterns, range of motion (ROM), muscles, and common injuries for each major joint of the body.
- Connect anatomy and biomechanics to exercise selection and/or correction.

INTRODUCTION

A major goal of exercise training is to improve cardiovascular and musculoskeletal fitness. The physiological adaptation of muscle to exercise training is evidenced by improvements in muscle strength, endurance, flexibility, and resistance to injury (1). The objective of this chapter is to gain an understanding of musculoskeletal functional anatomy of the major joint structures during exercise movements, with emphasis on body alignment and kinesiological principles. A thorough understanding of these principles is essential for the Personal Trainer to design safe, effective, and efficient exercise training programs to improve musculoskeletal fitness.

The disciplines primarily involved in describing and understanding human movement are biomechanics and kinesiology. Personal Trainers teach clients how to perform exercise movements and how to use exercise or rehabilitation equipment. Kinesiology is the study of the mechanics of human movement and specifically evaluates muscles, joints, and skeletal structures and their involvement in movement (2). Kinesiology is primarily based on three fields of science — biomechanics, musculoskeletal anatomy, and neuromuscular physiology. Kinesiology includes the study of gait, posture and body alignment, ergonomics, sports and exercise movements, and activities of daily living and work. Biomechanics is the study of the motion and causes of motion of living things, using a branch of physics known as mechanics (3). The study of biomechanics is essential for Personal Trainers because it forms the basis for documenting human motion (kinematics) and understanding the causes of that motion (kinetics). Chapter 4 covers this information in more detail. A variety of health care practitioners, including Personal Trainers, exercise physiologists, athletic trainers, physicians, physical educators, occupational therapists, physical therapists, chiropractors, and ergonomists, use biomechanical and kinesiological principles (4).

> Kinesiology is the study of the mechanics of human movement and specifically evaluates muscles, joints, and skeletal structures and their involvement in movement.

Describing Body Position and Joint Movement

Anatomical Position

Anatomical position is the universally accepted reference position used to describe regions and spatial relationships of the human body and to refer to body positions (*e.g.*, joint motions) (5). In the anatomical position, the body is erect with feet together and the upper limbs positioned at the sides, palms of the hands facing forward, thumbs facing away from the body, and fingers extended (Fig. 3.1). Other common terms to describe anatomical spatial relationships and positions are shown in Table 3.1 (4).

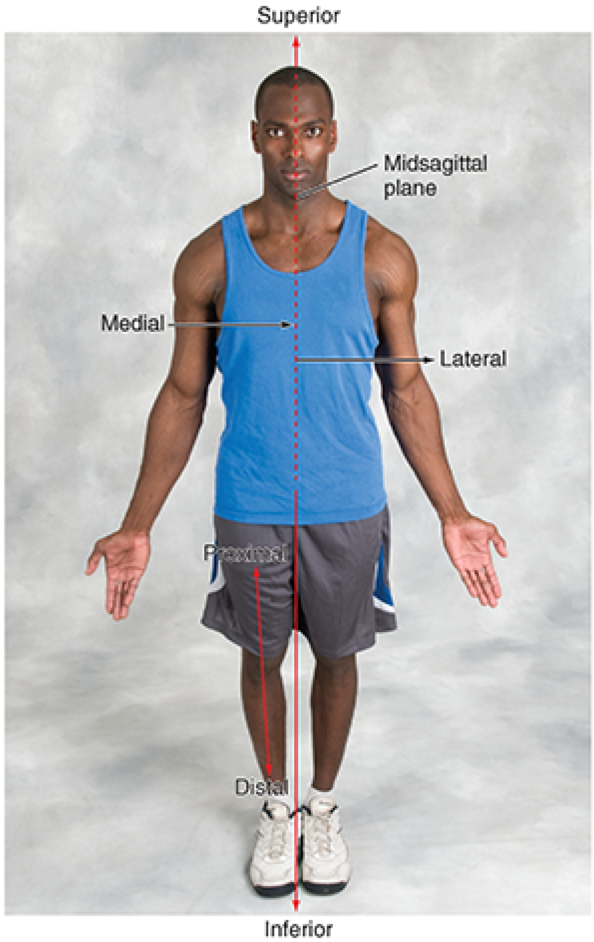


FIGURE 3.1. Anatomical position. Body is erect with the feet together, upper limbs hanging at the sides, palms of the hands facing anteriorly, thumbs facing laterally, and fingers extended. Typically, all anatomical references to the body are relative to this position.

Table 3.1 Definitions of Anatomical Locations and Positions

Term	Definition
Anterior	The front of the body; ventral
Posterior	The back of the body; dorsal
Superficial	Located close to or on the body surface
Deep	Below the surface
Proximal	Closer to any reference point
Distal	Farther from any reference point

Superior	Toward the head; higher (cephalic)
Inferior	Away from the head; lower (caudal)
Medial	Toward the midline of the body
Lateral	Away from the midline of the body; to the side
Ipsilateral	On the same side
Contralateral	On the opposite side
Unilateral	One side
Bilateral	Both sides
Prone	Lying face down
Supine	Lying face up
Valgus	Distal segment of a joint deviates laterally
Varus	Distal segment of a joint deviates medially
Arm	The region from the shoulder to elbow
Forearm	The region from the elbow to the wrist
Thigh	The region from the hip to the knee
Leg	The region from the knee to the ankle

Planes of Motion and Axes of Rotation

There are three basic anatomical planes that pass through the body (Fig. 3.2). The sagittal plane divides the body or structure into the right and left portions. The frontal plane (also called the coronal plane) divides the body or structure into anterior and posterior portions. The transverse plane (also called the cross-sectional, axial, or horizontal plane) divides the body or structure into superior and inferior portions (5). Activities of daily living, exercise, and sports usually involve movement in more than one plane at a given joint structure. If movement occurs in a plane, it must rotate about an axis that is perpendicular to that plane. Thus, movement in the sagittal plane rotates about the mediolateral axis (also called transverse axis), movement in the frontal plane rotates about the anteroposterior axis, and movement in the transverse plane rotates about the longitudinal axis (2).

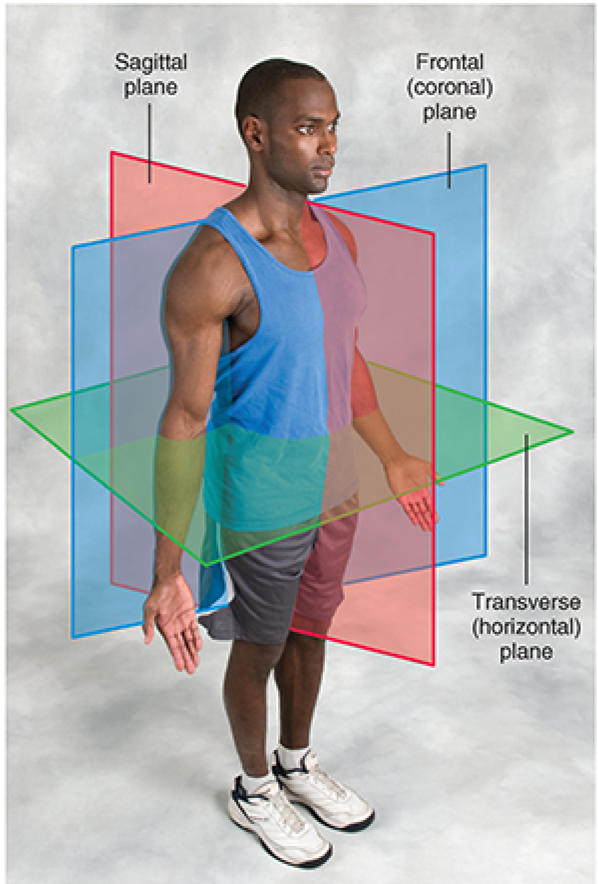


FIGURE 3.2. Anatomical planes of the body.

Center of Gravity, Line of Gravity, and Postural Alignment

An object's center of gravity is a theoretical point where the weight force of the object can be considered to act. Center of gravity changes with movement and depends on body position. When a person is standing in the anatomical position, the body's center of gravity is approximately at the second sacral segment (3). The kinematics (variation in height and horizontal distance) of the center of gravity relative to the base of support (3) is often studied to examine balance exhibited by the performer. In a sit-to-stand movement, for example, the center of gravity is shifted over the base of support when there is a transition from primarily horizontal motion to a vertical or lifting motion (Fig. 3.3).

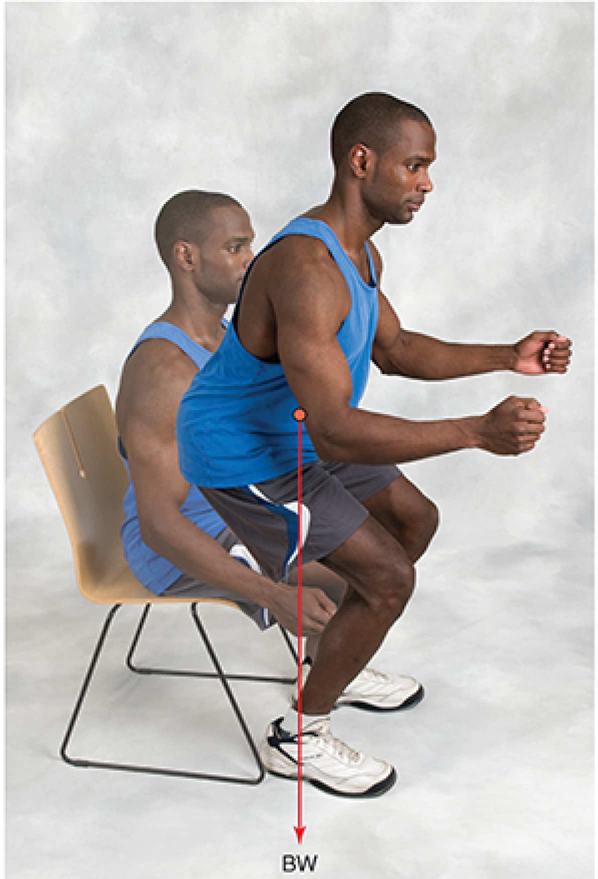


FIGURE 3.3. The initial phase of the sit-to-stand movement involves trunk lean and horizontal weight shift to position the center of gravity over the new base of support (feet). The movement of the center of gravity in several directions is often used to study balance. BW, body weight.

The line of gravity of the body is an imaginary vertical line passing through the center of gravity and is typically assessed while the subject is standing (5). The line of gravity helps define proper body alignment and posture, using various superficial landmarks from the head, upper extremity, trunk, and lower extremity regions as guides. From the sagittal view, the line of gravity should be slightly posterior to the apex of the coronal suture, through the mastoid process, through the midcervical vertebral bodies, through the shoulder joint, through the midlumbar vertebral bodies, slightly posterior to the axis of the hip joint, slightly anterior to the axis of the knee joint, and slightly anterior to the lateral malleolus. From the frontal view, the line of gravity should pass through the midline of the body, and bilateral structures such as the mastoids, shoulders, iliac crests, knees, and ankles should be in the same frontal plane (Fig. 3.4) (5). Personal Trainers should consider the ideal line of gravity when describing postural abnormalities.

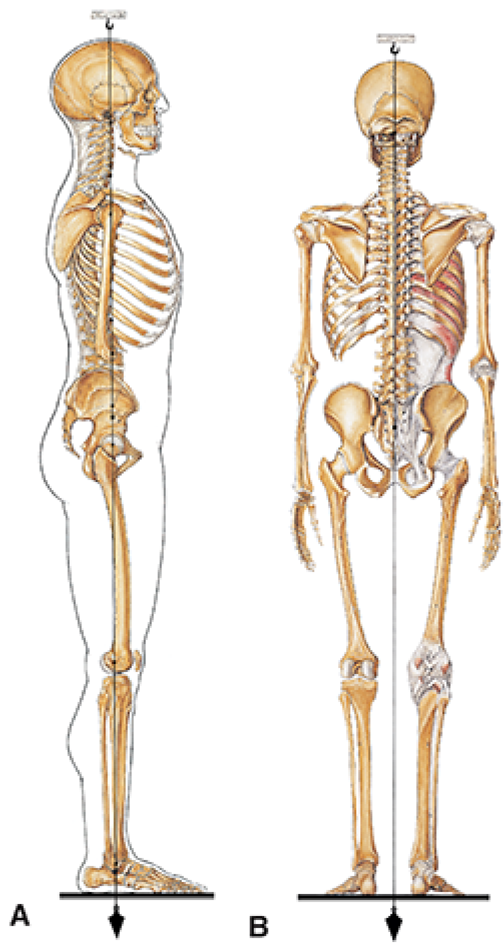


FIGURE 3.4. Line of gravity of the skeletal system. **A.** Lateral view. **B.** Posterior view. (Reprinted with permission from Anatomical Chart Company. *ACC's Skeletal System Chart*. Baltimore [MD]: Lippincott Williams & Wilkins; 2000.)

Joint Movement

Joint movement is often described by its spatial movement pattern in relation to the body, typically in terms of anatomical position. Terms used to describe joint movement are listed in Table 3.2 (5) and discussed in detail for the major joints in the next section.

Table 3.2 Joint Movement

Term	Description
Flexion	Movement resulting in a decrease of the joint angle, usually moving anteriorly in the sagittal plane
Extension	Movement resulting in an increase of the joint angle, usually moving posteriorly in the sagittal plane
Abduction	Movement away from the midline of the body, usually in the frontal plane
Adduction	Movement toward the midline of the body, usually in the frontal plane
Horizontal abduction	Movement away from the midline of the body in the transverse plane, usually used to describe horizontal humerus movement when the shoulder is flexed at 90°
Horizontal adduction	Movement toward the midline of the body in the transverse plane, usually used to describe horizontal humerus movement when the shoulder is flexed at 90°
Internal (medial) rotation	Rotation in the transverse plane toward the midline of the body
External (lateral) rotation	Rotation in the transverse plane away from the midline of the body
Lateral flexion (right or left)	Movement away from the midline of the body in the frontal plane, usually used to describe neck and trunk movement
Rotation (right or left)	Right or left rotation in the transverse plane, usually used to describe neck and trunk movement
Elevation	Movement of the scapula superiorly in the frontal plane
Depression	Movement of the scapula inferiorly in the frontal plane
Retraction	Movement of the scapula toward the spine in the frontal plane
Protraction	Movement of the scapula away from the spine in the frontal plane
Upward rotation	Superior and lateral movement of the inferior angle of the scapula in the frontal plane
Downward rotation	Inferior and medial movement of the inferior angle of the scapula in the frontal plane
Circumduction	A compound circular movement involving flexion, extension, abduction, and adduction, circumscribing a cone shape
Radial deviation	Abduction of the wrist in the frontal plane
Ulnar deviation	Adduction of the wrist in the frontal plane
Opposition	Diagonal movement of thumb across the palmar surface of the hand to make contact with the fifth digit

Eversion	Abducting the ankle
Inversion	Adducting the ankle
Dorsiflexion	Flexing the ankle so that the foot moves anteriorly in the sagittal plane
Plantarflexion	Extending the ankle so that the foot moves posteriorly in the sagittal plane
Pronation (foot/ankle)	Combined movements of abduction and eversion resulting in lowering of the medial margin of the foot
Supination (foot/ankle)	Combined movements of adduction and inversion resulting in raising of the medial margin of the foot

Musculoskeletal Anatomy

The three primary anatomical structures of the musculoskeletal system that are of interest to the Personal Trainer are bones, joints, and muscles. Mechanically, the interaction of the bones, joints, and muscles determines the ROM of a joint, the specific movement allowed, and the force produced. This section provides an overview of these structures. For in-depth study, the reader is referred to a variety of excellent sources (6–10).

Skeletal System

The skeletal system consists of cartilage, periosteum (a double-layer membrane covering bone surface), and bone (osseous) tissue. The bones of the skeletal system support soft tissue, protect internal organs, act as important sources of nutrients and blood constituents, and serve as rigid levers for movement. There are 206 bones in the human body, 177 of which engage in voluntary movement. The skull, hyoid, vertebral column, sternum, and ribs are considered the axial skeleton; the remaining bones, in particular those of the upper and lower limbs and their respective girdles, are considered the appendicular skeleton (11). The major bones of the body are illustrated in Figure 3.5.

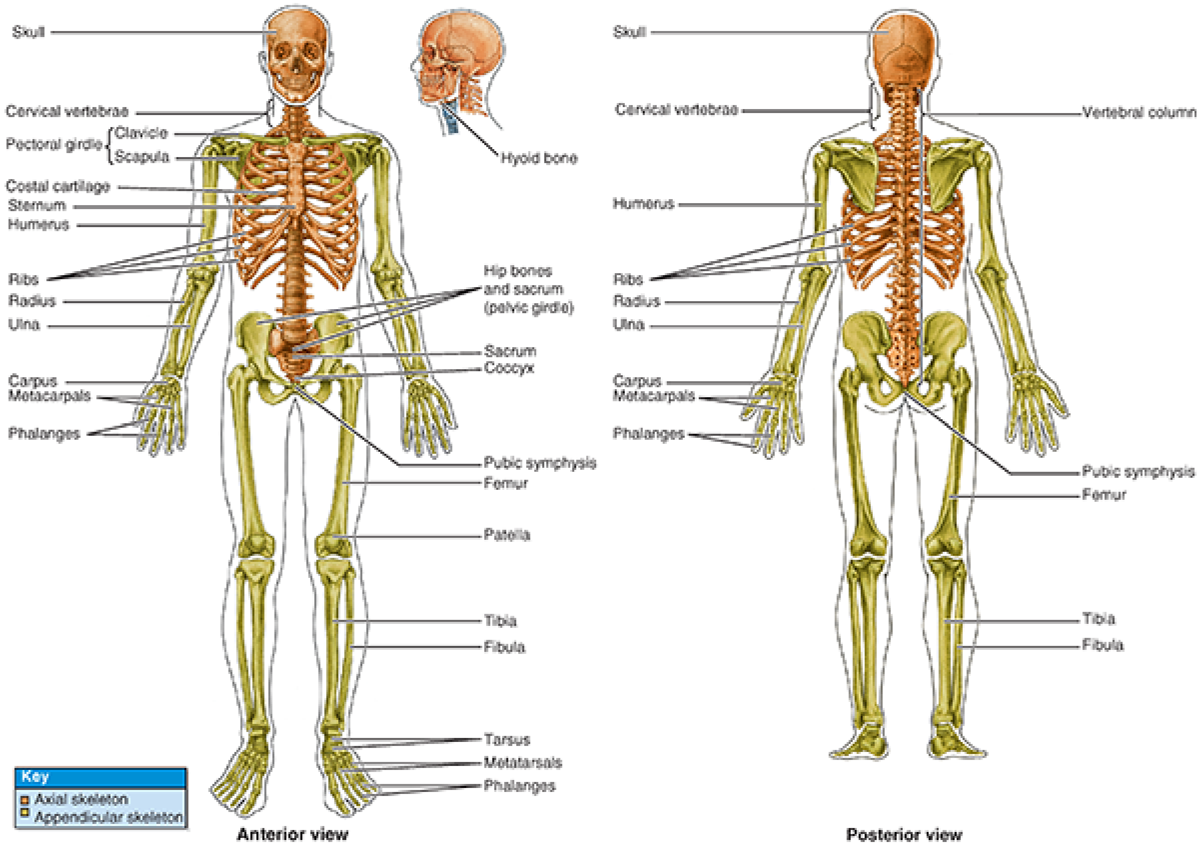


FIGURE 3.5. Divisions of the skeletal system. (From Moore KL, Dalley AF II. *Clinically Oriented Anatomy*. 4th ed. Baltimore [MD]: Lippincott Williams & Wilkins; 1999, with permission.)

The structure of a bone can be explained using a typical long bone such as the femur (the long bone of the thigh). The main portion of a long bone or shaft is called the "diaphysis" (Fig. 3.6). The ends of the bone are called the "epiphyses" (singular is "epiphysis"). The epiphyses are covered by articular cartilage. Cartilage is a resilient, semirigid form of connective tissue that reduces the friction and absorbs some of the shock in synovial joints. The region of mature bone where the diaphysis joins each epiphysis is called the "metaphysis." In an immature bone, this region includes the epiphyseal plate, also called the "growth plate." The medullary cavity, or marrow cavity, is the space inside the diaphysis. Lining the marrow cavity is the endosteum, which contains cells necessary for bone development. The periosteum is a membrane covering the surface of bones, except at the articular surfaces. The periosteum is composed of two layers: an outer fibrous layer and an inner highly vascular layer that contains cells for the creation of a new bone. The periosteum serves as a point of attachment for ligaments and tendons and is critical for bone growth, repair, and nutrition (3).

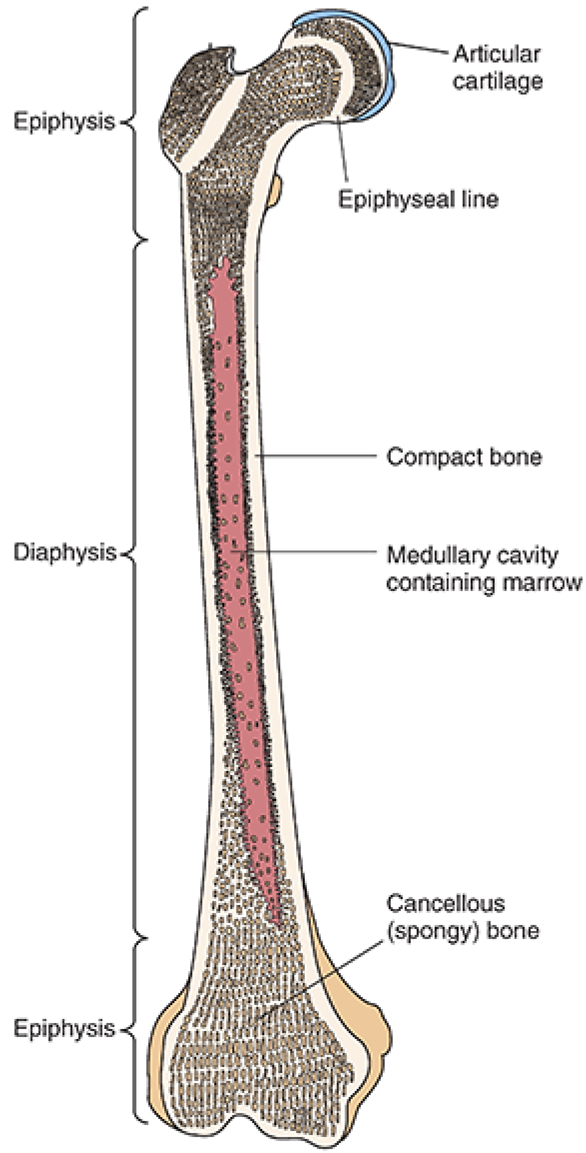


FIGURE 3.6. Bone anatomy. (From Willis MC. *Medical Terminology: A Programmed Learning Approach to the Language of Health Care*. 2nd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2011, with permission.)

There are two types of bones: cortical (compact) and trabecular (spongy). The main differences between the two types are the architecture and amount of matter and space they contain. Compact bone is architecturally arranged in “osteons” that contain few spaces. It forms the external layer of all bones of the body and a large portion of the diaphysis of the long bones, where it provides support for bearing weight. In contrast, spongy bone is characterized as being much less dense. It consists of a three-dimensional lattice composed of beams or struts of bone called “trabeculae.” Open spaces are present between the trabeculae, unlike in compact bone. The trabeculae are oriented to provide strength against the stresses normally encountered by the bone. In some bones, the space within these trabeculae is filled with red bone marrow, which produces blood (3). Although the main “advantage” of compact bone is its strength, the trabecular arrangement in spongy bone allows for the absorption of forces while reducing overall skeletal weight.

Bones are also classified according to their shape. Long bones contain a diaphysis with a medullary canal (*e.g.*, femur, tibia, humerus, ulna, and radius). Short bones are cube-like structures and relatively small and thick (*e.g.*, carpals and tarsals). Flat bones are plate-like (*e.g.*, sternum, scapulae, ribs, and pelvis). Irregular bones are oddly shaped (*e.g.*, vertebrae, sacrum, and coccyx). Finally, sesamoid bones are found within tendons and joint capsules and are shaped like sesame seeds (*e.g.*, patella) (2).

Articular System

Joints are the articulations between bones, and along with bones and ligaments, they constitute the articular system. Ligaments are tough, fibrous connective tissues anchoring bone to bone. Joints are classified as synarthrodial, amphiarthrodial, or diarthrodial (synovial) (3). Synarthrodial joints (*e.g.*, sutures of the skull) do not move appreciably. Amphiarthrodial joints move slightly and are held together by ligaments (syndesmosis; *e.g.*, inferior tibiofibular joint) or fibrocartilage (synchondrosis; *e.g.*, pubic symphysis). Synarthrodial and amphiarthrodial joints do not contain an articular cavity, synovial membrane, or synovial fluid (3).

Synovial Joints

The most common type of joint in the human body is the synovial joint. Synovial joints contain a fibrous articular capsule and an inner synovial membrane that encloses the joint cavity. Figure 3.7 illustrates a synovial joint's unique capsular arrangement. There are five distinct features of a synovial joint (3):

1. It is enclosed by a fibrous joint capsule.
2. The joint capsule encloses the joint cavity.
3. The joint cavity is lined with synovial membrane.
4. Synovial fluid occupies the joint cavity.
5. The articulating surfaces of the bones are covered with hyaline cartilage, which helps absorb shock and reduces friction.

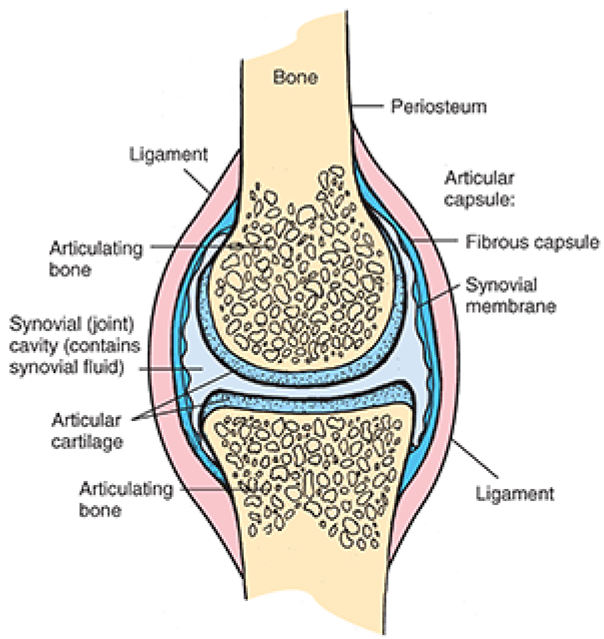


FIGURE 3.7. Synovial joint. (From Oatis CA. *Kinesiology: The Mechanics and Pathomechanics of Human Movement.* 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2016, with permission.)

The synovial membrane produces synovial fluid, which provides constant lubrication during movement to minimize the wearing effects of friction on the cartilaginous covering of the articulating bones (3). Ligaments sometimes reinforce synovial joints. These ligaments are either separate structures (extrinsic) or a thickening of the outer layer of the joint capsule (intrinsic). The collagen fibers of ligaments are typically arranged to counteract multidimensional stresses. Some synovial joints have other structures such as articular discs (*e.g.*, meniscus of the knee), bursae, or fat pads. There are seven major types of synovial joints classified by the shape of the articulating surfaces or types of movement allowed. Table 3.3 summarizes the joint classifications and examples in the human body. Table 3.4 summarizes the motions of the major joints and the planes in which they occur.

Table 3.3 Classification of Joints in the Human Body

Joint Classification	Features and Examples
Fibrous	
Suture	Tight union unique to the skull
Syndesmosis	Interosseous membrane between bones (*e.g.*, the union along the shafts of the radius and ulna, tibia and fibula, and distal tibiofibular joint)
Gomphosis	Unique joint at the tooth socket
Cartilaginous	
Primary (synchondroses; hyaline cartilaginous)	Usually temporary to permit bone growth and typically fuse (*e.g.*, epiphyseal plates); some do not (*e.g.*, at the sternum and rib [costal cartilage])
Secondary (symphyses; fibrocartilaginous)	Strong, slightly movable joints (*e.g.*, intervertebral discs, pubic symphysis)
Synovial	
Plane (arthrodial)	Gliding and sliding movements (*e.g.*, acromioclavicular joint)
Hinge (ginglymus)	Uniaxial movements (*e.g.*, elbow extension and flexion)
Ellipsoidal (condyloid)	Biaxial joint (*e.g.*, radiocarpal extension, flexion at the wrist)
Saddle (sellar)	Unique joint that permits movements in all planes, including opposition (*e.g.*, the carpometacarpal joint of the thumb)
Ball-and-socket (enarthrodial)	Multiaxial joints that permit movements in all directions (*e.g.*, hip and shoulder joints)
Pivot (trochoidal)	Uniaxial joints that permit rotation (*e.g.*, proximal radioulnar and atlantoaxial joints)
Bicondylar	Allow movement primarily around one axis with some limited

rotation in a second axis (*e.g.*, knee flexion and extension with limited internal and external rotation)

Table 3.4 Major Joint Motions and Planes of Motion

Major Joints	Type of Joints	Joint Movements	Planes
Scapulothoracic	Not a true joint ("physiological" or "functional" joint)	Elevation–depression	Frontal
		Upward–downward rotation	Frontal
		Protraction–retraction	Frontal
		Medial–lateral rotation	Transitional
		Anterior–posterior tilting	Sagittal
Glenohumeral	Synovial: ball-and-socket	Flexion–extension	Sagittal
		Abduction–adduction	Frontal
		Internal–external rotation	Transverse
		Horizontal abduction–adduction	Transverse
		Circumduction	Multiple
Elbow	Synovial: hinge	Flexion–extension	Sagittal
Proximal radioulnar	Synovial: pivot	Pronation–supination	Transverse
Wrist	Synovial: ellipsoidal	Flexion–extension	Sagittal
		Abduction–adduction	Frontal
Metacarpophalangeal	Synovial: ellipsoidal	Flexion–extension	Sagittal
		Abduction–adduction	Frontal
Proximal and distal interphalangeal	Synovial: hinge	Flexion–extension	Sagittal
Intervertebral	Cartilaginous	Flexion–extension	Sagittal
		Lateral flexion	Frontal
		Rotation	Transverse
Hip	Synovial: ball-and-socket	Flexion–extension	Sagittal
		Abduction–adduction	Frontal
		Internal–external rotation	Transverse

		Circumduction	Multiple
Knee	Synovial: bicondylar	Flexion–extension	Sagittal
		Internal–external rotation	Transverse
Ankle: talocrural	Synovial: hinge	Dorsiflexion–plantarflexion	Sagittal
Ankle: subtalar	Synovial: gliding	Inversion–eversion	Frontal

Synovial joints are typically perfused by numerous arterial branches and are innervated by branches of the nerves supplying the adjacent muscle and overlying skin. Proprioceptive feedback is a significant joint sensation, as is pain, because of the high density of sensory fibers in the joint capsule. This feedback has obvious importance in regulating human movement and preventing injury (3).

Joint Movements and Range of Motion

Joint movement is a combination of rolling, sliding, and spinning of the joint surfaces (4). "Open chain" movements occur when the distal segment of a joint moves in space. An example of an open chain movement for the knee joint is leg extension exercise on a machine. "Closed chain" movements occur when the distal segment of the joint is fixed in space. An example of a closed chain movement for the knee joint is standing barbell squats. A joint is in a "closed pack" position when there is both maximal congruency of the joint surfaces and maximal tautness of the joint capsule and ligaments (4). A joint is in an "open pack" (loose) position when there is the least joint congruency and the joint capsule and ligaments are most loose. Movement at one joint may influence the extent of movement at adjacent joints because a number of muscles and other soft tissue structures cross multiple joints. For example, finger flexion decreases in the presence of wrist flexion because muscles that flex both the wrist and fingers cross multiple joints (4).

The degree of movement within a joint is called the ROM. It can be active (the range that can be reached by voluntary movement from contraction of skeletal muscle) or passive (the ROM that can be achieved by external means, such as a Personal Trainer raising the leg of a client to stretch the hamstrings.). Joints with excessive ROM are called “hypermobile,” and joints with restricted ROM are called “hypomobile” (4). Joint ROM is quantified using goniometers or inclinometers, and each joint has normal ROM values for reference purposes (5). ROM measures at baseline help guide the exercise prescription, and ROM measures at follow-up help document progress.

Joint Stability

The stability of a joint is its resistance to displacement. All joints do not have the same degree of stability, and in general, ROM is gained at the expense of stability. Five factors account for joint stability (4):

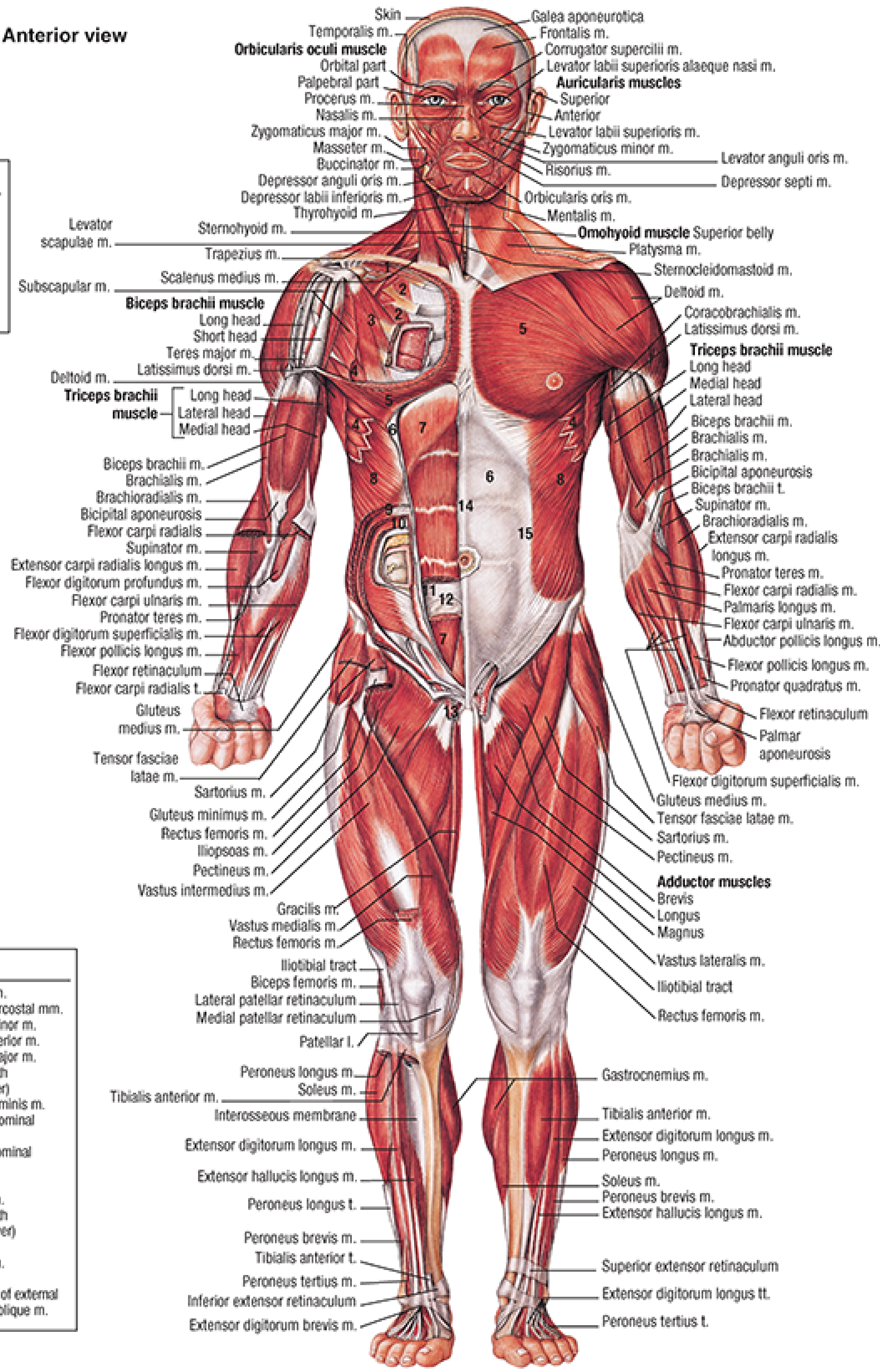
1. Ligaments facilitate normal movement and resist excessive movement.
2. Muscles and tendons that span a joint also enhance stability, particularly when the bony structure alone contributes little stability (*e.g.*, shoulder).
3. Fascia contributes to joint stability (*e.g.*, iliotibial band of the tensor fasciae latae).
4. Atmospheric pressure creates greater force outside of the joint than internal pressure exerts within the joint cavity (the suction created by this pressure is an important factor in aiding joint stability).
5. The bony structure of a joint is an important contributor to joint stability (*e.g.*, limitation of elbow extension by the olecranon process of the ulna) (4).

Muscular System

Bones provide support and leverage to the body, but without muscles, movement would not be possible. There are three types of muscle tissue: skeletal, cardiac, and smooth muscle. Skeletal muscle is primarily attached to bones and is under voluntary control. Skeletal muscle is responsible for moving the skeletal system and stabilizing the body (*e.g.*, maintaining posture). There are more than 600 skeletal muscles in the human body (2), approximately 100 of which are primary movement muscles with which

Personal Trainers should be familiar (4). The superficial muscles of the body are shown in Figures 3.8 and 3.9.

Anterior view



Key

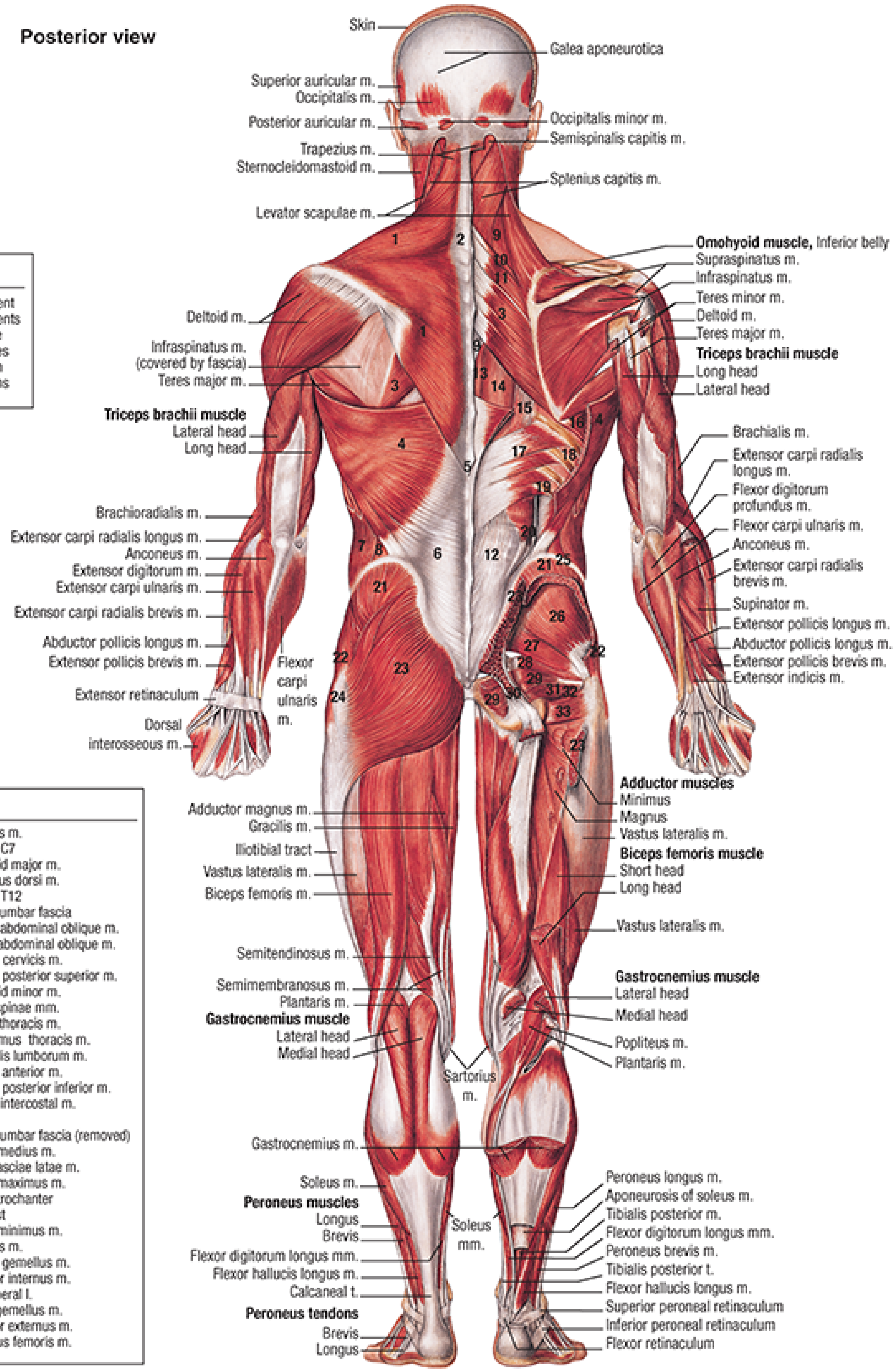
- **l.** Ligament
- **ll.** Ligaments
- **m.** Muscle
- **mm.** Muscles
- **t.** Tendon
- **tt.** Tendons

Key

1. Subclavius m.
2. External intercostal mm.
3. Pectoralis minor m.
4. Serratus anterior m.
5. Pectoralis major m.
6. Rectus sheath (anterior layer)
7. Rectus abdominis m.
8. External abdominal oblique m.
9. Internal abdominal oblique m.
10. Transversus abdominis m.
11. Rectus sheath (posterior layer)
12. Arcuate line
13. Cremaster m.
14. Linea alba
15. Aponeurosis of external abdominal oblique m.

FIGURE 3.8. Superficial muscles — anterior view. (Asset provided by Anatomical Chart Co., with permission. Reprinted with permission from Anatomical Chart Company. *ACC's Muscular System Chart*. Baltimore [MD]: Lippincott Williams & Wilkins; 2002.)

Posterior view



Key

- **l.** Ligament
- **ll.** Ligaments
- **m.** Muscle
- **mm.** Muscles
- **t.** Tendon
- **tt.** Tendons

Key

1. Trapezius m.
2. Spine of C7
3. Rhomboid major m.
4. Latissimus dorsi m.
5. Spine of T12
6. Thoracolumbar fascia
7. External abdominal oblique m.
8. Internal abdominal oblique m.
9. Splenius cervicis m.
10. Serratus posterior superior m.
11. Rhomboid minor m.
12. Erector spinae mm.
13. Spinalis thoracis m.
14. Longissimus thoracis m.
15. Iliocostalis lumborum m.
16. Serratus anterior m.
17. Serratus posterior inferior m.
18. External intercostal m.
19. 12th rib
20. Thoracolumbar fascia (removed)
21. Gluteus medius m.
22. Tensor fasciae latae m.
23. Gluteus maximus m.
24. Greater trochanter
25. Iliac crest
26. Gluteus minimus m.
27. Piriformis m.
28. Superior gemellus m.
29. Obturator internus m.
30. Sacrotuberal l.
31. Inferior gemellus m.
32. Obturator externus m.
33. Quadratus femoris m.

FIGURE 3.9. Superficial muscles — posterior view. (Asset provided by Anatomical Chart Co., with permission. Reprinted with permission from Anatomical Chart Company. *ACC's Muscular System Chart*. Baltimore [MD]: Lippincott Williams & Wilkins; 2002.)

There are more than 600 skeletal muscles in the human body, approximately 100 of which are primary movement muscles with which Personal Trainers should be familiar.

Skeletal muscles are generally anchored to the skeleton by tendons. Tendons are dense cords of connective tissue that attach a muscle to the periosteum of the bone. The collagen fibers of tendons are in parallel arrangement, which makes the tendon suitable for unidirectional stress. When the tendon is flat and broad, it is called an "aponeurosis." Tendons and aponeuroses provide the mechanical link between skeletal muscle and bone. Bursae are often positioned between tendons and bony prominences to allow the tendons to slide easily across the bones (3).

Classification of Skeletal Muscles

Skeletal muscles can be classified according to their muscle fiber architecture (*i.e.*, the arrangement of muscle fiber relative to the line of pull of the muscle) (Fig. 3.10). Muscles typically have either a parallel arrangement or a pennate arrangement. In parallel muscle, the muscle fibers run in line with the pull of the muscle. Fusiform muscles have a parallel arrangement and are spindle shaped, tapering at each end (*e.g.*, biceps brachii, brachialis). Longitudinal muscles are strap-like, with parallel fibers (*e.g.*, sartorius). Quadrate muscles are four sided, are usually flat, and consist of parallel fibers (*e.g.*, rhomboids). Fan-shaped or triangular muscles contain fibers that radiate from a narrow attachment at one end to a broad attachment at the other (*e.g.*, pectoralis major, trapezius) (2).

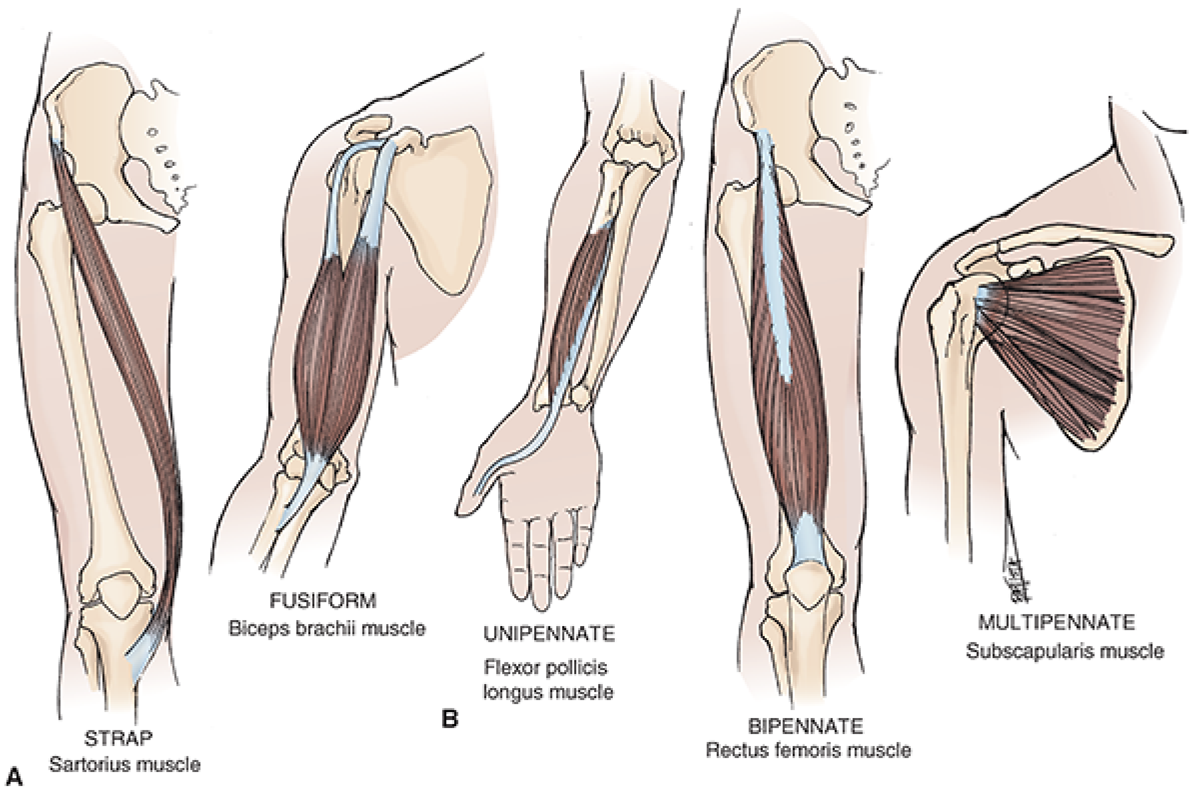


FIGURE 3.10. Skeletal muscle architecture **(A)** and shape **(B)**. (From Oatis CA. *Kinesiology: The Mechanics and Pathomechanics of Human Movement*. 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2016, with permission.)

In pennate muscle, the fibers run obliquely or at an angle to the line of pull. This architecture allows for the pennate muscle to produce greater force than a parallel arrangement in a smaller cross-sectional area. Pennate muscles can be classified as unipennate (fibers only on one side of the tendon; *e.g.*, flexor pollicis longus, tibialis posterior), bipennate (fibers on both sides of a centrally positioned tendon; *e.g.*, rectus femoris, flexor hallucis longus), or multipennate (two or more fasciculi attaching obliquely and combined into one muscle; *e.g.*, subscapularis and deltoid) (2).

Muscles can also be described on the basis of the number of joints upon which they act. For example, a muscle that causes movement at one joint is uniarticular (*e.g.*, brachialis). Muscles that cross more than one joint are referred to as biarticular (having actions at two joints; *e.g.*, hamstring muscles and biceps brachii) or multiarticular (*e.g.*, erector spinae). The main advantage of bi- and multiarticular muscles is that only one muscle is needed to generate tension in two or more joints. This is more efficient and conserves energy. In many instances, the length of the muscle stays within 100%–130% of the resting length. As one side of the muscle shortens, the other side lengthens, maintaining a near-constant overall length. This property of bi- and multiarticular muscles enhances tension production (4).

How Muscles Produce Movement

Skeletal muscles produce force that is transferred to the tendons, which in turn pull on the bones and other structures, such as the skin. Most muscles cross a joint, so when a muscle contracts, it pulls one of the articulating bones toward the other. Usually, both articulating bones do not move equally; one of the articulating bones remains relatively stationary. The attachment that is usually more stationary and proximal (especially in the extremities) is called the "origin." The muscle attachment located on the bone that moves more and is usually located more distally is called the "insertion" (4).

Muscle Roles

Movements of the human body generally require several muscles working together rather than a single muscle doing all the work. Keep in mind that muscles cannot push, they can only pull; therefore, most skeletal muscles are arranged in opposing pairs such as flexor–extensor, internal–external rotator, and abductor–adductor. Muscles can be classified according to their roles during movement (2). When a muscle or a group of muscles is responsible for the action or movement, it is called a "prime mover" or "agonist." For example, during a biceps curl, the prime movers are the elbow flexors, which include the biceps brachii, brachialis, and brachioradialis muscles. The opposing group of muscles is called the antagonist (*e.g.*, the triceps brachii and anconeus muscles in biceps curl). Antagonists relax to permit the primary movement and contract to act as a brake at the completion of the movement. In addition, most movements also involve other muscles called "synergists." The role of synergists is to prevent unwanted movement, which helps the prime movers perform more efficiently. Synergists can also act as fixators or stabilizers. In this role, the muscles stabilize a portion of the body against a force (2). For example, the scapular muscles (*e.g.*, rhomboids, serratus anterior, and trapezius) must provide a stable base of support for the upper extremity muscles during the throwing motion. Co-contraction is the simultaneous contraction of the agonist and antagonist. Co-contraction of the abdominal and lumbar muscles, for example, helps stabilize the lower trunk during trunk movements (12).

Specific Joint Anatomy and Considerations

Muscle actions produce force that causes joint movement during exercise. Personal Trainers need a solid working knowledge of the functional anatomy and kinesiology of major joint structures. Tables 3.5 and 3.6 summarize the major joint movements, muscles that produce those movements, normal ROM values, and examples of resistance exercises for the muscles. This knowledge is the basis for the development of exercise programs to be used in training (13). In this section, we describe the structure and function of each of the major joints of the body in four steps:

1. Structure: What are the initial considerations of the joint's structure (*e.g.*, bones, muscles, tendons, ligaments, cartilage, bursae) and ability to move?
2. Movements: What movements occur at the joint? What are the normal ROMs for each movement?
3. Muscles: What specific muscles are being used to create the movements? How are the muscles being used (*e.g.*, agonist, synergist, stabilizer)?
4. Injuries: What common injuries occur to the joint structure?

Table 3.5 Major Upper Extremity Joints: Movements, Range of Motion, Muscles, and Example Resistance Exercises

Joint	Movement	Range of Motion (°)	Major Agonist Muscles	Examples of Resistance Exercises
Scapulothoracic	Fixation		Serratus anterior, pectoralis minor, trapezius, levator scapulae, rhomboids	Push-up, parallel bar dip, upright row, shoulder shrug, seated row
	Upward rotation		Trapezius	
	Downward rotation		Rhomboids, pectoralis minor, levator scapulae	
	Elevation		Rhomboids, levator scapulae, trapezius	Shoulder shrug
	Depression		Pectoralis minor, trapezius	
	Protraction		Serratus anterior, pectoralis minor	Supine dumbbell serratus press, push-up
	Retraction		Rhomboids, trapezius	Seated row
Glenohumeral (shoulder)	Flexion	90–100	Anterior deltoid, pectoralis major (clavicular head), biceps brachii (long head)	Dumbbell front raise, incline bench press
	Extension	40–60	Latissimus dorsi, teres major, pectoralis major (sternocostal head), posterior deltoid and triceps brachii (long head)	Dumbbell pullover, chin-up
	Abduction	90–95	Middle deltoid, supraspinatus	Dumbbell lateral raise, dumbbell press
	Adduction	0	Latissimus dorsi, teres major, pectoralis major	Lat pull-down, seated row, cable crossover, flat bench dumbbell fly
	Horizontal abduction	45	Posterior deltoid, teres major, latissimus dorsi	Prone reverse dumbbell fly, reverse cable fly
	Horizontal adduction	135	Pectoralis major, anterior deltoid	Flat bench chest fly, pec deck, cable

				crossover
	Internal rotation	70–90	Latissimus dorsi, teres major, subscapularis, pectoralis major, anterior deltoid	Lat pull-down, bent over row, dumbbell row, rotator cuff exercises, dumbbell press, parallel bar dip, front raises
	External rotation	70–90	Infraspinatus, teres minor, posterior deltoid	External rotator cuff exercises — dumbbell side-lying, cable in; rotator cuff exercises — dumbbell side-lying, cable
Elbow	Flexion	145–150	Biceps brachii, brachialis, brachioradialis	Dumbbell curl, preacher curl, hammer curl
	Extension	0	Triceps brachii, anconeus	Dip, pulley triceps extension, close grip bench press, push-downs, dumbbell kickback
Radioulnar	Supination	80–90	Biceps brachii, supinator	Dumbbell curl (with supination)
	Pronation	70–90	Pronator quadratus, pronator teres	Dumbbell pronation
Wrist	Flexion	70–90	Flexor carpi radialis and ulnaris, palmaris longus, flexor digitorum superficialis	Dumbbell wrist curl
	Extension	65–85	Extensor carpi radialis longus, brevis, and ulnaris, extensor digitorum	Dumbbell reverse wrist curl
	Adduction	25–40	Flexor and extensor carpi ulnaris	Wrist curl, reverse wrist curl
	Abduction	15–25	Extensor carpi radialis longus and brevis, flexor carpi radialis	Wrist curl, reverse wrist curl

Table 3.6 Major Spine and Lower Extremity Joints: Movements, Range of Motion, Muscles, and Example Resistance Exercises

Joint	Movement	Range of Motion (°)	Major Agonist Muscles	Examples of Resistance Exercises
Cervical spine	Flexion	50	Sternocleidomastoid, anterior scalene, longus capitis/colli	Machine neck flexion
	Extension	60	Suboccipitals, splenius capitis/cervicis, erector spinae	Machine neck extension
	Lateral flexion	45	Unilateral contraction of flexor–extensor muscles above	Machine neck lateral flexion
	Rotation	80	Unilateral contraction of flexor–extensor muscles above	Machine neck rotation
Lumbar spine	Flexion	60	Rectus abdominis, internal–external oblique abdominis	Crunch, leg raise, machine crunch, high pulley crunch
	Extension	25	Erector spinae, multifidus	Roman chair, machine trunk extension, dead lift, squat, good morning
	Lateral flexion	25	Quadratus lumborum, internal–external oblique abdominals, unilateral erector spinae	Roman chair side bend, dumbbell side bend, hanging leg raise
	Rotation		Internal–external oblique abdominals, intrinsic spinal rotators, multifidus	Broomstick twist, machine trunk rotation
Hip	Flexion	130	Iliopsoas, rectus femoris, sartorius, pectineus, tensor fasciae latae	Leg raise, sit-up, machine crunch
	Extension	30	Gluteus maximus,	Squat, leg press, lunge,

			hamstrings	machine leg extension
	Abduction	35	Tensor fasciae latae, sartorius, gluteus medius and minimus	Cable or machine hip abduction
	Adduction	30	Adductor longus, brevis, and magnus, gracilis, and pectineus	Power squats, cable or machine hip adduction, lunge
	Internal rotation	45	Semitendinosus, semimembranosus, gluteus medius and minimus, tensor fasciae latae	
	External rotation	50	Biceps femoris, sartorius, gluteus maximus, deep rotators (piriformis, superior and inferior gemelli, internal and external obturators, quadratus femoris)	
Knee	Flexion	140	Hamstrings, gracilis, sartorius, popliteus, gastrocnemius	Leg curl (standing, seated, prone)
	Extension	0–10	Quadriceps femoris	Lunge, squats, machine leg extension
	Internal rotation	30	Gracilis, semimembranosus, semitendinosus	
	External rotation	45	Biceps femoris	
Ankle: talocrural	Dorsiflexion	15–20	Tibialis anterior, extensor digitorum longus, extensor hallucis longus, peroneus (fibularis) tertius	Ankle dorsiflexion resistance band
	Plantarflexion	50	Gastrocnemius, soleus, tibialis posterior, flexor digitorum longus, flexor hallucis longus	Standing/seated calf raise, donkey calf raise
Ankle:	Eversion	5–15	Peroneus (fibularis)	Elastic band eversion

subtalar			longus and brevis	
	Inversion	20–30	Tibialis anterior and posterior	Elastic band inversion

Upper Extremity

Shoulder

The shoulder complex is a multijoint structure that provides the link between the thoracic cage and upper extremity. The shoulder (glenohumeral joint) is a ball-and-socket joint. It has a high degree of mobility and, as a result, is very unstable. Because the bony structures of the shoulder provide relatively little support, much of the responsibility for stabilizing this region falls on the soft tissues — the muscles, ligaments, and joint capsules. Thus, the shoulder is more likely to be injured than the hip (14).

> The shoulder complex is a multijoint structure that provides the link between the thoracic cage and upper extremity. The shoulder has a high degree of mobility; as a result, the shoulder region is very unstable.

Structure

Bones

The bones of the shoulder region include humerus, scapula, and clavicle (Fig. 3.11). The humerus is a long bone and is the major bone of the arm. The humeral head is rounded and articulates with the glenoid fossa of the scapula. The greater and lesser tubercles of the humerus are attachment sites for many of the muscles that act on the shoulder. The scapula is a large triangular bone that rests on the posterior thoracic cage between the second rib and the seventh rib in the normal position. The scapula lies in the scaption plane, that is, obliquely at 30° to the frontal plane. The glenoid fossa of the scapula faces anterolaterally. The acromion process is located at the superior aspect of the scapula and articulates with the clavicle. The clavicle runs obliquely at 60° to the scapula and provides the link between the upper extremity and the axial skeleton. The clavicle provides protection for the neural bundle called the "brachial plexus" and the vascular system supplying the upper extremity, supports the weight of the humerus, and helps maintain the position of the scapula and the humerus (11).

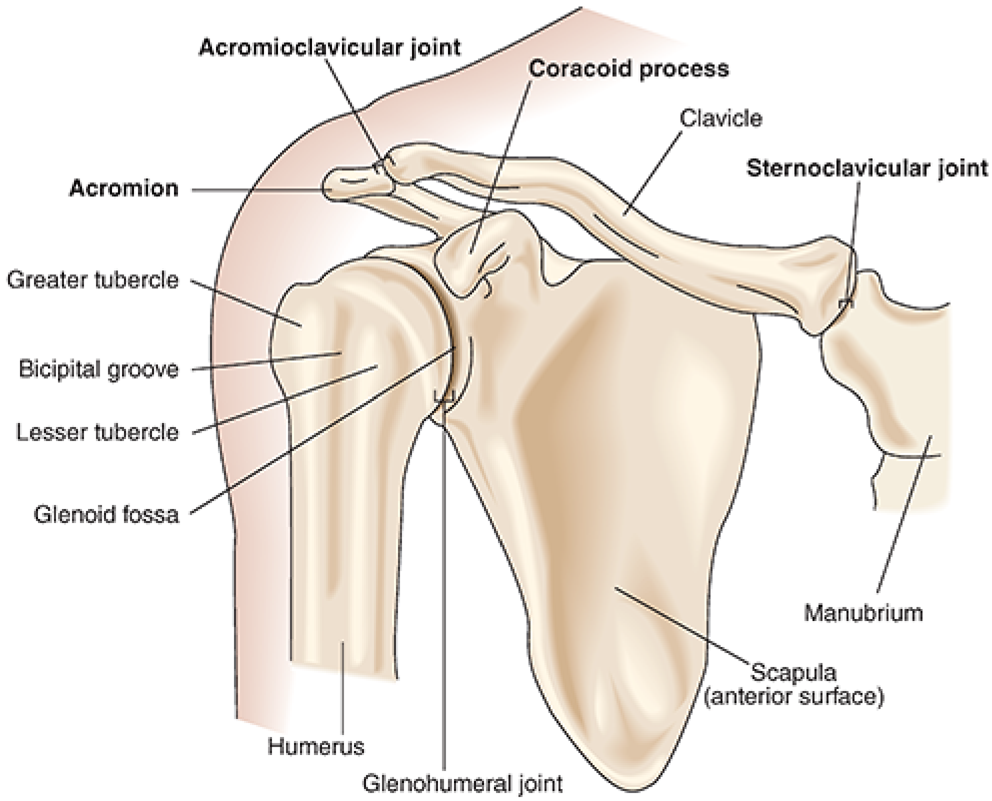


FIGURE 3.11. Bones and articulations of the shoulder region — anterior view. (From Bickley LS, Szilagyi P. *Bates' Guide to Physical Examination and History Taking*. 8th ed. Philadelphia [PA]: Lippincott Williams & Wilkins; 2003, with permission.)

Ligaments and Bursae

The ligaments and bursae of the shoulder region are shown in Figure 3.12, and some of these structures are discussed in this section. The coracohumeral ligament spans the bicipital groove of the humerus and provides anteroinferior stability to the glenohumeral joint. The glenohumeral ligament (anterior, middle, and anteroinferior bands) reinforces the anterior capsule and provides stability to the shoulder joint in most planes of movement. The coracoacromial ligament, located superior to the glenohumeral joint, protects the muscles, tendons, nerves, and blood supply of the region and prevents superior dislocation of the humeral head. The acromioclavicular ligament is the major ligament that provides stability to the acromioclavicular joint. The coracoclavicular ligament (trapezoid and conoid bands) prevents superior dislocation of the acromioclavicular joint. The sternoclavicular ligaments (anterior and posterior) help strengthen the capsule of the sternoclavicular joint. The costoclavicular ligament connects the first rib and clavicle, and the interclavicular ligament connects the two clavicles and manubrium. The subacromial (subdeltoid) bursa, which lies between the supraspinatus and deltoid tendons and the acromion, allows gliding and cushioning of these structures, especially upon shoulder abduction (4).

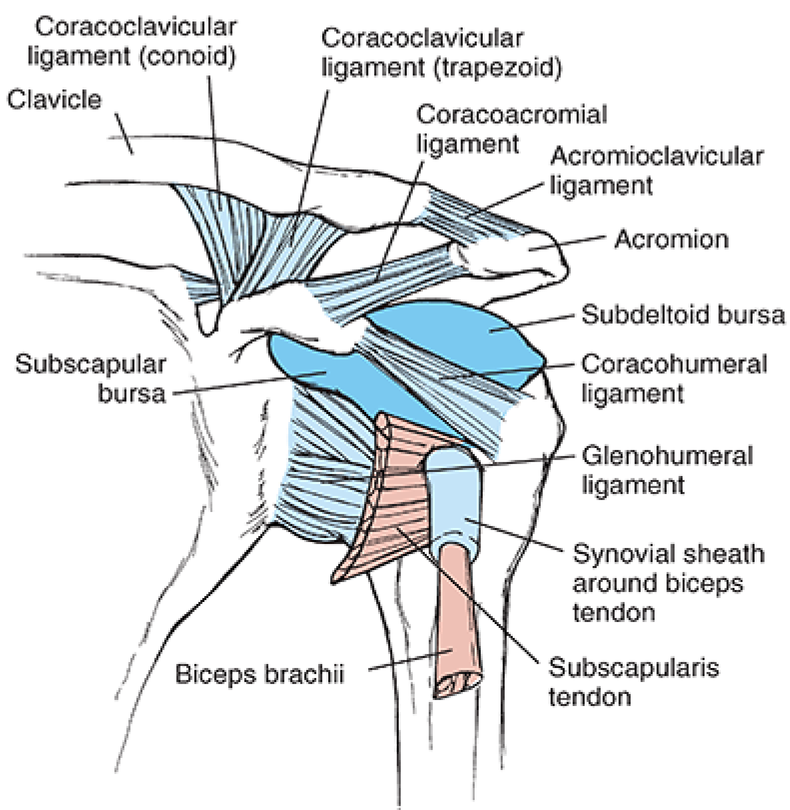


FIGURE 3.12. Ligaments and bursae of the shoulder region — anterior view. (From Hendrickson T. *Massage for Orthopedic Conditions*. Baltimore [MD]: Lippincott Williams & Wilkins; 2003, with permission.)

Joints

The shoulder region is a complex of four joints: the glenohumeral (shoulder), acromioclavicular, sternoclavicular, and scapulothoracic joints (see Fig. 3.12). The glenohumeral joint is a ball-and-socket joint and is the most freely moveable joint in the body. It consists of the articulation of the spherical head of the humerus with the small, shallow, and somewhat pear-shaped glenoid fossa of the scapula. The glenoid labrum (which is composed of fibrocartilage) of the scapula deepens the fossa and cushions against impact of the humeral head in forceful movements (Fig. 3.13) (4).

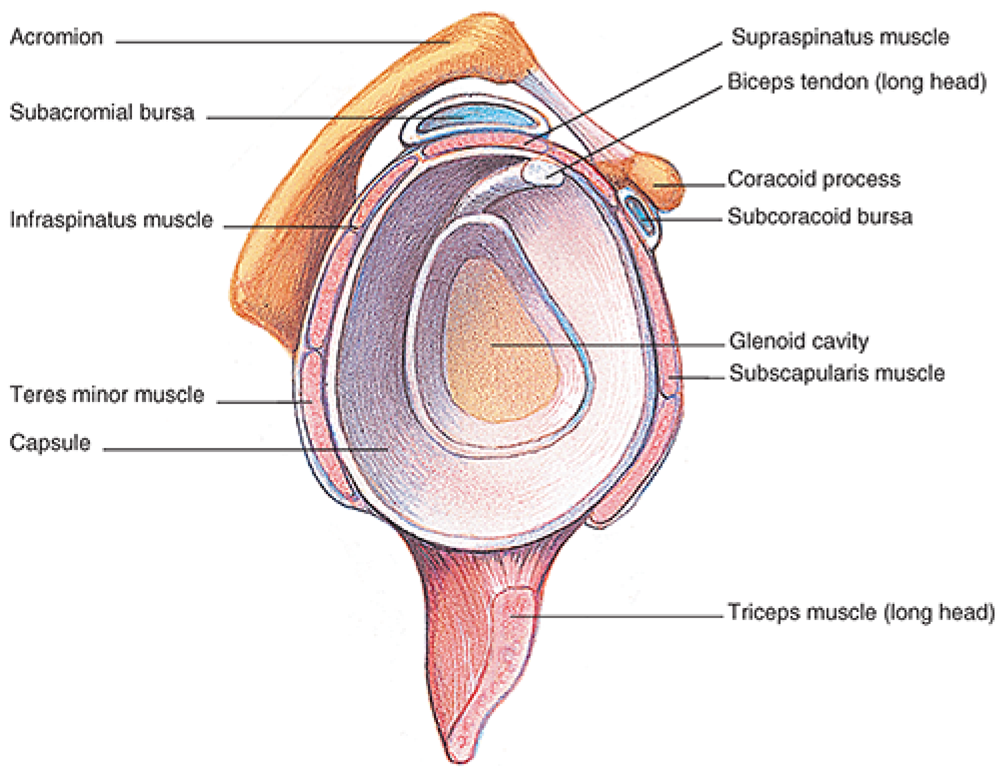


FIGURE 3.13. Shoulder joint socket. (Reprinted with permission from Anatomical Chart Company. *ACC's Shoulder and Elbow Anatomical Chart*. Baltimore [MD]: Lippincott Williams & Wilkins; 2003.)

The acromioclavicular joint is a plane synovial joint of the articulation of the acromion and the distal end of the clavicle. The acromioclavicular joint moves in three planes simultaneously with scapulothoracic motion. The sternoclavicular joint, the articulation of the proximal clavicle with the sternum and cartilage of the first rib, is a saddle synovial joint. The sternoclavicular joint moves in synchronization with the other three joints of the shoulder region and, importantly, provides the only bony connection between the humerus and the axial skeleton (2).

The scapulothoracic joint is not a true joint but a physiological (functional) joint. It is formed by the articulation of the scapula with the thoracic cage. In the kinematic chain, any movement of the scapulothoracic joint results in movement of the acromioclavicular, sternoclavicular, and glenohumeral joints. The scapulothoracic joint provides mobility and stability for the orientation of the glenoid fossa and the humeral head for arm movements in all planes (3).

Movements

Because the glenohumeral joint is a ball-and-socket joint, it is capable of motion in three planes: abduction–adduction in the frontal plane, flexion–extension in the sagittal plane, and internal–external rotation and horizontal abduction–adduction in the transverse plane. Furthermore, the multiplanar movement of circumduction is possible at the glenohumeral joint (2). Glenohumeral movements are demonstrated in Figure 3.14, and normal ROM values are listed in Table 3.5.

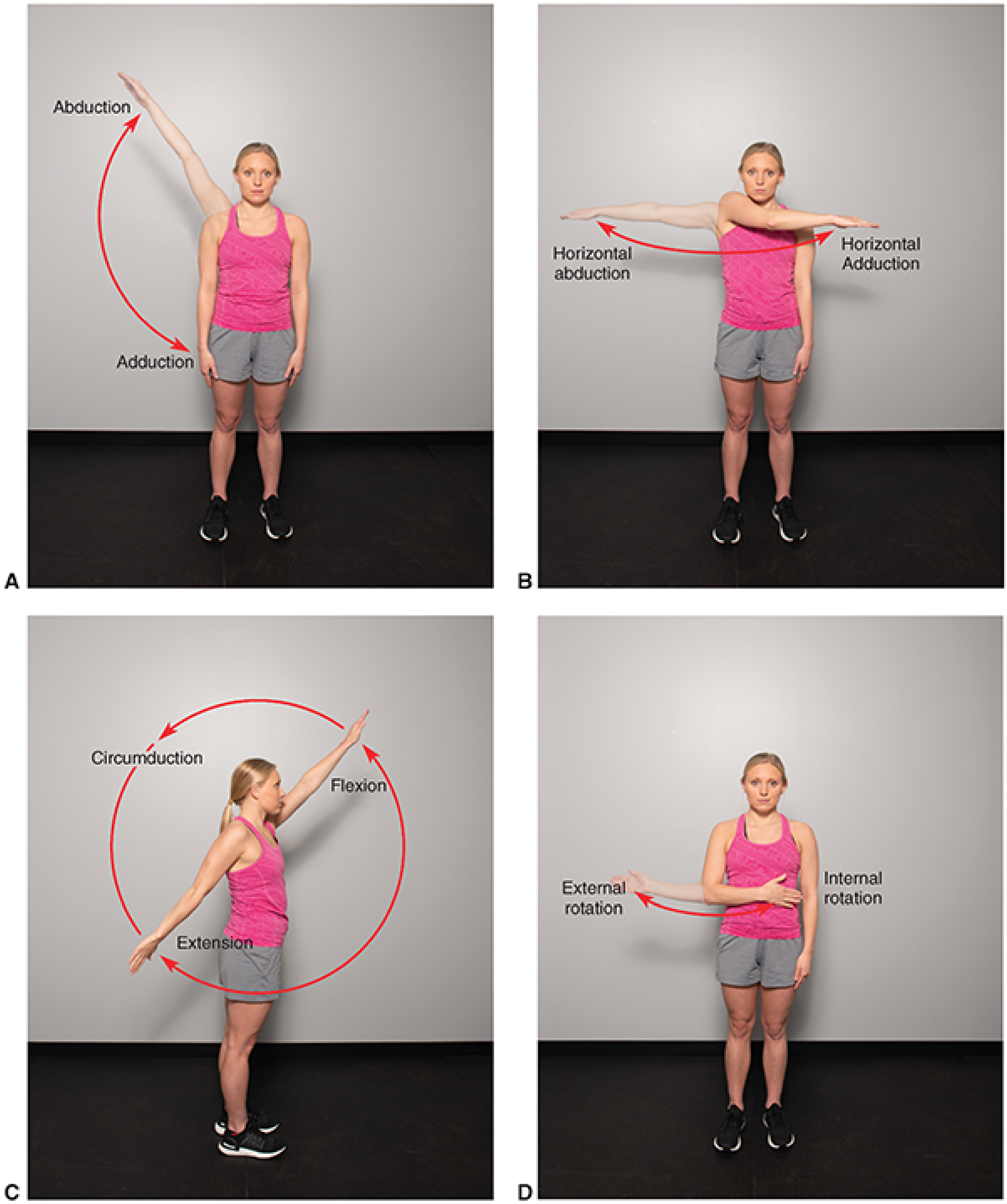


FIGURE 3.14. Movements of the shoulder. **A.** Abduction–adduction. **B.** Horizontal abduction–adduction. **C.** Flexion–extension and circumduction. **D.** Internal–external rotation.

The center of rotation of the glenohumeral joint occurs at the humeral head within the glenoid fossa. At 0°–50° of abduction, the lower portion of the humeral head is in contact with the glenoid fossa, whereas at 50°–90° of abduction, the upper portion of the humeral head is in contact with the glenoid fossa. Because shear force creates friction across surfaces, the rolling of the humeral head within the glenoid reduces stress on the joint (4).

The scapulothoracic joint is also capable of motion in three planes. These motions include upward–downward rotation, retraction–protraction, elevation–depression, anterior–posterior tilting, and medial–lateral rotation (4). Scapulothoracic joint movements are shown in Figure 3.15.

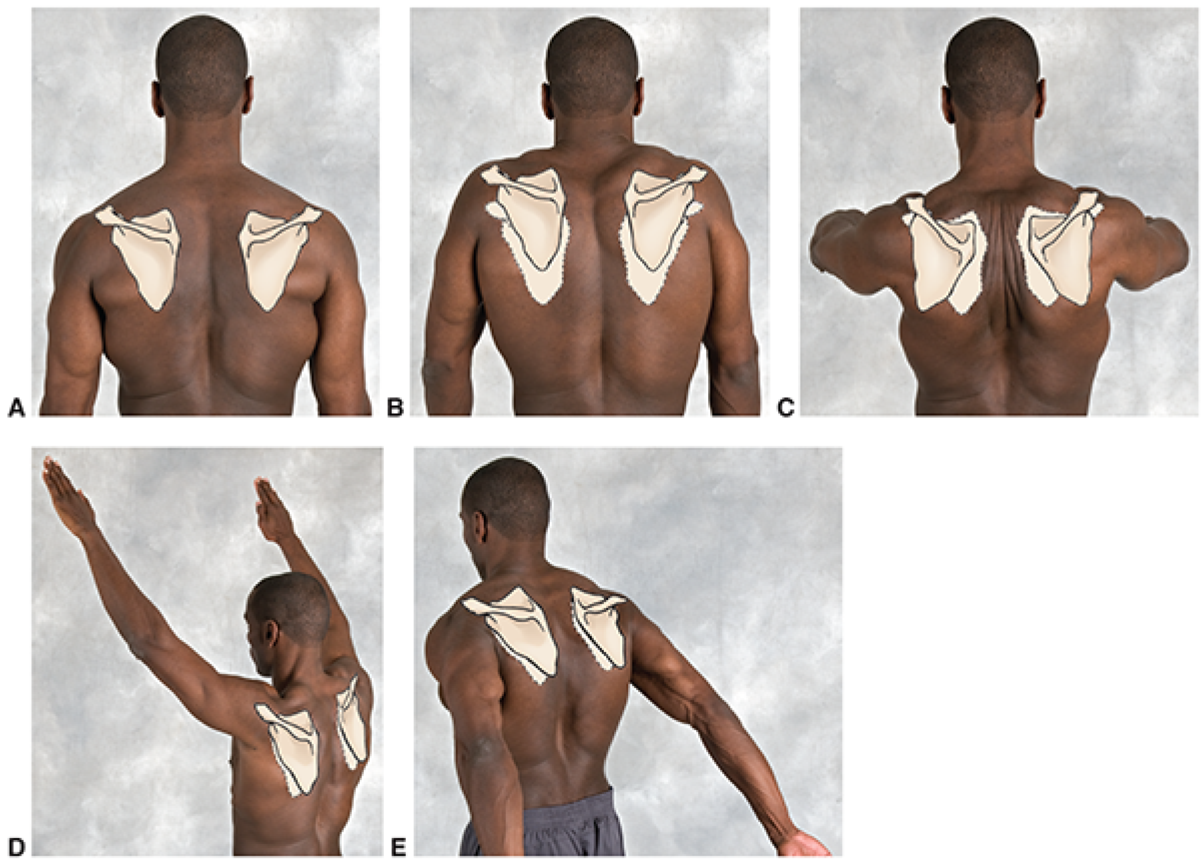


FIGURE 3.15. Movements of the scapulothoracic joint. **A.** Starting position. **B.** Elevation–depression. **C.** Protraction–retraction. **D.** Internal–external rotation. **E.** Anterior–posterior tilt.

Scapulohumeral Rhythm

Full abduction of the arm requires simultaneous movement of the glenohumeral and scapulothoracic joints. This dual movement is called "scapulohumeral rhythm" (Fig. 3.16). Scapulohumeral rhythm allows a greater abduction ROM, maintains optimal length–tension relationships of the glenohumeral muscles, and prevents impingement between the greater tubercle of the humerus and the acromion. After 100°–120° of abduction, upward rotation of the scapula in the frontal plane causes the glenoid fossa of the scapula to face upward, making further elevation of the arm above the head possible (15). Overall, in every 3° elevation of the arm, 2° occurs at the glenohumeral joint and 1° occurs at the scapulothoracic joint (16).

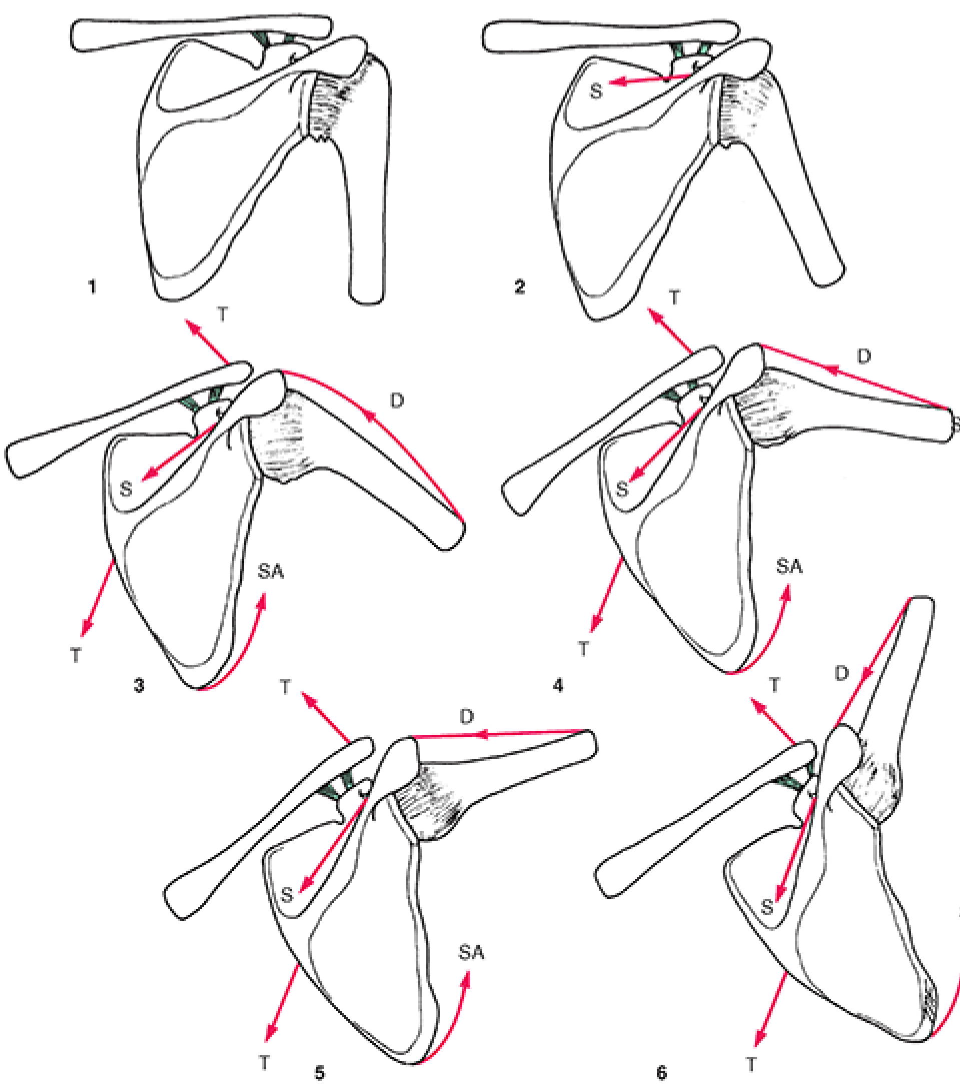
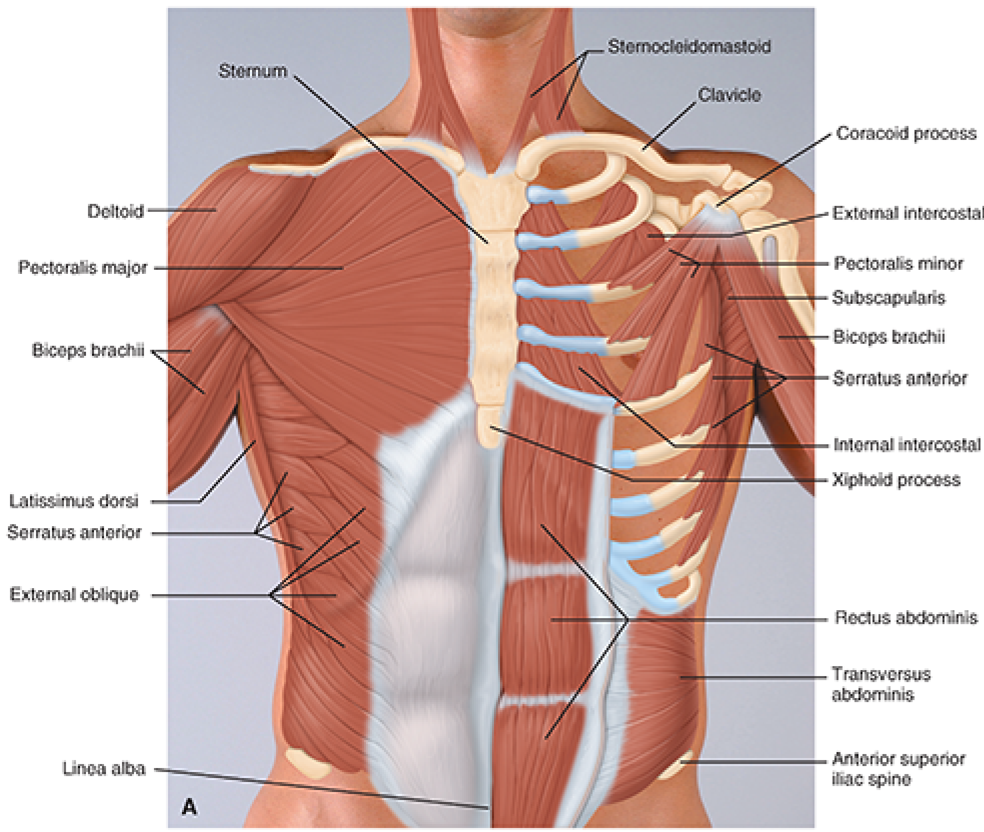


FIGURE 3.16. Scapulohumeral rhythm: movements of shoulder abduction and scapular upward rotation and the muscles that produce these movements at various stages of abduction. For every 3° elevation of the arm, 2° occurs at the glenohumeral joint and 1° occurs at the scapula. S, supraspinatus; T, trapezius; D, deltoid; SA, serratus anterior. (From Snell RS. *Clinical Anatomy*. 7th ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2003, with permission.)

Muscles

The numerous muscles of the shoulder region are typically characterized as either shoulder joint muscles or shoulder girdle muscles. The shoulder joint and shoulder girdle muscles work together to contribute to upper extremity movements. The shoulder joint muscles directly move the arm, whereas the shoulder girdle muscles mainly stabilize the scapula on the thoracic cage and are particularly important in maintaining proper posture (2). The muscles of the shoulder region are shown in Figures 3.17 and 3.18.



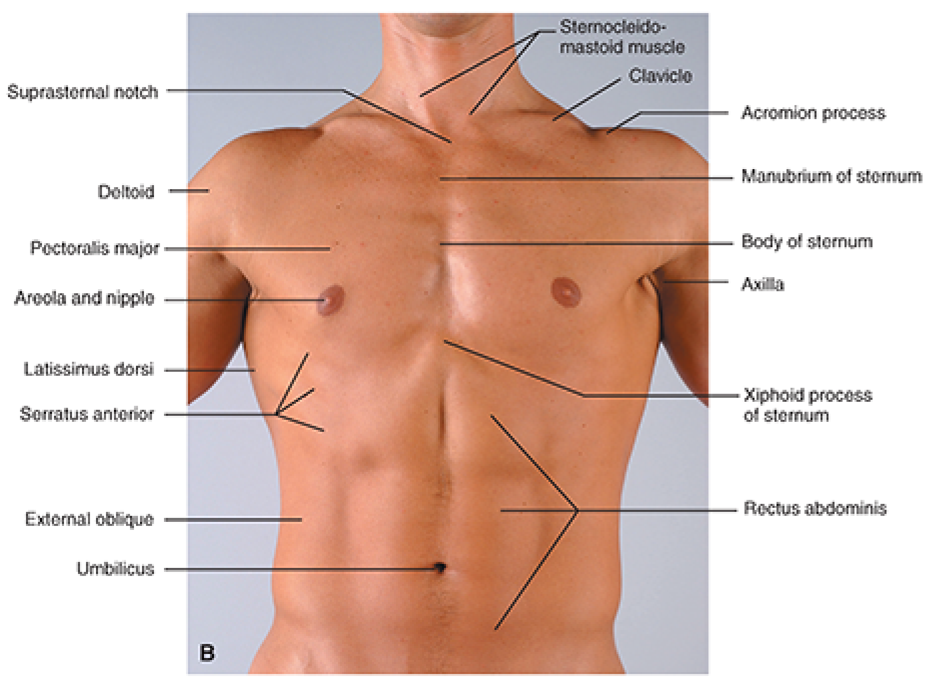


FIGURE 3.17. Muscles of the neck, shoulder, and trunk — anterior view. **A.** Superficial *(right)* and deep *(left)* muscles. **B.** Surface landmarks. (From Premkumar K. *The Massage Connection: Anatomy and Physiology*. 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2011, with permission.)

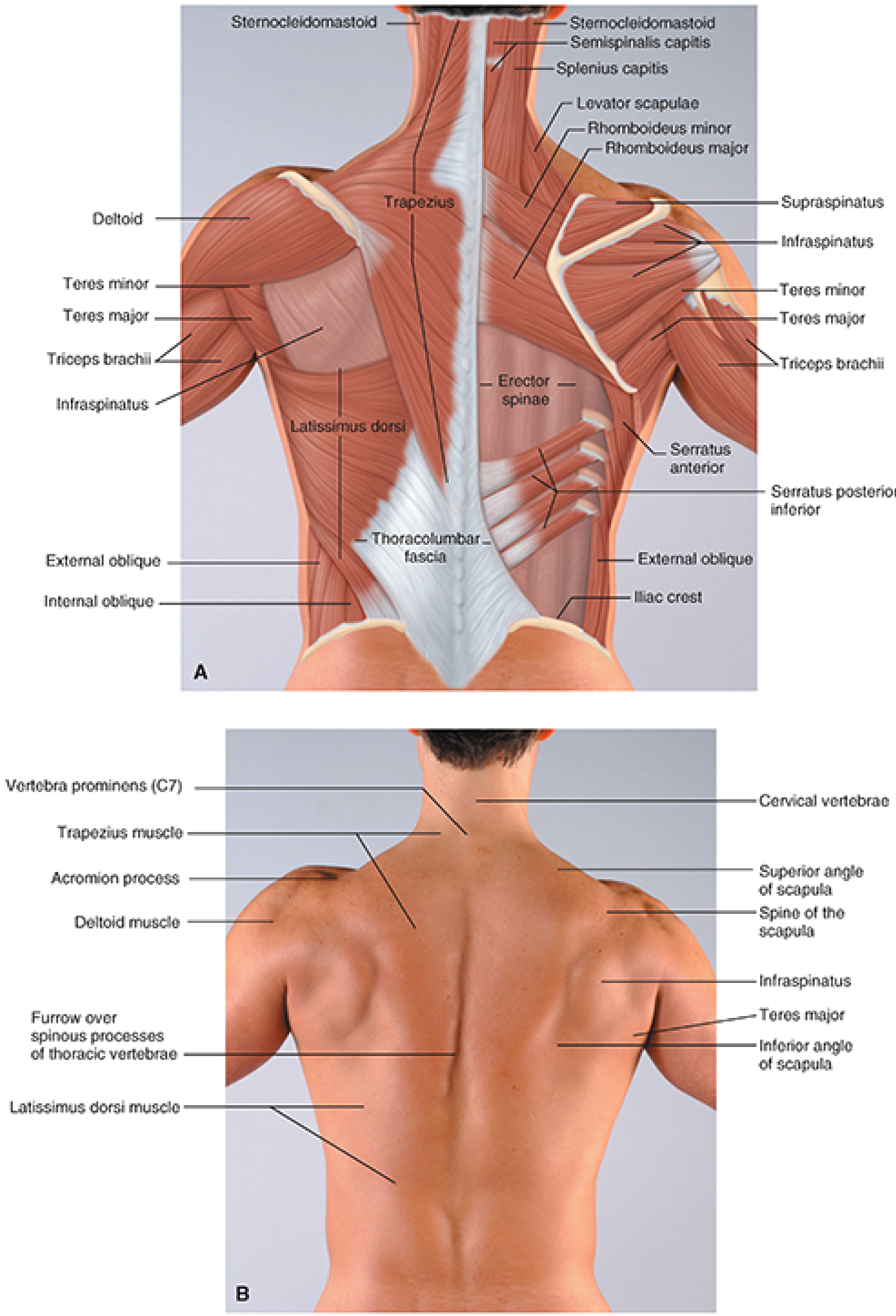


FIGURE 3.18. Muscles of the neck, shoulder, and trunk — posterior view. **A.** Superficial *(right)* and deep *(left)* muscles. **B.** Surface landmarks. (From Premkumar K. *The Massage Connection: Anatomy and Physiology*. 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2011, with permission.)

Anterior

The anterior muscles of the shoulder joint are the pectoralis major, subscapularis, coracobrachialis, and biceps brachii. The posterior muscles of the shoulder joint are the infraspinatus and teres minor. The superior muscles are the deltoid and supraspinatus, and the inferior muscles include the latissimus dorsi, teres major, and long head of the triceps brachii. The pectoralis major is a large and powerful muscle that is a prime mover in adduction, horizontal adduction, and internal rotation of the humerus. The pectoralis major is triangular, originating along the medial clavicle and sternum and attaching to the intertubercular groove of the humerus. The clavicular portion of the muscle primarily flexes the humerus, whereas the sternocostal portion extends the humerus from a flexed position (4). The coracobrachialis, a small muscle, assists with shoulder flexion and adduction. The biceps brachii is a two-joint, two-head muscle that crosses the shoulder and elbow. At the shoulder, the coracobrachialis assists with horizontal adduction, flexion, and internal rotation (4). Its primary functions and anatomical considerations are discussed in the section “Elbow” in this chapter.

Superior

The deltoid muscle has three heads: anterior, middle, and posterior. All heads insert at the deltoid tuberosity on the lateral humerus. The anterior deltoid originates from the anterolateral aspect of the clavicle. It is chiefly responsible for shoulder flexion, horizontal adduction, and internal rotation of the glenohumeral joint. The middle deltoid originates from the lateral aspect of the acromion and is a powerful abductor of the glenohumeral joint. The posterior deltoid originates from the inferior aspect of the scapular spine, and its actions of glenohumeral extension, horizontal abduction, and external rotation oppose those of the anterior deltoid (5). The anterior and posterior deltoids should be approximately the same size. However, in most individuals, the anterior deltoid is much more developed than the posterior deltoid. This imbalance can cause postural abnormalities (shoulder forward and internally rotated) and may be related to shoulder problems such as impingement syndrome (4).

Rotator Cuff

The rotator cuff muscles include the supraspinatus, infraspinatus, teres minor, and subscapularis, often remembered by the acronym "SITS," which describes their insertions on the greater and lesser tubercles of the humerus (Fig. 3.19). The rotator cuff muscles originate from the scapula and insert at the greater or lesser tubercle of the humerus (17). The supraspinatus primarily initiates abduction at the glenohumeral joint, the infraspinatus and teres minor externally rotate the glenohumeral joint, and the subscapularis internally rotates the glenohumeral joint. Although teres major does rotate the humerus, it is not considered a rotator cuff muscle because it inserts inferiorly on the shaft on the humerus.

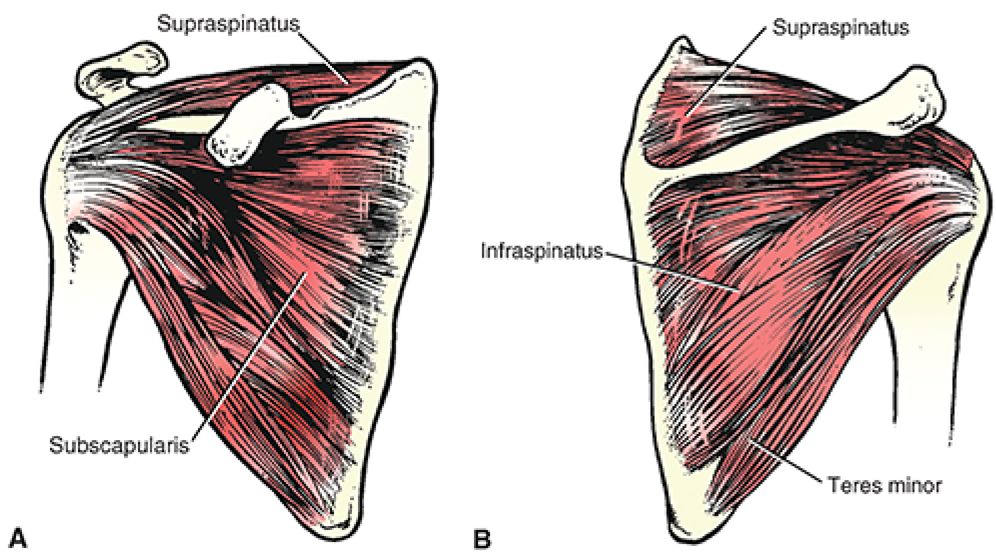


FIGURE 3.19. Rotator cuff muscles. **A.** Anterior view. **B.** Posterior view. (From Koval KJ, Zuckerman JD. *Atlas of Orthopaedic Surgery: A Multimedia Reference*. Philadelphia [PA]: Lippincott Williams & Wilkins; 2004, with permission.)

The rotator cuff muscles are important stabilizers of the glenohumeral joint and aid in glenohumeral positional control (17). These muscles hold the humeral head tightly in the glenoid fossa during arm movements initiated by the larger shoulder muscles. The rotator cuff stabilizes the shoulder through four mechanisms: (a) passive muscle tension, (b) contraction of the muscles causing compression of the articular surface, (c) joint motion that result in secondary tightening of the ligamentous restraints, and (d) the barrier effect (the ability to prevent dislocation of the joint) of contracted rotator cuff muscles (18).

> The rotator cuff muscles include the supraspinatus, infraspinatus, teres minor, and subscapularis, often remembered by the acronym "SITS."

Posterior

The latissimus dorsi is a large fan-shaped muscle that originates from the iliac crest and the posterior sacrum (via thoracolumbar fascia), lower six thoracic vertebrae, and lower three ribs. It inserts at the intertubercular groove of the humerus. The latissimus dorsi is a strong extensor, internal rotator, and adductor of the glenohumeral joint. The angle of pull of the latissimus dorsi increases when the arm is abducted to 30°–90°. The teres major muscle has actions similar to those of the latissimus dorsi. The triceps brachii is typically known as an elbow muscle, but its long head acts to extend the shoulder as well (5).

Scapular

The muscles of the anterior shoulder girdle include the pectoralis minor, serratus anterior, and subclavius. The pectoralis minor originates from the anterior aspects of the third to fifth ribs and inserts at the coracoid process of the scapula. Contraction of the pectoralis minor causes protraction, downward rotation, and depression of the scapula. The pectoralis minor has a lifting effect on the ribs during forceful inspiration and postural control. The serratus anterior contains several bands that originate from the upper nine ribs laterally and insert on the anterior aspect of the medial border of the scapula. The serratus anterior protracts the scapula and is active in reaching and pushing. Winging of the scapula results from serratus anterior dysfunction, which is possibly related to long thoracic nerve dysfunction. The subclavius is a small muscle that protects and stabilizes the sternoclavicular joint (5).

The posterior shoulder girdle muscles are the levator scapulae, rhomboids (major and minor), and trapezius. The levator scapulae originate from the transverse processes of the upper four cervical vertebrae, run obliquely, and insert at the medial border superior to the scapular spine. The levator scapulae produce elevation and downward rotation of scapula and also act on the neck. The rhomboids originate from the spinous processes of the last cervical and upper five thoracic vertebrae and insert on the medial border of the scapula from the spine to the inferior angle. Rhomboid action results in scapular retraction, downward rotation, and slight elevation. Along with the trapezius, proper rhomboid activity is necessary for good posture (*i.e.*, squeezing shoulder blades together) (4).

The trapezius muscle is a large triangular muscle and one of the largest muscles of the shoulder region. It contains three distinct regions: the upper, middle, and lower fibers. The origin of the trapezius covers a broad area from the base of the occiput to the spinous process of the twelfth thoracic vertebra, and its insertion runs from the lateral clavicle, medial border of the acromion, and scapular spine. Contraction of the upper trapezius causes scapular elevation, of the middle trapezius causes scapular retraction, and of the lower trapezius causes scapular depression (5). Together, the upper and lower fibers cause upward rotation of the scapula.

Injuries

Impingement syndrome is probably the most common nontraumatic cause of shoulder pain (19). Impingement syndrome results from approximation of the acromion and greater tubercle of humerus, which causes entrapment of the rotator cuff tendons (17). Shoulder impingement may also be associated with subacromial bursitis, biceps tendonitis, and degenerative tears of the rotator cuff tendons (14). A primary factor of impingement syndrome is muscular imbalance at the shoulder exacerbated by external rotator cuff muscle weakness and highly trained internal rotator muscles (particularly the prime movers) (19). This imbalance can lead to postural abnormalities, such as anterior shoulder carriage with excessive internal rotation (shoulder rounded forward), adaptive shortening and fibrosis of the internal rotators, and inflamed rotator cuff tendons. The progressive loss of external rotation, because of fibrosis or adaptive shortening of the internal rotators, is the most common factor in chronic rotator cuff disorders. Some of the predisposing factors for impingement syndrome include biomechanically unsound exercises, sports activities (*e.g.*, swimming), lifting weights with poor form, and training the same area of the body too often (overtraining anterior deltoids, pectoralis major, and latissimus dorsi) (19). Treatment of impingement syndrome is heavily focused on retraining proper exercise and posture. This includes strengthening and improving the function of the external rotators, stretching the internal rotators, and eliminating the training errors that started the dysfunction in the first place (19). All too often, however, a person who suffers from impingement syndrome is noncompliant with appropriate rehabilitation, and the condition becomes chronic, leading to permanent degenerative changes and dysfunction. A primary factor of impingement syndrome is muscular imbalance at the shoulder exacerbated by external rotator cuff muscle weakness and highly trained internal rotator muscles (particularly the prime movers) (19).

Thoracic outlet syndrome is another condition of the shoulder that can be related to faulty biomechanics, poor posture, and shoulder muscle imbalance (20). Thoracic outlet syndrome is compression of the neurovascular bundle (brachial plexus and axillary artery/vein) in the axillary (armpit) region and results in symptoms such as pain, numbness, and tingling in the upper extremity, usually in the fourth and fifth digits of the hand. The three sites of compression in thoracic outlet syndrome occur between the first rib and anterior scalene muscle, pectoralis minor muscle, or clavicle (20). Treatment of thoracic outlet syndrome includes correcting faulty biomechanics, strengthening the rotator cuff, and stretching the shoulder internal rotators and scalenes. As with impingement syndrome, complete recovery may take several months or longer.

The shoulder is also susceptible to traumatic injuries such as joint separation or dislocation and tearing of tendons, ligaments, or joint capsules. Glenohumeral joint dislocation usually occurs anteriorly because of capsular tears (4). The mechanism of glenohumeral joint dislocation is typically excessive abduction, external rotation, and extension of the shoulder. Stabilizing the shoulder after suspected glenohumeral joint dislocation is important to prevent any further damage, particularly to the neurological structures. Acromioclavicular joint separation (commonly referred to as shoulder separation and not to be confused with shoulder dislocation) is classically because of a direct blow to the shoulder or fall on an outstretched arm (14). Signs and symptoms of acromioclavicular joint separation include elevation of the distal clavicle and sharp pain in the joint. Rotator cuff tendon tears (particularly of the supraspinatus muscle) can be caused by forceful throwing (*e.g.*, baseball) and improper weightlifting techniques (14).

Elbow

The elbow is an important joint involved in lifting, carrying, throwing, swinging, and most upper extremity exercise movements. The elbow is commonly injured and is the second most injured joint from overuse or repetitive motion (21,22).

Structure

Bones

The bones of the elbow joint include the humerus, radius, and ulna. The humeroulnar joint is the articulation of the distal humerus with the proximal ulna, the humeroradial joint is the articulation of the distal humerus with the proximal radius, and the proximal radioulnar joint is the articulation of the proximal radius with the proximal ulna (Fig. 3.20) (2).

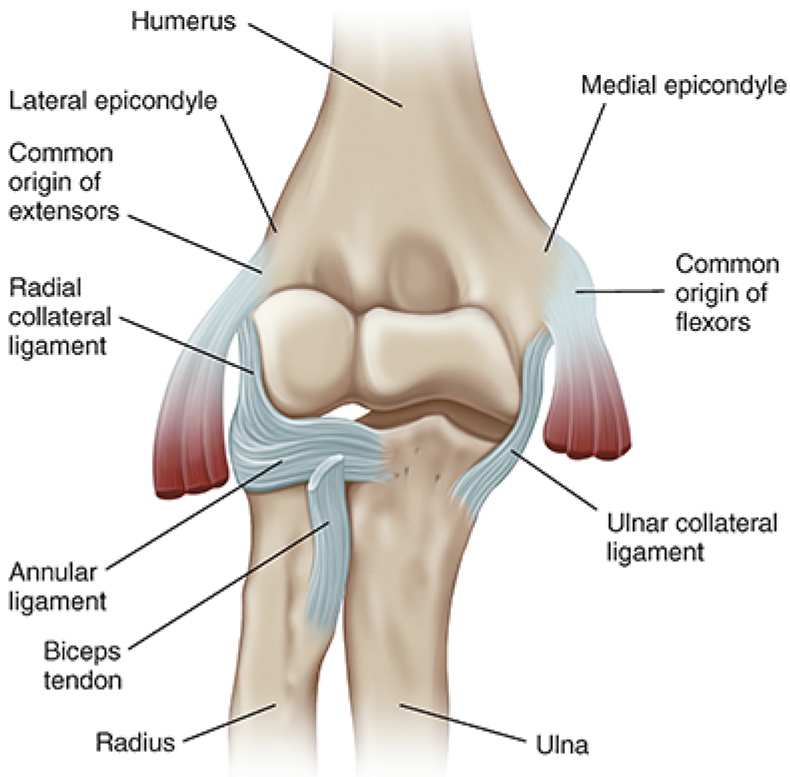


FIGURE 3.20. Bones and ligaments of the elbow joint — anterior view. (From Premkumar K. *The Massage Connection: Anatomy and Physiology*. 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2011, with permission.)

> The elbow is an important joint involved in lifting, carrying, throwing, swinging, and most upper extremity exercise movements. The elbow is commonly injured and is the second most injured joint from overuse or repetitive motion.

With the arms held at the side of the body and the palms of the hand facing anteriorly, the forearm and hands are usually held slightly away from the body. This is because of the carrying angle of the elbow, which is normally 5°–15° in males and 20°–25° in females. Carrying angle allows the forearm to swing free of the side of the hips during walking and provides a mechanical advantage when carrying objects (4).

Ligaments

Three major ligaments stabilize the elbow: the ulnar (medial) collateral ligament, which connects the humerus with the ulna; the radial (lateral) collateral ligament, which connects the humerus with the radius; and the annular ligament, which connects the radius with the ulna. The collateral ligaments provide support for stresses in the frontal plane, the medial collateral for valgus forces, and the lateral collateral for varus forces. The annular ligament provides stability for the radius, securing it to the ulna (see Fig. 3.20) (2).

Joints

The elbow joint complex is a compound synovial joint that consists of two articulations: humeroulnar and humeroradial. It is continuous with the proximal radioulnar joint, responsible for allowing the radial head to rotate during pronation and supination of the forearm. The distal humerus articulates with both the proximal ulna and proximal radius, and the two articulations are enclosed by one capsule and share a single synovial cavity. On the lateral side of the elbow, the capitulum of the humerus articulates with the head of the radius to form the humeroradial joint; medially, the trochlea of the humerus articulates with the trochlear notch of the ulna to form the humeroulnar joint. The proximal radioulnar joint, whose joint capsule is continuous with that of the humeroulnar and humeroradial joints, is the articulation of the radial head with the radial notch of the ulna (see Fig. 3.20) (2).

Movements

Both the humeroulnar and humeroradial are hinge joints that flex and extend the elbow in the sagittal plane (Fig. 3.21). The normal ROM for flexion–extension is 145°–150°, with the fully flexed position (elbow bent) represented by 145°–150° and the fully extended position (arm straight with forearm) represented by 0°. During sagittal movement of the elbow, the trochlear notch of the humerus slides into the trochlear groove of the ulna. Upon full flexion, the coronoid process of the ulna approximates the coronoid fossa of the humerus. At full extension, the olecranon process of the ulna hits the olecranon fossa of the humerus, which enhances stability of the elbow in full extension. The proximal radioulnar joint is a pivot joint, which permits axial rotation of the radial head during supination and pronation of the forearm. Normal ROM for supination (forearm rotated laterally — palms facing anteriorly) is 80°–90°; normal ROM for pronation (forearm rotated medially — palms facing posteriorly) is 80°–90° (2).

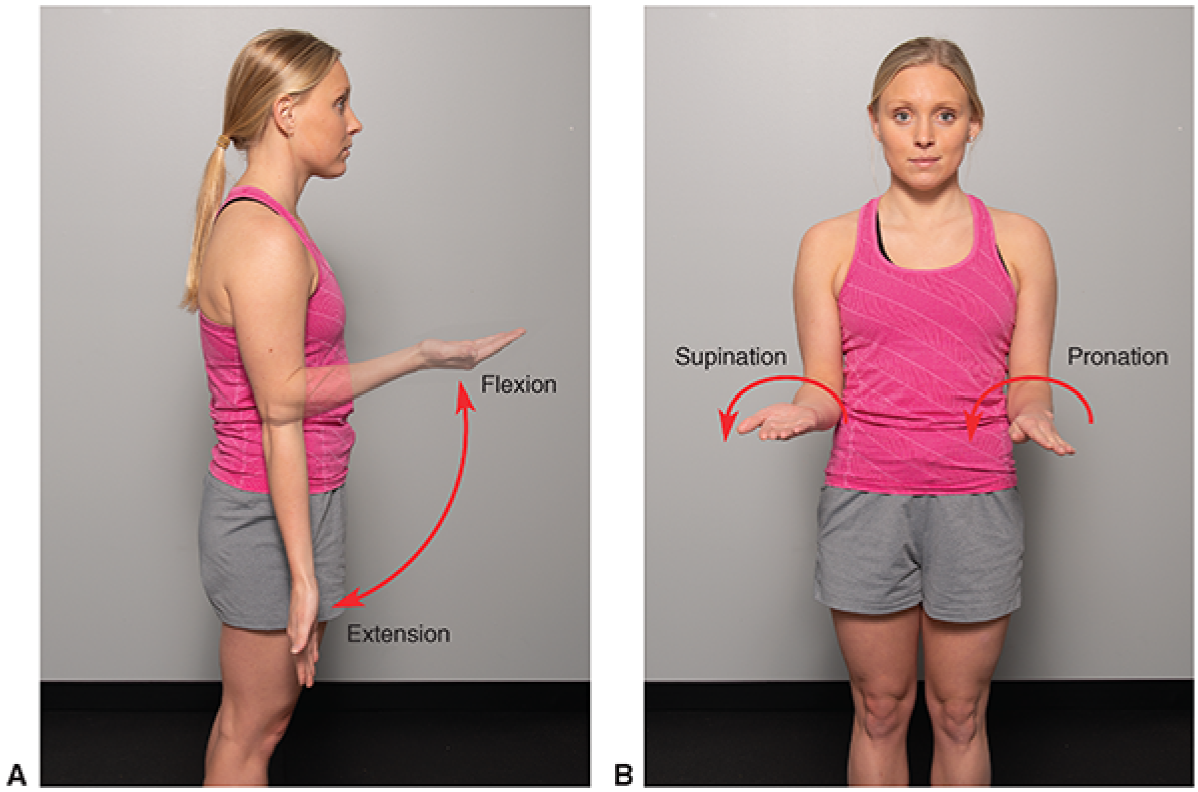


FIGURE 3.21. Movements of the elbow. **A.** Flexion–extension. **B.** Pronation–supination.

Muscles

Anterior

The anterior muscles of the arm mainly flex the elbow joint (23) and include the biceps brachii, brachialis, and brachioradialis (Fig. 3.22). The biceps brachii is a two-head, two-joint muscle that acts on both the shoulder and elbow. Its long head originates from the supraglenoid tubercle of the scapula, and the short head originates from the coracoid process of the scapula, with both heads inserting at the tuberosity of the radius. The biceps brachii is a strong supinator and flexes the elbow most effectively when the forearm is in supination. The long head of the biceps brachii also assists in shoulder flexion. To optimally train the biceps brachii, exercise movements should include both elbow flexion and forearm supination (*e.g.*, dumbbell biceps curl). The brachialis is considered the elbow flexor workhorse (4). Hammer curls, with the forearms maintained in a neutral position, are ideal to develop the brachialis and brachioradialis. In the forearm, the pronator quadratus and pronator teres, as their names suggest, cause pronation. The pronator quadratus is the stronger of the two.

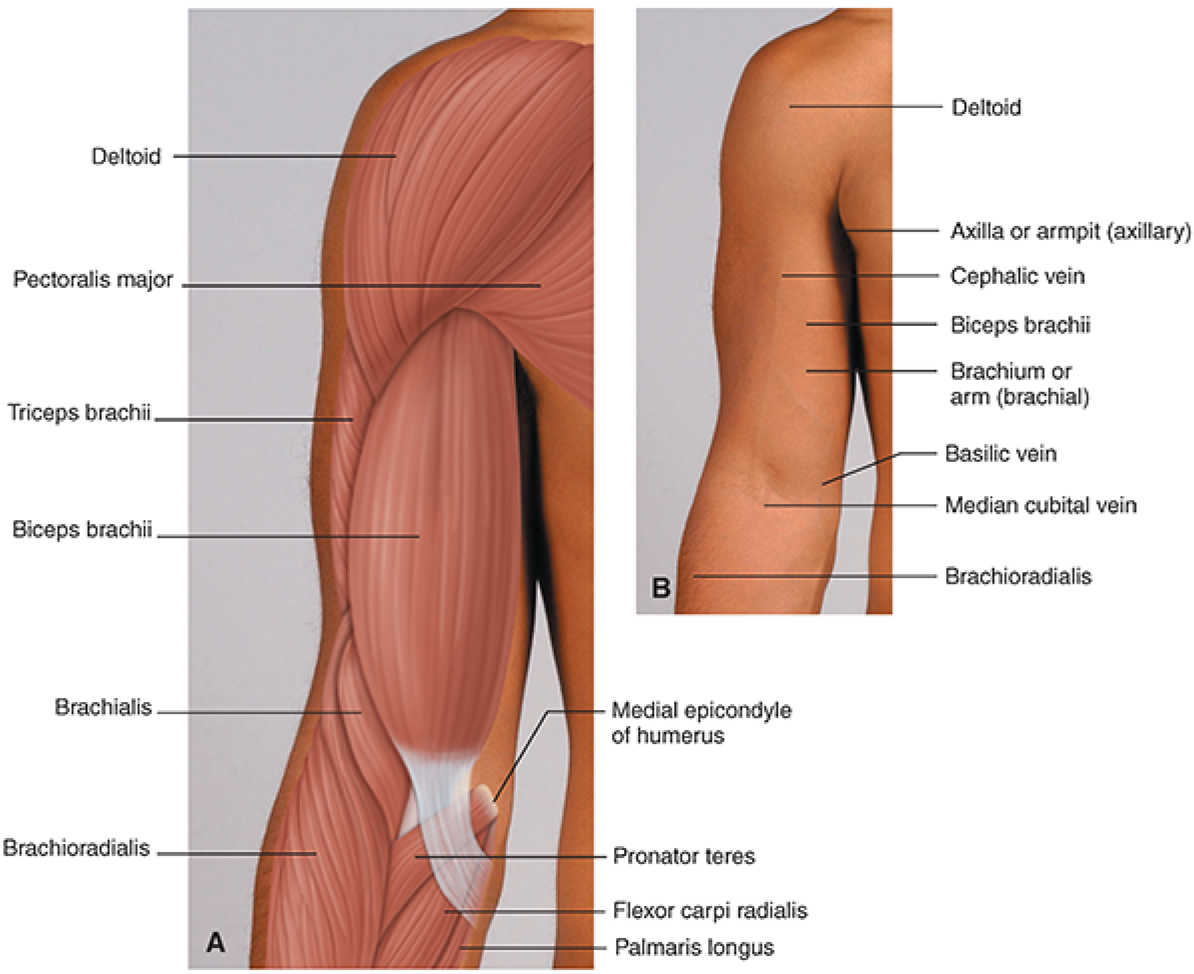


FIGURE 3.22. Muscles of the arm (brachium) — anterior view. **A.** Muscles. **B.** Surface landmarks. (From Premkumar K. *The Massage Connection: Anatomy and Physiology*. 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2011, with permission.)

Posterior

The posterior muscles of the elbow primarily extend the elbow joint and include the triceps brachii and anconeus (Fig. 3.23). The triceps brachii is a three-head, two-joint (long head) muscle that acts on the elbow and shoulder. Its long head originates from the infraglenoid tubercle of the scapula, whereas the medial and lateral heads originate from the upper humerus. All three heads insert on the olecranon of the ulna. The triceps brachii is the main elbow extensor, getting minor assistance from the anconeus. The anconeus, a small muscle, also adds stability to the posterior elbow joint (5).

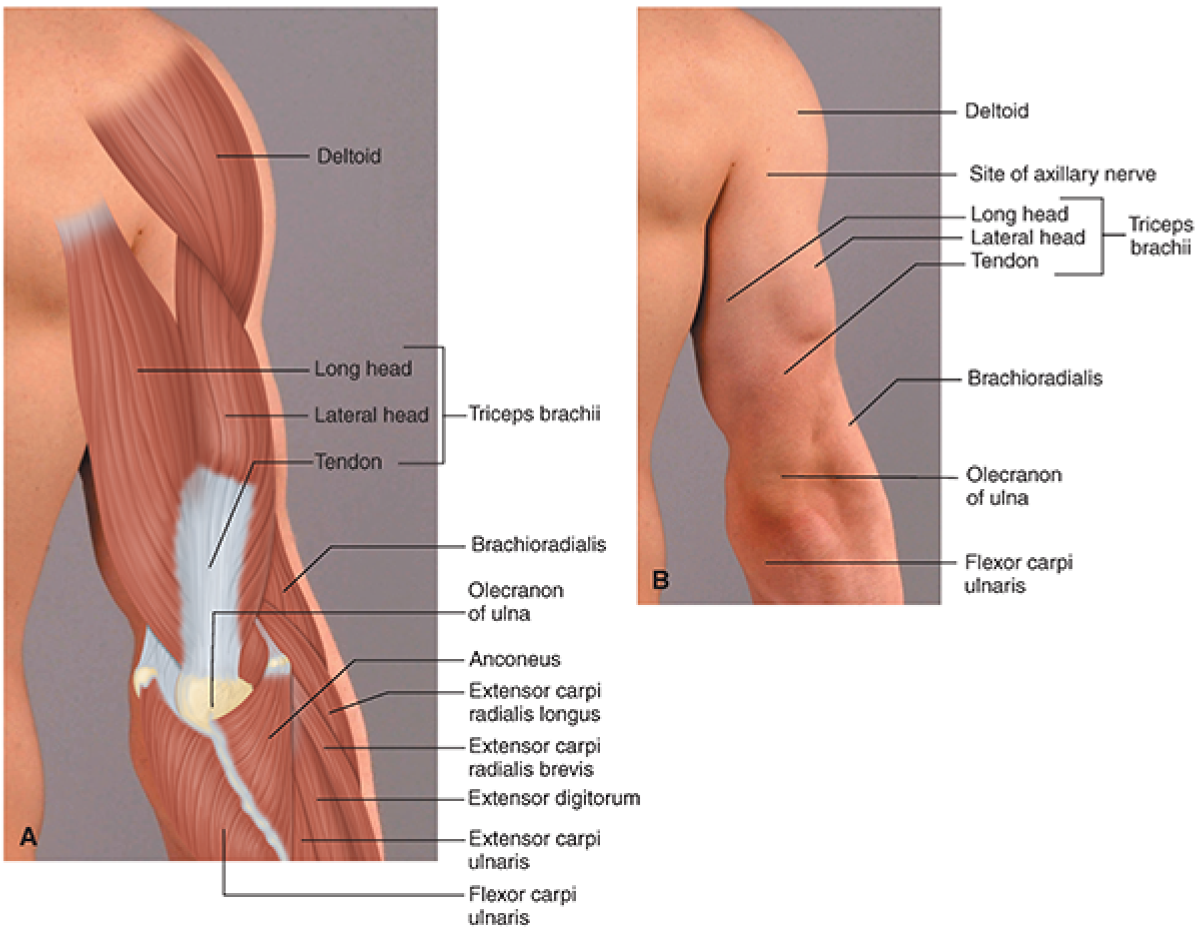


FIGURE 3.23. Muscles of the arm (brachium) — posterior view. **A.** Muscles. **B.** Surface landmarks. (From Premkumar K. *The Massage Connection: Anatomy and Physiology*. 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2011, with permission.)

Injuries

Because of its use in most upper extremity daily living activities, exercise, and sport activities, the elbow is frequently injured from chronic overuse or repetitive motion (14). Tendonitis is evident in a variety of muscular insertion points at the elbow. "Tennis elbow" (lateral epicondylitis), which creates lateral elbow pain, is the most widespread overuse injury of the adult elbow (21,22). It is usually caused by eccentric overload of the forearm extensor muscles (*e.g.*, gripping a racquet too tightly, wrong grip size, faulty backhand technique, excessive racquet weight) (24). "Golfer's elbow" (medial epicondylitis), which produces medial elbow pain, is often caused by repeated valgus stresses placed on the arm during swinging of racquets or clubs. Triceps tendonitis, which produces pain over the olecranon, is caused by repetitive posterior stresses during elbow extension. Resistance and flexibility exercises for elbow flexion, extension, pronation, and supination are often incorporated to prevent and treat these injuries. Medial collateral ligament sprain often results from repetitive microtrauma and excessive valgus force (14).

The elbow is also the site for traumatic injuries. Olecranon bursitis, which typically produces a large red swelling over the posterior elbow, usually results from a fall directly on the elbow. Ulnar dislocation typically results from violent hyperextension or varus or valgus forces. Ulnar dislocation, which is most common in individuals younger than 20 years, results in obvious elbow deformity and may present with neurological symptoms into the hand (fifth digit) because of entrapment of the ulnar nerve at the elbow (14).

Wrist, Hand, and Fingers

The wrist, hand, and fingers are required for most daily living, work, and sports activities, including tasks such as gripping, lifting, writing, typing, eating, and throwing. Because adequate wrist and hand function is necessary for these activities, injuries to the wrist and hand are often disabling. In addition, this section focuses mainly on the functional anatomy of the wrist. The reader is referred to other sources (6–10) for the functional anatomy of the intrinsic hand and fingers.

Structure

Bones

The wrist, hand, and fingers consist of 29 bones: a distal ulna, a distal radius, 8 carpals, 5 metacarpals, and 14 phalanges (Fig. 3.24) (15). The carpals are small oddly shaped bones arranged in two rows. The proximal row from lateral to medial includes scaphoid (navicular), lunate, triquetrum, and pisiform. The distal row from lateral to medial includes trapezium, trapezoid, capitate, and hamate. There is one metacarpal per digit, which connects the carpals to the phalanges. Each digit has three phalanges, except the thumb, which has two (11).

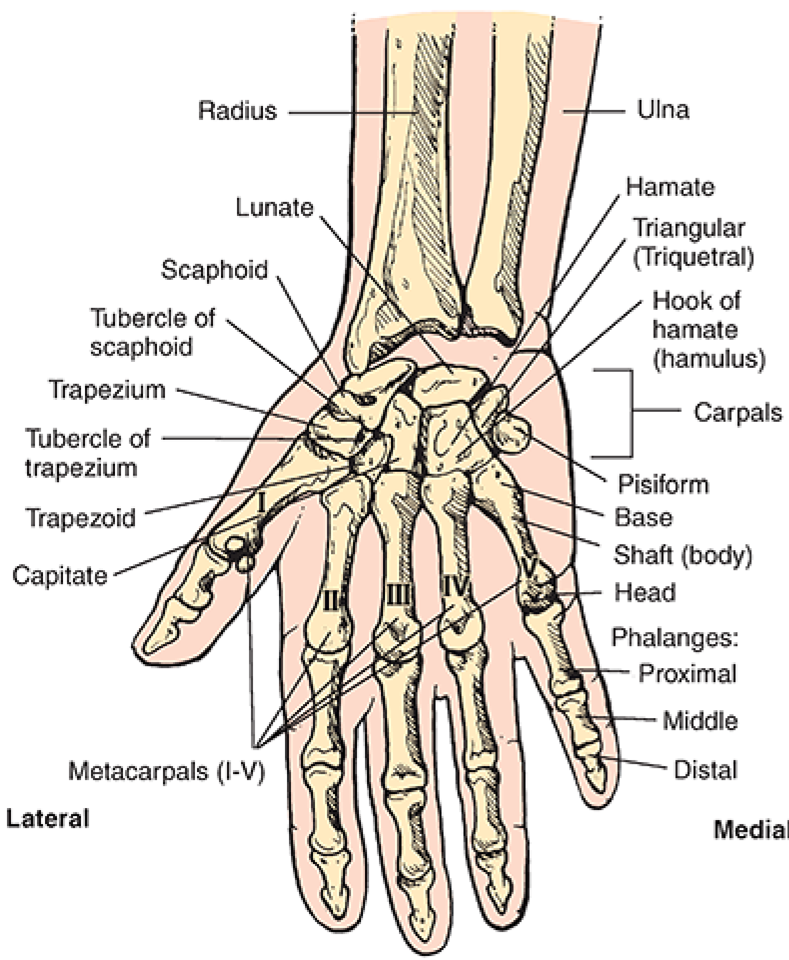


FIGURE 3.24. Bones of the wrist and hand — anterior view. (From Anderson M, Hall SJ. *Sports Injury Management*. 2nd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2000, with permission.)

Ligament

The volar radiocarpal, dorsal radiocarpal, radial collateral, and ulnar collateral ligaments support the radioulnar joint. The radiocarpal ligaments provide stability in the sagittal plane, whereas the collateral ligaments provide stability in the frontal plane (11). There are numerous other ligaments that stabilize the wrist, hand, and fingers, many of which have clinical implications for health care professionals other than Personal Trainers.

Joints

The primary wrist joint (radiocarpal joint) is a condyloid (ellipsoidal) joint consisting of the articulation of the distal radius with three proximal carpal bones: scaphoid, lunate, and triquetrum. The joint surface of the radius is concave, allowing the convex carpals to approximate it. The proximal and distal rows of carpal bones form the complex midcarpal joint. The distal radioulnar joint, a pivot joint, is situated medial to the radiocarpal joint and allows forearm supination and pronation (11).

Movement

The wrist allows approximately 70°–90° of flexion and 65°–85° of extension in the sagittal plane and 15°–25° of abduction (radial deviation) and 25°–40° of adduction (ulnar deviation) in the frontal plane (Fig. 3.25). Flexion–extension and abduction–adduction movements occur mainly at the radiocarpal joint. However, gliding motions at the midcarpal joint, which are facilitated by ligaments, allow full ROM in both planes. Circumduction of the wrist is also possible through the compound action of the radioulnar and midcarpal joints. The closed pack position of the wrist joint is full extension, whereas the open pack position is 0° of extension with slight adduction (4).

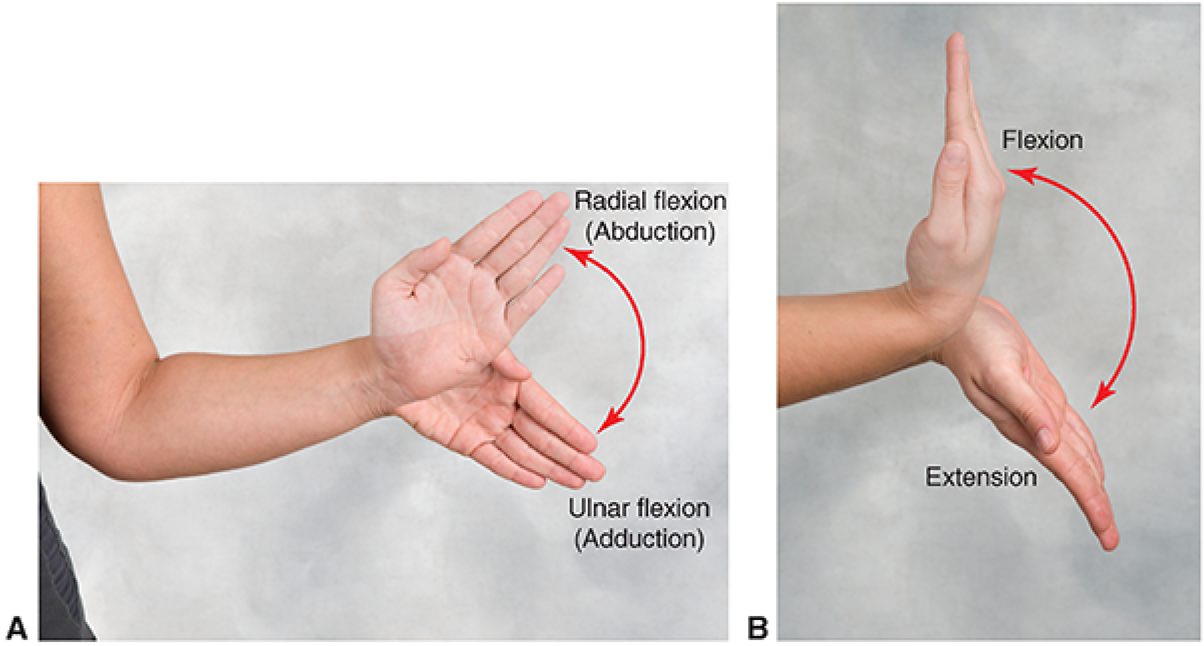


FIGURE 3.25. Movements of the wrist. **A.** Abduction–adduction. **B.** Flexion–extension. (From Premkumar K. *The Massage Connection: Anatomy and Physiology*. 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2011, with permission.)

Muscles

Anterior

The wrist flexor muscles, which are located on the anteromedial aspect of the wrist and generally originate from the medial epicondyle of the humerus, include the flexor carpi radialis, flexor carpi ulnaris, flexor digitorum superficialis, and palmaris longus (Fig. 3.26). In addition to the flexor activity, the flexor carpi radialis abducts the wrist, the flexor carpi ulnaris adducts the wrist, and the flexor digitorum superficialis flexes the phalanges as well (5).

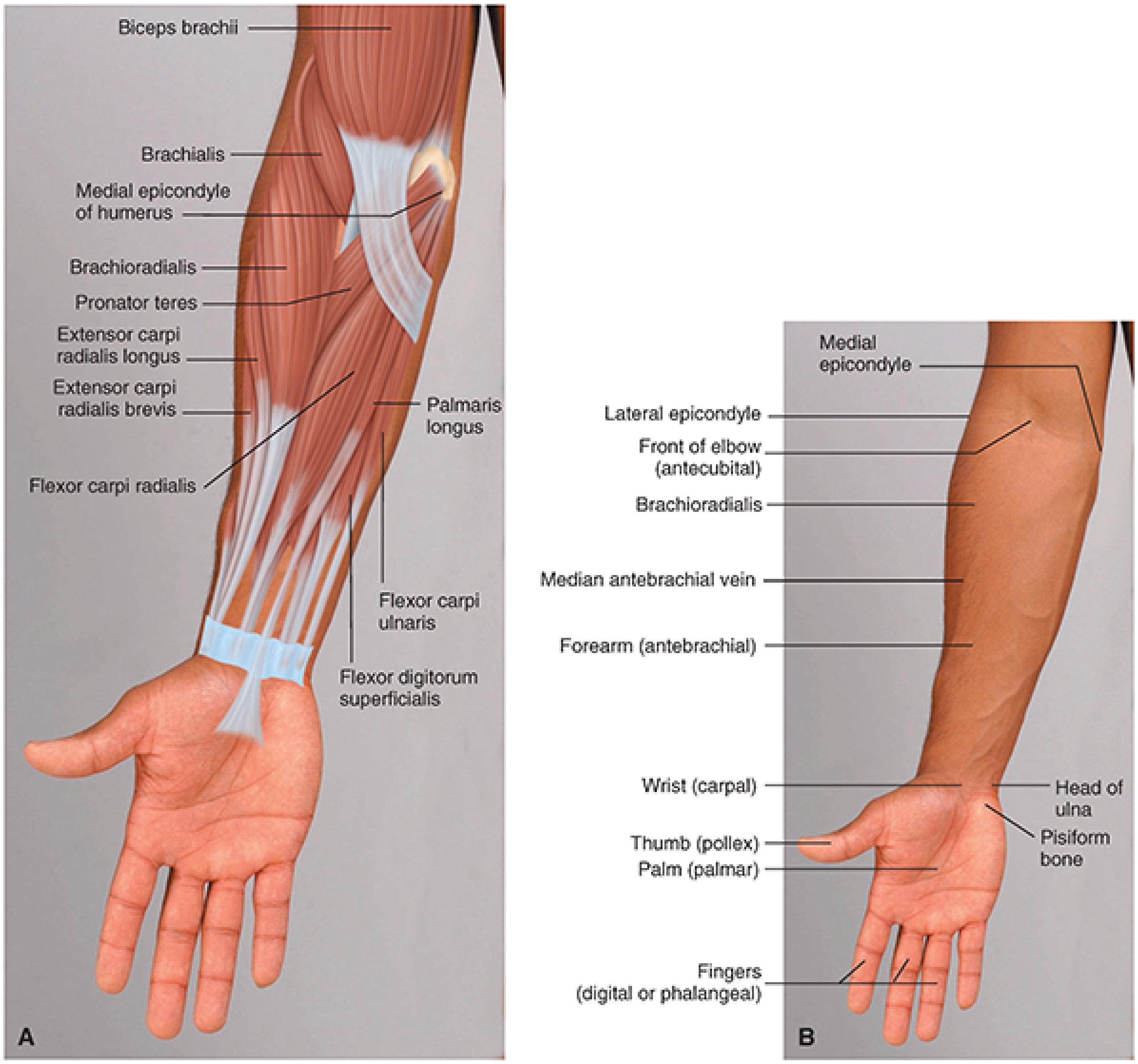


FIGURE 3.26. Muscles of the forearm (antebrachium) — anterior view. **A.** Muscles. **B.** Surface landmarks. (From Premkumar K. *The Massage Connection: Anatomy and Physiology*. 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2011, with permission.)

Posterior

The wrist extensor muscles, which are located on the posterolateral aspect of the wrist and generally originate at or near the lateral epicondyle of the humerus, include the extensor carpi radialis longus and brevis, extensor digitorum, extensor digiti minimi, and the extensor carpi ulnaris (Fig. 3.27). In addition to their extensor activity, the extensor carpi radialis longus abducts the wrist and the extensor carpi ulnaris adducts the wrist, and extensor digitorum and extensor digiti minimi extend the phalanges as well (5).

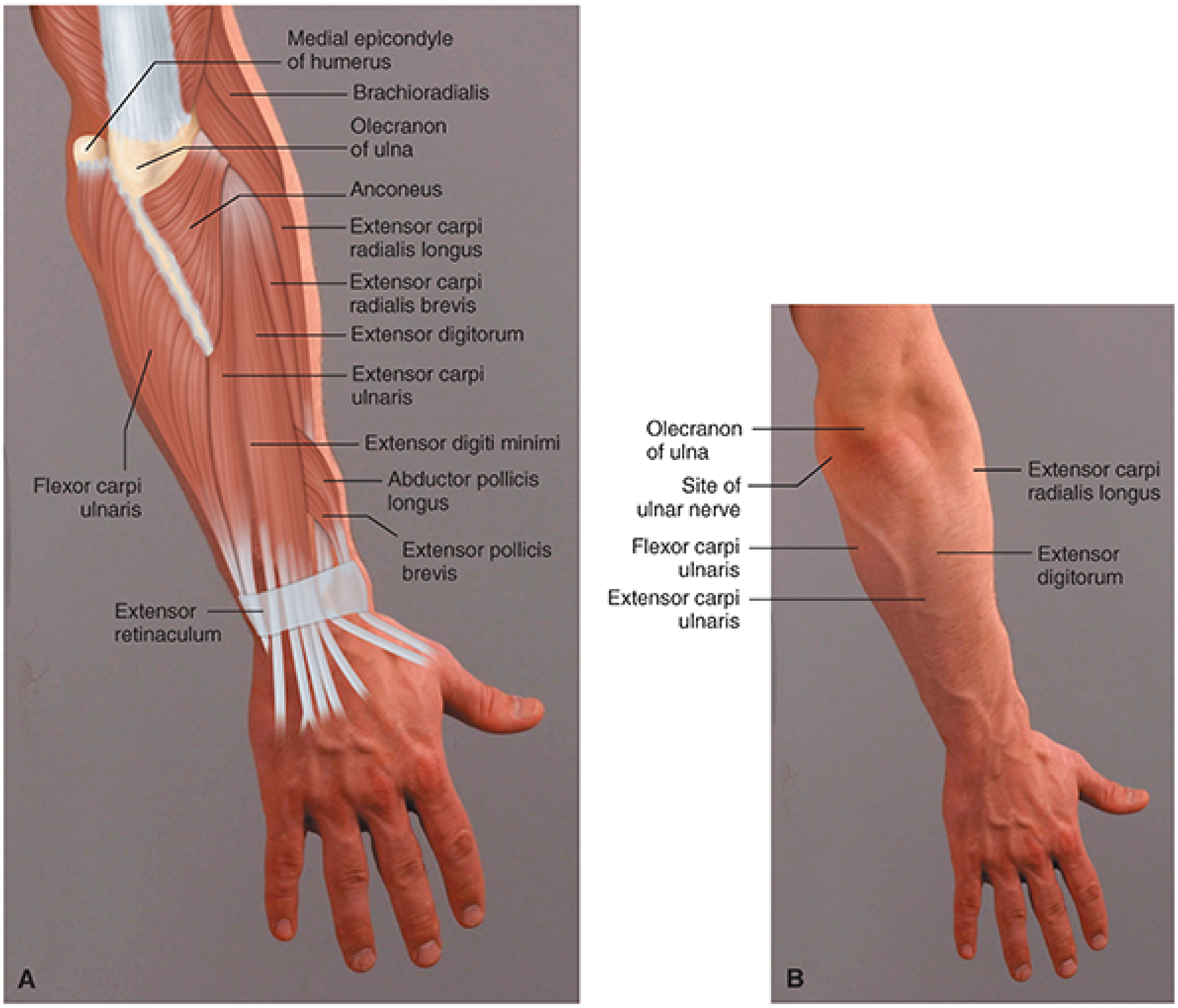


FIGURE 3.27. Muscles of the forearm (antebrachium) — posterior view. **A.** Muscles. **B.** Surface landmarks. (From Premkumar K. *The Massage Connection: Anatomy and Physiology*. 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2011, with permission.)

Injuries

Dislocations, fractures, and sprains are common at the wrist after falls. Falling on an outstretched arm with the wrist extended may cause lunate bone dislocation (usually anteriorly) or scaphoid bone fracture. Colles and Smith fractures are serious fractures affecting both the distal ulna and radius, which many times require fixation with rigid screws and plates to restore function

(25). Wrist ligament sprains are frequently caused by axial loading of the palm during a fall on an outstretched arm (14).

Carpal tunnel syndrome is a widespread cumulative trauma disorder that is caused by median nerve entrapment at the anterior wrist (20). It usually results from repeated microtrauma to the carpal tunnel and flexor retinaculum because of prolonged manual work with the wrist in a flexed position (*e.g.*, in individuals who work with computer keyboards, assembly line workers, cyclists). Its symptoms include pain, numbness, tingling, and weakness in thumb, index, and middle finger (median nerve distribution). Carpal tunnel syndrome usually requires physical rehabilitation, surgery, or ergonomic correction to restore function.

> Carpal tunnel syndrome usually results from repeated microtrauma to the carpal tunnel and flexor retinaculum because of prolonged manual work with the wrist in a flexed position (*e.g.*, in individuals who work with computer keyboards, assembly line workers, cyclists).

Lower Extremity

Pelvis and Hip

The pelvic girdle is the link between axial skeleton (trunk) and lower extremities. This region assists with motion, stability, and shock absorption and helps distribute body weight evenly to the lower extremities (4). The pelvic girdle is the link between the axial skeleton (trunk) and lower extremities.

Bones

The bones of the pelvic girdle (pelvis) are the sacrum and innominate (os coxae). The innominate bone includes the fused ilium (largest pelvic bone), ischium, and pubis on each side (which typically fuse by the end of puberty). The two sides of the pelvis join anteriorly at the pubic symphysis and posteriorly at the sacroiliac joints, where the sacrum and coccyx serve as the inferior foundation for the lumbosacral spine. The pelvis of females is usually wider than that of males, which contributes to the increased "Q angle" of the knee in females (4). The anterior superior iliac spine (ASIS) of the ilium is a bony protuberance that provides an attachment point for several muscles of the anterior thigh. The sacrum articulates with the pelvis on each side, forming the sacroiliac joints. The pelvis articulates with each femur at the acetabulum, forming the hip joints (Fig. 3.28) (11).

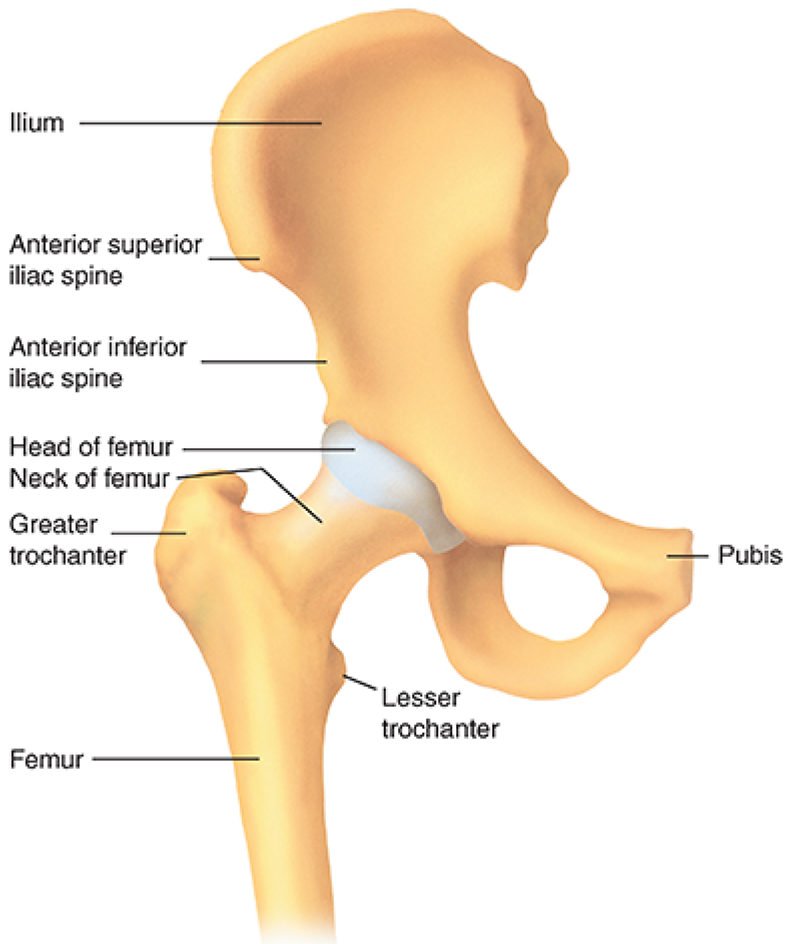


FIGURE 3.28. Bones of the pelvis and hip region — anterior view. (Reprinted with permission from Anatomical Chart Company. *ACC's Joints of the Lower Extremities Anatomical Chart*. Baltimore [MD]: Lippincott Williams & Wilkins; 2003.)

Ligaments

The anterior, posterior, and interosseous ligaments bind the sacroiliac joint. The highly mobile hip joint is stabilized by several intrinsic ligaments, forming a strong, dense joint capsule (2). They include iliofemoral, pubofemoral, and ischiofemoral ligaments. The iliofemoral ligament (“Y” ligament) is an extraordinarily strong band that checks hip extension and rotation. The pubofemoral ligament prevents excessive abduction. The ischiofemoral ligament is triangular and limits hip rotation and adduction in the flexed position (Fig. 3.29) (2). The transverse acetabular ligament is a sturdy band that bridges the acetabular notch and completes the acetabular ring of the hip joint. The ligamentum teres ligament (ligament of the femoral head) ties the head of the femur to the acetabulum, providing reinforcement from within the joint (Fig. 3.30).

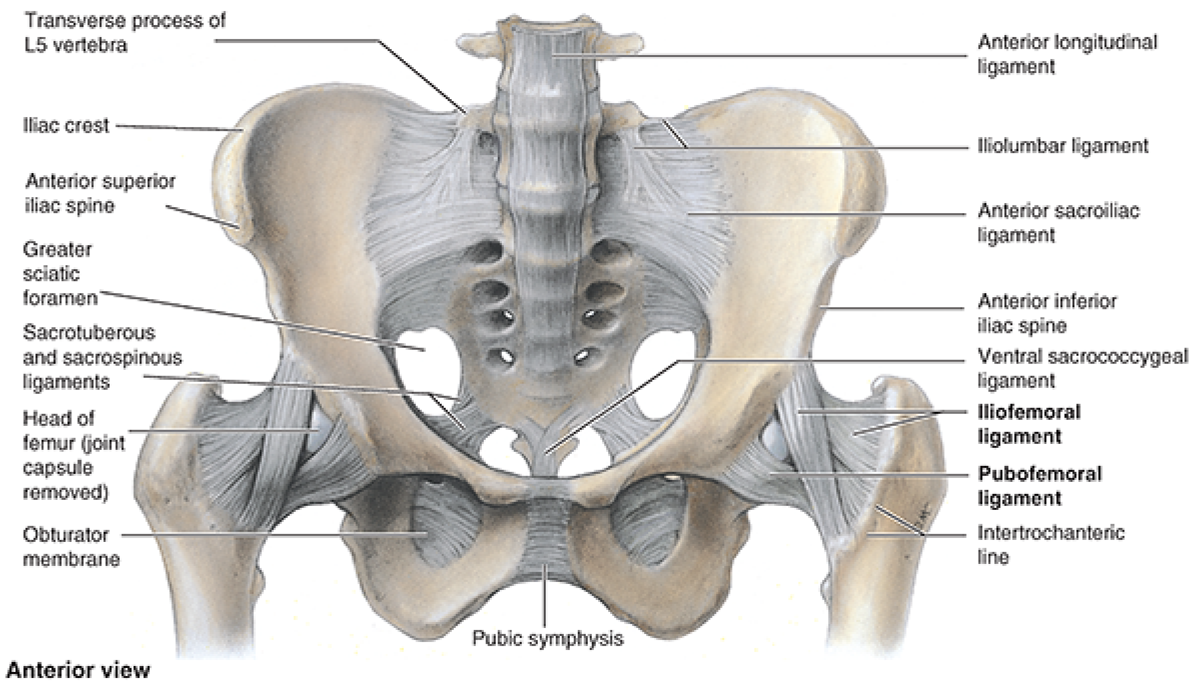


FIGURE 3.29. Ligaments of the pelvis and hip regions — anterior view. (From Moore KL, Dalley AF II. *Clinically Oriented Anatomy*. 4th ed. Baltimore [MD]: Lippincott Williams & Wilkins; 1999, with permission.)

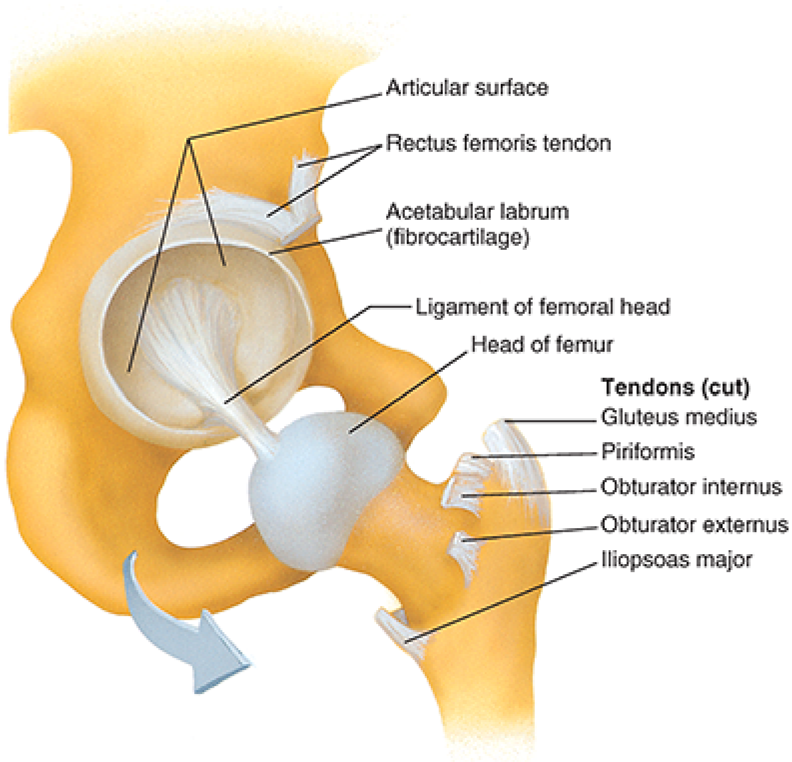


FIGURE 3.30. Acetabulum of the hip joint. (Reprinted with permission from Anatomical Chart Company. *ACC's Joints of the Lower Extremities Anatomical Chart*. Baltimore [MD]: Lippincott Williams & Wilkins; 2003.)

Joints

The pubic symphysis connects each side of the pelvic girdle anteriorly and is an amphiarthrodial joint. The sacroiliac joint connects the sacrum to the ilium on each side and is sometimes described as a gliding joint. These joints are capable of relatively little movement (2).

The hip joint is a ball-and-socket (enarthrodial) joint and is one of the most mobile joints in the body. The hip joint is formed by the articulation of the proximal femur (femoral head) with the acetabulum of the pelvis. The femoral head is covered with hyaline cartilage, except at the fovea capitis, and the acetabulum is lined with hyaline cartilage as well. The acetabular labrum is a fibrocartilaginous "lip" that adds depth to the acetabulum and serves as a cushion for the femoral head (see Fig. 3.30) (4).

Movements

The pelvic girdle allows movement in three planes. These movements are shown in Figure 3.31. Movement at the pelvis during normal activities usually involves simultaneous motion of the hip and lumbar spine (2). In the sagittal plane, the pelvis is capable of anterior–posterior tilt. With anterior pelvic tilt, the pubic symphysis moves inferiorly, the lumbar spine extends, and the hips flex, resulting in an increased lumbosacral angle. With posterior pelvic tilt, the pubic symphysis moves superiorly, the lumbar spine flexes, and the hips extend, resulting in a decreased lumbosacral angle. Lateral tilt of the pelvis occurs in the frontal plane, and rotation of the pelvis occurs in the transverse plane. Locomotion (walking or running) typically involves small oscillations of the pelvis in all three planes (2).

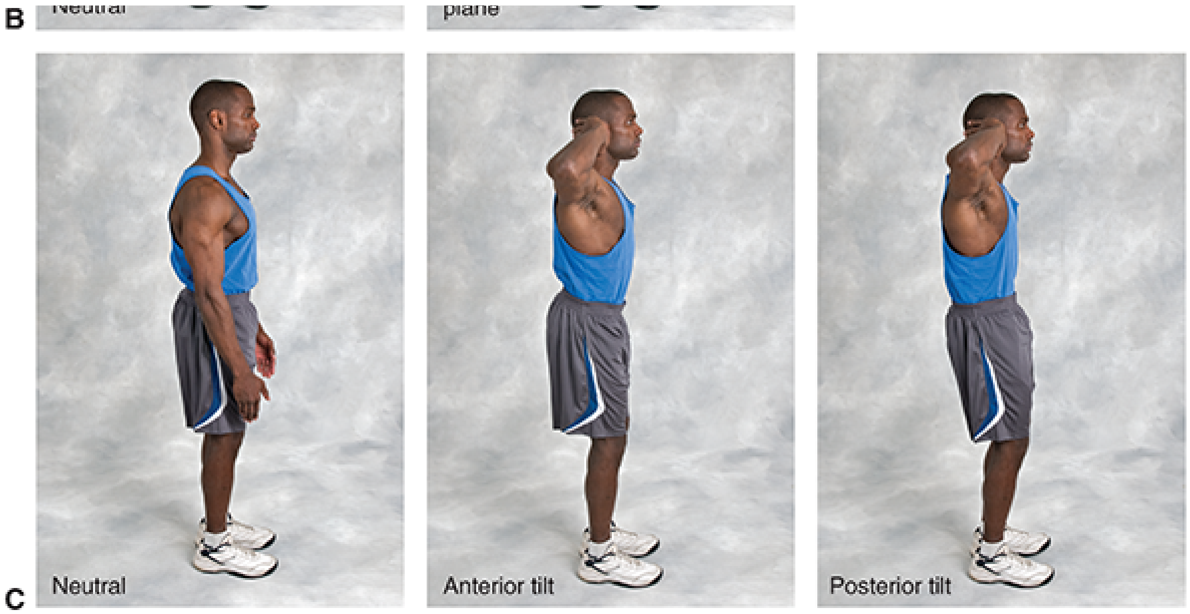


FIGURE 3.31. Movements of the pelvis. **A.** Rotation in the axial plane. **B.** Lateral tilt in the frontal plane. **C.** Anterior and posterior tilt in the sagittal plane.

The highly mobile hip joint allows movement in three planes: flexion–extension in the sagittal plane, abduction–adduction in the frontal plane, internal–external rotation in the transverse plane, and the combined plane movement of circumduction (2). Hip movements are shown in Figure 3.32.

FIGURE 3.32. Movements of the hip joint. **A.** Abduction–adduction. **B.** Flexion–extension. **C.** Internal–external rotation.

Muscles

Pelvis

The muscles of the pelvis include the muscles that act on the lumbar spine, lower trunk, and hip, which are discussed elsewhere in this chapter. In general, anterior pelvic tilt results from contraction of the hip flexors and lumbar extensors. Posterior pelvic tilt results from contraction of the hip extensors and lumbar flexors. Lateral tilt results from contraction of the lateral lumbar muscles (*e.g.*, quadratus lumborum) and hip abductor–adductor muscles, and axial rotation occurs through the action of the hip and spinal rotator muscles (4).

Hip

The muscles that act on the hip are shown in Figures 3.33–3.36.

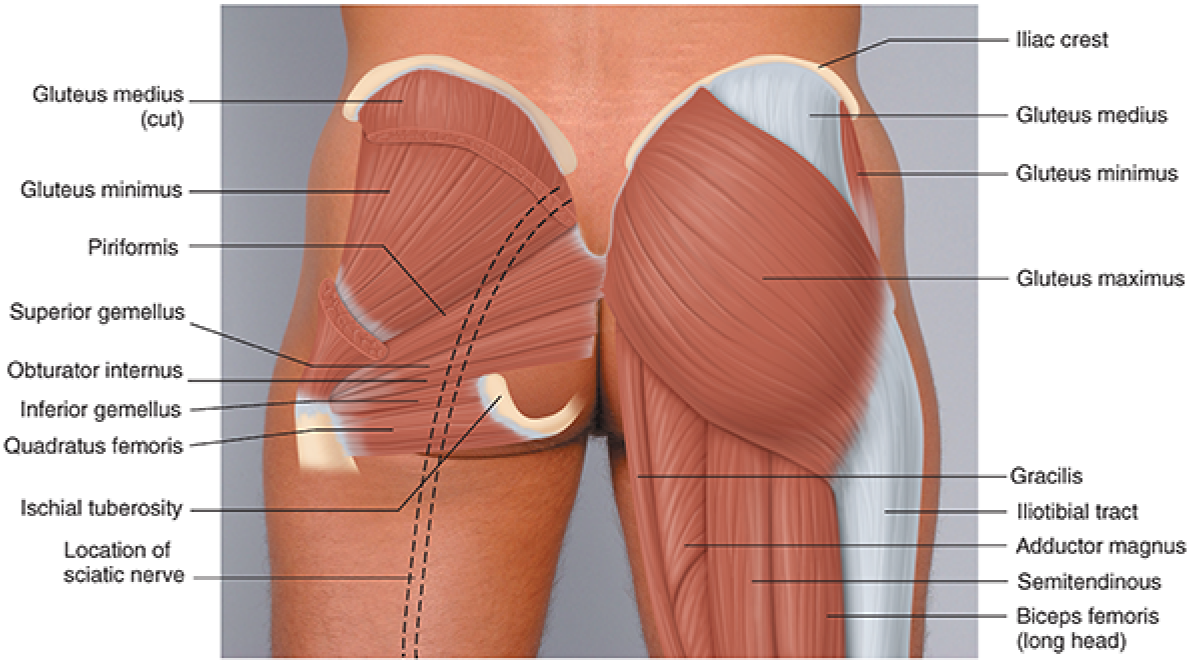


FIGURE 3.33. Superficial *(right)* and deep *(left)* muscles of the hip and pelvis — posterior view. (From Premkumar K. *The Massage Connection: Anatomy and Physiology*. 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2011, with permission.)

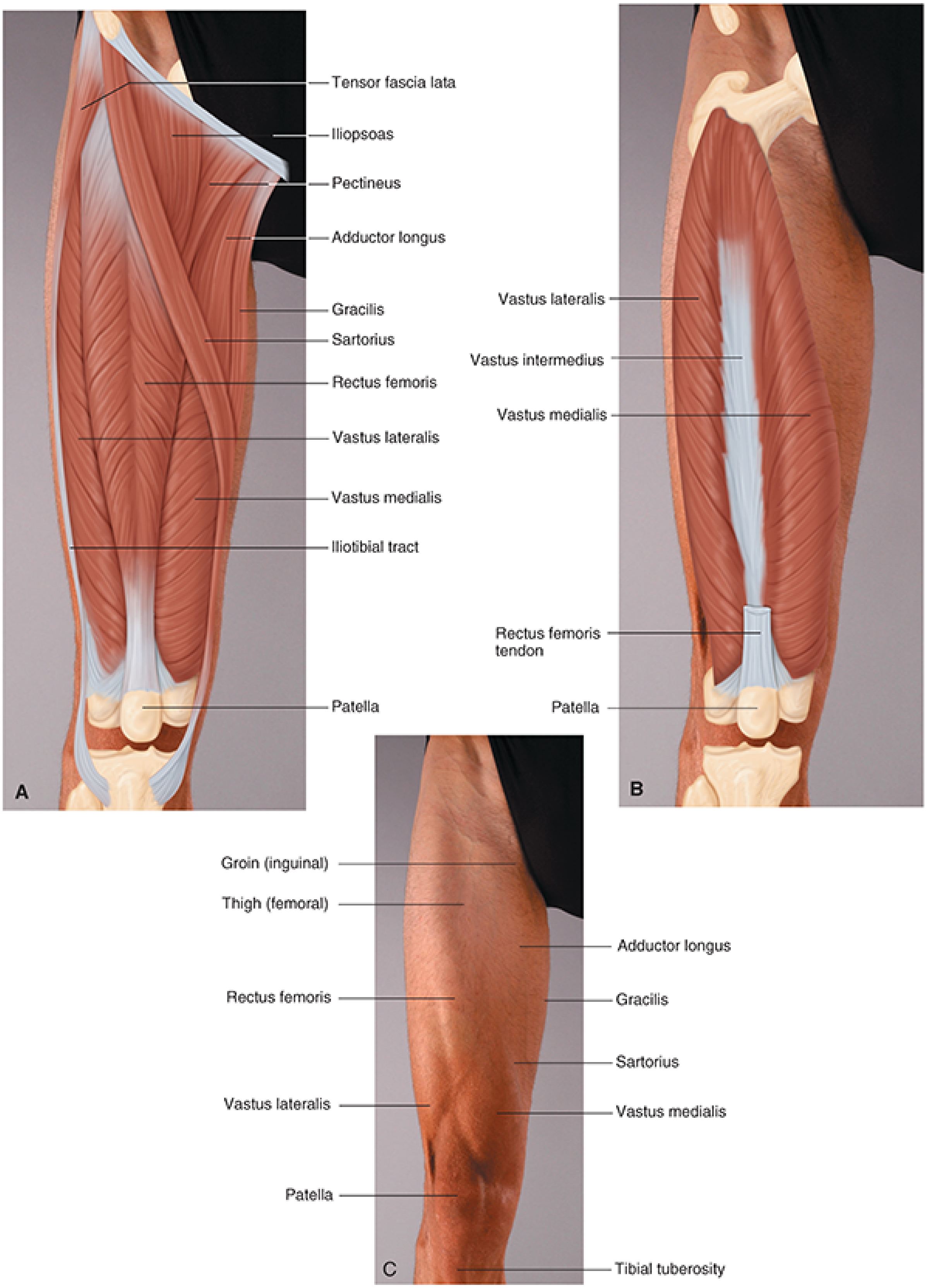

Tensor fascia lata
Iliopsoas
Pectineus
Adductor longus
Gracilis
Sartorius
Rectus femoris
Vastus lateralis
Vastus medialis
Iliotibial tract
Patella
A
Vastus lateralis
Vastus intermedius
Vastus medialis
Rectus femoris tendon
Patella
B
Groin (inguinal)
Thigh (femoral)
Rectus femoris
Vastus lateralis
Patella
Adductor longus
Gracilis
Sartorius
Vastus medialis
Tibial tuberosity
C

FIGURE 3.34. Muscles of the thigh — anterior view. **A.** Muscles. **B.** Quadriceps femoris. **C.** Surface landmarks. (From Premkumar K. *The Massage Connection: Anatomy and Physiology*. 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2011, with permission.)

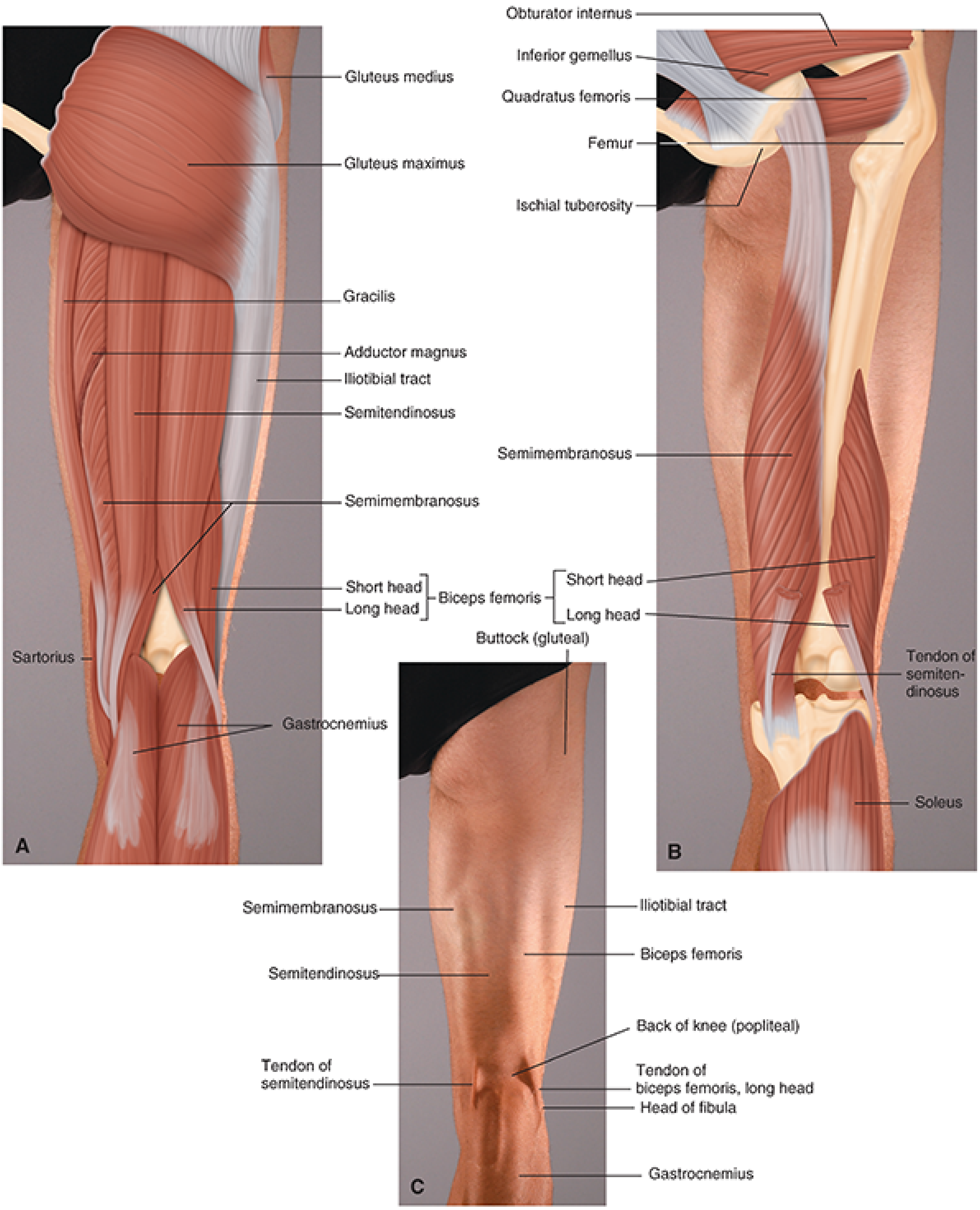


FIGURE 3.35. Muscles of the thigh — posterior view. **A.** Superficial muscles. **B.** Deep muscles. **C.** Surface landmarks. (From Premkumar K. *The Massage Connection: Anatomy and Physiology*. 3rd

ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2011, with permission.)

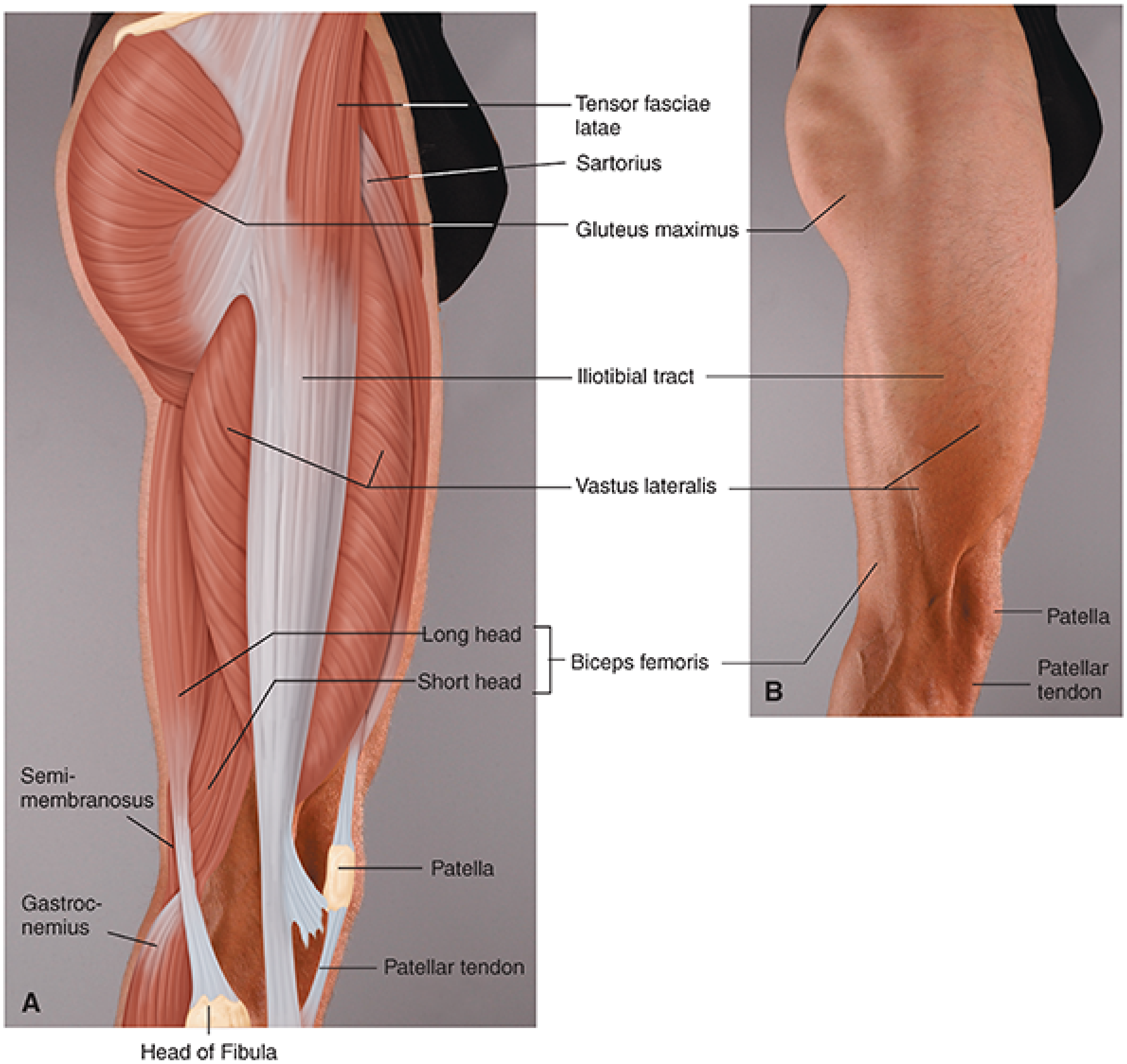


FIGURE 3.36. Muscles of the thigh — lateral view. **A.** Muscles. **B.** Surface landmarks. (From Premkumar K. *The Massage Connection: Anatomy and Physiology*. 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2011, with permission.)

Anterior

The anterior muscles of the hip region include the iliopsoas, pectineus, rectus femoris (a component of the quadriceps femoris), sartorius, and tensor fasciae latae. The iliopsoas muscle group, which consists of the psoas major and iliacus muscles, is a strong hip flexor. The pectineus is a small muscle that attaches the anterior pubis to the posteromedial side of the proximal femur. It assists in hip flexion, adduction, and internal rotation. The rectus femoris is a large two-joint muscle that flexes the hip and extends the knee. The rectus femoris originates from the anterior inferior iliac spine (AIIS) and inserts at the tibial tuberosity via the patellar ligament. The sartorius, a two-joint muscle, is the longest muscle in the body, originating from the ASIS and inserting at the medial tibial surface (pes anserinus). The sartorius flexes, abducts, and externally rotates the hip (it also assists with knee flexion). The tensor fasciae latae, a two-joint muscle, originates from the anterior iliac crest of the ilium and inserts at the anterolateral tibial condyle via a long band of fascia — the iliotibial band. The tensor fasciae latae abducts and flexes the hip and stabilizes the hip against external rotation when the hip is flexed (5) and also assists with extension and stabilization of the knee.

Medial

Medial muscles of the hip include gracilis and the adductors longus, brevis, and magnus. These muscles primarily adduct the hip. Variably, they may participate in hip flexion (adductor longus and brevis, upper fibers of adductor magnus) or extension (lower fibers of adductor magnus) and medial rotation (adductors longus, brevis, and magnus). Pectineus, a muscle previously considered with the anterior hip muscles, also participates in hip adduction. These muscles originate generally from the pubis and insert on the linea aspera of the femur. Gracilis, which is a two-joint muscle inserting on tibia (pes anserine), may also assist with knee flexion.

Posterior

The posterior muscles of the hip include gluteus maximus, medius, and minimus; six deep lateral rotators (piriformis, gemellus superior and inferior, obturators internus and externus, and quadratus femoris); and hamstrings (biceps femoris, semimembranosus, and semitendinosus). Gluteus maximus, which forms the bulk of the buttock regions, has an extensive origin from ilium, sacrum, and coccyx and inserts on the gluteal tuberosity, located on the lateral aspect of femur. In addition to being a powerful extensor of the hip, it also participates in lateral rotation, and abduction and lower fibers may participate in adduction. Gluteus medius and minimus lie deep to gluteus maximus and are abductors and medial rotators of the hip. Additionally, these muscles are important postural muscles to keep the pelvis level during locomotion. They arise from the external surface of ilium and insert on the greater trochanter of femur with most of the deep lateral rotators. Hamstrings (semimembranosus, semitendinosus, and biceps femoris) are two-joint muscles that extend the hip (except the short head of biceps femoris) and flex the knee. Biceps femoris originates from the ischial tuberosity (long head) and proximal femur (short head) and inserts on the lateral tibial condyle and fibular head. The long head extends the hip, flexes the knee, and causes lateral rotation at both joints, whereas the short head acts only on the knee. Semimembranosus and semitendinosus are also two-joint muscles that extend the hip, flex the knee, and internally rotate both joints. They originate on the ischial tuberosity and insert on the medial aspect of the tibia.

> Hip and pelvis have a strong structural anatomy, so traumatic sports injuries at these locations are relatively infrequent compared with injuries to other joints. However, the soft tissues of the thigh are often injured in sports, and the hip and pelvis are sites of several chronic overuse disorders.

Injuries

Hip and pelvis have a strong structural anatomy, so traumatic sports injuries at these locations are relatively infrequent compared with injuries to other joints (14). However, the soft tissues of the thigh are often injured in sports (14), and the hip and pelvis are sites of several chronic overuse disorders.

Traumatic injuries of the pelvis and hip include dislocation, fracture, contusion, and muscle strain. Hip dislocation results from falls, violent twisting of the hip, or jamming the knee into the dashboard of a car. Some 85% of hip dislocations are posterior. Hip fractures (fractures of the femoral neck) are common in older adults with osteoporosis and can cause permanent disability. Contusions (crush injuries of muscle against bone) are common in the region. Iliac crest contusion ("hip pointer") is caused by a direct blow to the pelvis region. Quadriceps contusion ("charley horse") and tearing can result in permanent muscle abnormality called "myositis ossificans," in which bone tissue is deposited within the muscle (14). Hamstring muscle strains and tears are often caused by sudden changes in direction and speed, with underlying factors of muscular imbalance, fatigue, and a deconditioned athlete (14). Hamstring injuries are frequent in preseason or early season activities.

Chronic and overuse injuries to the hip and pelvis include arthritis, bursitis, and tendonitis. Degenerative arthritis of the hip results from abnormal articular cartilage wear from either too much or too little resistance. Avascular necrosis of the hip is caused by the lack of proper blood flow to the femoral head and typically results in severe hip degeneration. Trochanteric bursitis involves irritation of the bursa between the iliotibial band and greater trochanter of the femur. Chronic bursitis in this region can lead to "snapping hip syndrome" (14). Iliotibial band friction syndrome is a chronic overuse injury that causes pain along the lateral aspect of the thigh. Piriformis syndrome is a myofascial disorder that can be caused by overuse and faulty lower extremity biomechanics. The hypertonic piriformis muscle may compress the sciatic nerve because the nerve may course through the muscle. This results in pain and neurological symptoms of the posterior aspect of the lower extremity (sciatica) (20).

Knee

The knee joint is the largest joint in the body. Because the knee joint bears the load of the upper body and trunk and is crucial for locomotion, it is frequently subject to overuse and traumatic injuries (2).

Structure

Bones

The knee joint consists of the distal femur, proximal tibia, and patella (Fig. 3.37). The tibia is the major weight-bearing bone of the leg. The fibula is not considered part of the knee joint (2). The patella (kneecap) is a triangular sesamoid bone that is located within the patellar tendon of the quadriceps muscle group. The patella protects the anterior knee (14) and creates an improved angle of pull for the quadriceps muscles, which results in a mechanical advantage during knee extension (2).

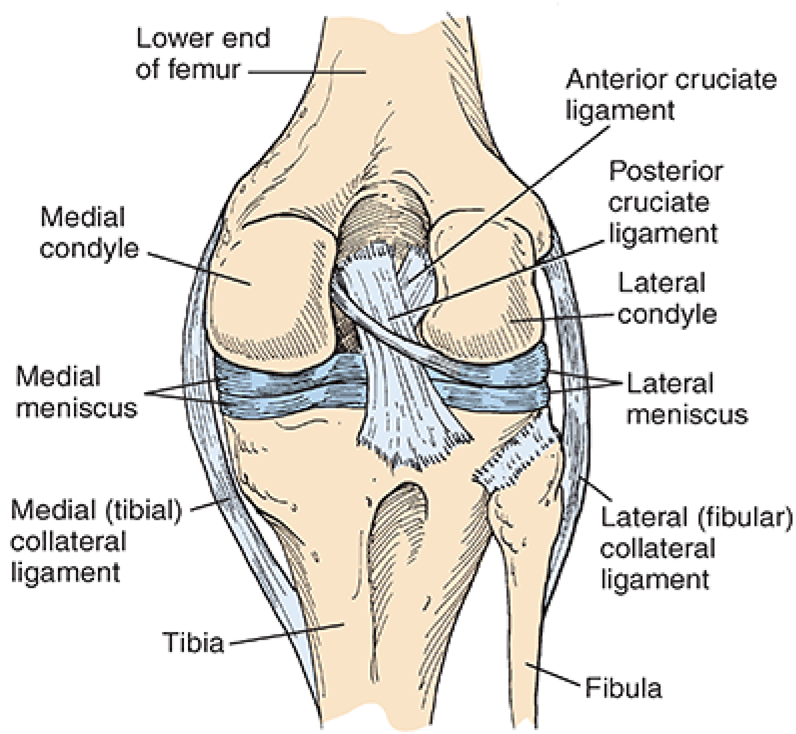


FIGURE 3.37. Bones, ligaments, and menisci of the knee region — posterior view — with the knee extended. (From Cipriano J. *Photographic Manual of Regional Orthopaedic and Neurological Tests*. 5th ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2014, with permission.)

Ligaments

There are two major pairs of ligaments in the knee: the cruciate and collateral ligaments (see Fig. 3.37). The cruciate ligaments cross within the joint cavity between the femur and tibia and are important in maintaining anterior–posterior and rotational stability at the knee. The anterior cruciate ligament is slightly longer and thinner than the posterior ligament (4).

The collateral ligaments connect the femur with the leg bones — the medial collateral with the tibia and the lateral collateral with the fibula. The collateral ligaments aid in stability of the knee, counteracting valgus (lateral deviation) and varus (medial deviation) forces. The medial collateral ligament attaches to the medial meniscus of the knee, but the lateral collateral ligament does not attach to the lateral meniscus (4).

Joints

The knee consists of the tibiofemoral and patellofemoral joints (see Fig. 3.37). The proximal tibiofibular joint, although an important attachment site for knee structures, is typically not considered a compartment of the knee joint (2). The tibiofemoral joint is the primary joint of the knee and primarily a hinge joint allowing flexion and extension; however, with its rotational components about the vertical axis, it is better considered bicondylar. The tibiofemoral joint is formed by the articulation of the medial and lateral femoral condyles with the medial and lateral tibial plateaus. The knee is equipped with fibrocartilage discs (menisci) that are attached to the tibial plateaus and knee joint capsule (see Fig. 3.37) (4). The menisci improve congruency of the joint surfaces (allowing better distribution of joint pressure), add stability, aid in shock absorption, provide joint lubrication, aid in load bearing, add anterior–posterior stability, and protect articular cartilage. The medial meniscus is larger, thinner, and more "C"-shaped than the lateral meniscus (4). The medial femoral condyle typically extends more distally than the lateral condyle, giving the knee a slight valgus arrangement (2).

The patellofemoral joint is an arthrodial joint formed by the posterior aspect of the patella and patellofemoral groove between the condyles of the femur. "Q angle" is the angle formed from the line connecting ASIS to the center of the patella and the line connecting the center of the patella to the tibial tuberosity (Fig. 3.38) (4). It determines the line of pull of the patella at the patellofemoral joint. A normal Q angle is 18° in females and 13° in males. A Q angle that is below normal (negative) results in a genu varum position of the knee (bow-legged), whereas a Q angle that is above normal results in a genu valgum position (knock-kneed) (4).

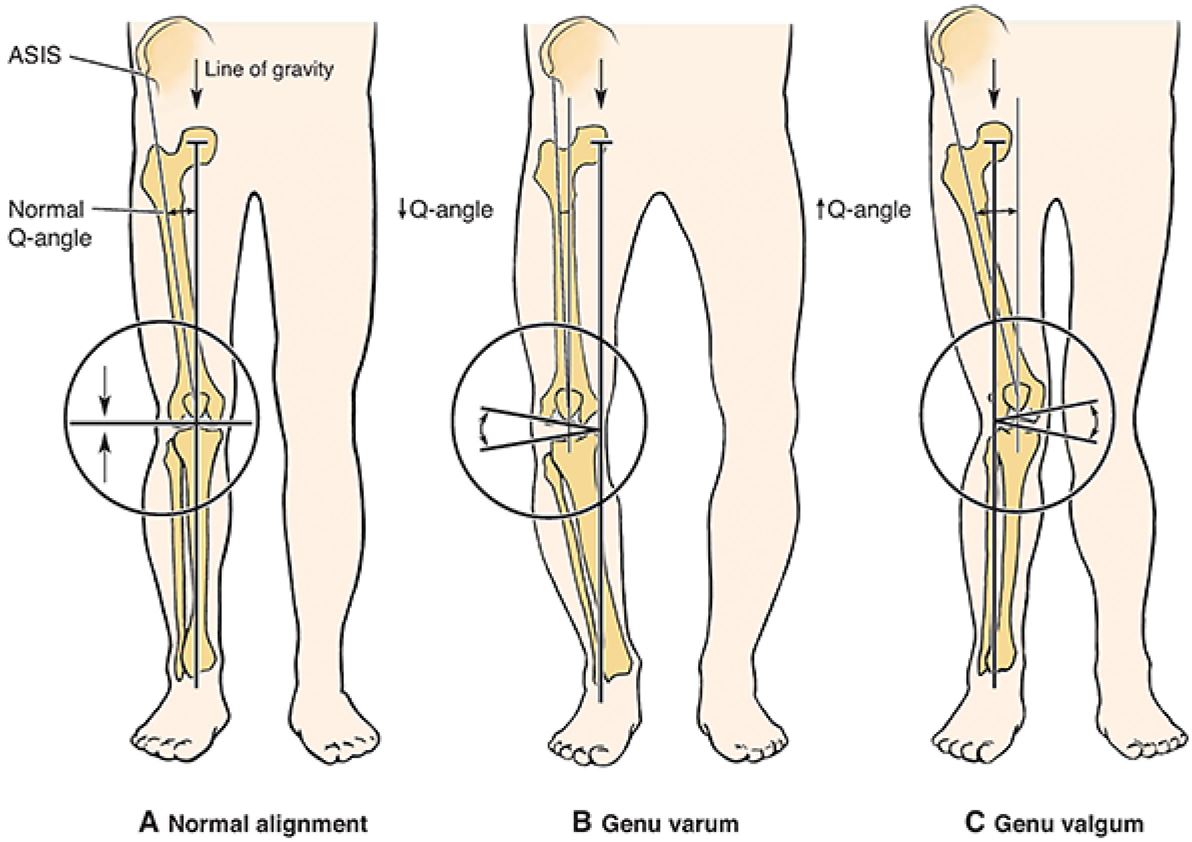


FIGURE 3.38. Q angle of the knee: normal alignment **(A)**, genu varum **(B)**, and genu valgum **(C)**. (From Moore KL, Dalley AF II. *Clinically Oriented Anatomy*. 5th ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2006, with permission.)

Movements

The major movements at the tibiofemoral joint are flexion and extension in the sagittal plane (Fig. 3.39). The knee has a normal ROM of 140° in the sagittal plane, with 0° representing full extension (knee straight) and 140° representing full flexion (knee bent). When the knee is flexed, the tibiofemoral joint is also capable of internal and external rotation in the transverse plane. Approximately 30° of internal rotation and 45° of external rotation can be achieved at the knee (4). During the final few degrees of extension, the tibia externally rotates on the femur, which brings the knee into a close-packed, or locked, position. This phenomenon is known as the "screwing home" mechanism (14).

FIGURE 3.39. Movements of the knee joint (flexion–extension).

Muscles

Anterior

Large and powerful thigh muscles cross the knee joint, several of which are two-joint muscles acting on the hip joint as well. The quadriceps muscles (*i.e.*, rectus femoris, vastus lateralis, vastus intermedius, and vastus medialis) are anterior knee muscles and act to extend the knee joint (see Fig. 3.34). The quadriceps muscles insert into the superior aspect of the patella and ultimately to the tibial tuberosity by the patellar ligament. The rectus femoris is a large, two-joint muscle that originates from the AIIS. The rectus femoris flexes the hip in addition to extending the knee. The three vasti muscles originate from the proximal femur. The vastus lateralis and vastus medialis are pennate muscles that pull on the patella at oblique angles (26).

Posterior

The muscles of the posterior knee joint are the hamstrings (biceps femoris, semitendinosus, and semimembranosus), sartorius, gracilis, popliteus, and gastrocnemius (see Fig. 3.35). The biceps femoris (lateral hamstrings) muscle contains a long head (which originates from the ischial tuberosity and is a two-joint muscle) and a short head (which originates from the midfemur). The biceps femoris inserts into the lateral condyle of the tibia and head of the fibula. It acts to flex and externally rotate the knee and extend and externally rotate the hip. The semimembranosus and semitendinosus (medial hamstrings) are two-joint muscles that act to flex and internally rotate the knee and extend and internally rotate the hip. The sartorius muscle, which originates from the ASIS, acts on both the knee and hip joints. The tendons of the sartorius, gracilis, and semimembranosus join together to form the pes anserinus, which inserts to the anteromedial aspect of the proximal tibia, just inferior to the tibial tuberosity. The gastrocnemius muscle is a two-head and two-joint muscle that acts to flex the knee and plantarflex the ankle (5). The gastrocnemius is discussed in detail in the "Ankle and Foot" section of this chapter. The popliteus is a weak flexor of the knee but, more importantly, "unlocks" the extended knee by laterally rotating the femur on the fixed tibia.

Injuries

As mentioned earlier, the knee is a frequently injured joint, with its ligaments, menisci, and patellofemoral joint vulnerable to acute and repetitive use damage. Most knee injuries require exercise training for rehabilitation, and some require surgery as well. Predisposing factors to knee injury include the following (7,14,22):

- Lower extremity malalignment (*e.g.*, Q angle abnormalities, flat feet)
- Limb length discrepancy
- Muscular imbalance and weakness
- Inflexibility
- Previous injury
- Inadequate proprioception
- Joint instability
- Playing surface and equipment problems

- Slight predominance in females (particularly for patellofemoral problems)

Ligamentous sprains and tears are common in the knee, particularly in athletes. Because of its structure and insertion points, the anterior cruciate ligament is more frequently injured compared with the posterior cruciate ligament. Classically, the anterior cruciate ligament is injured when external rotation of the tibia is coupled with a valgus force on the knee (*e.g.*, direct force from the lateral side of the knee, planting the foot and twisting the knee) (14). Ligamentous sprains and tears are common in the knee, particularly in athletes.

The menisci are also frequently injured, particularly in athletes. The medial meniscus is more frequently torn than the lateral meniscus due in part to its attachment to the medial collateral ligament. The menisci are poorly innervated and relatively avascular; thus, they are not very pain sensitive and are slow to heal following injury. The "terrible triad" is a traumatic sports injury in which the anterior cruciate ligament, medial collateral ligament, and medial meniscus are damaged simultaneously (4).

Patellofemoral pain syndrome is a common disorder in young athletes (particularly females) that produces anterior knee pain. Often, patellofemoral pain syndrome is caused by an off-center line of pull of the patella, which irritates the joint surfaces and retinaculum of the knee (27). An off-center pull of the patella can result from insufficiency muscular imbalance during knee extension (28) and from excessive varus and valgus stresses from Q angles outside of the normal range of 13°–18°.

Ankle and Foot

Ankles and feet are responsible for weight bearing and ambulation. Proper function and mechanics of ankles and feet are essential for most sports activities and performance of activities of daily living. Slight abnormalities in the feet and ankles (*e.g.*, muscular imbalance, proprioceptive dysfunction, and structural changes) are transmitted via the kinetic chain to most joints superior to them in the body (4). Thus, knee, hip, low back, neck, shoulder, and body alignment and postural problems can at times be traced to dysfunctional ankles and feet. This section focuses on ankle functional anatomy. For the functional anatomy of the intrinsic foot, the reader is referred to other sources (6–9,29). Proper function and mechanics of ankles and feet are essential for most sports activities and performance of activities of daily living.

Structure

Bones

The foot has 26 articulating bones contained in three functional units: the anterior (forefoot), middle (midfoot), and posterior (hindfoot) (Fig. 3.40). The forefoot contains the five metatarsals (one for each digit) and 14 phalanges (toes), three each for digits 2–5 and two for the great toe. The midfoot contains the five tarsal bones: a navicular, a cuboid, and three cuneiforms. The hindfoot contains the talus and calcaneus bones. The dome of the talus articulates with the distal tibia and fibula and provides the link between the leg and foot at the talocrural joint. The ankle is formed by the fibrous union of the distal tibia, the medial malleolus of the tibia, and the lateral malleolus of the fibula (20). The location of the talus is superior to the calcaneus, between the malleoli of the tibia and fibula. Most of the calcaneus represents the posterior projection of the heel. The calcaneus provides important attachment sites for the ankle plantarflexor muscles.

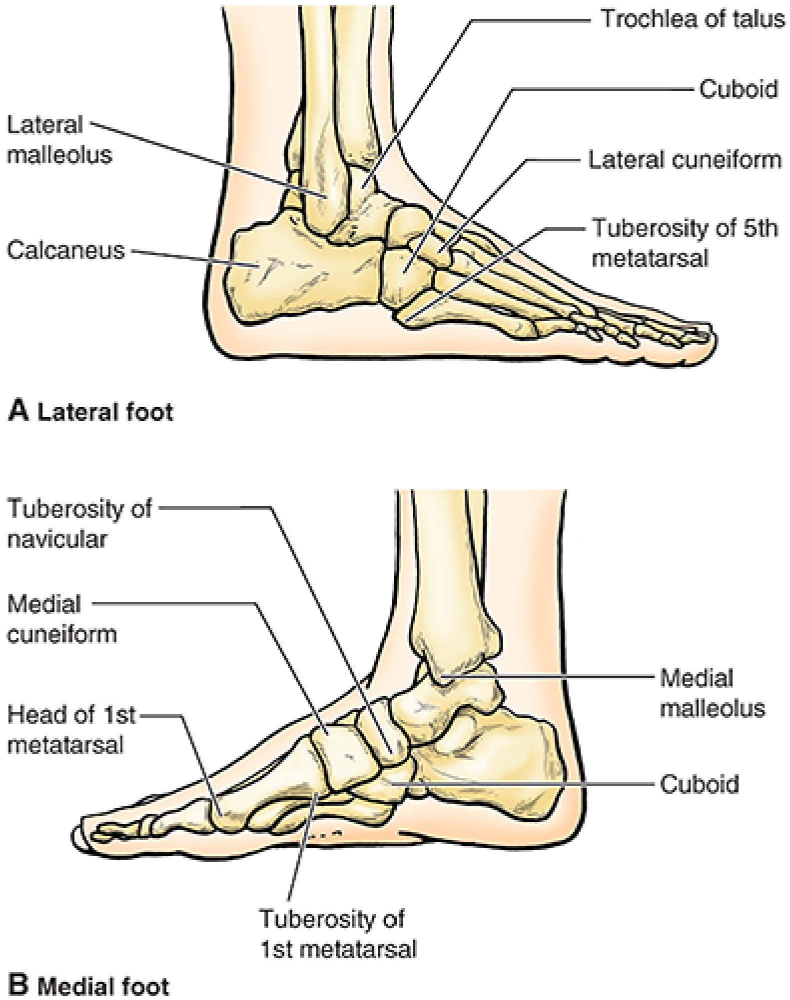


FIGURE 3.40. Bones of the ankle and foot regions. **A.** Lateral view. **B.** Medial view. (From Moore KL, Dalley AF II. *Clinically Oriented Anatomy*. 4th ed. Baltimore [MD]: Lippincott Williams & Wilkins; 1999, with permission.)

Ligaments

There are approximately 100 ligaments in the ankle and foot region (Fig. 3.41). On the lateral side of the ankle, the major ligaments include the anterior and posterior talofibular and the calcaneofibular ligaments. The deltoid ligament complex is on the medial ankle and includes the tibiocalcaneal, anterior and posterior tibiotalar, and tibionavicular ligaments. The plantar calcaneonavicular ligament (spring ligament) of the foot helps support the talus and maintains the longitudinal arch (11).

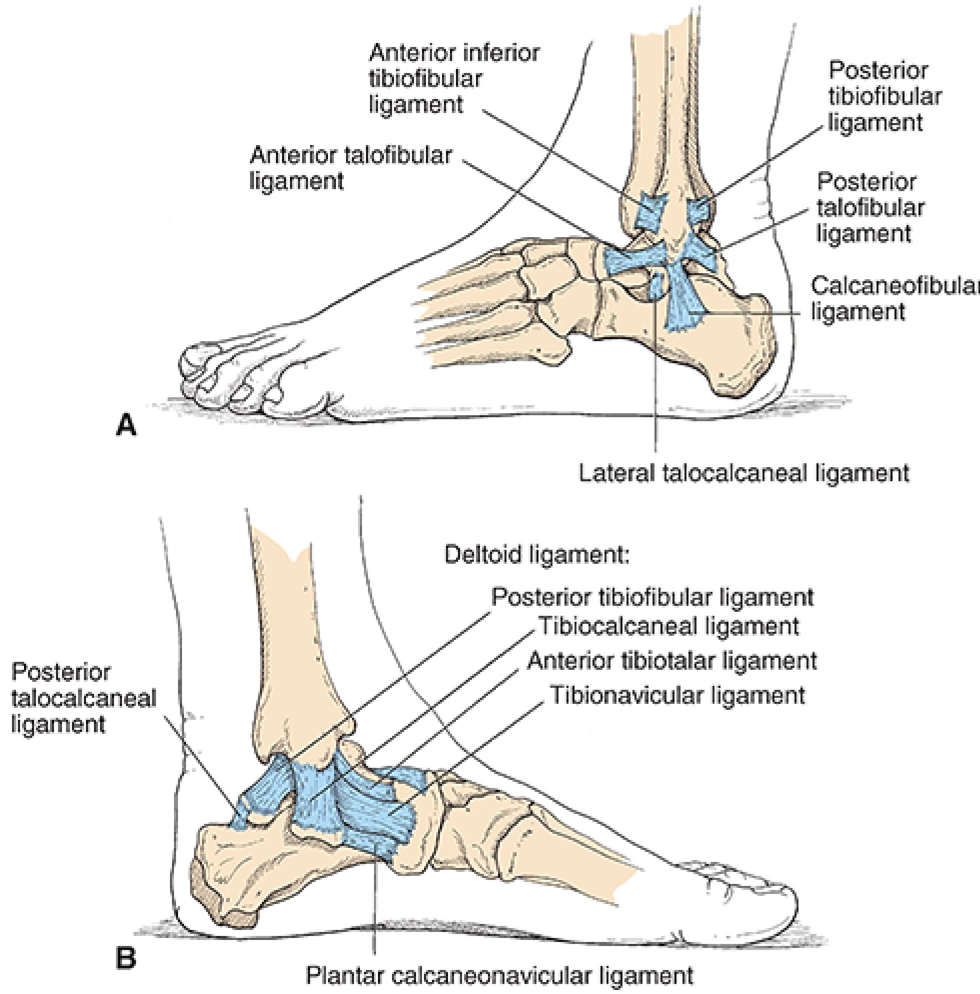


FIGURE 3.41. Ligaments of the ankle and foot regions. **A.** Lateral view. **B.** Medial view. (From Cipriano J. *Photographic Manual of Regional Orthopaedic and Neurological Tests*. 5th ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2014, with permission.)

There are two arches on the plantar aspect of the foot that give the foot its shape and distribute body weight from the talus to the foot during various load-bearing conditions (14). The various ligaments and bones primarily support the arches, with muscles providing secondary support. The longitudinal arch extends from the calcaneal tuberosity to the five metatarsals, whereas the transverse arch extends crosswise from medial to lateral in the midtarsal region. The plantar fascia, or plantar aponeurosis, is a strong fibrous connective tissue that provides support for the longitudinal arch. The plantar fascia acts as an extension of the calcaneal (Achilles) tendon of the plantarflexor muscles. During weight-bearing phase of gait, the plantar fascia acts like a spring to store mechanical energy that is then released during foot push-off (2).

Joints

The ankle joint is a synovial, hinge-type joint between the distal tibia and fibula and the dome of talus. A tight fibrous syndesmosis between tibia and fibula unites the distal ends of the bones and forms a “malleolar mortise” into which the trochlea or “dome” of talus fits. The subtalar joint is a plane synovial joint between talus and calcaneus. There are many other joints between the other tarsal bones that allow varying degrees and types of movements. Additionally, there are tarsometatarsal, intermetatarsal, metatarsophalangeal, and interphalangeal joints (11).

Movements

The talocrural joint allows approximately 15°–20° of dorsiflexion and 50° of plantarflexion in the sagittal plane. The subtalar joint allows approximately 20°–30° of inversion and 5°–15° of eversion in the frontal plane. The midtarsal and tarsometatarsal joints permit gliding motion. The metatarsophalangeal and interphalangeal joints primarily allow flexion and extension of the digits in the sagittal plane. Pronation and supination are combination movements at the ankle and foot that allow the foot to maintain contact with the ground in a variety of stances or on uneven ground. Pronation is a combination of talocrural dorsiflexion, subtalar eversion, and forefoot abduction. Supination is a combination of talocrural plantarflexion, subtalar inversion, and forefoot adduction (Fig. 3.42) (2).

FIGURE 3.42. Movements of the ankle and foot. **A.** Dorsiflexion–plantarflexion. **B.** Normal, inversion, and eversion.

Muscles

The major muscles that act on the ankle and foot are located in the leg, and these muscles are typically grouped by their compartmental location — anterior, lateral, superficial posterior, and deep posterior (2).

Anterior and Lateral

The anterior muscles, tibialis anterior, peroneus (fibularis) tertius, extensor digitorum longus, and extensor hallucis longus, are ankle dorsiflexors (Fig. 3.43). The tibialis anterior also inverts the foot, whereas the peroneus tertius everts the foot. The extensor hallucis longus acts to extend the big toe, and extensor digitorum longus extends digits 2–5. The lateral muscles, peroneus longus and brevis, evert the foot and assist with plantarflexion as well (Fig. 3.44) (5).

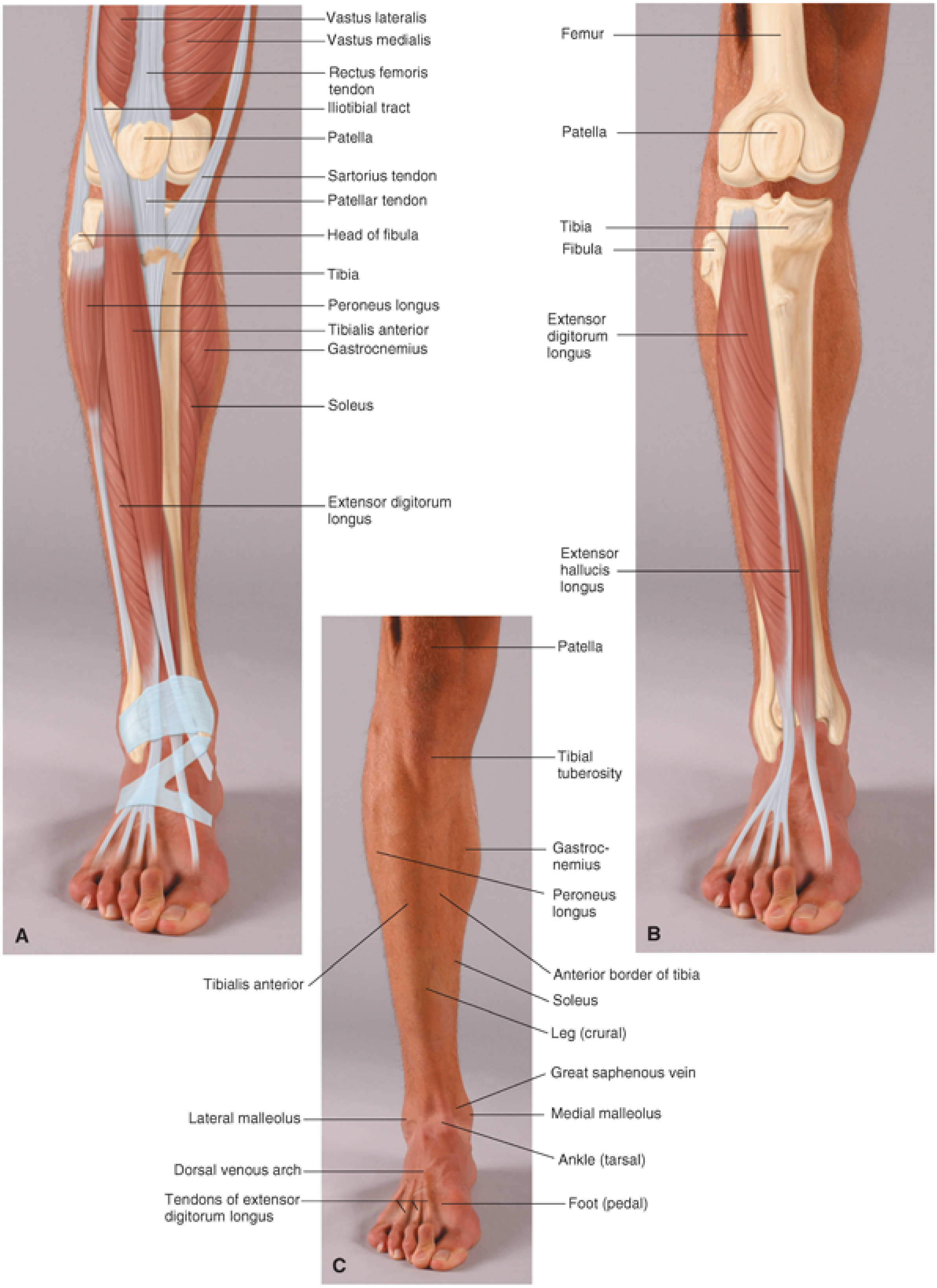

Vastus lateralis
Vastus medialis
Rectus femoris tendon
Iliotibial tract
Patella
Sartorius tendon
Patellar tendon
Head of fibula
Tibia
Peroneus longus
Tibialis anterior
Gastrocnemius
Soleus
Extensor digitorum longus
A
Femur
Patella
Tibia
Fibula
Extensor digitorum longus
Extensor hallucis longus
B
Patella
Tibial tuberosity
Gastroc-nemius
Peroneus longus
Anterior border of tibia
Tibialis anterior
Soleus
Leg (crural)
Great saphenous vein
Lateral malleolus
Medial malleolus
Ankle (tarsal)
Dorsal venous arch
Tendons of extensor digitorum longus
Foot (pedal)
C

FIGURE 3.43. Muscles of the leg — anterior view. **A.** Superficial muscles. **B.** Deep muscles. **C.** Surface landmarks. (From Premkumar K. *The Massage Connection: Anatomy and Physiology*. 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2011, with permission.)

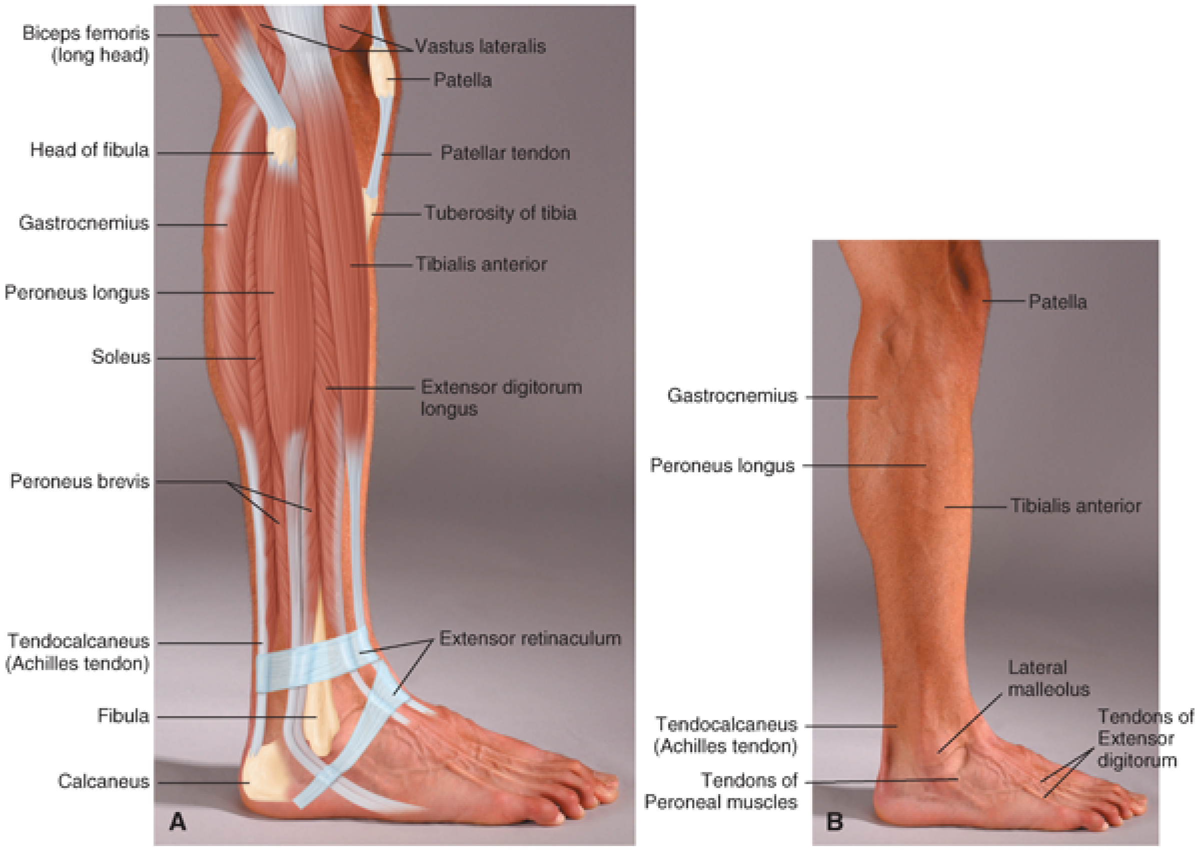


FIGURE 3.44. Muscles of the leg — lateral view. **A.** Muscles. **B.** Surface landmarks. (From Premkumar K. *The Massage Connection: Anatomy and Physiology*. 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2011, with permission.)

Superficial and Deep Posterior

The superficial posterior muscles, gastrocnemius, soleus, and plantaris, are ankle plantarflexors (Fig. 3.45). The gastrocnemius is a two-head and two-joint muscle and is a powerful plantarflexor of the ankle as well as a flexor of the knee. The gastrocnemius has relatively faster twitch fibers than the soleus. Thus, the gastrocnemius is used more during dynamic, higher force activities, and the soleus is more active during postural and static contractions (4). Because the gastrocnemius crosses the knee and ankle, the position of the knee during plantarflexion resistance exercise affects the activity of the gastrocnemius. At 90° of knee flexion, the gastrocnemius experiences passive insufficiency and thus is less active than when the knee is straight (0° of flexion). In other words, during calf raise exercise, keep the knees straight to emphasize the gastrocnemius and bend the knees to emphasize the soleus. The deep posterior muscles are flexor digitorum longus, flexor hallucis longus, tibialis posterior, and popliteus. All except for popliteus are ankle plantarflexors and inverters. Additionally, the tibialis posterior inverts the foot. The flexor digitorum and hallucis longus flex their respective digits.

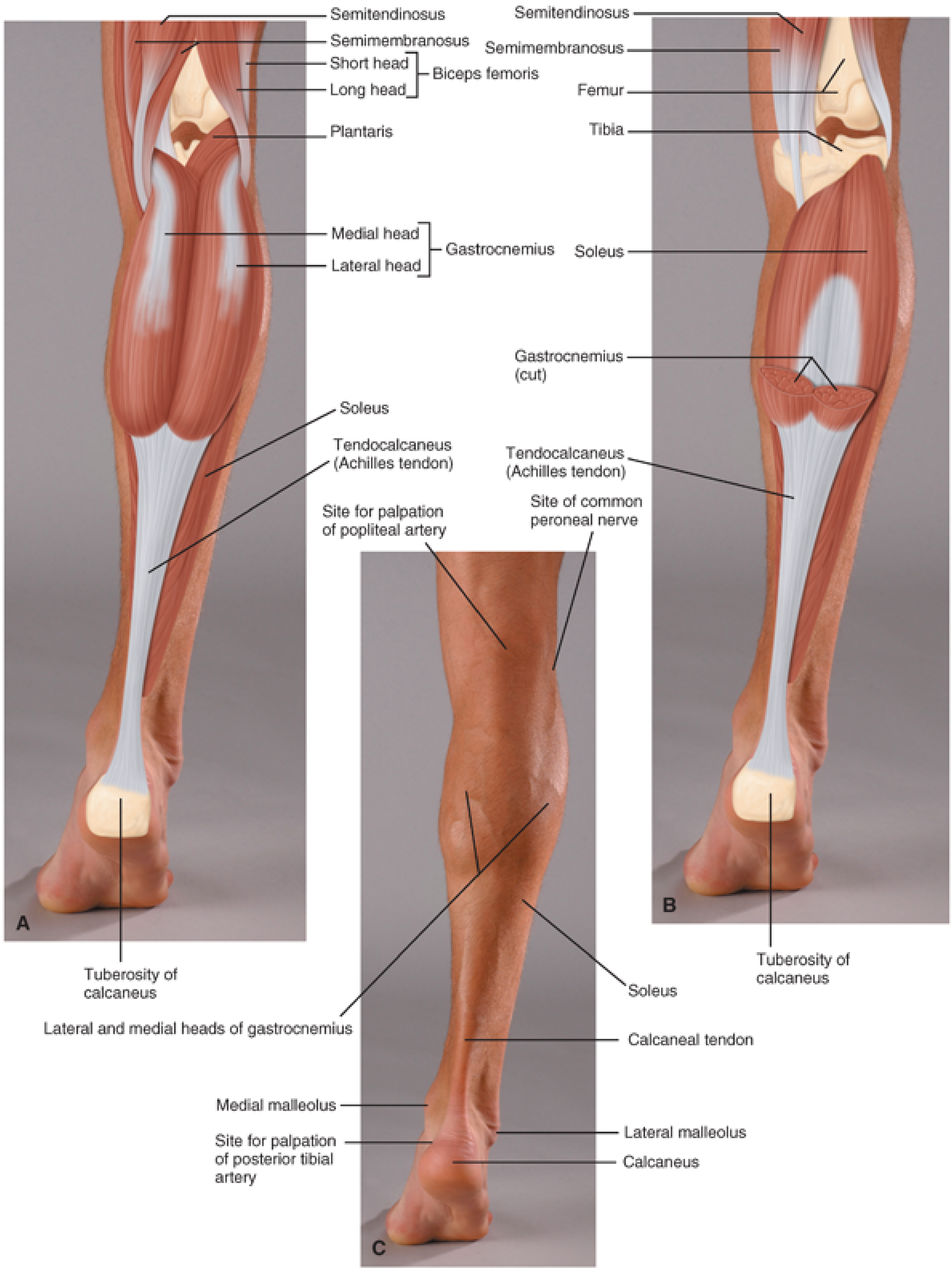


FIGURE 3.45. Muscles of the leg — posterior view. **A.** Superficial muscles. **B.** Soleus. **C.** Surface landmarks. (From Premkumar K. *The Massage Connection: Anatomy and Physiology*. 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2011, with permission.)

Injuries

Because of the burden placed on the ankle and foot during activities such as walking, running, jumping, and lifting, traumatic and overuse injuries frequently occur to these structures (14). Numerous acute muscular strains and cramps occur in the leg and foot, and many ligament sprains occur in this region as well. Ankle sprains are more common on the lateral side than on the medial side because there is less bony stability and ligamentous strength on the lateral side. The mechanism of injury for lateral ankle sprains is excessive inversion (rolling out of the ankle), as occurs when landing on someone's foot after jumping in basketball. The anterior talofibular ligament is the most frequently sprained ligament in inversion injuries (14).

> Because of the burden placed on the ankle and foot during activities such as walking, running, jumping, and lifting, traumatic and overuse injuries frequently occur to these structures.

Achilles tendon rupture is possibly the most serious acute injury of the leg (14). Nearly 75% of Achilles tendon ruptures are seen in male athletes between 30 and 40 years of age. The typical mechanism is forceful plantarflexion while the knee is extended. These injuries almost always require surgical repair and extensive long-term rehabilitation. Achilles tendon rupture is often a career-ending injury for athletes, especially if it occurs in the later stages of their careers (4).

Plantar fasciitis is a chronic inflammatory condition that typically results in pain at the calcaneal insertion of the plantar fascia (14). Plantar fasciitis is usually caused by chronic pulling on the plantar fascia, tight Achilles tendon, hyperpronation (flat feet or pes planus), or other factors that overload the fascia (*e.g.*, obesity). Treatment of plantar fasciitis includes stretching and strengthening exercises for the posterior calf muscles, orthoses to correct hyperpronation, and physiotherapy modalities and medication to reduce inflammation. Sometimes, surgery is required to release the plantar fascia. Plantar fasciitis is often associated with calcaneal heel spurs (14).

Other chronic conditions of the foot and ankle include bunions, neuromas, Achilles tendonitis, and calcaneal bursitis. These conditions are frequently related to structural problems of the foot and ankle, such as hyperpronation or hypersupination (high arch or pes cavus). Unilateral hyperpronation or hypersupination may cause instability and proprioceptive difficulties at the ankle and postural imbalances and mechanical problems to proximal joint structures in the kinetic chain.

Spine

The spine is an intricate multijoint structure that plays a crucial role in functional mechanics. The spine provides the link between the upper and lower extremities, protects the spinal cord, and enables trunk motion in three planes (14). Moreover, the rib cage of the thoracic spinal region protects the internal organs of the chest. Because of its intricacies, the spine is susceptible to injuries that may severely impair physical function.

Structure

Bones

The spinal column contains a complex of irregular bones called “vertebrae” that are stacked on one another (Fig. 3.46). There are 24 individual vertebrae: 7 cervical (neck), 12 thoracic (midback), and 5 lumbar (low back) (11). The most superior cervical vertebra (C1) articulates with the occipital bone of the skull, whereas the most inferior lumbar vertebra (L5) articulates with the sacrum. The size of the vertebrae increases from the cervical to the lumbar region because of an increase in load-bearing responsibilities. Each vertebra contains anterior and posterior elements. The anterior element, called the “vertebral body,” is oval with flat superior and inferior surfaces for articulation with the adjacent vertebral bodies. The posterior element, or posterior arch, consists of pedicles and laminae, which join anteriorly at the body and posteriorly at the spinous process to form the vertebral foramen (canal). The vertebral foramen provides a space through which the spinal cord passes. The posterior arch also contains facets on each side and top and bottom for articulation with adjacent vertebrae. The spinous and transverse processes are bony protuberances that provide attachment points for the spinal musculature (11).

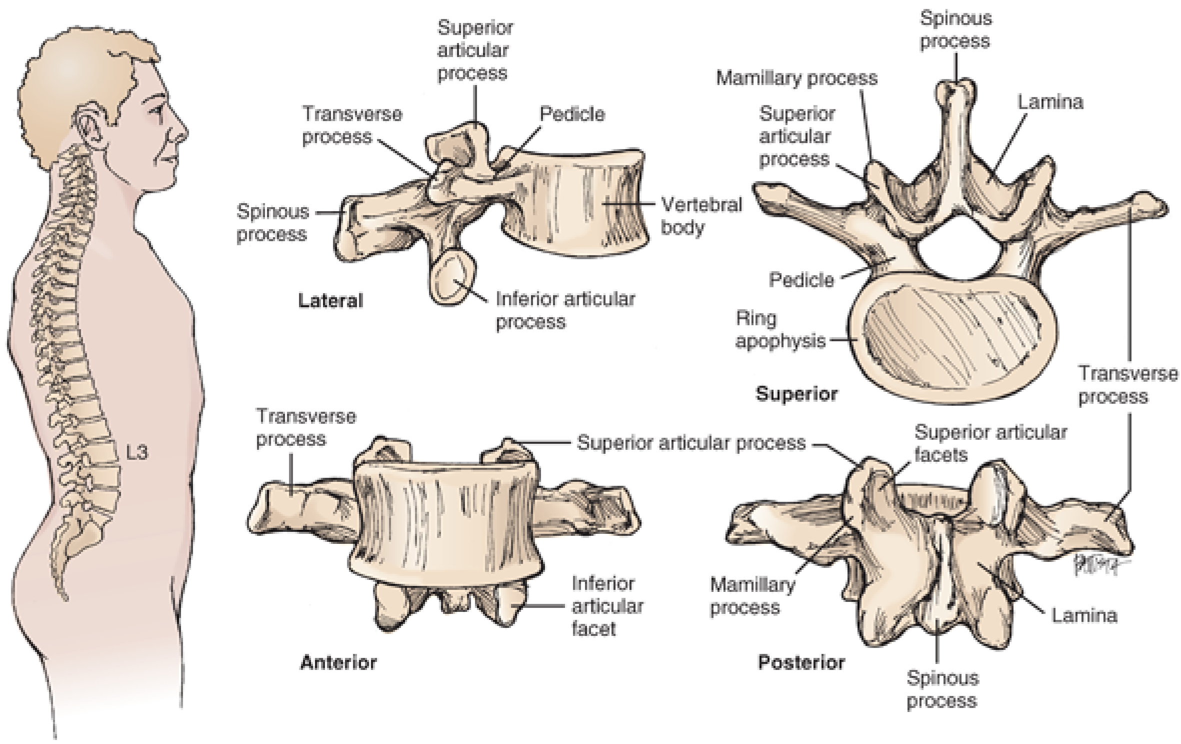


FIGURE 3.46. A typical lumbar vertebra (L3) in four views identifying the relevant landmarks. (From Oatis CA. *Kinesiology: The Mechanics and Pathomechanics of Human Movement*. 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2016, with permission.)

Ribs attach to each of the 12 thoracic vertebrae bilaterally and form the thoracic cage (Fig. 3.47). The seven most superior pairs of ribs are considered true ribs and attach directly to the sternum. The five lower pairs of ribs are considered false ribs. Three pairs of false ribs attach indirectly to the sternum by the costal cartilages. Two most inferior pairs of false ribs do not attach to the sternum and are considered floating ribs (2).

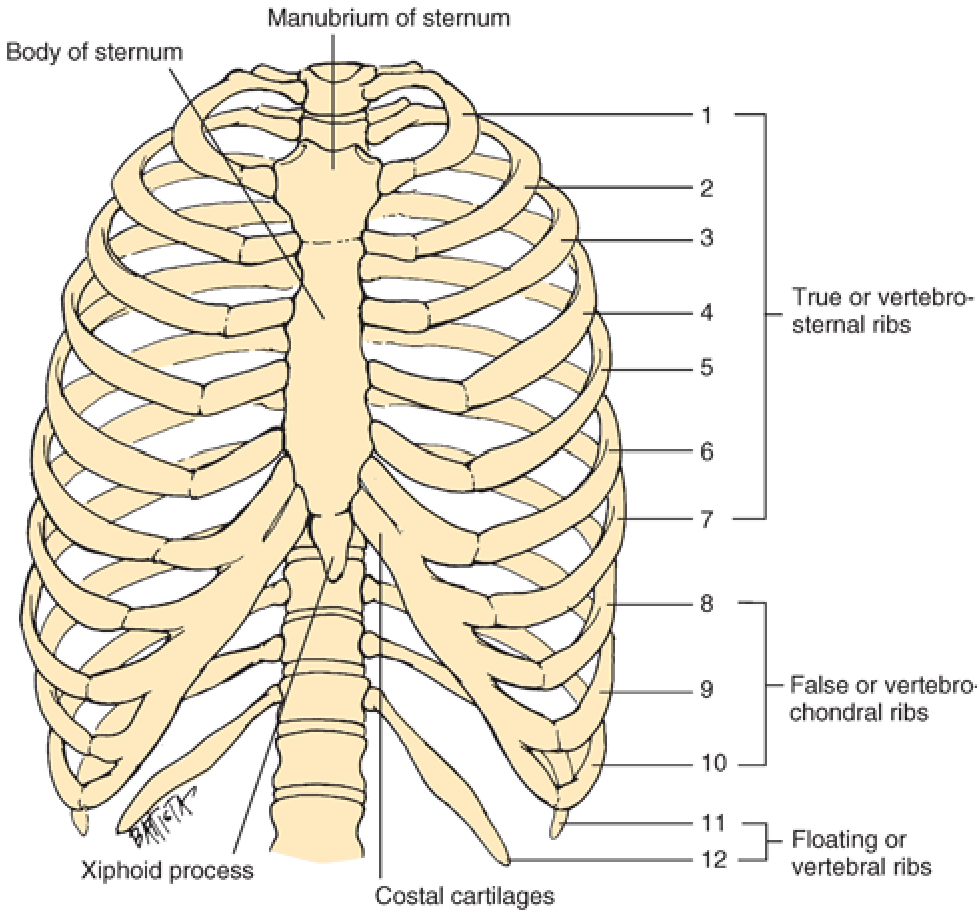


FIGURE 3.47. The thoracic cage — anterior view. (From Oatis CA. *Kinesiology: The Mechanics and Pathomechanics of Human Movement*. 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2016, with permission.)

The spinal column also contains a sacrum and coccyx, which are situated at the lower spine, immediately inferior to the fifth lumbar vertebra. The sacrum is a large triangular bone that acts as the transition point between the spine and pelvis. The coccyx is a bone formed of three to five fused vertebrae located at the distal sacrum (11).

In the sagittal plane, the spinal column normally demonstrates four curves instead of a straight line (Fig. 3.48). These curves give the spine mechanical advantage and improved load-bearing capabilities. When the convexity of the curve is posterior, the curve is known as kyphosis, and when the convexity of the curve is anterior, the curve is known as lordosis. The cervical and lumbar regions have lordosis, and the thoracic and sacral regions have kyphosis.

Deviations in the sagittal plane are referred to as “hyperlordosis” or “hyperkyphosis.” In the frontal plane, the spinal column should normally be positioned in the midline. Lateral deviation is referred to as “scoliosis” (Fig. 3.49) (4).

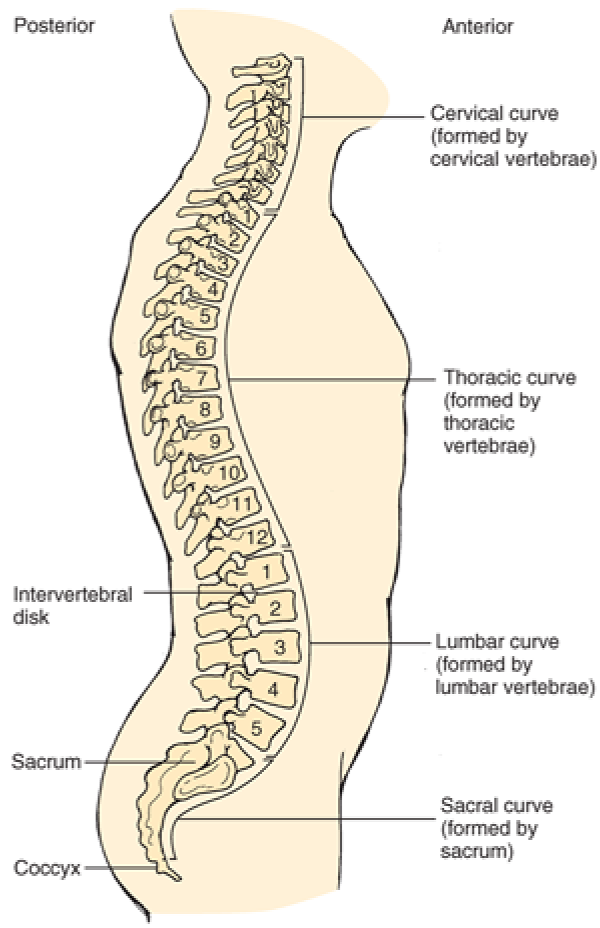


FIGURE 3.48. Vertebral column — lateral view showing the four normal curves and regions. (From Oatis CA. *Kinesiology: The Mechanics and Pathomechanics of Human Movement.* 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2016, with permission.)

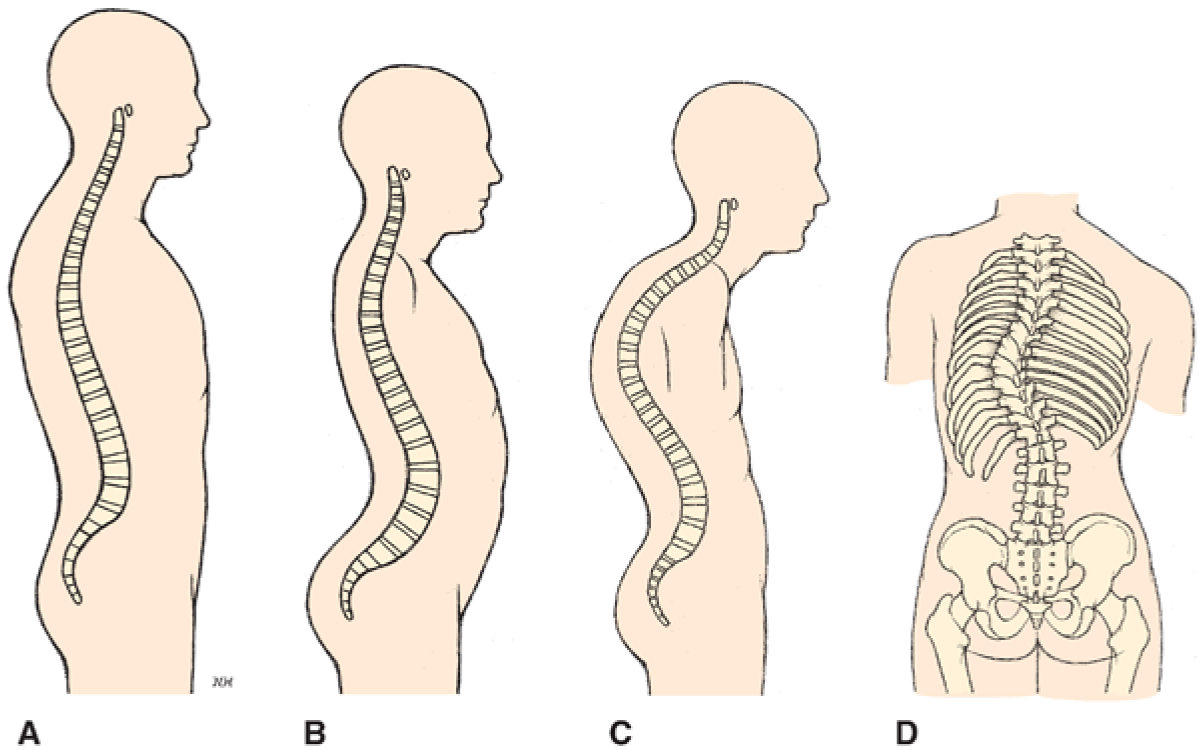


FIGURE 3.49. Normal and abnormal curves of the vertebral column. **A.** Normal. **B.** Hyperlordosis. **C.** Hyperkyphosis. **D.** Scoliosis.

Ligaments

The main supporting ligaments of the spinal column are the anterior and posterior longitudinal ligaments and the ligamentum flavum, which span from the upper cervical to lower lumbar region (Fig. 3.50). The anterior and posterior longitudinal ligaments attach to the vertebral bodies, and the ligamentum flavum connects the posterior arches and forms the posterior border of the vertebral canal. The interspinous and supraspinous ligaments attach to adjacent posterior arch structures (4).

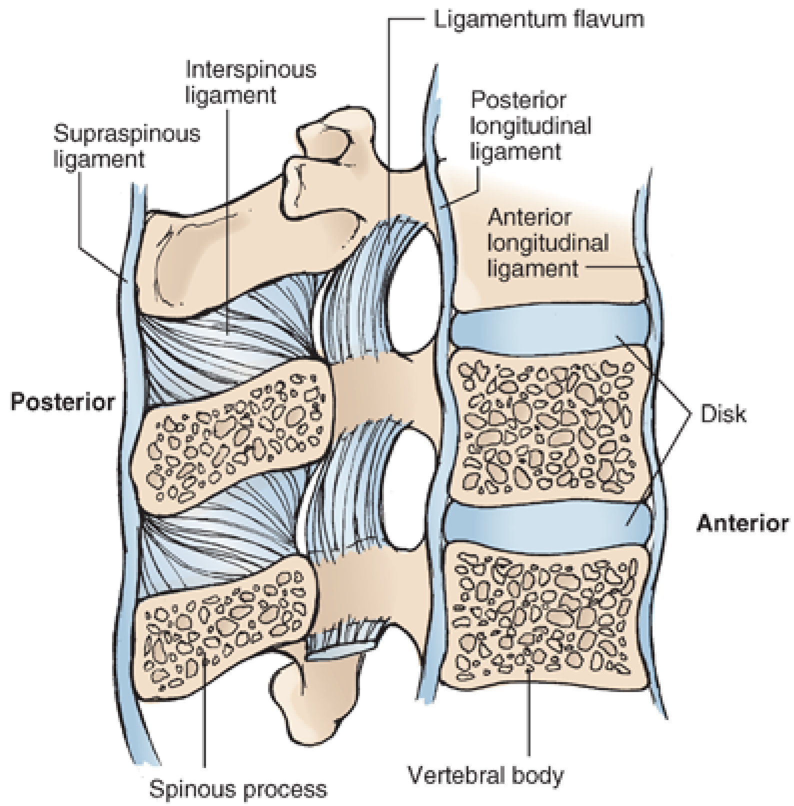


FIGURE 3.50. Ligaments and discs of the lumbar spine — midsagittal view. (From Oatis CA. *Kinesiology: The Mechanics and Pathomechanics of Human Movement*. 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2016, with permission.)

Intervertebral Discs

The intervertebral discs are important structures that provide load bearing, shock absorption, and stability to the vertebral column. The discs are located between the vertebral bodies and constitute about 20%–33% of the height of the vertebral column (see Fig. 3.50) (3). Each intervertebral motion segment contains a disc, except for the articulation between the first and second cervical vertebrae (the atlas and axis, respectively). The intervertebral disc consists of the nucleus pulposus, annulus fibrosis, and endplates. These structures are composed of various concentrations of water, collagen, and proteoglycans. The nucleus pulposus, located in the center of the disc, is gel-like and more liquid than the annulus fibrosis. The nucleus pulposus dehydrates with age, which is one of the reasons why overall body height reduces with age (3). The annulus fibrosis, located at the periphery of the disc, is a more rigid structure and contains more collagen fibers than the nucleus. The oblique arrangement of the collagen fibers of the annulus helps the annulus resist tensile and compressive forces in various planes. However, the annulus is most susceptible to tearing with movements involving rotation and flexion under load. The vertebral endplates are thin layers of fibrocartilage that cover the inferior and superior aspects of the vertebral body and help anchor the disc to the vertebrae (12).

Joints

The spinal column consists of numerous motion segments (two adjacent vertebrae). Each motion segment of spine contains five articulations: one intervertebral joint and four zygapophysial (facet) joints. The intervertebral joint connects adjacent bodies, whereas the zygapophysial joints connect adjacent facets (superior and inferior on each side). The lumbar zygapophysial joints are angled to allow flexion and extension and restrict axial rotation. The cervical and thoracic zygapophysial joints, on the other hand, are angled to accommodate axial rotation (4).

Movements

The spine is capable of motion in all planes, and the extent of motion varies with region. In the cervical spine, the atlantooccipital joint allows flexion and extension and slight lateral flexion. The atlantoaxial joint allows primarily rotation. The remaining cervical joints allow flexion and extension, lateral flexion, and rotation. The thoracic joints allow moderate flexion, slight extension, moderate lateral flexion, and rotation. The lumbar joints allow flexion and extension, lateral flexion, and slight rotation (Fig. 3.51) (4). Refer to Table 3.6 for normal cervical and lumbar ROM values.

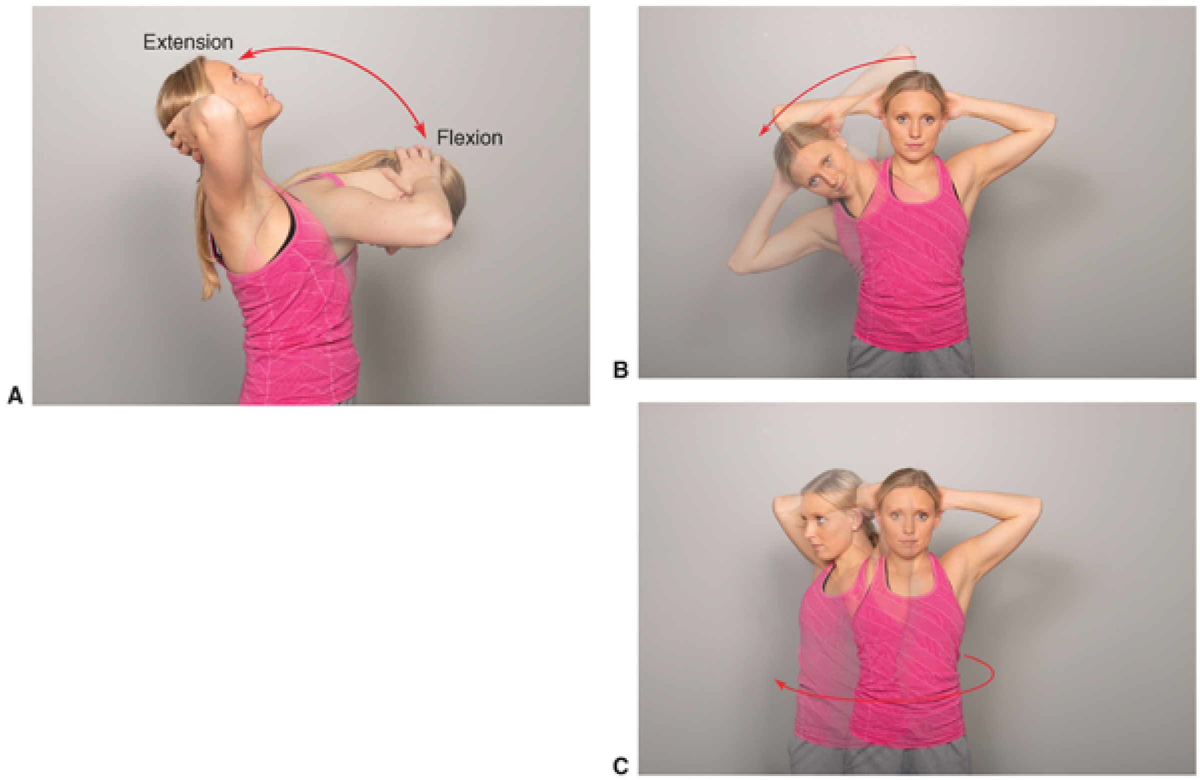


FIGURE 3.51. Movements of the lower trunk. **A.** Flexion–extension. **B.** Lateral flexion. **C.** Rotation.

Compound Trunk Extension

Trunk motion in the sagittal plane during normal activities, such as lifting and bending, requires the compound movement of the lumbar spine, pelvis, and hip joints (30). This action is called "compound trunk extension" or "lumbopelvic rhythm." From a position of full trunk flexion, the lumbar extensors (erector spinae and multifidus) and hip extensors (gluteals and hamstrings) work together to actively rotate the trunk through approximately 180° in the sagittal plane (Fig. 3.52) (20). Lumbar movement accounts for approximately 72° of this motion, whereas hip and pelvis movement accounts for the remaining 108° (31). The relative contribution of individual muscle groups to force production during compound trunk extension is unknown, but it is assumed that the larger hip extensors generate most of the force (20). Because the pelvis remains free to move during activities of daily living such as lifting and bending, it is assumed that the small lumbar muscles play only a minor role in trunk extension torque production. Thus, they are considered to be the weak link in trunk extension movements (32). The rationale behind isolating the lumbar spine through pelvic stabilization mechanisms during exercise training is to force the lumbar muscles to be the primary trunk extensors, thereby providing the overload stimulus for strength gains (32). Dynamic progressive resistance exercise protocols on devices that stabilize the pelvis have produced unusually large gains (greater than 100%) in lumbar extension strength, even with training frequencies as low as one time per week (32). Clinically, patients with low back pain have displayed significant improvements in symptoms, disability, and psychosocial function following intensive exercise training with pelvic stabilization (33,34).

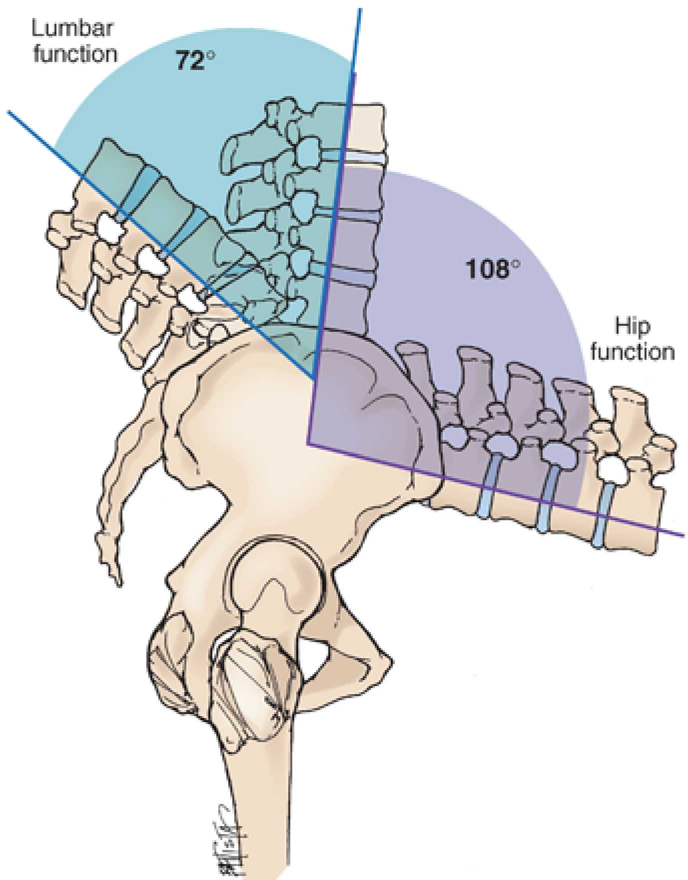


FIGURE 3.52. Compound trunk extension (lumbopelvic rhythm). Compound trunk extension involves the simultaneous movement of the lumbar spine (72°) and pelvis/hips (108°).

Muscles

The spine and trunk muscles exist in pairs, one on each side of the body. In general, bilateral contraction results in movement in the sagittal plane. The anterior muscles flex the spine, whereas the posterior muscles extend the spine. Unilateral contraction results in lateral bend or axial rotation.

Cervical

Anterior

The major anterior muscles of the cervical region include the sternocleidomastoid, scalenes (anterior, middle, and posterior), longus capitis, and longus colli muscles. On unilateral contraction, these muscles laterally flex and rotate the neck and head. On bilateral contraction, the anterior scalene, longus capitis and colli, and sternocleidomastoid muscles flex the neck and head. The scalenes attach proximally to the upper cervical transverse processes and distally to the upper two ribs. The sternocleidomastoid attaches proximally to the mastoid process of the occiput and distally to the sternum (medial head) and clavicle (lateral head) (see Fig. 3.17). The longus muscles run from the transverse processes of the upper cervical vertebrae to the anterior aspect of the superior cervical vertebrae (longus colli) or the base of the occiput (longus capitis) (5).

Posterior

The suboccipital muscles, which attach the upper cervical vertebrae to the occiput, extend the head when they contract bilaterally and laterally bend and rotate the neck when they contract unilaterally. Similarly, the splenius (capitis and cervicis) and erector spinae (spinalis, longissimus, and iliocostalis) muscles extend the neck when they contract bilaterally and laterally bend and rotate the neck when they contract unilaterally (see Fig. 3.18) (5).

Lateral

The lateral muscles of the neck and head include the levator scapulae and upper trapezius muscles, both of which laterally bend and rotate the neck on unilateral contraction. The upper trapezius extends the neck as well on bilateral contraction. The levator scapulae attaches superiorly to the transverse processes of the upper four cervical vertebrae and inferiorly to the vertebral border of the scapula above the spine. The upper trapezius attaches proximally to the occiput and spinous processes of the cervical vertebrae and distally to the clavicle and acromion of the scapula (5). The levator scapulae and upper trapezius muscles also cause movement of the scapulothoracic joint, as discussed in the section "Shoulder" in this chapter.

Lumbar

Anterior

The anterior muscles of the lumbar region consist of the abdominal group: the rectus abdominis, internal and external abdominal oblique, and transversus abdominis (see Fig. 3.17). The rectus abdominis originates from the pubic bone and inserts at the fifth through seventh ribs and xiphoid process. The rectus abdominis exists as two vertical muscles separated by a connective tissue band, the linea alba. Horizontally, the rectus abdominis appears to be separated by three distinct lines. These lines represent areas of connective tissue that support the muscle in place of attachment to bones (2). The rectus abdominis is the primary trunk flexor, and through its attachment to the pubic bone, it also tilts the pelvis posteriorly. The internal and external obliquus abdominis muscles rotate the trunk on unilateral contraction and flex the trunk on bilateral contraction. The transversus abdominis runs horizontally, attaching medially to the linea alba via the abdominal aponeurosis and laterally to the thoracolumbar fascia, inguinal ligament, iliac crest, and the lower six ribs. Contraction of the transversus abdominis stabilizes the lumbar spine and increases intra-abdominal pressure, and aberrant firing patterns of the transversus abdominis appear to be related to low back pain (35).

To isolate the abdominal muscles during trunk flexion exercise, it is advisable to shorten the psoas and other hip flexor muscles (active insufficiency) by flexing the hips and knees (13). Thus, crunches with the hips and knees flexed may be more effective in conditioning the abdominals than straight knee sit-ups (5).

Posterior

The posterior musculature of the lumbar spine consists of three muscle groups, namely, the erector spinae, multifidus muscles, and intrinsic rotators (Fig. 3.53). Additionally, the latissimus dorsi, which is usually considered a muscle that acts on the shoulder, extends and stabilizes the lumbar spine through its attachment to the thoracolumbar fascia (12). The erector spinae group, which lies lateral and superficial to the multifidus, is divided into the iliocostalis lumborum and longissimus thoracis muscles (23). These muscles are separated from each other by the lumbar intramuscular aponeurosis, with the longissimus lying medially. The longissimus and iliocostalis are composed of several multisegmental fascicles, which allow for extension and posterior translation when the muscles are contracted bilaterally. The fascicular arrangement of the multifidus muscle suggests that the multifidus acts primarily as a sagittal rotator (extension without posterior translation) (36). Lateral flexion and axial rotation are possible for both the multifidus and erector spinae musculature during unilateral contraction. The iliocostalis may be better suited to exert axial rotation on the lumbar vertebral motion segment than either the longissimus or multifidus muscles (23). Because of their anatomical and biomechanical properties, the posterior lumbar muscles are particularly adapted to maintain posture and stabilize the spine and trunk (23). The intrinsic rotators, rotators, and intertransversarii muscles, are primarily length transducers and position sensors for the vertebral segment (29).

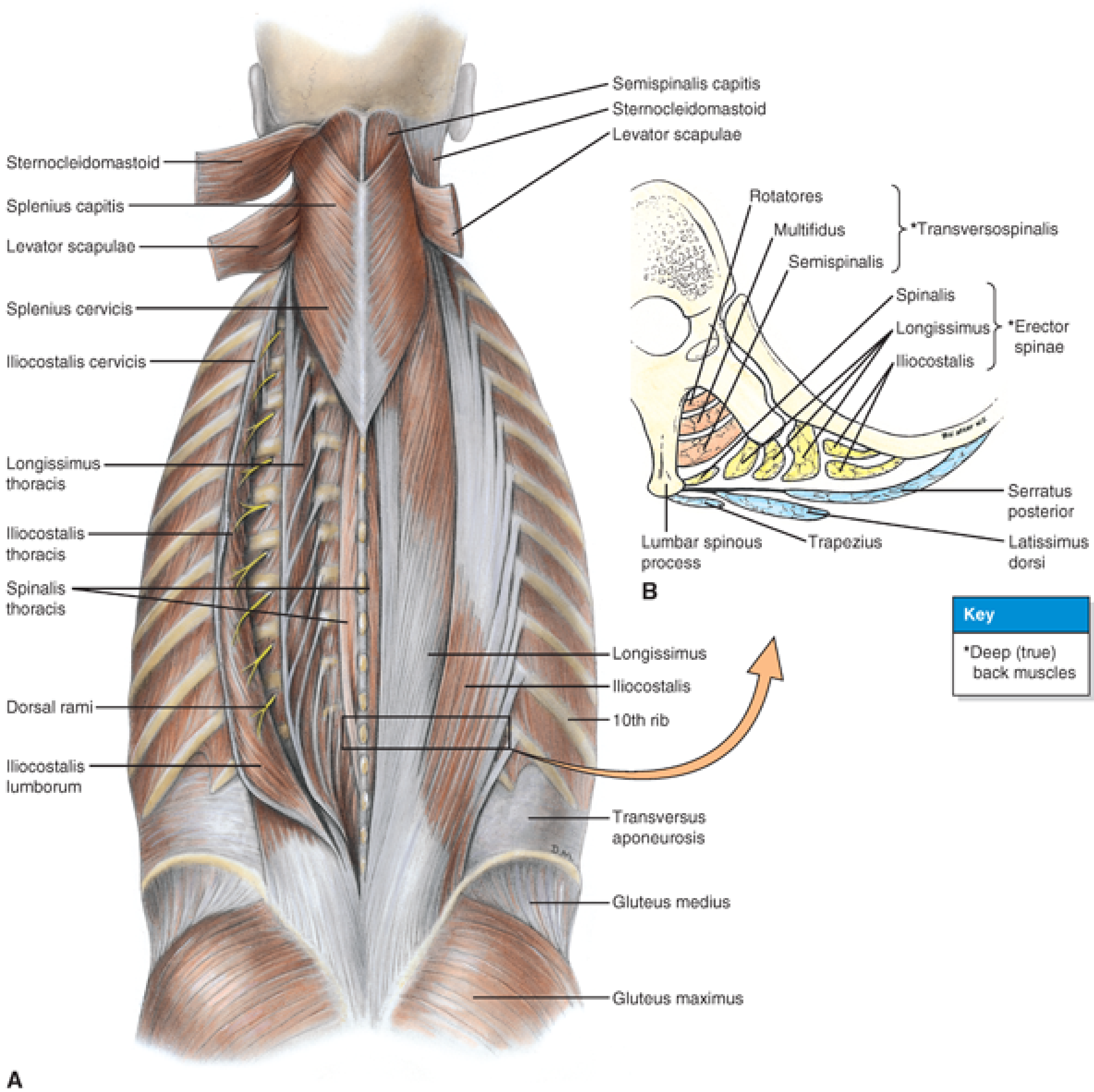


FIGURE 3.53. Deep muscles of the back. **A.** *Right*, the three columns of the erector spinae. *Left*, the spinalis is displayed by reflecting the longissimus and iliocostalis. **B.** Transverse section of the back showing arrangement of the erector spinae, multifidus, and rotator muscles. (From Moore KL, Dalley AF II. *Clinically Oriented Anatomy*. 4th ed. Baltimore [MD]: Lippincott Williams & Wilkins; 1999, with permission.)

Lateral

The lateral muscles of the lumbar spine include the quadratus lumborum and psoas (major and minor). The quadratus lumborum originates from the iliac crest and inserts at the 12th rib and transverse process of the lower four lumbar vertebrae. The quadratus lumborum produces lateral bending of the lumbar spine with unilateral contraction and stabilizes the trunk with bilateral contraction. The psoas major muscle originates from the anterior surfaces of the transverse processes of all the lumbar vertebrae and inserts at the lesser trochanter of the femur. The psoas major flexes the trunk and the hip (5).

Injuries

Cervical

The cervical region is the most mobile region of the spine, and relatively small cervical muscles are responsible for supporting the head. These factors make the cervical region vulnerable to instability and injury (14). The most dangerous injuries to the cervical region are traumatic fractures and dislocations that result in instability of the column. The combination of axial compression and hyperflexion is a common mechanism for severe cervical injuries such as these (37). Examples of activities with these mechanisms include diving into a shallow pool or a football player making a head-on tackle. The direct consequence of upper cervical dislocation or fracture is neural damage to the upper spinal cord, which may result in paralysis or death (14). Thus, any traumatic neck injury should be treated as a medical emergency (38).

Sprains and strains of the neck muscles and ligaments are frequently the result of violent hyperextension–hyperflexion from sudden acceleration–deceleration, such as a head-on car collision. This condition, commonly called “whiplash,” can cause tears of the anterior and posterior structures of the cervical region, including the muscles (*e.g.*, sternocleidomastoid, upper trapezius, and cervical paraspinals) and ligaments (20). After ruling out fracture, dislocation, instability, and disc herniation, treatment of whiplash usually includes passive modalities, stretches, and strengthening exercises for the neck.

Lumbar

Low back pain is one of the leading causes of disability and consistently ranks as one of the top reasons for visits to physicians. Low back pain affects

60%–80% of the general population at some point during their lifetime, and 20%–30% suffer from this disorder at any given time (39,40). Attaching a specific diagnosis to low back pain is difficult and elusive because there often is no identifiable source of the pain or injury (41). It should not be assumed that all low back pain is musculoskeletal in nature. Back pain can be experienced secondary to a wide variety of other medical conditions that are not musculoskeletal in nature (*e.g.*, abdominal aneurysm, kidney infection, cancer). These should be ruled out by the appropriate medical professionals.

Some of the causes of low back pain include intervertebral disc herniation, facet joint inflammation, muscular strains, and ligamentous sprains. Injury to these structures can be traumatic, caused by events such as inappropriately lifting or falling, or degenerative, caused by a deconditioned lumbar spine, poor posture, prolonged mechanical loading, or poor body mechanics during work, home, or sports activities (14,25). A common cause of lumbar disc herniation is forceful flexion and rotation of the lumbar spine. A protruded lumbar disc that encroaches on the lumbar nerve roots may result in lower extremity sensory and motor problems such as pain, numbness, and muscular weakness and atrophy. Bowel and bladder dysfunction are serious conditions that can result from herniated lumbar discs and require immediate medical treatment (14).

Restorative exercise designed to improve the structural integrity of the lower trunk is commonly used for the treatment of low back pain, and generally, the efficacy of this approach has been supported (26). Many types of exercises, including aerobic, flexibility, muscular strength and endurance, and core stability, are used. The Personal Trainer should be particularly well versed in low back exercise techniques, incorporating those needed when appropriate.

SUMMARY

This chapter provides an overview of musculoskeletal functional anatomy of the major joint structures of the human body. These principles play a major role in nearly all aspects of the Personal Trainer's practice, including exercise testing, exercise prescription, and analysis of exercise movements. Thus, the Personal Trainer is urged to master these principles so that safe, effective, and efficient exercise training programs can be designed to improve musculoskeletal fitness.

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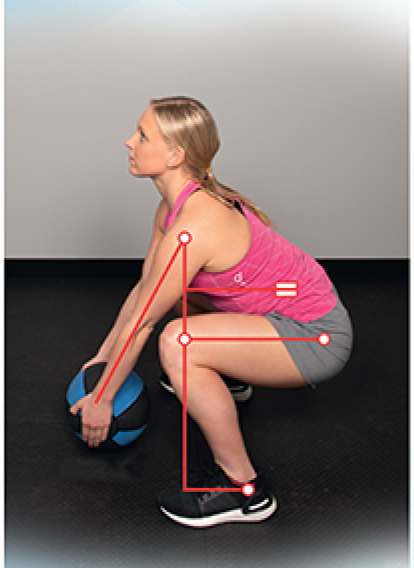
CHAPTER

4

Biomechanics



OBJECTIVES

Personal Trainers should be able to:

- Explain the fundamentals of biomechanics and how this discipline is used to assess, teach, and perform research related to Personal Training.
- Understand and apply the three laws of motion to Personal Training.
- Describe how forces, moments, and powers are applied to quantifying load on clients during training.
- Understand how mechanical work may be used to calculate training load on clients.
- Differentiate between exercises that require positive and negative work and how these relate to training load.
- Identify how mechanical power is calculated and how it is related to intensity.
- Understand how prescriptive exercise may be used to help recover from an injury.
- Characterize biomechanics of common movements.

INTRODUCTION

Biomechanics combines the fields of physics and physiology and helps Personal Trainers quantify training load and prescribe form adjustments to clients (1). The modern roots of this discipline trace back to a bar bet between Leyland Stanford and another man whether all the hooves of a horse leave the ground during horse trotting. Stanford recruited Eadweard Muybridge to build a camera system with a sufficient capture rate to record the gait of horses in order to settle the bet. Although most individuals now know horses' hooves all leave the ground during trotting, this bet laid the ground work for future biomechanics. In the 1930s, Nikolai Bernstein used a high-speed camera (like what was designed by Muybridge) to record skilled laborers kinematics (movements) as they performed their jobs. A fascinating finding of this work is that while skilled laborers routinely perform their task (*e.g.*, hit a nail on the head), their joints (*i.e.*, shoulder, elbow, wrist) take slightly different trajectories each swing to do so. Bernstein hypothesized that humans have a surplus of degrees of freedom (each of our joints) (which allows for many different combinations of joint trajectories) to accomplish a task (2). Similarly, when training, a client can perform a movement with infinitely many variations in his or her movement paths. Some variations in movement are perfectly acceptable — and may be beneficial for the clients to use — whereas others may put them at risk for an injury. Biomechanics is important for a Personal Trainer to understand how to quantify movement differences and how these differences may lead to different adaptations in training and to recognize the subset of possible ways to safely complete a movement (3).

Biomechanics applies the laws of physics to reduce the human body to a mechanical system of moving parts in order to quantify movement.

An understanding of biomechanics allows the Personal Trainer to accurately quantify the difficulty of a lift or training session, estimate which muscle groups and joints will transfer most of the load during a movement, and properly periodize a client's training. The overload principle indicates that a greater than normal stress must be applied to produce an adaptation (such as an increase in strength or size). Armed with the knowledge of biomechanics, the magnitude and timing of this stress can be properly quantified, so clients can achieve their goal while reducing risk of injury.

Because biomechanics is based on the laws of physics, it is important to review and understand how these fundamental laws are applied to training.

Standard international unit: Newtons (N) = $1\ \text{kg} \cdot 1\ \text{m} \cdot \text{s}^{-2}$
English: pound (lb)
Conversion: 1 lb ≈ 4.45 N

Mechanical Laws of Motion

Force was first defined by Sir Isaac Newton (1) in his seminal text, *Philosophiæ Naturalis Principia Mathematica*, which laid the groundwork for what we know as physics today. Newton describes three laws of motion that are the cornerstone of understanding biomechanics (Table 4.1).

1. **Law of Inertia** is the resistance of an object to change its state of motion. This law is critical in understanding how different exercises may exploit the inertial properties of the human body or an object. For example, if you are riding a bicycle and stop pedaling, you will continue moving in the direction you were heading until you apply a force to stop yourself (such as the brakes). Similarly, at the bottom of a bench press using a barbell with plates on it, you must produce force to push the bar away from your body, overcoming the inertia of the bar being lowered toward you.
2. **Law of Acceleration: force = mass × acceleration.** The total force required to accelerate a mass can be calculated for any movement, which

provides the basis for quantifying the training load of an exercise of a training program. This law explains why it is much easier to lift a lighter weight than a heavy one. For a given force applied to a light weight, it will accelerate more than a heavy weight. Later in this chapter, we discuss ways to quantify the work performed in a training session. The Law of Acceleration forms the basis of quantifying training load.

$$F = m \times a$$

(Equation 4.1)

3. **Law of Reaction: Equal and opposite** is critical to understand that the force required to lift an object is directly proportional to the load placed on your body. In order to create adaptations, sufficient load must be placed on the client; however, too much may lead to injury. Without quantifying this load, it is hard to ensure the training program is providing a parsimonious level of stress. For example, when you are running, you exert a force on the ground that moves your center of mass up and forward. Due to the Law of Reaction, the ground also produces an equal and opposite reaction force called the ground reaction force. Many biomechanical studies will investigate how this force propagates up each joint and quantify joint reaction forces.

Table 4.1 Newton's Three Laws of Motion

Law	Linear Movement	Angular Movement
1. Law of Inertia	An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction (velocity) unless acted on by an external *force*.	An object will maintain a constant angular velocity unless acted on by an external torque (moment).
2. Law of Acceleration	The linear acceleration of an object is produced by a force directly proportional to that force	The angular acceleration of an object is produced by a torque (moment) directly proportional to that torque and inversely

	and inversely proportional to the object's mass. Equation: $F = m \cdot a$	proportional to the object's moment of inertia. Equation: $M = I \cdot \alpha$
3. Law of Reaction	For every force, there is a reaction force equal in magnitude and opposite in direction.	For every torque (moment), there is a reaction torque (moment) equal in magnitude and opposite in direction.

Quantifying Movement

We can use biomechanics to estimate the forces required by the client to perform a task and how those forces affect each joint during the movement.

Force is a vector quantity, meaning it has both a magnitude and direction (4). Because it is a vector, force may be decomposed into components that make up the net force. For the context of most resistance training movements, it is sufficient to decompose force into its two primary components: a force that is working parallel to the path of movement, $\mathbf{F}_{||}$ (often referred to as force stabilizing the joint), and a component perpendicular to the object, $\mathbf{F}_{\perp}$, which is the proportion of force that is causing the movement. As you change the position of the object with respect to the axis of rotation, the amount of your total force being used to lift and rotate the object versus that used to stabilize the joint changes (Fig. 4.1).

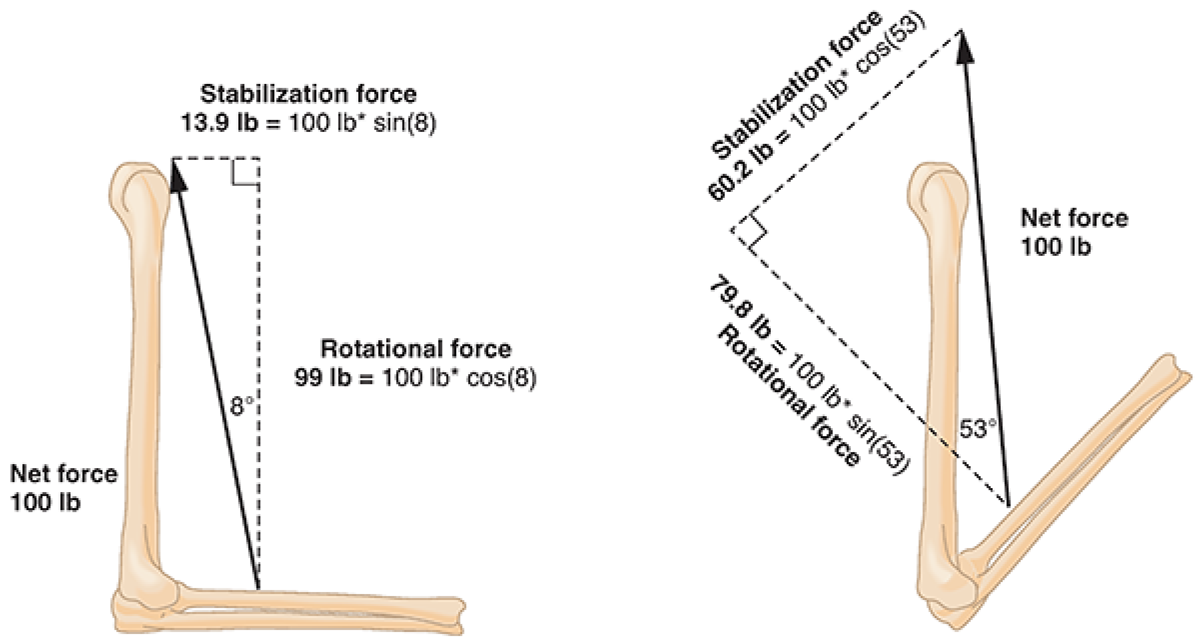


FIGURE 4.1. At two different joint angles, the effective rotational force and stabilization forces are shown along with how to calculate them. In this example, the net muscle force remains constant, but the amount of force used to create movement we observe is substantially reduced. If the resultant muscle force stays constant, it is critical to recognize the amount of muscle force that is used to create the rotation varies throughout the lift.

In Figure 4.2, we observe how the components of the ground reaction force while accelerating during a running sprint. The ground reaction force may be broken down into a vertical, anterior–posterior, and medial–lateral ground reaction force. The vertical and anterior–posterior forces are shown in Figure 4.2. The anterior–posterior force in this case may be considered the braking and propulsive component of the ground reaction force begins with a negative deflection, meaning the runner is being pushed back on by the ground upon initial contact. This force transitions to positive, indicating forward propulsion and acceleration. The goal for a sprinter would be to increase their propulsive force without changing their vertical force.

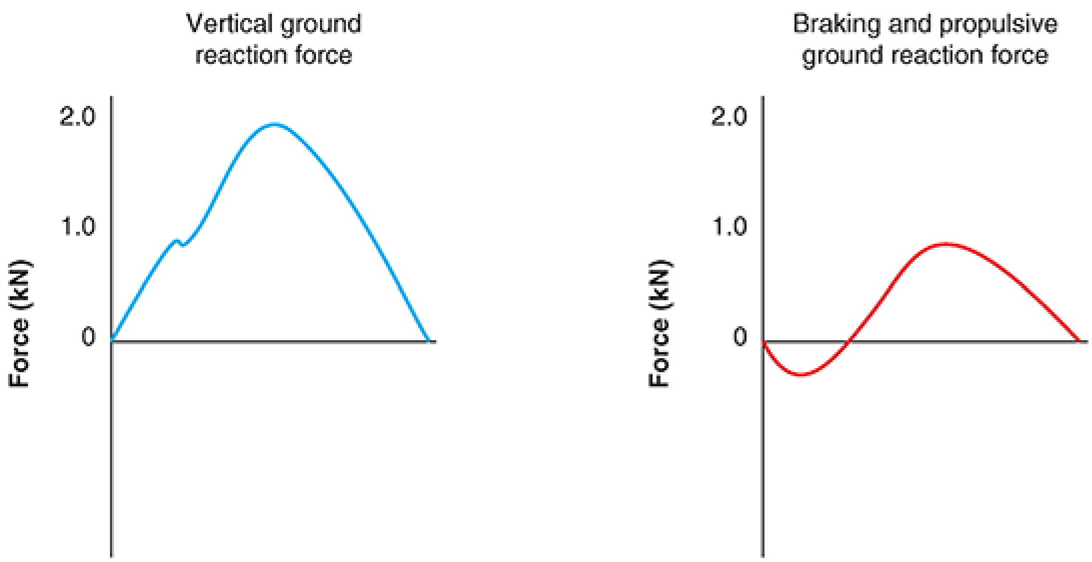


FIGURE 4.2. The components of the ground reaction force while accelerating during a running sprint. The ground reaction force may be broken down into a vertical, anterior–posterior, and medial–lateral ground reaction force. The vertical and anterior–posterior forces are shown.

Although a Personal Trainer will not need to calculate the components of force during a training session, it is important to understand why various parts of a lift will feel harder than others. It may not be obvious to clients why performing a lift in one position feels easier than others or why their form is deemed incorrect. A Personal Trainer can leverage their knowledge of forces during a lift to estimate when a client is placing undue stress on an area of his or her body with a given form or answer why particular parts in the client's range of motion feel more difficult. For example, if a client has a history of low back pain, a trainer may assign him or her a hex deadlift instead of a standard deadlift because the total distance of the force away from the hip joint is smaller, thus placing a smaller load on their lower back throughout the entire movement (this will be discussed later in the chapter). This effect is not only due to the mechanical action of muscles but also due to a critical effect of force: rotational moments.

Rotational Effect of Force Moments

The moment caused by a force refers to the tendency of a force to cause a rotation. This is mathematically calculated by as the product of force and the perpendicular distance from the axis of rotation or lever arm length. The moment about a joint can increase by either increasing the force or the distance from the axis of rotation. Mechanical levers are designed specifically to take advantage of the longer moment arm; the farther a force is applied from the axis of rotation, the larger the rotational moment will be. It is critical for practitioners to understand how different variations of movements may change the moment placed on a client's joints.

$$M = F \cdot d_{\perp}$$

(Equation 4.2)

Moment or Torque
Standard international units: $N \cdot m$
English: lb–foot (ft) ($lb \cdot ft$)
Conversion: $1\ N \cdot m \approx 0.738\ lb \cdot ft$

In the hex deadlift discussed earlier, the total mass of the object remains unchanged, but the lever arm with respect to the hip is smaller, thus creating a smaller moment about the hip. In contrast, the lever arm with respect to the knee increases during the hex lift, which is why more this lift variation will require additional knee extensor force. These two variations of a deadlift should be assigned to compliment the goals of the client (Fig. 4.3).

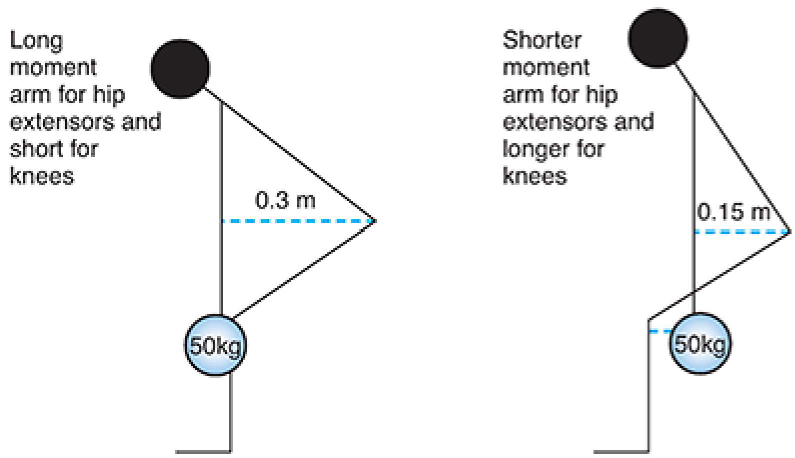


FIGURE 4.3. A standard deadlift and a hex deadlift. In these two variations of this lift, the longer lever arm about the hip during a standard deadlift will result in a moment of 15 kg · m (0.3 × 50) and only 7.5 kg · m (0.15 × 50) for the hex dead lift. This reduction, however, means the knee extensors will have a greater moment to overcome.

Training Example

Many selectorized resistance machines are designed with a cam system that will vary the moment arm during a lift (Fig. 4.4). This oblique-shaped pulley allows for a different moment arm based on where the cable is contacting the cam. In this way, when the moment arm is longer, the effective resistance will be greater. The standard practice with these machines is to set them up so the torque requirements of the muscle will be greatest when the muscle is producing the largest rotational force.

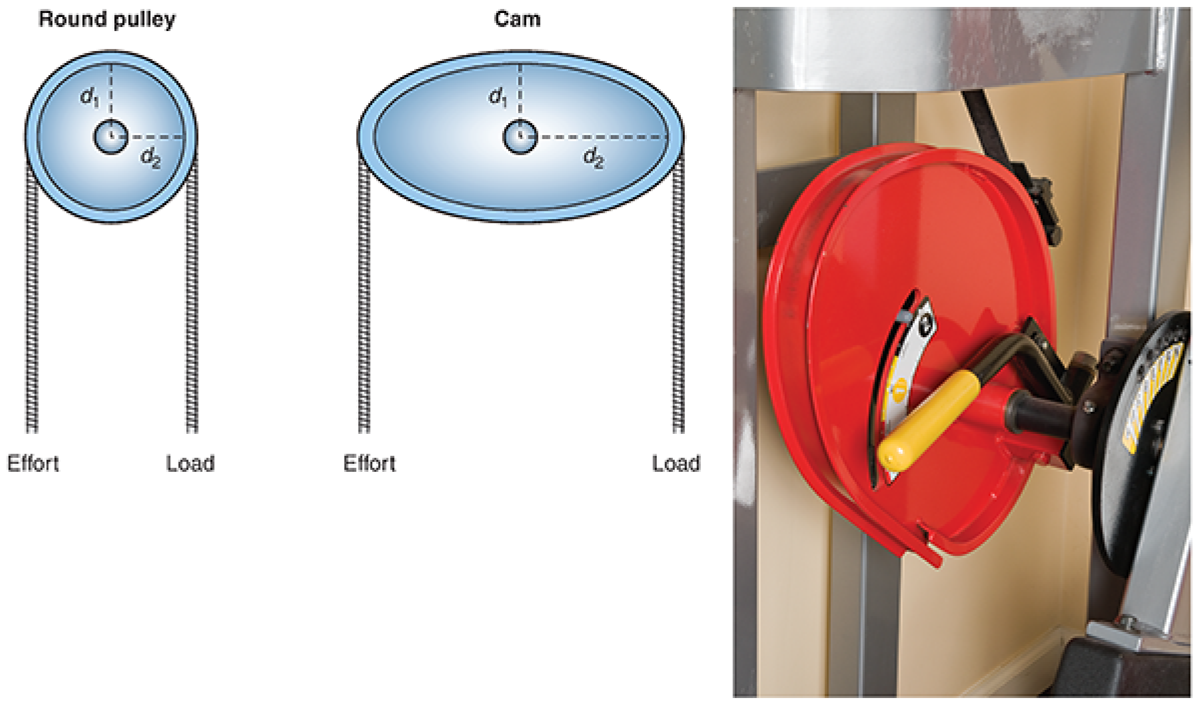


FIGURE 4.4. The moment arm (d) distance of a round pulley and a cam. Not that the moment arm of the round pulley is always equal ($d_1 = d_2$), versus changing constantly for a cam ($d_1 < d_2$). The cam allows for variation in the moment arm during an exercise. In this way, the largest moment may be achieved.

Levers

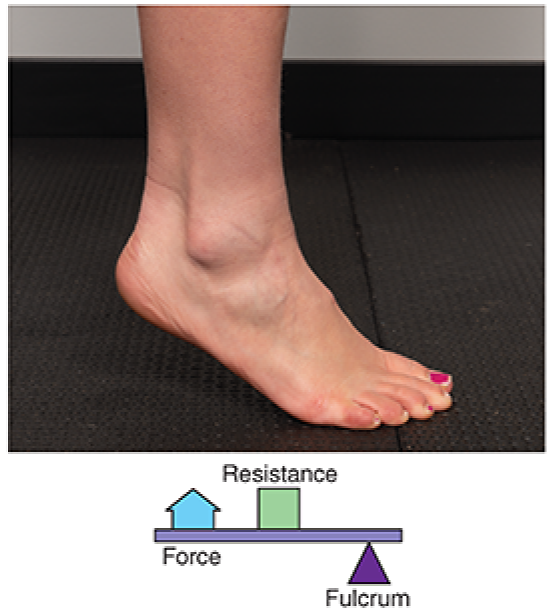
When you are asking clients to perform certain lifts, it is helpful to understand what types of levers you are asking them to use. There are three classes of levers, which can be defined based on the orientation of applied force, pivot point, and resistance (Fig. 4.5).

Class 1: In this class of lever, the pivot point (or fulcrum) is located between the force and the resistance. This lever system is rarely found in the human body. An example of this is between the head and the first vertebrae. In this case, the mass (or resistance) is the head, the fulcrum is this joint (the atlantooccipital joint), and the force comes from a posterior muscle such as the trapezius.

Class 2: This class of lever has both the force and resistance on one side of the fulcrum, with the force being farther from the pivot point. In calf raises, the triceps surae are contracting to move the center of mass vertically while the client's body weight is between the insertion of the triceps surae (calcaneal tendon) and the forefoot.

Class 3: This class is most commonly associated with free weights. In this case, the resistance and force are both on one side of the fulcrum (as in class 2), but the resistance is farther from the pivot than the force. For example, during a bicep curl, the weight will be in the client's hand, and the biceps are contracting and pulling on their insertion (the radial tuberosity) and causing a rotation about the elbow. Most muscles in the body are third-class levers, and therefore, they perform movements at a mechanical disadvantage.

Class 1 Lever



Class 2 Lever

Class 3 Lever

FIGURE 4.5. The three classes of lever systems. Class 1: fulcrum in the middle; class 2: load or resistance in the middle; and class 3: effort force in the middle.

Quantifying Training Effects

In order to adequately prepare clients to meet their goals, the Personal Trainer should periodize their training appropriately. One crucial step in periodization is quantifying the total load placed on the client as well as understanding the intensity at which the client accumulated this load. Although many endurance-oriented exercise protocols such as running, stair stepping, or cycling will quantify training load in metabolic equivalents, the training load and work rate during resistance training can be quantified through physical principles. Moreover, cardiopulmonary and strength assessments require an understanding of mechanical work and power to calculate them. Although both methods of calculating training load are necessary for the Personal Trainer to understand, the mechanical principles of quantifying work are especially valuable when the goals of training are to increase muscular strength or size.

Mechanical Work

From a mechanical perspective, *work* (W) is the product of a force (F) causing a change in position and the magnitude of this linear displacement (d).

$$\text{Mechanical work } (W) = F \cdot d$$

(Equation 4.3)

For example, if a client moves a squat bar exactly 2 ft vertically with 200 lb of force, the total work done is 400 ft · lb.

Training example: Although most training will fall somewhere between completely strength oriented and completely endurance oriented, it is helpful to intentionally quantify the total training volume and intensity so each session can be catered to clients needs. The following example is a simplified way to illustrate the concept of work. Of course, prescriptive exercise will change based on the exact needs of the client.

Strength training: 3 sets of 5 reps of bench press at 225 lb (each rep moves the mass 3 ft)

Endurance training: 3 sets of 15 reps of bench press at 100 lb (each rep moves the mass 3 ft)

Strength training total volume = (225 × 3 ft) × 5 × 3 = 10,125 ft · lb

Endurance training total volume = (100 × 3 ft) × 15 × 3 = 13,500 ft · lb

Another example is achieving the same workload on a stepping exercise. A client can achieve the same total work with two different step heights (based on the client's range of motion). If you are working with an elderly client, you may prescribe him or her twice as many repetitions on a box that is half as tall (*e.g.*, 1 ft vs. 2 ft) to achieve the same work load but reduce fall risk during training.

Mechanical Work in Angular Movements

Although it is straightforward to calculate the linear work a client performs, most movements are rotational in nature. As a result, it is important to consider the rotational work.

$$\text{Angular work} = M \text{ (angular moment)} \times \Delta\theta \text{ (angular displacement)} \qquad \text{(Equation 4.4)}$$

Example: A client is doing a knee extension exercise, the total angular moment is calculated to be 10 ft · lb and the range of motion of the machine allows for 90° of extension (Fig. 4.6). The total angular work is 900 ft · lb.

FIGURE 4.6. Figure of client doing knee extension machine.

If this same client lowers the load from full extension to 90° of flexion, the client is controlling the rotation of the leg, but the client is producing a rotational moment less than that of the resistance on the leg. The total range of motion would remain constant at 90°, but in this case, the quadriceps muscles are contracting (producing force) while lengthening. This is an example of negative work and is an example of an eccentric (or lengthening) contraction (1). Although the total amount of work is negative in magnitude, this type of contraction is associated with greater muscle soreness the following day (5).

Power

Power is linearly defined as the product of force and velocity and is a method to quantify the work rate of a client. Work is defined as the product of force and distance, and power is this work divided by time. A high-power movement can occur through a combination of higher speed and/or higher force. In the endurance versus strength-oriented training example earlier, if you assume the endurance training took longer (30 min) compared with 525 minutes for the strength. This would result in an average power of 6.75 ft · lb · s^{-1} for the strength routine and 6 ft · lb · s^{-1} for the endurance routine.

$$P = F \times \left(\frac{D}{t}\right) = F \times V = \frac{W}{t} \qquad \text{(Equation 4.5)}$$

Where P is power, F is force, D is distance, V is velocity, W is work (in Joules), and t is time.

$$\frac{10{,}800 \text{ ft} \cdot \text{lb}}{30 \text{ min} \times 60 \frac{\text{s}}{\text{min}}} = 6\, ft \cdot \frac{\text{lb}}{\text{s}}$$

$$\frac{10{,}125 \text{ ft} \cdot \text{lb}}{20 \text{ min} \times 60 \frac{\text{s}}{\text{min}}} = 8.44 \text{ ft} \cdot \frac{\text{lb}}{\text{s}}$$

This demonstrates how the strength routine required a greater average power but had a lower total work load. The total work load, average, and peak power of the session should be modulated according to client's goals.

Angular Power

Just as work has a linear and angular equivalent, so does power. Again, this quantity represents an angular rate of work to quantify the intensity of the training (6).

$$\text{Angular power} = M \text{ (angular moment)} \cdot \omega \text{ (angular velocity)} \qquad \text{(Equation 4.6)}$$

In many overhead sports, the ability to create a large peak angular power is essential for success, but this requires adequate training of the shoulder muscles to perform this work. For example, the tennis serve requires clients to impart force on a ball with a relatively large lever arm (the racquet) at a high angular velocity. The muscles that provide internal rotation and flexion of the shoulder can easily become injured due to overuse. Similarly, the posterior shoulder muscles need to be strong enough to stabilize the joint during these high-power movements. For example, an extremely high instantaneous power ($15{,}000 \text{ ft} \cdot \text{lb} \cdot \text{s}^{-1}$) may be observed when an athlete imparts 100 ft · lb of torque onto a racquet moving at 300° per second. In this case, the torque is the force (100 lb) multiplied by the lever created by the arm and racquet (3 ft). Recall, the average power from the strength training routines earlier were 6–7 ft · lb · s^{-1}.

$$P = (300 \text{ ft} \cdot \text{lb}) \times \left(500 \frac{\text{degrees}}{\text{s}}\right) = 15{,}000 \text{ ft} \cdot \frac{\text{lb}}{\text{s}}$$

Power training is important for all clients, from healthy athletes to elderly adults. In most specific movements, such as taking a jump shot in basketball, doing a high jump, or an older adult recovering from a trip, power is critical, and, as you know, force is only half of the equation. Being able to produce a lot of force is helpful and sometimes required, but if the force cannot be produced quickly, your client will not often be able to meet his or her performance goals (*e.g.*, the client will get his or her shot blocked or continue falling on tripping hazards).

Muscular Properties

In order for a muscle to produce force, an action potential from the nervous system must propagate from the spinal cord to the muscles via a peripheral nerve, reach the neuromuscular junction, and cause an electrical depolarization, which causes muscular contraction. These contractions, however, can occur with the muscle lengthening (eccentric), shortening (concentric), or remaining a constant length (isometric). The magnitude of the peak force that can be produced by a muscle varies based on its rate of change of movement during a condition.

The total force a muscle can exert is a summation of *active* and *passive* muscle forces. The active force is produced from the sliding-filament theory (discussed in Chapter 5) and may be thought of as the amount of force an individual intends to produce and is directly related to the magnitude of the command signal that exits the spinal cord and propagates to the muscle. The passive muscle force comes from the tendency of a muscle to resist being lengthened. If an external load is placed on a muscle that causes it to lengthen, the material properties of the muscle and musculotendinous junction will exert a force opposing that lengthening. The total force produced during a movement is a combination of the active and passive muscle forces.

Force–Length Relationship

The maximal force a muscle can exert varies with the length of that muscle. If you put a client in a position to reach a peak force, make sure the primary muscles contributing to this force are in an optimal length, or a length that will be required by the activity or goals (Fig. 4.7). There may be activities required for the sport the client is participating in that require a high force output at a suboptimal joint angle. An example of this may be observed in American football, where linemen need to block their opponents using their entire body; however, their elbows will be bent as they contact their opponents, meaning their elbow extensor muscles (triceps) are in an extremely lengthened position, but they must still produce force to prevent movement. In this case, practicing high-force movements near those joint angles may aid in performance.

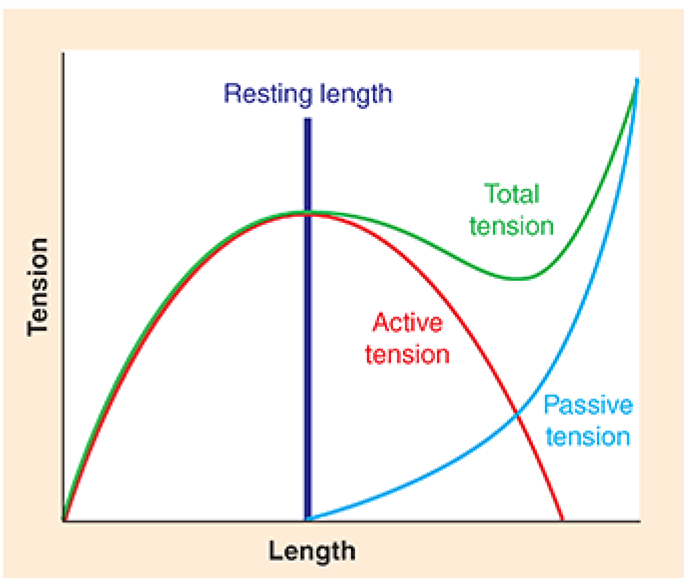


FIGURE 4.7. The tension a muscle can produce at any time is a combination of its active and passive forces. As the muscle gets shorter than its resting length, the total tension it can produce is substantially reduced. Although the total tension increases as the muscle increases in length, there is a point where more damage may be inflicted to the muscle as a larger portion of the tension is due to passive tension.

Training Illustration: Lengthening Heel Drops

Personal Trainers and clinicians can take advantage of the force–length relation of muscles in circumstances that require tissue regeneration. For clients with Achilles tendinitis, lengthening heel drops are often prescribed by clinicians because they have aided in the recovery of this injury (1). The client starts with one foot plantarflexed and the ball of the foot on the edge of a step. The heel is slowly lowered into dorsiflexion, which requires the triceps surae muscle group to contract while lengthening, placing stress on the aponeurosis of the calcaneal tendon and the triceps surae. This is an example of a negative work exercise that may be prescriptive to help rehabilitate a client from tendinopathy (1). Although this is one example of prescriptive exercise for Achilles tendinopathy, similar examples have been used in anterior cruciate ligament rehabilitation and hamstring rehabilitation. Although the exact mechanism is not fully understood, it appears this type of exercise may help collagen fibers in the tendon realign after being broken down due to the nature of lengthening contractions (see the sliding-filament theory in Chapter 5) (1).

Force–Velocity Relationship

The velocity of muscular contraction also affects the force output. This makes intuitive sense; if you try to flex your elbow as quickly as possible, you would not be able to lift much weight, whereas a maximal repetition usually occurs relatively slowly. Muscles can produce the greatest force when being lengthened (often during eccentric contractions), which is partially due to the passive force of the joint along with other attributes of the sliding-filament theory (Fig. 4.8). Lengthening contractions also may cause the client to be sorer the following day (7). Personal Trainers should consult with their clients to understand what their goals of training are and adequately prepare them for the loads they will experience when chasing their goals.

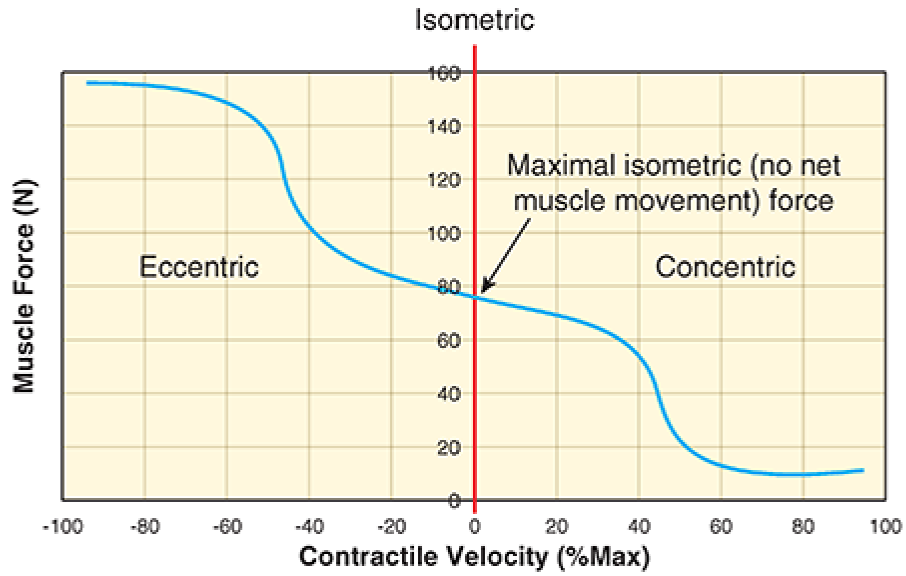


FIGURE 4.8. The force–velocity relation shows that during shortening or concentric movements, the maximal force declines with an increase in shortening velocity. There is a brief region of eccentric (or lengthening) contractions, where the maximal force a client can achieve is greatest near 12.5% of maximal lengthening velocity.

The force–length and force–velocity relationships can be leveraged by Personal Trainers to gradually increase a client's strength and movement capabilities. For example, a client unable to do a traditional chin-up may be able to slowly lower himself or herself from the top of a chin-up, which would result in a lengthening contraction for many of the muscles involved. Because the muscles are lengthening during the movement, they can produce a greater force. A similar approach can be used when an athlete is coming back from injury.

Biomechanics of Selected Movements

Lifting Objects from the Floor

Almost everybody has been told "lift from your legs" when lifting a heavy object from the floor. Why is this sound advice?

The answer lies in two important points the Personal Trainer can glean from the basic biomechanics earlier: moment arm distance and a quick understanding of which joints are producing power.

Figure 4.9A shows a more dangerous lifting technique due to the larger moment arm with respect to the hips. Although the total load does not change, the rotational moment is quite large in this case. The proper technique is shown in Figure 4.9B. In this figure, the moment arm is minimized across the low back, hip, knee, and ankle, so all the extensor muscles can work in concert to lift the object. The back is anatomically more suited to compressive forces rather than rotational moments (8), which will put the client at greater risk for injury.

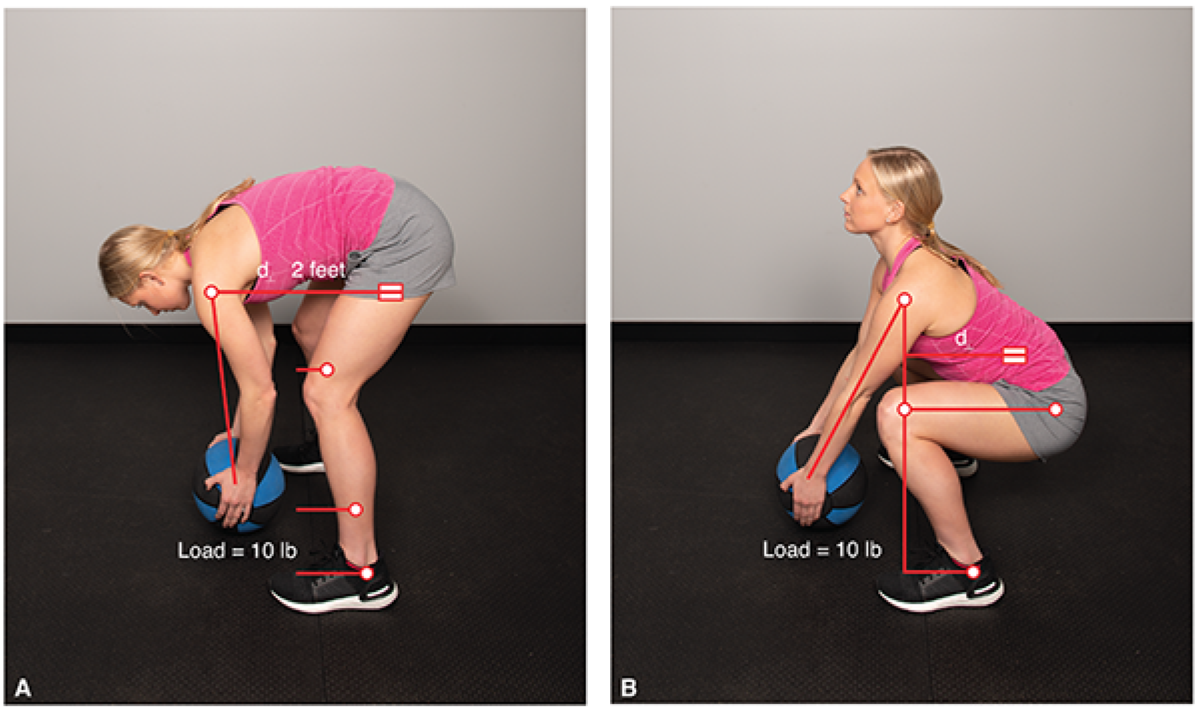


FIGURE 4.9. Improper **(A)** and proper **(B)** biomechanical lifting technique for lifting an object from a standing position. **A.** Improper technique produces a large rotational moment at the low back due to the large moment arm ($d_\perp$) from the low back to the loading point at the arms. **B.** Proper technique aligns the hips, knees, and ankles as close to the line of force as possible to minimize any rotational moment on the low back.

Walking Gait

Walking may be decomposed into multiple phases based on the orientation of the feet with respect to the ground. When thinking of just one foot at a time, the foot can either be in stance (on the ground) or in swing (no ground contact). Stance can be further broken down into landing, midstance, and toe off. Lastly, when thinking of both feet together, the person can be in single or double (both feet on the ground simultaneously) support (Fig. 4.10).

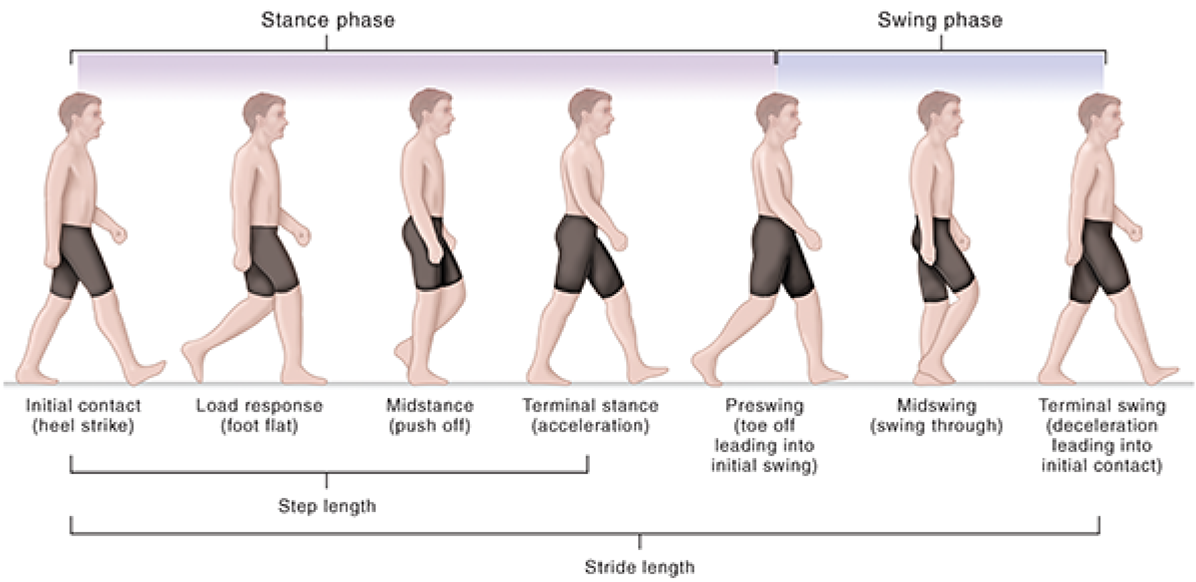


FIGURE 4.10. Normal walking gait. (From Braun MB, Simonson SJ. *Introduction to Massage Therapy*, 3rd ed. Philadelphia: Lippincott Williams & Wilkins, 2014.)

The phases of stance have common force characteristics associated with them. Initial contact generally occurs at the heel during walking; therefore, it is referred to as heel strike. At the moment of heel strike, there is a breaking action due to the equal and opposite reaction of the anterior–posterior ground reaction force with respect to the body's center of mass. At midstance, the breaking force turns into a propulsive force as the angle of the anterior–posterior force vector begins to face posteriorly. During late stance, the foot generally pronates from the lateral aspect of the foot to the medial side in preparation for toe off, which generally occurs near the first distal phalanx. Some common gait abnormalities, along with the biomechanical response, are briefly summarized in Table 4.2.

Table 4.2 **Common Gait Abnormalities and Associated Biomechanical Responses**

Gait Abnormality	Description	Biomechanical Response
Antalgic (painful) gait	A self-protective result of injury to the pelvis, hip, knee, ankle, or foot	Stance phases of two limbs are not equal in time (swing phase of the unaffected limb is shorter).
Arthrogenic (stiff hip or knee) gait	Results from stiffness, laxity, or deformity	Unequal step lengths of the two limbs Circumduction of the affected limb
Equinus gait	Inadequate dorsiflexion range	Weight bearing on lateral edge of the foot Decreased stance time on affected side Pelvis and femur may be laterally rotated
Short leg gait	Leg length difference	Pelvic obliquity (rotation to one side) Exaggerated flexion of knee and hip of unaffected limb Hip "hiking" during swing phase for foot clearance Transverse plane movement of arm on one side

Running Mechanics

Although similar to walking, running mechanics have a few differences that should be considered by the Personal Trainer. It is key to understand there is no scientifically validated perfect running form! The primary difference between running and walking is the flight phase (when both feet are off the ground) and the increased speed of all phases. Each foot undergoes initial contact (which can occur at the heel, midfoot, or forefoot), stance, and toe off, just like walking. Typical ground contact times for running are around 0.15–0.2 seconds compared with 0.8–1 seconds for walking.

Bicycling Form

When an athlete is riding a bike, most of his or her limbs are fixed into a narrow movement path, which means the fit of the bike is critical to his or her success. If a bike seat is too high, a cyclist will overreach during the downstroke, which can cause knee or low back pain. Similarly, a bike seat that is too low may cause knee pain. Although there is an entire bike-fitting industry, a good start is to have athletes reach about 170° of knee extension at the bottom of their pedal stroke. Similarly, the fore-aft position of the handlebars should allow the rider to comfortably reach brakes and have a slight bend in the elbow.

SUMMARY

Biomechanics is a discipline of science that combines physiology and physics in an effort to apply the laws of physics to living organisms. An understanding of biomechanics allows the Personal Trainers to understand and explain why they prescribe specific movements to their clients as well as spot potential shortcomings in form to enhance performance and prevent injury.

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CHAPTER

5

Exercise Physiology

OBJECTIVES

Personal Trainers should be able to:

- Provide fundamental background about the biological function of the human body.
- Introduce the physiological mechanism of various systems of the body and how they relate to exercise training.
- Identify key elements of how the body reacts and adapts to exercise stimulus so that effective exercise training can be prescribed.

INTRODUCTION

For the Personal Trainers to maximize the safety and efficacy of the individualized exercise prescriptions they develop for their clients, they must understand how the body systems behave during the stress of exercise and what physiological changes this stress elicits. This chapter introduces essential concepts of exercise physiology and how different biological systems (*e.g.*, cardiovascular, respiratory, metabolic, muscular and skeletal, and neurological) play intricate roles during exercise performance and physical activity.

Overview

Exercise physiology is a branch of physiology that studies the reactions of body systems to the "stress" of exercise. Classically studied biological systems in the field of exercise physiology include the cardiovascular, respiratory, musculoskeletal, and nervous systems. Multiple systems work interactively to respond to an exercise stimulus to produce an efficient and effective outcome. For example, at the start of exercise, heart rate (HR), blood volume, and respiration increase in order to provide the working muscles with oxygen and nutrients. Similarly, by knowing the structure of each muscle and how muscular contraction works, a Personal Trainer is able to provide appropriate exercises to target the desired muscle groups. Finally, knowledge of energy metabolism and how muscles adapt allows the Personal Trainer to determine the appropriate frequency, intensity, and duration of the exercise training bout and prescribe an appropriate training plan based on the individual's fitness goals. For example, many individuals adopt exercise as part of a weight loss program. Armed with an understanding of energy metabolism, a Personal Trainer determines the appropriate type of exercise that will maximize weight loss and decrease body fat through maximizing the number of calories burned.

With rapid advances in technology and research, the depth and breadth of the field of exercise physiology is growing rapidly. Traditional beliefs may be challenged as new ideas and concepts are generated. Thus, it is important for Personal Trainers not only to master the basic concepts of exercise physiology but also to stay abreast of new developments that will challenge what is known today.

Cardiovascular System

Cardiovascular exercise physiology, a subdiscipline of exercise physiology, examines how oxygen and nutrients are transported through the cardiovascular system and into the working muscle during exercise. The cardiovascular system consists of the heart and the blood vessels. The length of blood vessels required to adequately feed this body's tissues so long that it is estimated that if one were to lay out the entire length of vasculature, an average-sized adult has enough blood vessels to encircle the Earth about two times (1). The primary purpose of the cardiovascular system is to deliver nutrients to and remove metabolic waste products from the tissues. The cardiovascular system performs the following specific functions (2):

1. Transportation of deoxygenated (depleted in oxygen) blood from heart to lungs and oxygenated (full of oxygen) blood from the lungs to the heart
2. Transportation of oxygenated blood from the heart to tissues and deoxygenated blood from the tissues to the heart
3. Distribution of nutrients (*e.g.*, glucose, free fatty acids, amino acids) to cells
4. Removal of metabolic wastes (*e.g.*, carbon dioxide, urea, lactate) from the working cells for elimination or reuse
5. Regulation of pH to control acid–base balance
6. Transportation of hormones and enzymes to regulate physiological function

7. Maintenance of fluid balance to prevent dehydration
8. Maintenance of body temperature by absorbing heat and redistributing to the surface of the body

The Heart

Figure 5.1 shows the anatomy of the heart. The heart sits in the chest cavity at an angle, with the larger left ventricle (LV) pointed toward the left foot. It is surrounded by the thoracic vertebral column in the back, the lungs on both sides, and the chest wall (sternum/ribs) in the front.

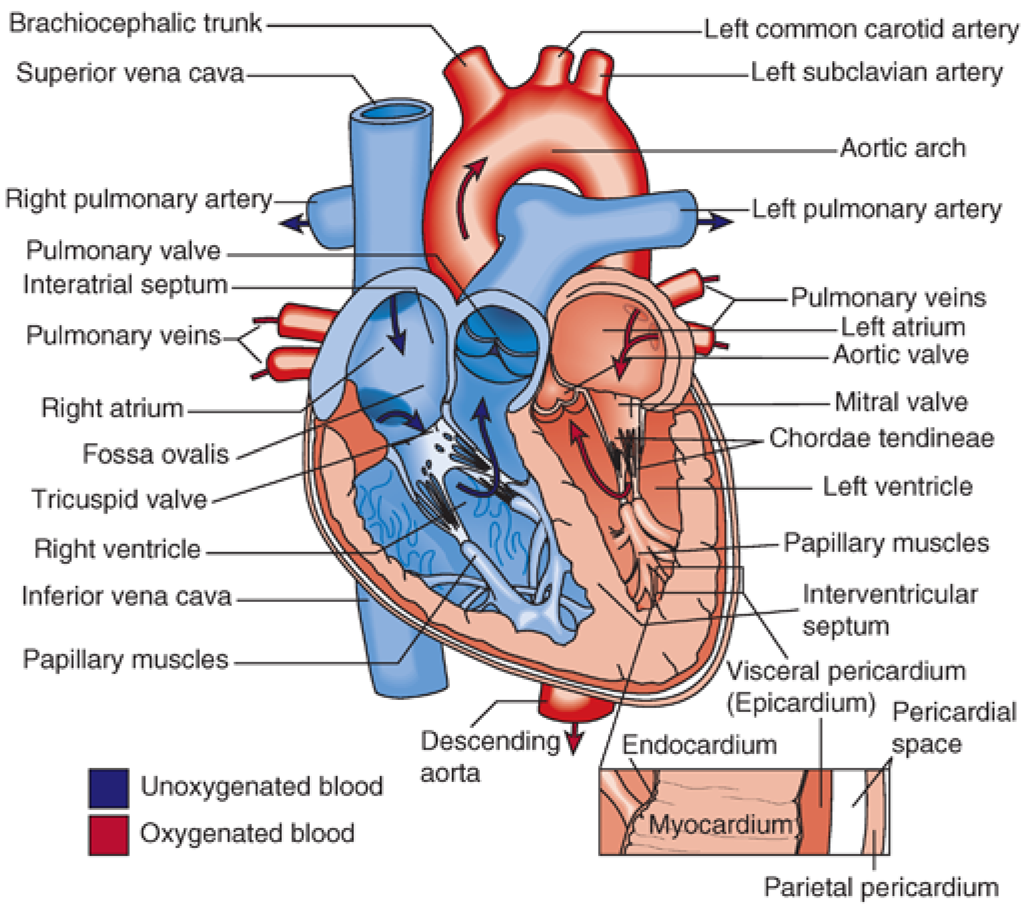


FIGURE 5.1. Anatomy of the heart and direction of blood flow. (From Smeltzer SCO, Bare BG. *Brunner and Suddarth's Textbook of Medical–Surgical Nursing*. 9th ed. Philadelphia [PA]: Lippincott Williams & Wilkins; 2002, with permission.)

The heart has four chambers that serve as reservoirs and pumps. The upper two chambers are called the atria, and the lower two are the ventricles

(3). The atria are separated from the ventricles by the coronary sulcus and the interventricular sulcus separates right ventricle (RV) and LV. The sulci also contain the major arteries and veins that provide circulation to the heart (3).

The base of the heart consists of the structures on the top portion of the heart, such as the left atrium (LA), the right atrium (RA), and parts of the large veins that enter the heart from behind. The base is located above and close to the right sternal border at the level of the second and third ribs. The apex of the heart is located at the level of the fifth intercostal space (2). On average, the heart weighs about 11 and 9 oz for males and females, respectively, pumps 2.4 oz (70 mL) in each beat (1) and is about the size of a closed fist.

Chambers and Valves

In simple terms, the heart is composed of two pumps (right and left), with two chambers or cavities in each pump. The right side of the heart is composed of the RA and RV. The right side is responsible for collecting blood coming from the body (deoxygenated) and pumping the blood through the lungs (pulmonary circulation). On the other side, the left side of the heart, LA and LV collects blood from the lungs and pumps it to all parts of the body (through the arteries) (1).

In addition to the right- and left-side chambers, the heart has four valves, whose function is to maintain blood flow in a single direction. The atrioventricular (AV) valves separate the atria from the ventricles. The right AV valve is called the tricuspid valve and controls the flow of blood from the RA to the RV. The left AV valve is called the mitral (or bicuspid) valve and controls blood flow between the LA and LV. The papillary muscles and the string-like chordae tendineae help the AV valves stay closed, preventing them from swinging back into the atria, which would result in reversed blood flow when the ventricles contract. Two additional valves, known as semilunar valves, separate the ventricles from the aorta and the pulmonary artery. These valves in the heart prevent backflow of blood to the ventricles.

The pulmonic and aortic valves lie between the RV and the pulmonary artery and the LV and the aorta, respectively (3).

Blood Flow through the Heart

Blood flow through the heart, depicted by the arrows in Figure 5.1, begins with the return of systemic blood from the body to the RA.

1. Deoxygenated blood flows into the RA through the superior and inferior vena cava, the coronary sinus, and the anterior cardiac veins.
2. The RA contracts and blood moves through the tricuspid valve into the RV.
3. The RV contracts, the tricuspid valve closes, and blood flows through the pulmonic valve into the pulmonary arteries and the branches of the pulmonary system.
4. Blood enters the alveolar capillaries from the pulmonary arteries, where gas exchange occurs. Oxygen is absorbed and carbon dioxide is removed.
5. Blood flows back to the LA through the pulmonary veins.
6. The LA contracts and blood flows through the mitral valve and into the LV.
7. The LV contracts, the mitral valve closes, and blood flows through the aortic valve into the aorta and its branches, where it is distributed to the heart (coronary circulation) and the rest of the body (systemic circulation) (4).

Tissue Coverings and Layers of the Heart

The heart is covered by a double-walled, loose-fitting membranous sac called the pericardium, which helps anchor the heart within the chest, maintaining its position (3). The outer wall of the pericardium has both a fibrous (tough) layer and a serous (smooth) layer. The thickest layer of the cardiac muscle is known as the myocardium. The blood vessels and nerves that supply the heart are embedded in this layer. In addition, within the myocardium, there is a network of connective tissue fibers, a fibrous skeleton that separate the atria from the ventricles. This skeleton provides support for the myocardium and the valves of the heart.

Electrical Conduction in the Heart

Unlike skeletal muscle, cardiac muscle has unique properties that allow it to contract without an external nervous system impulse. The heart's conduction system includes specialized cells that initiate the heartbeat and electrically coordinate contractions of the heart chamber (3). The sinoatrial node is considered the intrinsic pacemaker because this is where most normal electrical impulses originate. The AV node is responsible for delaying the electrical impulses for approximately 0.12 second between the atria and the ventricles. This allows the atria to contract and fill the ventricles with blood. After a brief pause, the electrical impulse moves rapidly to the apex of the heart through the bundle of His, the right and left bundle branches, and through the Purkinje fibers in the myocardium of both ventricles. This rapid conduction allows the two ventricles to contract at approximately the same time.

The Blood Vessels

Once the blood exits the heart, it enters the vascular system, which is composed of numerous blood vessels. The blood vessels deliver blood to the tissues; help promote the delivery of nutrients and oxygen as well as the exchange of metabolic wastes, hormones, and other substances with cells; and return blood to the heart. Arteries carry blood away from the heart, with large arteries (*e.g.*, the aorta) branching into smaller arteries and eventually to even smaller arterioles. Arterioles branch into capillaries, and it is here where the exchange of blood and other nutrients happens with various tissues (*e.g.*, digestive system, liver, kidneys, and muscles). Unlike the arterial side, the venous side of the circulation starts with the capillaries converging into small venules, which join to form larger vessels called veins. The larger veins (*i.e.*, the venae cavae) return blood to the heart.

Arterioles, or smaller arteries, are made up of smooth muscle and play a major role in regulating blood flow and pressure to the capillaries because of their ability to constrict or dilate, controlling the amount of blood entering the capillaries at one time. Capillaries have extremely thin walls and are the site of exchange of nutrients between blood and the interstitial fluid. Veins receive blood from the venules, and in general, they are thinner, with less smooth muscle, and more compliant than arteries; they act as blood reservoirs. The walls of some veins, such as those in the legs, contain one-way valves that help maintain venous return to the heart by preventing backward blood flow even under relatively low pressures (1).

Cardiac Function

Heart Rate

HR is the number of times the heart beats per minute, and it is measured in beats per minute (bpm). The average normal resting HR is approximately 60–80 bpm, and at rest, the average heart pumps 1,900 gallons of blood daily or over 50 million gallons over a lifetime of 75 years (1). However, differences exist between men and women as well as between adults and children. On average, women have a resting HR that is typically 10 bpm higher than that of men. Children have higher HRs than adults do primarily because their hearts are smaller and eject less blood with each beat. However, among individuals of the same age and sex, individuals with higher levels of fitness have a lower resting HR than those with lower levels of fitness. This adaptation to exercise training occurs due to a larger stroke volume (SV; the volume of blood ejected from the heart per beat). The result of an increased SV is that the heart of a fit person does not have to beat as many times per minute to maintain the same output of blood from the heart (cardiac output) (5).

Stroke Volume

The amount of blood ejected from the LV in a single contraction is the SV. The SV is equal to the difference between the amount of blood in the ventricle before contraction (end-diastolic volume) and the amount of blood left in the ventricle at the end of contraction (end-systolic volume). In an upright posture, SV is lower in untrained individuals than in trained individuals. The SV of men is usually greater than that of women because of their larger heart size. In the supine or prone postures, SV increases. Due to the increase in SV, HR is lower in the supine or prone postures compared to an upright posture.

Cardiac Output

Cardiac output is the volume of blood pumped by the heart per minute in liters ($L \cdot min^{-1}$). It is calculated by multiplying the HR by the SV (cardiac output = HR × SV). The typical cardiac output for adults is 4–5 $L \cdot min^{-1}$ at rest regardless of fitness. However, when measuring maximal values, cardiac output is higher in aerobically fit individuals than in untrained individuals.

Blood Pressure

Blood pressure (BP) is the product of cardiac output and the resistance of flow encountered in the vessel (total peripheral resistance). When the heart beats, blood is propelled from the LV into the systemic circulation. Throughout each phase of the cardiac cycle, the force exerted by the blood against the arteries is the BP. BP is measured in millimeters of mercury (mm Hg). Systolic blood pressure (SBP) is the pressure exerted on the arterial wall during the ventricles' contraction phase, and diastolic blood pressure (DBP) is the pressure exerted on the arteries during the relaxation phase of the ventricles (6). A normal resting BP is below 120/80 mm Hg. A condition known as hypertension (chronically high BP) may be present when SBP and DBP measures exceed 130/80 mm Hg at rest (7).

Acute Response to Cardiovascular Exercise

As exercise intensity increases, oxygen demand and carbon dioxide production of the working muscles increase as well. The cardiorespiratory system is tasked with delivering oxygen to and removing carbon dioxide from these tissues in an attempt to maintain cellular homeostasis. Many mechanisms function collectively to support the increased oxygen demands required to perform such activities. Oxygen delivery to the working muscle during activity is accomplished by increases in HR, SV, blood flow, BP, arteriovenous oxygen (a-$\bar{v}O_2$) difference, and pulmonary ventilation ($\dot{V}E$). The process of pulmonary ventilation allows inspired oxygen to enter the bloodstream and carbon dioxide to leave the bloodstream. This exchange of gases occurs on the surfaces of the alveoli in the lungs. The central nervous system (CNS) plays an important role in this process, increasing neural ventilatory and cardiac drive, which causes an increase in cardiac and respiratory muscle activity, resulting in an increased blood flow and airflow.

Heart Rate

The normal HR response during an acute bout of dynamic exercise is a linear increase with increasing exercise intensity and oxygen uptake. However, as exercise intensity progresses from vigorous to near-maximal or supramaximal levels, the increase in HR will plateau. Therefore, any increases in oxygen uptake beyond this point are accomplished via enhanced oxygen extraction in skeletal muscle rather than enhanced oxygen delivery by the cardiorespiratory system. The magnitude of the HR response is related to age, body position, fitness, type of activity, presence of heart disease, medications, blood volume, and environmental factors such as temperature and humidity (1). Maximal heart rate (HR_{max}) usually decreases with age. In the field, the most common equation used to estimate HR_{max} in men and women is the equation: 220 − age in years. Although this equation has been used extensively over the years, it has a great deal of variability (≥12 bpm) (8). Another equation (HR_{max} = 207 − [0.7 × age]) has been suggested for both men and women, with a broad range of age and fitness (9).

Stroke Volume

During dynamic exercise, SV increases curvilinearly with intensity until reaching near-maximal levels approximately at 40%–50% of maximum aerobic capacity, increasing only slightly thereafter (10). Once SV reaches its maximum levels, the increase in oxygen demand is met by increasing the HR. At very high HRs, SV may actually decrease because of the disproportionate shortening of diastolic filling time in the heart (11).

Cardiac Output

In healthy adults, cardiac output increases linearly with an increase in exercise intensity. However, maximal levels are dependent on many factors including age, posture, body size, disease status, and aerobic fitness level. At the lower intensities (<50% of maximum), cardiac output is increased as a function of both HR and SV (10). Once SV reaches its maximal physiological capacity, further increases cardiac output result from a continued rise in HR.

Arteriovenous Oxygen Difference

Arteriovenous oxygen (a-$\bar{v}O_2$) difference represents the amount of oxygen extracted by the tissues and reflects the difference between the oxygen content of arterial blood and the oxygen content of venous blood. At rest, a-$\bar{v}O_2\Delta$ is usually about 5 mL of oxygen per 100 mL of blood and represents about 25% of the oxygen content in arterial blood. In response to aerobic exercise at incrementally increasing intensities, widening the a-$\bar{v}O_2\Delta$ increases from 5 to 15 mL $O_2 \cdot dL^{-1}$ of blood, corresponding to a use coefficient of 75% (10). In other words, during vigorous exercise, the active muscle extracts greater amounts of oxygen from the arterial blood and reduces the oxygen content in the venous blood (1).

Blood Flow

At rest, 15%–20% of cardiac output is distributed to the skeletal muscles, with the remainder going to the visceral organs, the heart, and the brain.

However, during exercise, as much as 85%–90% of cardiac output is selectively delivered to working muscles and shunted away from the skin and the internal organs. Blood flow to the heart may increase 4–5 times with exercise, whereas blood supply to the brain is maintained at resting levels.

Blood Pressure

Similar to HR, SBP increases in a linear fashion with exercise intensity (8). Maximal SBP values typically reach 190–220 mm Hg; however, maximal SBP should not exceed 250 mm Hg (8). An SBP that fails to rise or that falls (>10 mm Hg) with increasing workloads may signal either a plateau or decrease in cardiac output (12). Exercise testing should be terminated in persons demonstrating a decrease in SBP during further exercise (exertional hypotension). Unlike SBP, DBP may decrease slightly or remain unchanged during exercise (8) because of the decrease in peripheral resistance caused by the enlargement of arterioles in the active muscles during exercise (13). DBP should not exceed 115 mm Hg, as this could indicate a problem with venous return (8).

Maximal Oxygen Consumption

Maximal volume of oxygen consumed per unit time, or $\dot{V}O_{2max}$, is the most widely recognized measure of cardiorespiratory endurance. $\dot{V}O_{2max}$ is defined physiologically as the highest rate of oxygen transport and use that can be achieved at maximal physical exertion. $\dot{V}O_{2max}$ may be expressed mathematically by a rearrangement of the Fick equation (14):

$$\dot{V}_{2max} = HR_{max} \times SV_{max} \times a\text{-}\bar{v}O_2\Delta_{max}$$

Thus, it is apparent that both central (*i.e.*, cardiac output) and peripheral (*i.e.*, $a\text{-}\bar{v}O_2\Delta$) regulatory mechanisms affect the magnitude of $\dot{V}O_{2max}$.

$\dot{V}O_{2max}$ may be expressed either on an absolute or a relative basis (see example in Box 5.1). Absolute $\dot{V}O_{2max}$ reflects the total body energy output and energy expenditure (*i.e.*, 1 L O_2 consumption ≈ 5 kcal) and uses the units of ($L \cdot min^{-1}$) without taking in consideration body weight. Relative $\dot{V}O_{2max}$ reflects the individual's oxygen consumption based on the body weight, dividing the absolute $\dot{V}O_{2max}$ value by body weight in kilograms ($mL \cdot kg^{-1} \cdot min^{-1}$). Because large persons usually consume larger absolute amounts of oxygen by virtue of a larger muscle mass, expressing $\dot{V}O_{2max}$ values as "relative" is appropriate for comparisons between individuals of different body masses (*i.e.*, men and women). This measure is widely considered the single best index of physical work capacity or cardiorespiratory fitness (11). In terms of cardiorespiratory endurance, the higher the $\dot{V}O_{2max}$, the better (15).

Box 5.1 Absolute versus Relative $\dot{V}O_{2max}$

To illustrate the difference between absolute and relative expressions of $\dot{V}O_{2max}$, consider two individuals with the same absolute $\dot{V}O_{2max}$ but who have different body weights.

Jim
45 years old, 200 lb (90.7 kg)
Absolute $\dot{V}O_{2max}$: 3.5 L · min^{-1}
Relative $\dot{V}O_{2max}$: 38.5 mL · kg^{-1}· min^{-1}

3.5 L · min^{-1} × 1,000 mL / 1 L = 3,500 mL · min^{-1} / 90.7 kg = 38.5 mL · kg^{-1} · min^{-1}

38.5 mL · kg^{-1} · min^{-1} / 3.5 mL · kg^{-1} · min^{-1} = 11 METs

Amber
45 years old, 120 lb (54.4 kg)
Absolute $\dot{V}O_{2max}$: 3.5 L · min^{-1}
Relative $\dot{V}O_{2max}$: 64.3 mL · kg^{-1}· min^{-1}

3.5 L · min^{-1} × 1,000 mL / 1 L = 3,500 mL · min^{-1} / 54.4 kg = 64.3 mL · kg^{-1} · min^{-1}

64.3 mL · kg^{-1} · min^{-1} / 3.5 mL · kg^{-1} · min^{-1} = 18 METs

Even though Jim and Amber both have the same absolute $\dot{V}O_{2max}$, Amber has a greater oxygen capacity in relation to her body mass.

Another term commonly used to express exercise intensity is the *metabolic equivalent* (MET). A MET is a simple way to estimate the energy cost of an activity and is equivalent to 3.5 mL · kg^{-1} · min^{-1}, which is approximately equal to resting metabolism. In practical terms, a MET is a multiple of resting energy expenditure. For example, walking at a speed of 2.5 mph on a level, firm surface has a MET value of 2.0, meaning that it is approximately twice as metabolically demanding as resting (16). The number of calories (kcals) burned during a given bout of activity can also be estimated using an activity's associated MET value using the following equation: $\text{kcal} \cdot \text{min}^{-1} = [(\text{METs} \times 3.5\ \text{mL} \cdot \text{kg}^{-1} \times \text{body weight in kg}) / 1{,}000] \times 5$.

Respiratory System

The respiratory system is responsible for filtering the air that enters the body and allowing gas exchange within the alveoli, which are microscopic air sacs in the lungs. The primary structures of the respiratory system are depicted in Figure 5.2. The lungs provide the surface for gas exchange and are situated inside the chest cavity above the diaphragm and protected by the ribs and pectoral muscles. The lungs of an average-sized adult weigh approximately 1 kg and have a volume between 4 and 6 L, which is similar to the air in a basketball (1). Breathing is an involuntary action controlled by movements of the respiratory muscles, diaphragm, and changes in pressure. At rest and during inspiration, the pressure inside the lungs is less than the atmospheric pressure. Therefore, when one takes a breath, an active process, the lower pressure inside the lungs allows them to inflate and prevents the collapse of the fragile air sacs within the lung. These pressure differences reverse during exhalation, a passive process at rest, where the lungs deflate and push air out. In contrast, during exercise, both inspiration and exhalation are active processes. The muscular work needed to accomplish these tasks during exercise increases as a function of exercise intensity.

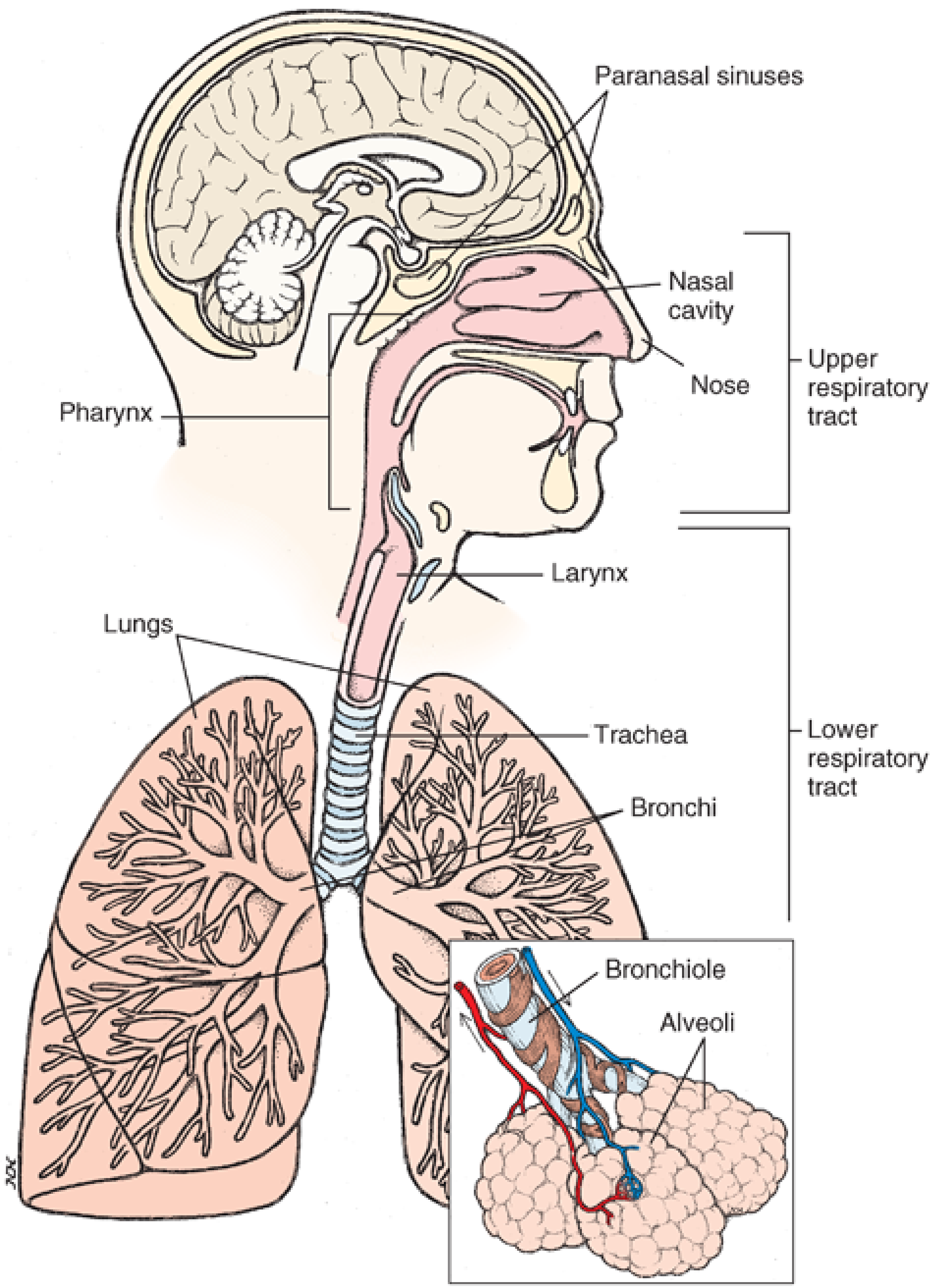


FIGURE 5.2. The structures of the respiratory system (anterior view). (From Thomas LS. *Stedman's Medical Dictionary*. 27th ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2000, with permission.)

Control of Breathing

Respiratory muscles lack the ability to regulate their own contractions, and thus, the control of breathing results from the interaction of brainstem and respiratory pathways (1). Autonomic control structures are located in the brainstem, and voluntary control structures are located in the cerebral cortex of the brain.

Distribution of Ventilation

Ventilation of the pulmonary system is accomplished in two major divisions, the upper and lower respiratory tracts, illustrated in Figure 5.2.

Upper Respiratory Tract

The upper respiratory tract acts as a pathway for air to move into the lower respiratory tract. The upper respiratory tract is composed of the nose, sinuses, pharynx, and larynx, and its sole function is to purify, warm, and humidify the air before it reaches the gas exchange units (*i.e.*, alveoli). During normal, quiet breathing, inspired air passing through the nose is heated to body temperature, and the relative humidity is increased to more than 90%.

The pharynx is divided by the soft palate into the nasopharynx and the oropharynx. The epiglottis, located at the base of the tongue, protects the laryngeal opening during swallowing. The larynx contains the vocal cords, which contribute to speech and participate in coughing.

Lower Respiratory Tract

The lower respiratory tract begins in the trachea just below the larynx and includes the bronchi, bronchioles, and alveoli (see Fig. 5.2). There are approximately 23 divisions of airways: The first 16 are conducting airways, and the last 7 are respiratory airways, ending in approximately 300 million alveoli, which form the gas exchange surface. The trachea is anterior to the esophagus and begins at the base of the neck, extending approximately 4–4.5 in (10.2–11.4 cm) before it divides into the right and left main bronchi. The trachea consists of a series of anterior horseshoe-shaped cartilaginous rings and a posterior longitudinal muscle bundle. The right main bronchus divides into three lobar bronchi: upper, middle, and lower. The left main bronchus divides into upper and lower lobar bronchi. Fissures separate the two lobes with two layers of visceral pleura. The lobar bronchi divide into segmental bronchi and segments, 10 on the right and 10 on the left. Segmental bronchi divide further into the terminal bronchioles, which have a diameter of about 1 mm.

The major bronchi contain cartilage that keeps the airway open, as well as large numbers of mucous glands that produce secretions in response to irritation, infection, and/or inflammation. In the large airway, irritant receptors initiate the cough reflex when stimulated. Columnar cells lining the epithelium (inner lining) of the bronchi consist predominantly of ciliated cells containing motile cilia, which move or beat in a coordinated manner to move the mucous layer toward the mouth (“mucociliary escalator”). The columnar is an important barrier for lung defense. Goblet cells interspersed among the ciliated cells secrete mucus. Beyond the terminal bronchioles are respiratory bronchioles, alveolar ducts, and the alveoli. Air flows through the conducting airways and down to the level of the alveolar ducts and alveoli. Movement of air or gas from the lungs into the bloodstream occurs by diffusion.

Ventilatory Pump

The ventilatory pump provides the mechanisms for breathing and consists of the chest wall, the respiratory muscles, and the pleural space.

Chest Wall

The chest wall includes the muscles of ventilation (primarily intercostal muscles) and bones (spine, ribs, and sternum). The ribs are hinged on the spine by ligaments and cartilage so that the ribs move upward and outward during inspiration and downward and inward during expiration. The hinging movement results in a change in thoracic volume and pressures. At the end of a normal expiration at rest, the elastic properties of the chest wall exert an outward (expansion) force, whereas the elastic properties of the lung structures exert an inward (recoil) force.

Ventilatory Muscles and Their Normal Functions

The ventilatory muscles are the only skeletal muscles essential to life. The diaphragm, the major muscle of inspiration, is innervated by the phrenic nerve, which originates from the third to fifth cervical spinal segments. Inspiration (airflow into the lungs) occurs by activation of the ventilatory muscles, particularly the diaphragm, which creates a more negative pressure in the pleural space and the lungs than that in the atmosphere. Air enters the lungs until the intrapulmonary gas pressure equals atmospheric pressure. During expiration, when the ventilatory muscles relax, air flows from the lungs into the atmosphere because of the positive pressure generated by the elastic recoil of the lungs. Figure 5.3 depicts the role of the diaphragm in ventilation. The diaphragm functions as a piston, with contraction and relaxation of the vertical muscle fibers. With contraction, the muscle fibers move downward and displace the abdominal contents so that the abdomen moves outward, as does the chest wall. Expiration is normally passive under quiet breathing because of elastic recoil of the lung; it requires no work and is therefore passive. However, during active breathing, when ventilatory requirements are increased (*e.g.*, during exercise), the internal intercostals and the abdominal muscles (rectus abdominis, external and internal oblique, and transverse abdominis) are recruited to actively pull down on the ribs.

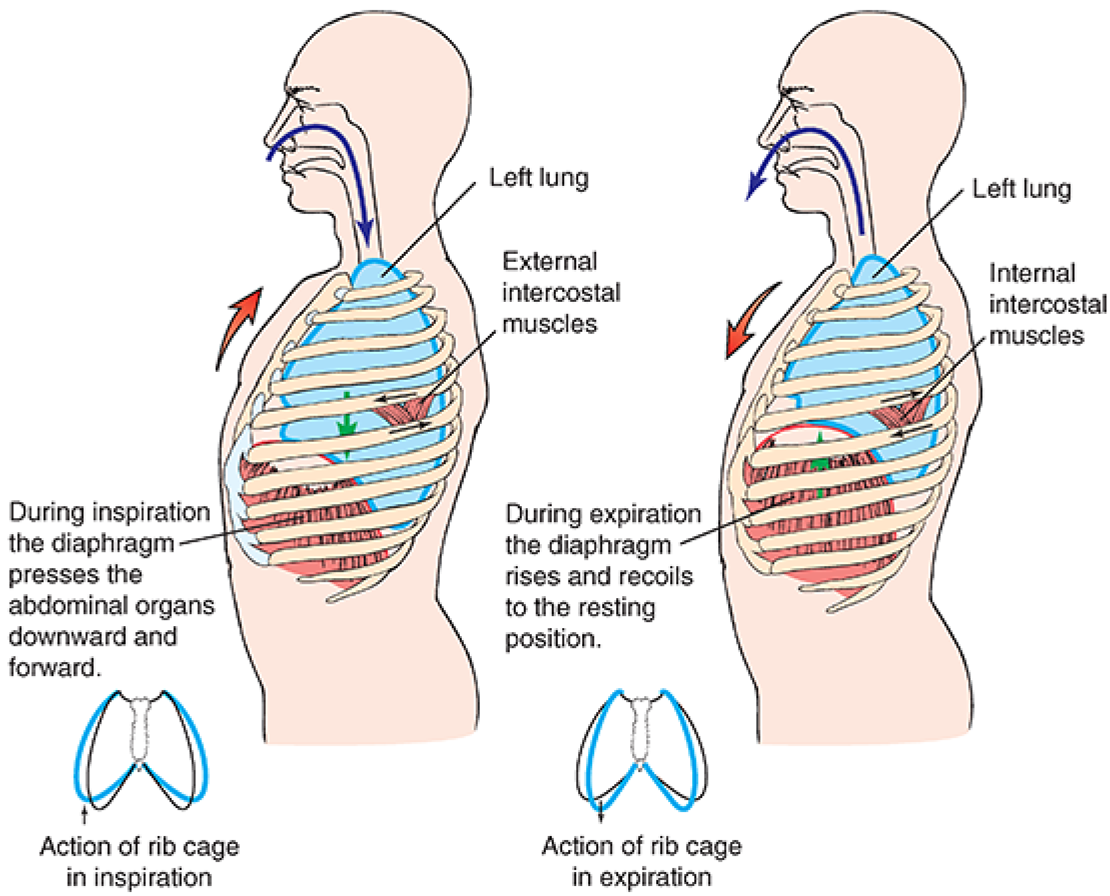


FIGURE 5.3. Mechanics of normal — not deep, not shallow — inspiration *(left)* and expiration *(right)*. (From Weber J, Kelley J. *Health Assessment in Nursing*. 2nd ed. Philadelphia [PA]: Lippincott Williams & Wilkins; 2003, with permission.)

Abnormal Ventilatory Muscle Function

Therefore, a spinal cord injury at or above the third to fifth cervical vertebrae compromises respiratory muscle function and, consequently, ventilation. Additionally, in clients with airflow obstruction (*e.g.*, asthma or emphysema), hyperinflation of the lungs stretches the lung tissue and leads to additional elastic recoil, thus impairing the diaphragm's ability to contract.

Distribution of Blood Flow

The lungs receive blood from the pulmonary arteries, which contain systemic venous blood from the RV and bronchial arteries. The pulmonary artery emerges from the RV and divides into the right and left main pulmonary arteries. The pulmonary arteries divide into branches corresponding to the divisions of the bronchial tree and supply the pulmonary arterioles. The pulmonary circulation is a low-pressure system with a normal mean pressure of approximately 15 mm Hg at rest (compared to systolic pressure that is about 120 mm Hg). Most blood flow to the alveoli is derived from the pulmonary circulation, whereas the bronchial arteries (part of the systemic circulation loop) supply blood to the walls of the bronchi and bronchioles to the level of the alveoli. Pulmonary arterioles divide into pulmonary capillaries that form networks in the walls of the alveoli, where gas exchange occurs. The pulmonary veins carry oxygenated blood from the pulmonary capillaries and converge into the main pulmonary veins, which empty into the LA.

Pulmonary Ventilation

$\dot{V}E$ is the volume of air exchanged in 1 minute. For an average, sedentary adult male, the volume of air exchanged at rest is approximately 6 $L \cdot min^{-1}$. However, at maximal exercise, $\dot{V}E$ often increases 15- to 25-fold over resting values. Even though oxygen delivery is vital, $\dot{V}E$ may be more regulated by the requirement for carbon dioxide removal than by oxygen consumption.

Ventilatory Changes

Several ventilatory adaptations result from physical conditioning regimens. Aerobically trained persons demonstrate larger lung volumes and diffusion capacity at rest and during exercise than their sedentary counterparts. However, ventilation is either unaffected or only modestly affected by cardiorespiratory training. Maximal ventilatory capacity may be increased by exercise training, but it is unclear that this provides any advantage other than increased buffering capacity for lactate. Submaximal ventilation is probably not affected at all, but it may be decreased in some circumstances because a decrease in the production of lactate coincides with a decrease in the need to buffer lactate, which results in decreased ventilation.

Energy Systems

Energy is essential to produce mechanical work, maintain body temperature, and fulfill all biological and chemical activities inside the body. To release energy, foodstuff that is consumed (*i.e.*, protein, carbohydrate, and fat) must be metabolized to yield a high-energy compound called adenosine triphosphate (ATP). In the human body, all mechanical work produced by physical activity relies on the continuous supply and resynthesis of ATP. A small amount of ATP is stored inside muscles so that it is immediately available to produce movement when a stimulus is given to the muscles. However, the storage of ATP in the muscles is limited. If the ATP in the muscle was the only energy available, physical activity could only last for a few seconds. Therefore, for movement that lasts longer than a few seconds, ATP must be further resynthesized through other means outlined in this section. The relationship between exercise duration and energy sources is illustrated in Figure 5.4.

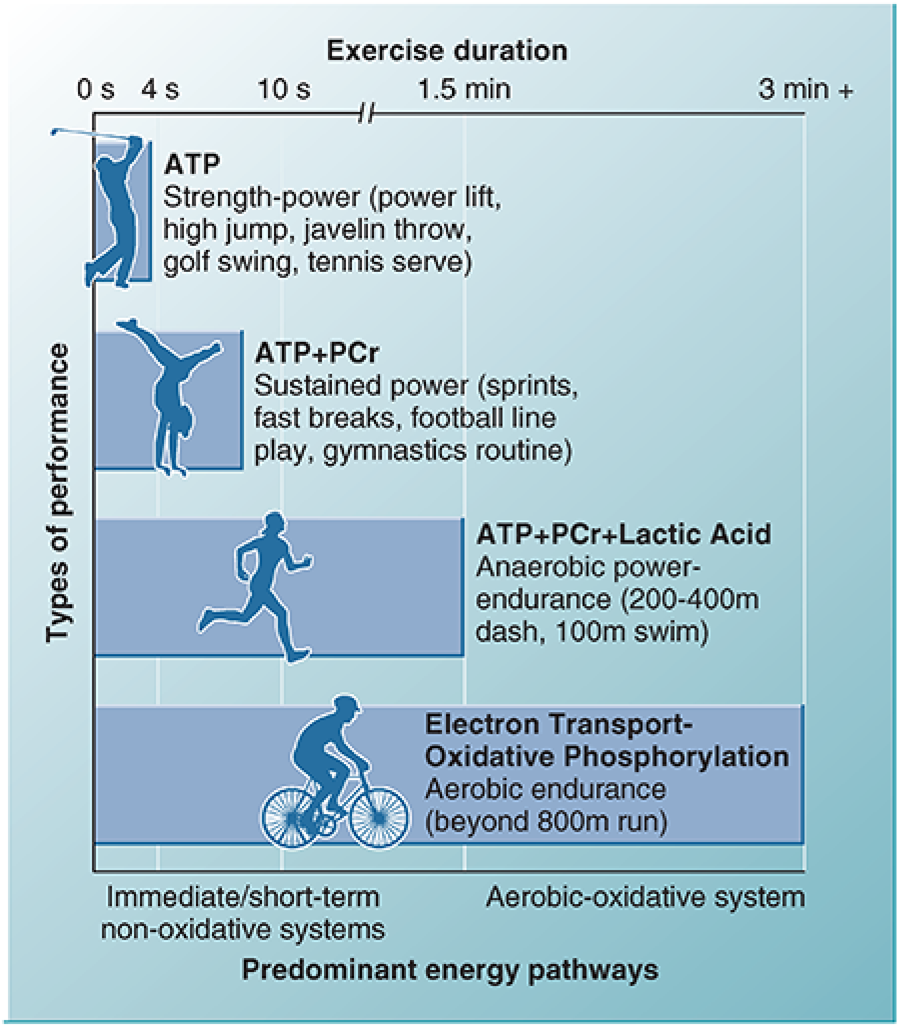


FIGURE 5.4. Comparison of activity with the energy pathways used (ATP = adenosine triphosphate; PCr = creatine phosphate; ATP + PCr + lactic acid = anaerobic glycolysis; electron transport-oxidative phosphorylation = aerobic oxidation). (From Premkumar K. *The Massage Connection: Anatomy and Physiology*. 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2011, with permission.)

Aerobic and Anaerobic Metabolism

In the transition from rest to maximal exertion, the energy requirements of the exercising muscle increase substantially. Therefore, ATP must be constantly resynthesized to maintain the energy requirements of the movement. Hence, the exercising muscle must possess a large capacity of energy to produce sufficient ATP so that increased activity can continue. Energy production relies heavily on the respiratory and cardiovascular systems for the delivery of oxygen and nutrients and for the removal of waste products to maintain the internal equilibrium of cells.

Anaerobic Metabolism

Adenosine Triphosphate

ATP serves as the ideal energy-transfer agent that powers all of the cell's energy needs (1). The energy released through hydrolysis of the high-energy compound ATP to form adenosine diphosphate (ADP) and inorganic phosphate (Pi) powers skeletal muscle contractions. The following reaction is catalyzed by the enzyme ATPase:

$$\text{ATP} + \text{H}_2\text{O} \rightarrow \text{ADP} + \text{H}^+ + \text{Pi}$$

The amount of ATP directly available in muscle at any time is small, so it must be resynthesized continuously if exercise lasts for more than a few seconds. Muscle fibers contain the metabolic machinery to produce ATP by three pathways: creatine phosphate (CP), anaerobic glycolysis, and aerobic oxidation of nutrients to carbon dioxide and water.

Creatine Phosphate

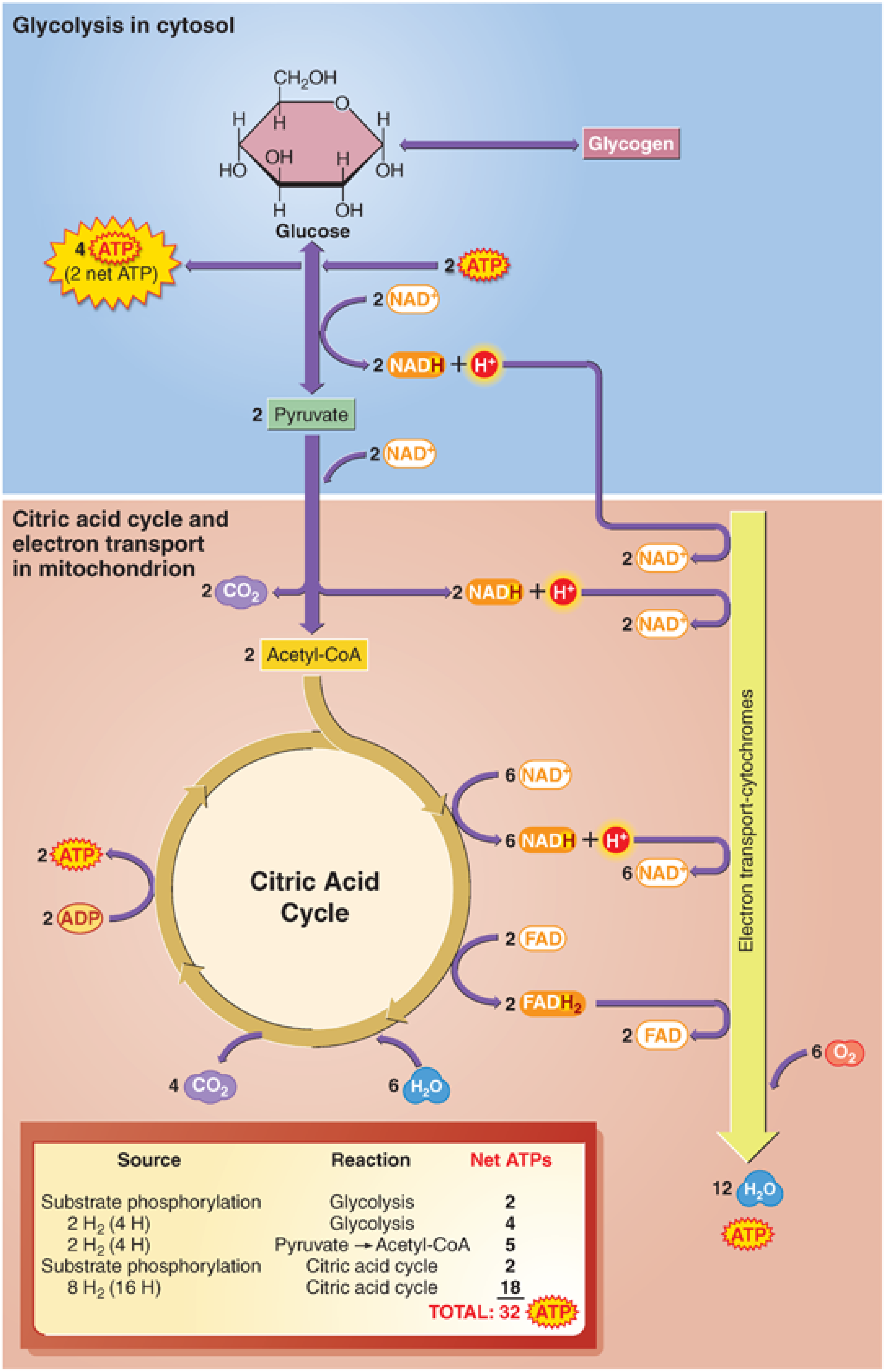
The CP system transfers high-energy phosphate from CP to rephosphorylate ATP from ADP (using the enzyme creatine kinase) as follows:

$$\text{ADP} + \text{CP} + \text{H}^+ \rightarrow \text{ATP} + \text{Cr}$$

This system is rapid because it involves only one enzymatic step (*i.e.*, one chemical reaction). However, CP exists in finite quantities in cells as well, so the total amount of ATP that can be produced is limited, enough for only 5–10 seconds of strenuous exercise. Oxygen is not involved in the rephosphorylation of ADP to ATP, so the CP system is considered anaerobic (without oxygen).

Anaerobic Glycolysis

The rapid breakdown of carbohydrate molecules, either glycogen or glucose, occurring without the presence of oxygen, is called anaerobic glycolysis. This process is capable of producing ATP rapidly. The degradation of carbohydrate (glycogen or glucose) to pyruvate or lactate through glycolysis involves a series of enzymatically catalyzed steps, and even though glycolysis does not use oxygen and is considered anaerobic, pyruvate can readily participate in aerobic production of ATP when oxygen is available in the sufficient quantity in the cell. Therefore, glycolysis can be an anaerobic pathway capable of producing ATP without oxygen, or the first step in the aerobic degradation of carbohydrate (1) (Fig. 5.5).



Source	Reaction	Net ATPs
Substrate phosphorylation	Glycolysis	2
2 H_2 (4 H)	Glycolysis	4
2 H_2 (4 H)	Pyruvate → Acetyl-CoA	5
Substrate phosphorylation	Citric acid cycle	2
8 H_2 (16 H)	Citric acid cycle	18
	TOTAL:	32 ATP

FIGURE 5.5. A net yield of 32 ATPs from energy transfer during the complete oxidation of one glucose molecule in glycolysis, the citric acid cycle, and electronic transport. Abbreviations: acetyl-CoA, acetyl coenzyme A; FAD, flavin adenine dinucleotide; NAD, nicotinamide adenine dinucleotide. (From Katch VL, McArdle WD, Katch FI. *Essentials of Exercise Physiology*. 4th ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2011, with permission.)

Lactate, a byproduct of anaerobic glycolysis, can also be resynthesized for ATP production during exercise (13). Although the details of how this process occurs are beyond the scope of this chapter, it is important to understand that lactate is produced with the initiation of exercise and accumulates in the muscle during intense exercise. During rest or moderate exercise, lactate is oxidized in muscles with high oxidizing capacity (*i.e.*, heart and ventilatory muscles) (17). In strenuous exercise, when energy demand is high and ventilation is at its peak, lactate accumulates contributing to fatigue (18). During recovery, when enough oxygen becomes available, lactate is oxidized and used for ATP production in the muscle or in the liver (4,19). Contrary to popular belief, lactate accumulation does not cause soreness after intense exercise. This soreness, which usually appears after an intense bout of exercise and can last various days, is most commonly due to muscle fiber damage and is referred to as delayed-onset muscle soreness (DOMS) (20).

Aerobic Oxidation

The amount of ATP yielded by anaerobic glycolysis is extremely small (1). Nevertheless, anaerobic mechanisms provide a rapid source of ATP, which is particularly important at the beginning of any exercise bout and during high-intensity activity that can be sustained only for a brief period. As the duration of exercise increases, the relative contribution of anaerobic energy sources decreases (1), whereas the relative contribution of aerobic metabolic processes increases. Aerobic oxidation combines two complex metabolic processes, which occur inside the mitochondria: the Krebs cycle and the electron transport chain (ETC). These processes are illustrated in Figure 5.5. Unlike glycolysis, aerobic metabolism can use fat, protein, and carbohydrate as substrates to produce ATP. Conceptually, the Krebs cycle can be considered a primer for oxidative phosphorylation. The primary function of the Krebs cycle is to remove hydrogen from four of the reactants involved in the cycle. The electrons from these hydrogens follow a chain of cytochromes (ETC) in the mitochondria, and the energy released from this process is used to rephosphorylate ADP to form ATP. Oxygen is the final acceptor of hydrogen to form water, and this reaction is catalyzed by cytochrome oxidase (1).

The aerobic system requires adequate delivery and use of oxygen and uses carbohydrate, fats, and proteins as energy substrates, sustaining high rates of ATP production for muscular energy over long periods of time. The relative contributions of anaerobic and aerobic metabolism depend on oxygen exchange (ventilation), delivery (cardiovascular), and use (muscular extraction) at rates commensurate with the energy demands of activity. A *steady state* is the term used to depict a balance between the energy required by the muscle to perform work and the production of ATP via aerobic metabolism. A steady state corresponds to the flattening or plateau seen in the oxygen consumption curve during submaximal exercise. Although proteins can be used as a fuel for aerobic exercise, carbohydrates and fats are the primary energy substrates used to resynthesize ATP during exercise in a healthy, well-fed individual. In general, carbohydrates are used as the primary fuel at the onset of exercise and during high-intensity work (1). However, during prolonged exercise of low to moderate intensity (longer than 30 min), a gradual shift occurs from carbohydrate toward an increasing reliance on fat as a substrate.

Oxygen Requirement: Beginning of Exercise and in Recovery

Oxygen Deficit

Oxygen deficit refers to the lag in oxygen consumption at the beginning of exercise. At the initial stage or transitional stage from rest to submaximal exercise, oxygen consumption increases gradually until it reaches a steady state. However, in order to supply the energy costs of the initial exercise stage, an oxygen deficit is incurred. Due to this deficit, part of the ATP demand must be supplied by anaerobic metabolism. Once steady state is reached, the majority of the ATP supply can be sufficiently provided through aerobic oxidation. In other words, oxygen deficit describes the difference between the required oxygen amount necessary for meeting the energy demand of the exercise and the actual oxygen consumption. An additional oxygen deficit accumulates whenever energy demand is abruptly increased, as in sudden increase in exercise pace or intensity. After the exercise stops, the oxygen deficit accumulated will be replenished during recovery by consuming more oxygen than would normally be required.

Excess Postexercise Oxygen Consumption

The consumption of more than usual amounts of oxygen after exercise is termed *excess postexercise oxygen consumption* (EPOC) (1). Oxygen uptake remains elevated above resting levels for several minutes during recovery from exercise. In general, postexercise metabolism is higher following high-intensity exercise than after light or moderate work. Furthermore, EPOC remains elevated for longer duration after prolonged exercise than after shorter term exertion. EPOC helps to restore CP in muscles and oxygen in blood and tissues.

Muscular System

The human body is composed of three types of muscles: skeletal, smooth, and cardiac. Skeletal muscle, or “striated muscle” as it is also known due to its alternating light and dark fibers, is the type of muscle that attaches to the skeleton and produces physical movements. All internal organs are composed of smooth muscle with the exception of the heart, which is composed of cardiac muscle.

Skeletal muscle is considered voluntary muscle because the individual has a substantial amount of control over its usage. Smooth muscle and cardiac muscle are involuntary muscles because they are controlled by the autonomic nervous system (ANS), the involuntary division of the nervous system. All three kinds of muscle possess characteristics of extensibility, elasticity, excitability, and contractility. In this chapter, the focus is placed on skeletal muscle because it is strongly related to human movement during exercise.

Skeletal Muscles

The structure of skeletal muscle is shown in Figure 5.6. Individual skeletal muscles are composed of a varying number of muscle bundles referred to as "fasciculi" (an individual bundle is a fasciculus). Fasciculi are likewise covered and thus separated by the perimysium. Individual muscle fibers are enveloped by the endomysium. Immediately beneath the endomysium is the thin, membranous sarcolemma, the cell membrane that encloses the cellular contents of the muscle fiber, nuclei, local stores of fat and carbohydrate (stored glucose is referred to as glycogen), enzymes, contractile proteins, and other specialized structures such as the mitochondria.

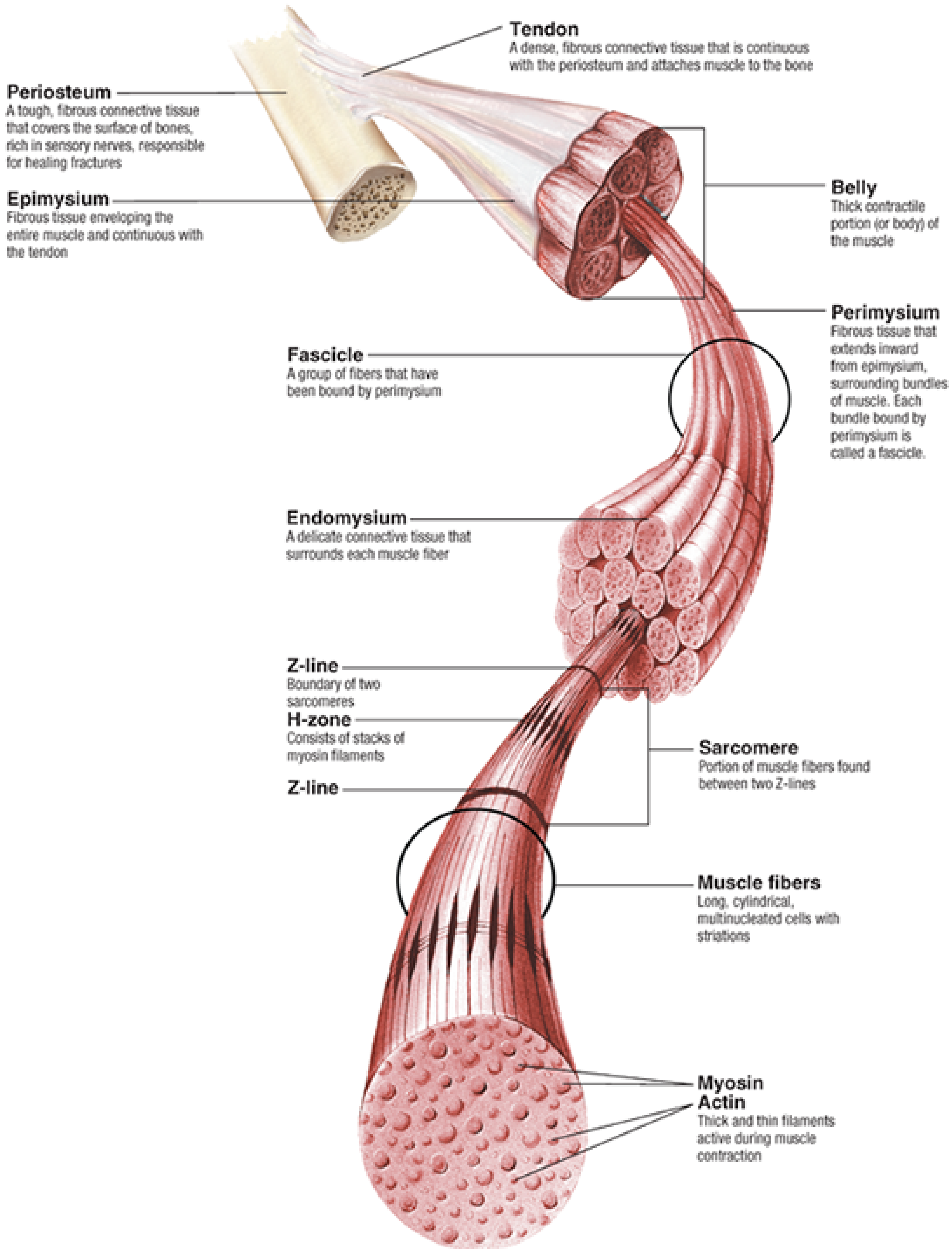


FIGURE 5.6. Structure of skeletal muscle. (Reprinted with permission from Anatomical Chart Company. *ACC's Illustrated Pocket Anatomy: The Muscular & Skeletal Systems Study Guide*. Baltimore [MD]: Lippincott Williams & Wilkins; 2007.)

Muscle Contraction

The smallest contractile unit of a muscle cell is the sarcomere. A sarcomere is primarily composed of two types of muscle protein: actin (the thin filament) and myosin (the thick filament). Actin contains two other components: troponin and tropomyosin. Myosin contains many cross-bridges where the actin attaches. Figure 5.7 illustrates the relationship between muscle contraction and microscopic action within the sarcomere. Two major principles describe the mechanism of muscle contraction: the sliding-filament theory and the all-or-none principle.

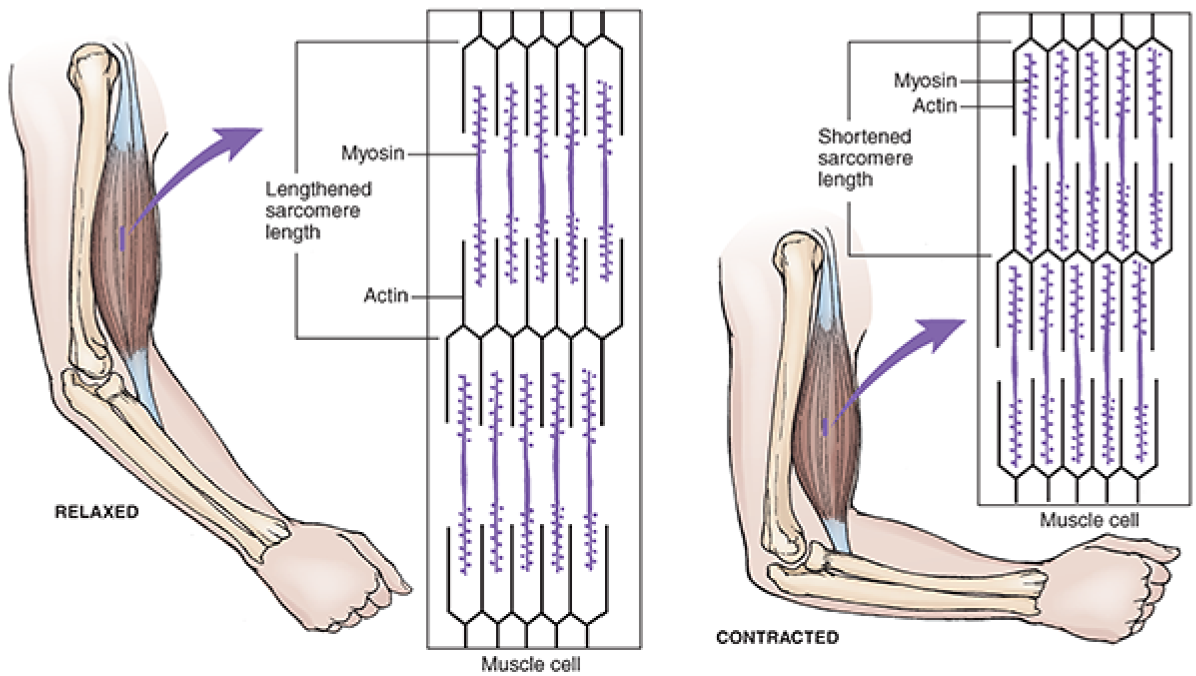


FIGURE 5.7. The sliding-filament model (contraction of skeletal muscle results from the sliding of the actin chains on the myosin chains). (From Oatis CA. *Kinesiology: The Mechanics and Pathomechanics of Human Movement*. 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2016, with permission.)

The sliding-filament theory describes the events that occur between the actin and myosin filaments during muscle contraction and relaxation. When a nerve impulse is received, the cross-bridges of the myosin pull the actin filaments toward the center of the sarcomere and tension is created. The sliding motion between the actin and myosin causes the shortening of a sarcomere and subsequently the entire muscle fiber. Moreover, the nerve impulse that applies to the muscle cell, regardless of its “strength,” causes the sarcomere to contract maximally or not all. This is called the all-or-none principle. The length of a muscle fiber during a contraction is determined by the number of muscle fibers (cells) being recruited for the contraction. The more the sarcomeres are recruited for contraction, the shorter the contracted muscle length. The amount of force that is produced from a muscle contraction is determined by the number of motor units (one motor nerve together with all the muscle fibers that it innervated) that are recruited and the number of fibers contained in each motor unit (1).

Muscle Contraction and Training

During static (isometric) contractions, the muscle or muscle group maintains a constant length as resistance is applied, and no change in the joint position occurs. Research has demonstrated that static training produces significant improvements in muscular strength. The strength gains, however, are limited to the specific joint angles at which the static contractions are performed (21). As a result, static training may have limited value in enhancing functional strength. "Functional strength" is defined as work performed against a resistance in such a way that the strength gained directly benefits the execution of activities of daily life and/or movements associated with sports. Static training has also been associated with short-term elevations in BP perhaps because of increased intrathoracic pressure during static contractions. Despite the limitations, static training appears to play a positive role in physical rehabilitation. For example, static training is effective in maintaining muscular strength and preventing atrophy associated with the immobilization of a limb (*e.g.*, application of a cast, splint, or brace) (21,22).

Dynamic (isotonic) resistance training is another common method of muscular training. The term *dynamic* is used because movement occurs at the joint of action. If force is sufficient to overcome the external resistance (*e.g.*, dumbbell) and the muscle shortens (*e.g.*, the lifting phase of a biceps curl), the muscle action is called concentric. When the resistance is greater than force applied by the muscle and the muscle lengthens, it is known as eccentric muscle action (*e.g.*, the lowering phase of the biceps curl). Most dynamic resistance training includes both concentric and eccentric actions. Significantly heavier loads can be moved eccentrically. For example, maximal eccentric weight is 1.4 times the maximal concentric weight in the same muscle group/movement (21,22). The greater force production occurring during the eccentric action compared with the concentric action probably results from the greater recruitment of motor units and a slow movement velocity. Eccentrical training, in particular, is known to increase the likelihood of DOMS (although concentric training can cause this as well) (21). However, eccentric training can play an important role in preventing or rehabilitating certain musculoskeletal injuries. For example, eccentric training has been demonstrated to be effective for treating hamstring strains, tennis elbow, and patellofemoral pain syndrome (21).

Isokinetic exercise is the other major type of resistance training and entails a muscular contraction at a constant speed against accommodating resistance. The speed of movement is controlled, and the amount of resistance is proportional to the amount of force produced throughout the full range of motion (ROM). The theoretical advantage of isokinetic exercise is the potential for development of maximal muscle tension throughout the ROM. Research documents the effectiveness of isokinetic training (21). Strength gains achieved during high-speed training (*i.e.*, contraction velocities of $180° \cdot s^{-1}$ or faster) appear to carry over to all speeds below that specific speed (23). Improvement in strength at slow speeds of movement, however, has not been shown to carry over to faster speeds.

Muscle Fiber Types

The human body has the ability to perform a wide range of physical tasks, combining varying composites of speed, power, and endurance. No single type of muscle fiber possesses the characteristics that would allow optimal performance across this continuum of physical challenges. Rather, muscle fibers possess certain characteristics that result in relative specialization. For example, certain muscle fibers are selectively recruited by the body for tasks of short duration that require speed and power, whereas others are recruited for endurance tasks of long duration and relatively low intensity. When the challenge not only requires elements of speed or power but also has an endurance component, yet another type of muscle fiber is recruited. These different fiber types should not be thought of as mutually exclusive. In fact, intricate recruitment and switching occurs within the muscle over the performance of many tasks, and fibers designed to be optimal for one type of task can contribute to the performance of another. The net result is a functioning muscle that can respond to a wide variety of tasks but is best suited toward the type of activity that was predominantly used in training. For example, even if the training is endurance focused and the composition of the muscle lends itself to performing best in endurance activities, it still can accomplish speed and power tasks to a lesser degree (24).

Although there is a fair amount of controversy about the classification of muscle fiber types, there is general agreement that two distinct fiber types exist: type I or slow twitch and type II or fast twitch, with their proposed subdivisions. These fibers have been identified and classified by contractile and metabolic characteristics such as the chemical breakdown of carbohydrate, fat, and protein for energy within the muscle cell (25).

Slow-Twitch Muscle Fibers

The characteristics of slow-twitch muscle fibers are consistent with those of muscle fibers that resist fatigue. Thus, type I fibers are selected for activities of low intensity and long duration. In addition to their inherent resistance to fatigue, endurance is prolonged by the constant switching that occurs to ensure freshly charged muscle fibers are activated as the exercise stimulus continues. The average person has approximately 50% slow-twitch fibers, and this distribution is generally equal throughout the major muscle groups of the body (1). Individuals most successful at endurance activities generally have a higher proportion of slow-twitch fibers, and this is most likely due to genetic factors supplemented through appropriate exercise training. From a metabolic perspective, slow-twitch fibers are those frequently called "aerobic" because the generation of energy for continued muscle contraction is met through the ongoing oxidation (chemical breakdown using oxygen) of available energy substrates. Thus, with minimal accumulation of anaerobically (chemical breakdown without oxygen) produced metabolites, continued submaximal muscle contraction is favored in slow-twitch fibers.

Fast-Twitch Muscle Fibers

At the opposite end of the continuum, those who achieve the greatest success in power and high-intensity speed tasks usually have a greater proportion of fast-twitch muscle fibers distributed through the major muscle groups. Because force generation is so important, fast-twitch fibers shorten and develop tension considerably faster than type I fibers (23). These fibers are typically thought of as type IIx fibers (23). Metabolically, these fibers have minimal aerobic capacity due to a small amount of mitochondria. When an endurance component is introduced, such as in events lasting upward of several minutes (*e.g.*, 800–1,500-m races), a second type of fast-twitch fiber, type IIa, is recruited. The type IIa fibers represent a transition of sorts between the needs met by the type I and type IIx fibers. Metabolically, although type IIa fibers have the ability to generate a moderately large amount of force, they also have some aerobic capacity. In addition, type IIa fibers are adaptable with training. For example, with significant endurance training, it is possible for type IIa fibers to increase their aerobic capacity such that these type IIa fibers behave much more like type I fibers (23). This is a logical and necessary bridge between the types of muscle fibers and the ability to meet the variety of physical tasks imposed.

Neuromuscular Activation

Physical activity involves purposeful, voluntary movement. The stimulus for this voluntary muscle activation comes from the brain, where the signal is relayed through the brainstem, through the spinal cord, and transformed into a specific motor unit activation pattern. To perform a specific task, the required motor units meet specific demands for force production by activating associated muscle fibers (23).

Motor Unit Activation

The functional unit of the neuromuscular system is the motor unit. It consists of the motor neuron and the muscle fibers it innervates. A motor unit can range in size from a few to several hundred muscle fibers. Muscle fibers from different motor units can be anatomically adjacent to each other, and therefore, a muscle fiber may be actively generating force, whereas the adjacent fiber moves passively with no direct neural stimulation. When maximal force is required, all available motor units are activated. Another adaptive mechanism affected by heavy resistance training is the muscle force affected by different motor unit firing rates and/or frequencies.

Skeletal System

In addition to protecting vital organs, and acting as an important source of nutrients and blood constituents, the primary role of the skeletal system is to provide support for locomotion and movement (26). The skeletal system can be divided into the axial skeleton (skull, vertebral column, and sternum) and the appendicular skeleton (upper and lower extremities). An outer fibrous layer of connective tissue attaches the bone to muscles, deep fascia, and joint capsules. Just beneath the outer layer is a highly vascular inner layer that contains cells for the creation of new bone. The outer and inner layers that cover the bones constitute the periosteum. The periosteum, continuous with tendons and adjacent articulated structures, anchors muscle to bone. Tendons are likewise continuous with the epimysium, the outer layer of connective tissue covering muscle.

Types of Bone

The human skeletal system is composed of two different types of bone. The first, known as cortical bone, makes up approximately 80% of total bone mass. Cortical bone is dense and almost uniformly parallel in structure. As a result, cortical bone primarily forms the long axes of bones and provides a tough outer shell. The remaining 20% of bone mass consists of trabecular bone. Trabecular bone is more porous and therefore less rigid compared to cortical bone. Trabecular bone is most abundant toward the distal ends of long bones and in the vertebrae. The structure of trabecular bone allows it to transfer mechanical loads from the articular surface to the cortical bone (27).

Bone Mass and Physical Activity

As bones age, they become more porous and therefore more fragile. When the loss of bone reaches pathological levels, there is a substantially increased risk of fractures of the hip, spine, and wrist. This condition is known clinically as “osteoporosis.” Recent data suggest that over 1.7 million Americans are hospitalized annually due to a fragility fracture, with an estimated cost of over 70 billion dollars (28). This is especially relevant to the Personal Trainer, given that physical activity represents a convenient and low-cost method of osteoporosis prevention. Specifically, the forces transmitted to the skeleton during physical activity send mechanical signals, which initiate both an increase in bone accrual and preservation of existing bone (26).

The effects of physical activity on bone accrual are most pronounced during adolescence, given that the rate of bone formation is most rapid during this time period. As a result, individuals who are physically active during this critical period of development generally have a higher peak bone mass. Although bone mass typically peaks during young adulthood, individuals who maintain a physically active lifestyle experience a less rapid rate of bone decline compared with those who become less active with age (14). In older adults, physical activity will not result in the formation of new bone but can prevent the loss of existing bone. With respect to the type of physical activity, it is widely accepted that weight-bearing exercises, such as jumping, running, walking, and resistance training, provide the optimal stimulus for bone formation and maintenance. Due to the relatively high degree of mechanical strain induced by these types of activity, they have demonstrated positive effects on bone mass throughout the lifespan (29).

Structure and Function of Joints in Movement

The effective interaction of bone and muscle to produce movement depends somewhat on joint function. Joints are the articulations between bones, and, along with bones and ligaments, they constitute the articular system. Ligaments are tough, fibrous connective tissues that connect one bone to another, whereas tendons connect muscle to bone. Joints are typically classified as fibrous, in which bones are united by fibrous tissue, cartilaginous (with cartilage or a fibrocartilaginous anchor), or synovial, in which a fibrous articular capsule and an inner synovial membrane lining enclose the joint cavity. The cavity is filled with synovial fluid, which provides constant lubrication during human movement to minimize the wearing effects of friction on the cartilaginous covering of the articulating bones. Joints are typically well perfused by numerous arterial branches and are innervated by branches of the nerves supplying the adjacent muscle and overlying skin.

Proprioception is defined as the receipt of information from joints, muscles, and tendons that enables the brain to determine movements and position of the body and its parts. Proprioceptive feedback is an important joint sensation owing to the high density of sensory fibers in the joint capsule. This feedback has obvious importance in regulating human movement and in preventing injury. The degree of movement within a joint is typically called ROM. ROM can be active, where the range can be reached by voluntary movement, or passive, as the range can be achieved by external means (*e.g.*, an examiner or a device). Joints are typically limited in range by the articulations of bones (as in the limitation of elbow extension by the olecranon process of the ulna), ligamentous arrangement, and soft tissue limitations, as occurs in elbow or knee flexion. Movement at one joint may influence the extent of movement at adjacent joints, as a number of muscles and other soft tissue structures cross multiple joints. For example, finger flexion decreases in the presence of wrist flexion because muscles that flex both the wrist and fingers cross multiple joints. More in-depth information about the skeletal system is provided in Chapter 3.

Neurological System

In the earlier discussion on muscle contraction, the contraction was described as triggered by a nervous impulse of a motor unit. The nervous impulse is released from a motor neuron, which originates from the spinal cord. The spinal cord is a part of the CNS, which helps control all of the peripheral and internal organs. All muscular movements are controlled by the nervous system. To understand the complex control of human movement, understanding neural control is essential.

The nervous system consists of the brain, spinal cord, and peripheral nerves and is divided into the CNS and the peripheral nervous system (PNS). The CNS consists of the brain and spinal cord, whereas the PNS consists of all other peripheral nerves of the voluntary system (Fig. 5.8) (2).

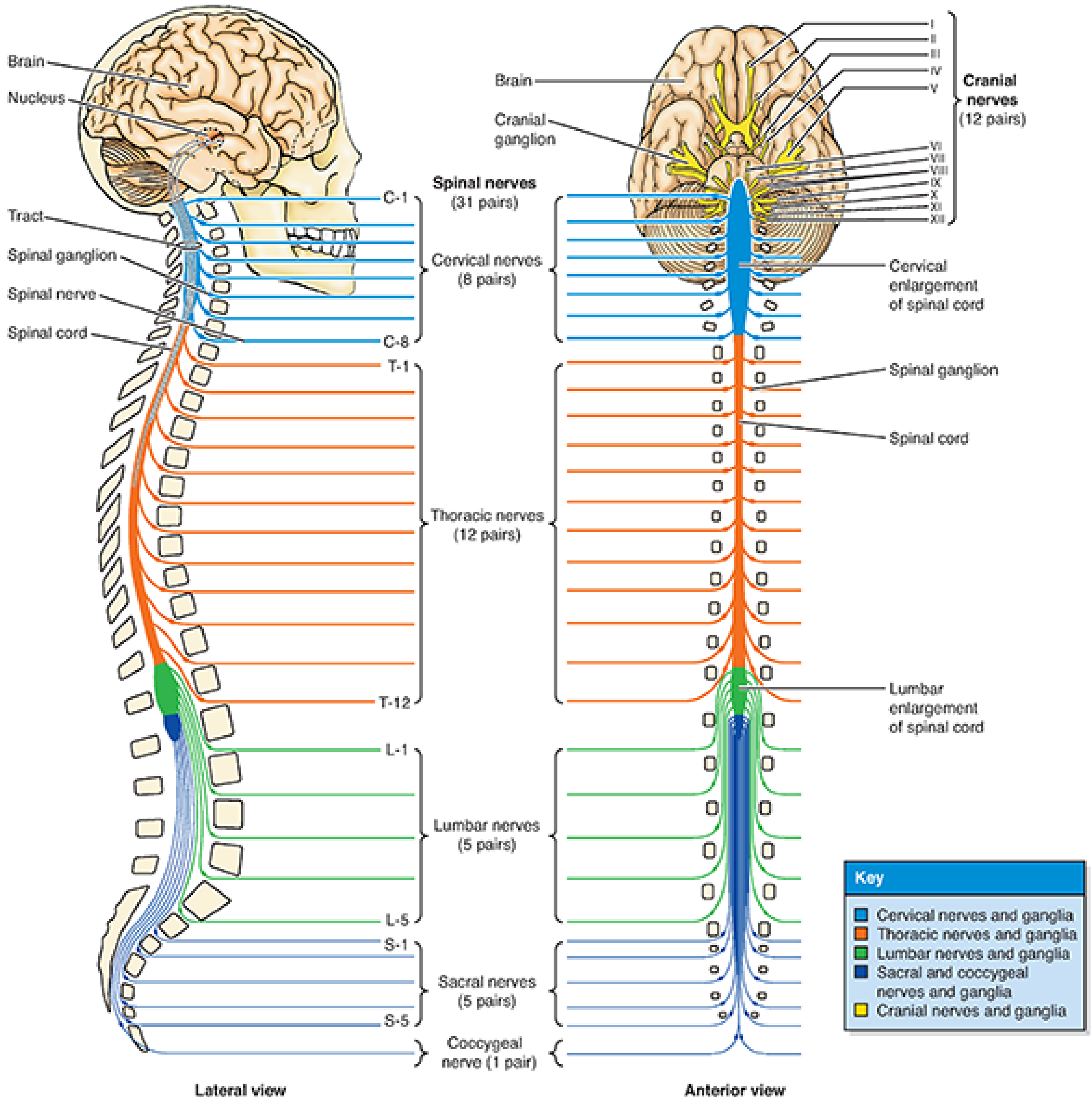


FIGURE 5.8. Basic organization of the nervous system. The brain and spinal cord constitute the CNS. A collection of nerve cell bodies in the CNS is a nucleus, and a bundle of nerve fibers connecting neighboring or distant nuclei in the CNS is a tract. The PNS consists of nerve fibers and cell bodies outside the CNS. Peripheral nerves are either cranial or spinal nerves. A collection of nerve cell bodies outside the CNS is a ganglion (*e.g.*, a cranial or spinal ganglion). (From Moore KL, Dalley AF II. Clinically Oriented Anatomy. 4th ed. Baltimore [MD]: Lippincott Williams & Wilkins; 1999.)

Central Nervous System

The brain is the most important part of the CNS and is surrounded and protected by the bony skull. The spinal cord is the extension of the brain, which runs along and is surrounded and protected by the vertebral column.

The CNS is the body's central control center where sensory stimuli are received, integrated, analyzed, interpreted, and finally relayed as nerve impulses to muscles and glands for taking action.

Peripheral Nervous System

The PNS is composed of the cranial nerves associated with the brain and the spinal nerves associated with the spinal cord as well as groups of nerve cell bodies called "ganglia." In other words, the PNS is made up of the nerve cells and their fibers that lie outside the brain and spinal cord (29). The PNS allows the brain and spinal cord to communicate with the rest of the body. There are two types of nerve fibers in the PNS: the afferent, or sensory, fibers and the efferent, or motor, fibers. The sensory nerve fibers are responsible for carrying nerve impulses from sensory receptors in the body to the CNS. Once the received signal is processed and analyzed in the CNS and an action is determined, then motor nerve fibers are called to convey the nerve signal from the CNS to the effectors, either the muscles or other organs. The PNS can be subdivided into two functional branches: the somatic nervous system and the visceral nervous system. Both systems are composed of an afferent division (sending feedback to the CNS to adjust responses) and an efferent division (sending signals out to the body).

Autonomic Nervous System

Within the CNS and PNS exist functional divisions based on whether the actions are voluntary or involuntary. The somatic nervous system primarily regulates the voluntary contraction of the skeletal muscles, whereas the autonomic (or visceral) nervous system involves the motor activities that control internal organs such as the smooth (involuntary) muscles, cardiac muscle, and glands of the skin and viscera. The ANS regulates visceral activities such as HR, digestion, breathing, and the secretion of hormones. These activities normally are operated subconsciously and continue to function throughout life. However, they can also be altered to a certain limit consciously. These activities can be carried out even if the organs are deprived of innervation by the ANS. The ANS includes two pathways, the sympathetic pathway and the parasympathetic pathway, which complement each other. The sympathetic pathway stimulates visceral activities under stressful (or alarming) conditions, which results in acceleration of metabolism, HR, and breathing and adrenal hormone release. Exercise can be viewed as a stressful stimulus to the body that triggers the sympathetic pathway for generating more energy and muscular force. When the stressful stimulus subsides, the parasympathetic pathway brings the visceral activities back to normal, for example, decreasing HR and breathing, relaxing the muscles, and increasing gastrointestinal activities. The parasympathetic pathway helps conserve and restore body resources.

Neuromuscular Control

The information transmitted and relayed by the sensory and motor nerves is in a form of electrical energy referred to as the "nerve impulse." The sensory stimulation received through vision or touching is transmitted to the CNS. A motor command is then released after the integration and decision making of the motor cortex of the brain. A nerve pulse is then transmitted to the targeted muscles through an efferent neuron for activating muscle contraction. The functional unit of the neuromuscular system is the motor unit (30). It consists of the motor neuron and the muscle fibers it innervates. When maximal force is required, all available motor units are activated. Another adaptive mechanism affected by heavy resistance training is the muscle force affected by different motor unit firing rates and frequencies (30).

Motor unit activation is also influenced by the size principle. This principle is based on the observed relationship between motor unit twitch force and recruitment threshold. Specifically, motor units are recruited in order according to recruitment thresholds and firing rates, resulting in a continuum of voluntary force. Whereas type I motor units are the smallest and possess the lowest recruitment thresholds, type IIa and IIx motor units are larger in size and have higher activation thresholds. Therefore, as force requirements of an activity increase, the recruitment order progresses from type I to IIa to IIx motor units. Thus, most muscles contain a range of motor units (type I and II fibers), and force production can span wide levels. Maximal force production requires not only the recruitment of all motor units, including high-threshold motor units, but also the recruitment at a sufficiently high firing rate. It has been hypothesized that untrained individuals cannot voluntarily recruit the highest threshold motor units or maximally activate muscles. Furthermore, electrical stimulation has been shown to be more effective in eliciting gains in untrained muscle or injury rehabilitation scenarios, suggesting further inability to activate all available motor units. Thus, training adaptation develops the ability to recruit a greater percentage of motor units when required.

Muscle Spindle and Golgi Tendon Organs

Other than the motor unit, muscular contraction is also affected by specialized sensory receptors in the muscles and tendons that are sensitive to stretch, tension, and pressure. These receptors are termed “proprioceptors.” A sensory receptor called a “muscle spindle” is sensitive to the stretch of a muscle and is embedded within the muscle fiber. Anytime the muscle is stretched or shortened, the spindle is also stretched or shortened. The muscle spindles provide sensory information regarding the changes and rate of change in the length and tension of muscle fibers. Their main function is to respond to stretch of a muscle and, through reflex action, to initiate a stronger muscle action to reduce this stretch (30). This is known as the “stretch reflex.” In contrast to the muscle spindles, the Golgi tendon organs are another type of specialized proprioceptor that attaches to the tendons near the junction of the muscle (Fig. 5.9). These receptors detect differences in the tension generated by active muscle rather than muscle length. When excessive tension is detected by the Golgi tendon organs, a continuous reflex inhibition signal is fired to prevent the muscle from contracting. Hence, the Golgi tendon organs serve as a protective sensory system to prevent muscle injury resulting from overcontraction.

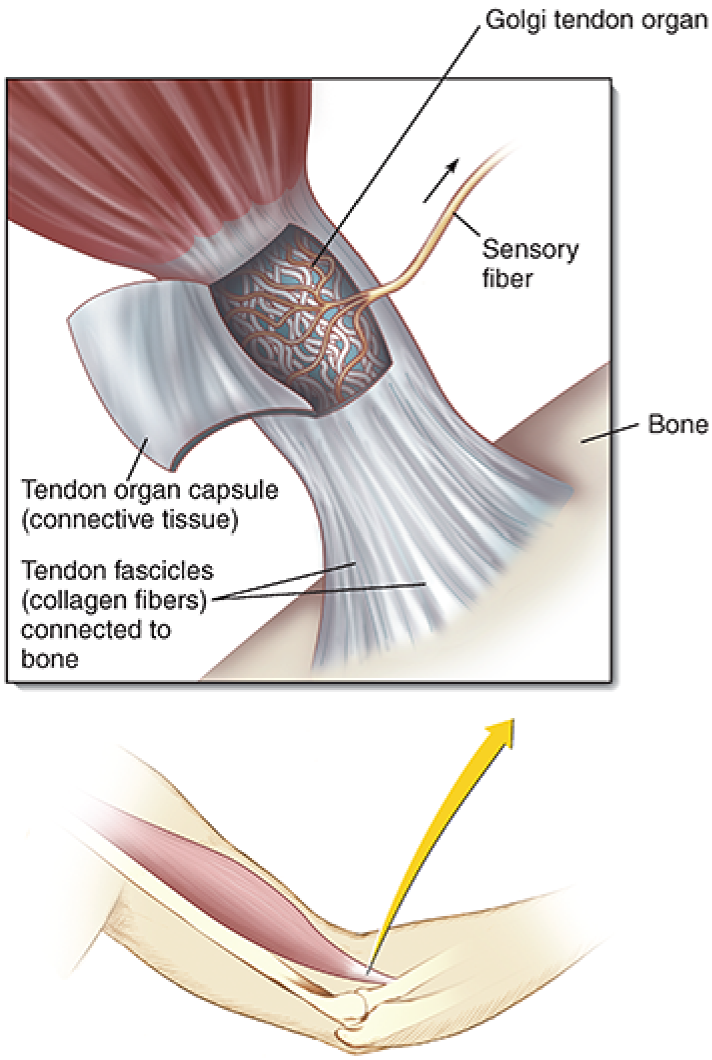


FIGURE 5.9. Structure of the Golgi tendon organ. (From Premkumar K. *The Massage Connection: Anatomy and Physiology*. 3rd ed. Baltimore [MD]: Lippincott Williams & Wilkins; 2011, with permission.)

Exercise System Adaptations: Strength, Cardiovascular

Long-term exercise training is important to overall health and physical fitness. A well-designed exercise training program leads to long-term physiological changes (adaptation), including improvements in muscular strength and endurance, cardiovascular function, musculoskeletal flexibility, and changes in body composition. These improvements allow for the enhancement of athletic performance, increased function to engage in leisure-time physical activity and perform activities of daily living more comfortably, and maintain functional independence later in life.

Resistance Training

Resistance training is an effective exercise modality to improve muscular strength and endurance. Strength improves when a load greater than what one is accustomed is applied to the muscle fiber and its contractile proteins over a period. The tension required for strength gain is about 60%–80% of the muscle's maximum force; however, a range of 75%–90% of one repetition maximum is recommended for optimizing strength gains (21). For improvements to take place, the resistance applied against a muscle must be large enough to impose a demand on the body system, thus creating an "overload" of the muscle. This is the so-called overload principle and can be accomplished by modifying the number of repetitions, the amount of resistance, or the number of sets. The amount of overload required depends on the individual's current level of muscular fitness. Hypertrophy, or the increase in muscular size, is thought to occur through the remodeling of proteins within the muscle cell and an increase in the number of myofibrils (23). Hypertrophy is the most prominent adaptation seen with resistance training (23). However, changes to the muscle fibers are not the only adaptations seen with resistance training. Tendons, ligaments, and the muscles' surrounding tissue also undergo hypertrophy and strengthening in order to withstand the greater amount of forces produced by the hypertrophied muscle (26,31).

Strength training also improves aerobic enzyme systems. Increases in aerobic enzyme activity have been reported from resistance training (23,32). Moreover, increases in oxidative enzymes have been demonstrated to be higher in type IIa fibers than in type IIx fibers. The increase in oxidative metabolism of muscles after long-term strength training is also associated with increases in capillary supply and the concentration of cellular mitochondria. Capillaries per unit area and per fiber are significantly increased in response to varying types of heavy resistance training (such as a combination of concentric and eccentric resistance exercise). Increased capillary density may facilitate performance of low-intensity weight training by increasing blood supply to active muscle. It also increases the ability to remove lactate and thereby improves the ability to tolerate training under highly acidic conditions. All of these changes promote oxygen delivery and use within the muscle fiber, thereby improving muscular endurance (21).

Part of the strength gain resulting from strength training is attributed to changes in the nervous system. This is especially true during the early stages of strength training. Training tends to reduce the neuromuscular inhibition in both the CNS and proprioceptors (*e.g.*, Golgi tendon organs). Other neural factors include the increased neural drive to muscle, increased synchronization of motor units, and increased activation of the contractile apparatus.

Cardiovascular Exercise

Physical inactivity is classified as a major contributing risk factor for heart disease, with a similar impact to that of elevated blood cholesterol level, cigarette smoking, and hypertension (26). Moreover, longitudinal studies have shown that higher levels of aerobic fitness are associated with lower mortality from heart disease even after statistical adjustments for age, coronary risk factors, and family history of heart disease. These findings and other recent reports in persons with and without heart disease have confirmed an inverse association between aerobic capacity and cardiovascular mortality (33,34).

Endurance exercise training increases functional capacity and provides relief of symptoms in many clients with coronary artery disease (CAD). This is particularly important because most clients with clinically manifest CAD have a subnormal functional capacity (50%–70% of those of similar age and sex), and some may be limited by symptoms at relatively low levels of exertion. Improvement in function appears to be mediated by increased central and/or peripheral oxygen transport and supply, whereas relief of angina pectoris (*i.e.*, chest pain/discomfort) may result from increased myocardial oxygen supply, decreased oxygen demand, or both.

Most exercise studies on healthy subjects demonstrate 20% (±10%) increases in aerobic capacity ($\dot{V}O_{2max}$), with the greatest relative improvements among the most unfit (35). Because a fixed submaximal work rate has a relatively constant aerobic requirement, the physically trained individual works at a lower percentage of $\dot{V}O_{2max}$, with greater reserve after exercise training. Enhanced oxygen transport, particularly increased maximal SV and cardiac output, have traditionally been regarded as the primary mechanism underlying the increase in $\dot{V}O_{2max}$ with training.

The effects of long-term exercise training on the ANS act to reduce myocardial demands at rest and during exercise. A lower HR during submaximal exercise after endurance training may be attributed to an intracardiac mechanism (an effect directly on the myocardium, *e.g.*, increased SV during submaximal work) or an extracardiac mechanism (*e.g.*, alterations in trained skeletal muscle) or both. The result is a reduced HR and SBP at rest and at any fixed oxygen uptake or submaximal work rate.

The increased oxidative capacity of trained skeletal muscle appears to offer a distinct hemodynamic advantage. Lactic acid production and muscle blood flow are decreased at a fixed external workload, whereas submaximal cardiac output and oxygen uptake are unchanged or slightly reduced. As a result, there are compensatory increases in a-$\bar{v}O_2$ difference at submaximal and maximal exercise. All of this means that at submaximal exercise levels, the cardiovascular system functions more effectively, and at maximal exercise, a greater power output can be achieved.

Overall Changes

The HR response plays a critical role in the delivery of oxygen to working skeletal muscle. The resting HR decreases by approximately 10–15 bpm as a result of cardiovascular training (36). SV will increase both at rest and during exercise up to a point because a result of long-term cardiovascular training will increase during exercise but will not change significantly at rest in endurance-trained individuals. The a-$\bar{v}O_2$ difference increases with long-term cardiovascular training, particularly near-maximal exertion. Both resting SBP and DBP may decrease (if elevated consistently before starting regular cardiovascular training) with long-term cardiovascular training. Resting lactate levels remain relatively unchanged with long-term cardiovascular training (37). As a result of proper cardiovascular training, less lactic acid will be produced at submaximal workloads during exercise (11). For responses to aerobic conditioning in untrained individuals, see Table 5.1.

Table 5.1 Physiological Adaptations to Aerobic Conditioning in Untrained Individuals

Variable	Unit of Measure	Physiological Response: Submaximal Effort	Physiological Response: Maximal Effort
$\dot{V}O_{2max}$	$mL \cdot kg^{-1} \cdot min^{-1}$	↔	↑
Resting heart rate	bpm	↓	↑
Exercise heart rate	bpm	↓	↑
Maximum heart rate	bpm	↔	↔
a-$\bar{v}O_2$ difference	$mL\ O_2 \cdot 100\ mL^{-1}$ blood	↑	↑
Maximum minute ventilation	$L \cdot min^{-1}$	↓	↑
Stroke volume	$mL \cdot beat^{-1}$	↓	↑
Cardiac output	$L \cdot min^{-1}$	↓	↑
Blood volume	L	↑	↑
Systolic blood pressure	mm Hg	↓	↔ or ↑
Blood lactate	$mL \cdot 100\ mL^{-1}$ blood	↓	↑
Oxidative capacity of skeletal muscle	Multiple variables[a]	↓	↑

[a]Represents increase in skeletal muscle mitochondrial number and size, capillary density, and/or oxidative enzymes.
↔, no change; ↑, increase; ↓, decrease.

Sex-Specific Improvement

The salutary effects of chronic endurance training in men are well documented (Table 5.2). Numerous studies now provide ample data on $\dot{V}O_{2max}$, cardiovascular hemodynamics, body composition, and blood lipids as well as changes with physical conditioning of middle-aged and older women. The results demonstrate that women with and without CAD respond to aerobic training in much the same way as men when subjected to comparable programs in terms of frequency, intensity, and duration of exercise (38). Improvement is negatively correlated with age, habitual physical activity, and initial $\dot{V}O_{2max}$ (which is generally lower in women than in men) and positively correlated with conditioning frequency, intensity, and duration (39). There are, however, large differences between individuals in the effects of physical conditioning independent of age, initial capacity, or conditioning program. These individual variations in response to aerobic exercise training may result from childhood patterns of activity, state of conditioning at the initiation of the program, or degree of physiological aging. Body compositional differences in trainability may also play an important role with respect to the results of physical conditioning. Obese women demonstrate lower aerobic capacity (per kilogram body weight), altered cardiovascular hemodynamics, and elevated serum lipids than leaner women (40). This initial varied profile may serve to modify the outcome of an aerobic conditioning program with respect to the magnitude of quantitative change.

Table 5.2 Benefits of Increasing Cardiorespiratory Activities and/or Improving Cardiorespiratory Fitness[a]

Improved cardiorespiratory function:	Decreased risk of the following:

- Increased maximal oxygen uptake
- Increased maximal cardiac output and SV
- Increased capillary density in skeletal muscle
- Increased mitochondrial density
- Increased lactate threshold
- Lower HR and BP at a fixed submaximal work rate
- Lower myocardial oxygen demand at a fixed submaximal work rate
- Lower minute ventilation at a fixed submaximal work rate

- Mortality from all causes
- Coronary artery disease
- Cancer (colon, perhaps breast and prostate)
- Hypertension
- Noninsulin-dependent diabetes mellitus
- Osteoporosis
- Anxiety
- Depression

Other benefits:

- Improved glucose tolerance and insulin sensitivity
- Improved work, recreational and sports performance
- Decreased fatigue in daily activities
- Improved body composition
- Enhanced sense of well-being

Improved blood lipid profile:

- Decreased triglycerides
- Increased high-density lipoprotein cholesterol
- Decreased postprandial lipemia

[a]Many of the health benefits accrued from physical activity may have relatively little effect on increasing cardiorespiratory fitness. From Physical Activity Guidelines Advisory Committee. *Physical Activity Guidelines Advisory Committee Report, 2008*. Washington (DC): U.S. Department of Health and Human Services; 2008. 683 p.

SUMMARY

The purpose of this chapter was to introduce the Personal Trainer to the basic concepts of exercise physiology. The topics in this chapter are not all inclusive due to length limitations not because other areas of exercise physiology are not important. Emphasis is placed on cardiovascular and pulmonary physiology, musculoskeletal function, and adaptations to training because the Personal Trainer may encounter these more often. However, endocrine, metabolic, and other body functions are also important; thus, it is recommended that as new issues with individual clients arise, Personal Trainers should seek out additional references that can assist in understanding the conditions and how the body functions under conditions of physical stress. This proactive approach to learning a client’s condition will assist the Personal Trainers to develop safe and effective exercise program for their clients.

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CHAPTER 6

Nutrition and Human Performance

OBJECTIVES

Personal Trainers should be able to:

- Understand the functions of the three energy substrates (carbohydrate, protein, and fat) in health and performance.
- Know the role of vitamins and minerals in health and performance.
- Understand the importance of hydration in maintaining health and achieving optimal performance.
- Know the essential elements of energy balance as related to weight management, body composition, and performance.
- Understand issues related to nutrient supplementation and strategies for discerning the circumstances under which specific supplements may be appropriate.
- Understand practical issues related to eating for performance, including travel, the precompetition meal, during-competition nourishment, and postcompetition replenishment.

INTRODUCTION

Nutrition and athletic performance are closely linked, making it unlikely to experience success with a physical training program without proper nutrition. Personal Trainers who recommend the use of nutrition strategies to achieve an ideal weight or body composition should bear in mind the negative impact this strategy could have on physical performance and should consider that certain nutritional strategies may not just not negatively impact performance but could also lead to a poor health outcome.

An improvement in client conditioning cannot be realized by focusing only on time spent in training to improve flexibility, endurance, and/or power. The concomitant nutritional strategies clients should follow before the physical activity or training regimen, the foods and drinks they consume immediately following exercise and competition and after they go home, and what they do to ensure an optimal flow of fluid and energy into their muscles during training and competition are all critical to improving power and endurance, sustaining concentration, and optimizing performance. Failure to consider nutrition as an integral component of the skills training and/or conditioning program could result in poor performance outcomes and, in the long term, negatively impact health. Well-nourished clients do better, recover more quickly from soreness and injuries, and derive more performance-improving benefits from long and strenuous training sessions. Therefore, Personal Trainers should help clients match the dynamics of exercise with a nutrition strategy that is effective yet within one's scope of practice. It's important to check state statutes where you practice in order to determine the depth of nutrition information that can be given.

Scientific information exists on the relationship between good nutrition and exercise performance, but the readily available, massive quantities of misinformation on nutrition makes it difficult for Personal Trainers to know when and what to eat before practice and competition; the foods that will best sustain energy levels; the best drinks and foods to consume before, during, and after exercise; how to balance an optimal energy intake with an ideal body composition; and how to make certain that the intake of nutrients is optimal for an individual's health and performance. These and other issues are covered in this chapter with the aim of helping the Personal Trainer assist his or her clients in understanding the key nutritional strategies that are related to improving exercise performance while sustaining good health.

> Well-nourished clients do better, recover more quickly from soreness and injuries, and derive more performance-improving benefits from long and strenuous training sessions.

Scope of Practice

Personal Trainers have a key opportunity to discuss nutrition topics with their clients because they see them more frequently than do nutrition professionals. It can be confusing about the type of nutrition guidance that can be provided when assisting clients with their nutrition questions and goals. Many kinesiology and exercise science degree programs may require one or two nutrition courses or include nutrition content in an existing course. However, this general nutrition overview does not provide the education and training necessary to perform individualized nutrition assessment, counseling, and meal planning, especially for those who have health issues. Personal Trainers should be aware that, in most states, the profession of nutrition and dietetics is regulated by state law via specific state statutes and varies from state to state. American College of Sports Medicine (ACSM) certifications have associated job task analyses (JTA), some related to nutrition. These related to nutrition are knowledge statements about general nutrition principles and not skill statements encompassing certified exercise professionals to provide nutrition assessments and nutrition interventions. These statements include possible nutrition topics sought by clients (1).

Nutrition and dietetics professionals have one professional organization, the Academy of Nutrition and Dietetics (https://www.eatright.org), that provides the Registered Dietitian Nutritionist (RDN) credential for practice. Currently, 46 states, the District of Columbia, and Puerto Rico have enacted statutory provisions regulating the practice of nutrition and dietetics either through state licensure or statutory certification (https://www.eatrightpro.org/advocacy/licensure/licensure-map). Although statutes vary, many states dictate that it is illegal to engage in the profession without first obtaining a license. On the other hand, there is no single accrediting body or professional organization for programs in the exercise sciences that results in a uniform nationally recognized credential (1).

There are additional Academy of Nutrition and Dietetics board certifications beyond the RDN credential, including the Board Certified Specialist in Sports Dietetics (CSSD) (http://www.scandpg.org/sports-nutrition/be-a-board-certified-sports-dietitian-cssd). This person has demonstrated training in both exercise and nutrition and possesses specialized expertise in working with athletes and highly active individuals. When referring a client for nutrition advice, especially for those active individuals with disease, the CSSD credential is preferred (1).The practice of nutrition and dietetics is typically performed by an RDN who has his or her academic degree from a program accredited by the Accreditation Council for Education in Nutrition and Dietetics, and, where required, a proper license to allow provision of clinically relevant nutrition assessments, nutrition diagnoses, and individualized specific nutrition interventions (*e.g.*, nutrition education, nutrition counseling, nutrition prescriptions, and meal/diet plans) for all clients and to include medical nutrition therapy as part of the nutrition intervention for individuals suffering from specific diseases or conditions. The Personal Trainer must respect these professionals by always seeking out their assistance or referring to them when governed by state law. Typically, Personal Trainers do not conduct nutrition assessments and provide individualized nutrition prescriptions and meal/diet plans for clients, particularly when a nutrition-related disease or condition is involved, because this activity falls within the scope of practice for RDN. On the other hand, Personal Trainers should properly provide general, nonmedical nutrition information using established nutrition guidelines as long as the guidance is accurate and provided for healthy individuals. Examples of general, nonmedical nutrition information includes the following:

- Principles of healthy food preparation (*e.g.*, baking vs. frying; healthy oils vs. solid vegetable shortenings)
- The essential nutrients and recommended amounts of essential nutrients for healthy individuals based on nationally established standards such as Dietary Guidelines for Americans and the Dietary Reference Intakes (DRIs)
- The effects of deficiencies or excesses of nutrients (*e.g.*, deficiency of dietary iron can lead to the medical condition called iron deficiency anemia)
- Specific foods or supplements that are sources of essential nutrients (*e.g.*, oranges are an excellent source of vitamin C)
- Information about food guidance systems (*i.e.*, Dietary Guidelines for Americans, how to read and use food labels, and MyPlate)
- The basic functions of carbohydrates, proteins, fats, vitamins, minerals, water in the body (*e.g.*, carbohydrate is an important fuel source for organs and skeletal muscle during exercise; protein is necessary for growth, maintenance, and repair of tissues and synthesis of hormones and immune proteins)
- Statistical information about the relationship between chronic disease and the excesses/deficiencies of certain nutrients
- ACSM guidelines for proper hydration

Personal Trainers do not conduct nutrition assessments and provide individualized nutrition prescriptions and meal/diet plans for clients, particularly when a nutrition-related disease or condition is involved, because this activity falls within the scope of practice for RDN.

Note in the examples presented earlier, these examples pertain to healthy individuals, as these public guidance systems are designed for the general population. If a client has a disease or nutrition-related condition, the Personal Trainer should then refer the client to an RDN. Establishing a referral system or network for each profession to work together can optimize outcomes for best serves clients.

Although laws have been written to protect the scope of practice for RDNs, the specific scope of practice for Personal Trainers regarding nutrition is not as clear because states do not require licensure for Personal Trainers. However, Personal Trainers and other health care practitioner can provide general, nonmedical nutrition information to clients (as outlined in this chapter) and, in some states, to also assist with general principles of energy balance in a weight loss program (Fig. 6.1 and Table 6.1). Personal Trainers should also be aware of, and be able to recognize, patterns of disordered eating and make the appropriate referral to a qualified health care practitioner who has the experience necessary to treat these conditions. Personal Trainers are urged to investigate any and all laws pertaining to the practice of nutrition and dietetics in their state.

FIGURE 6.1. Scope of practice.

Table 6.1 Examples of General, Nonmedical Nutrition Information

- Principles of healthy food shopping and preparation
- Foods to be included in the normal daily diet of healthy individuals
- Recommended amounts of the essential nutrients (DRIs) for healthy individuals
- The effects of deficiencies or excesses of nutrients
- Specific foods or supplements that are sources of essential nutrients
- Providing information about food guidance systems (*e.g.*, Dietary Guidelines for Americans, food labels, and MyPlate)
- The actions of nutrients on the body
- The basic roles of carbohydrates, proteins, fats, vitamins, minerals, and water
- Giving statistical information about the relationship between chronic disease and the excesses/deficiencies of certain nutrients
- Following ACSM guidelines for proper hydration in healthy individuals

Essential Nutritional Concepts

Nutrients give metabolically active tissues, including muscles, organs, and bones, the energy needed for work, tissue repair, and tissue development. Proper nutrition can be beneficial for disease prevention and maintenance of bodily tissues and systems and plays a role in healing after an injury (2). For clients to be healthy and successful, they must consider nutritional needs as important as the skills/performance training.

Nutrients

There are six classes of nutrients: carbohydrates, proteins, fats, vitamins, minerals, and water (3). Clients should not be taught to think of any individual nutrient as more important than any other nutrient; rather, the focus should be on nutrient balance, which is critical to good health and performance. With the help of a Personal Trainer, clients should try to find the appropriate balance between all of the nutrients because too much or too little of any single nutrient increases the risk of developing poor health and/or may lead to performance problems. For example, too little iron intake could lead to poor endurance and a lower ability to oxidize fat for fuel, whereas too much calorie intake may lead to unwanted weight gain. The best strategy for maintaining nutrient balance is to eat a wide variety of foods, regularly consume fresh fruits and vegetables, and avoid a monotonous intake of the same few foods day after day (Fig. 6.2). No single food has all the nutrients a person needs to stay healthy, so eating a wide variety of foods helps people ensure nutrient needs are being met. An added benefit of eating a wide variety of foods, especially from plants, is ingesting phytochemicals/phytonutrients. These are biologically active compounds with health-promoting properties, but we don't yet have exact, established recommendations for optimal intake (3). Although it is not common to suffer from nutrient toxicity from eating whole foods, easily available and inexpensive nutrient supplements dramatically increase the possibility of nutrient toxicities. The common belief that "if a little bit of a nutrient is good, and then more must be better" can lead to negative health consequences. Providing more nutrients than the body can use does not provide a benefit; it forces cells into using valuable energy resources to process the surplus, with the additional risk of developing toxicity reactions and/or nutrient insensitivities.

FIGURE 6.2. Nutrients that provide energy: oil, grains, legumes, meats, fruits, fruit juices, and vegetables. (Thomas DT, Erdman KA, Burke LM. American College of Sports Medicine joint position statement. Nutrition and athletic performance. *Med Sci Sports Exerc*. 2016;48[3]:543–68.)

There are six classes of nutrients: carbohydrates, proteins, fats, vitamins, minerals, and water.

There is a great deal of nutritional misinformation on television, in popular magazines, and on the Internet, making it difficult for people to make the right nutritional decisions. Many believe the claims made by people (particularly celebrities) who promote fad diets or sell nutritional supplements despite the lack of credible scientific evidence for what they're selling. Part of the problem is that the "placebo effect" is at play with nutrition (*e.g.*, if you believe that something will work, it will actually work despite the lack of biological reason for the result). Personal Trainers should seek and understand scientific evidence about whether nutritional strategies or products actually work before having a thorough discussion with a client. Scientific (peer-reviewed) journals are the best, original source of scientific information, but credible, professional organizations such as the ACSM also translate that science for use in practice. It should be clearly understood that one person's positive experience from a nutritional regimen or taking a substance does not translate into a universal benefit. Claims that sound too good to be true probably are *not* true.

Nutrients that Provide Energy

The biologically usable form of energy for the working skeletal muscle is adenosine triphosphate (ATP). Energy nutrients are metabolized (broken down) to ATP to provide fuel for cellular work. Carbohydrates, proteins, and fats (Box 6.1) are considered energy nutrients because they all contain carbon (fuel), which can be oxidized for energy production. Energy nutrients allow us to do muscular work, transfer electrical energy between nerve cells, and help us maintain body temperature at 98.6° F (37° C). In nutrition education, the term *calorie* is commonly used to refer to a unit of food energy. The more precise term is the *kilocalorie* (kcal), which is the amount of energy required to raise the temperature of a liter of water by 1° C. When health professionals discuss the concept of calories in terms of the energy content in foods or energy expended by the body during exercise, technically, they are referring to kilocalories (3,4).

Box 6.1 Recommended Energy (Calorie) Distribution for Athletes and Physically Active Adults

6–10 g (and up to 12 g for extreme and prolonged activities) carbohydrate per kilogram of body weight (45%–65% of total calories)
1.2–2.0 g protein per kilogram of body weight (10%–35% of total calories)
20%–35% of total calories from fat

Adapted from American College of Sports Medicine, American Dietetic Association, Dietitians of Canada. Joint position statement: nutrition and athletic performance. American College of Sports Medicine, American Dietetic Association, and Dietitians of Canada. *Med Sci Sports Exer*. 2000;32(12):2130–45; and American College of Sports Medicine, American Dietetic Association, Dietitians of Canada. American College of Sports Medicine position stand. Nutrition and athletic performance. *Med Sci Sports Exer*. 2009;41(3):709–31.

Exercise results in an increase in the *rate* at which energy is burned. This process is not 100% efficient, so only 20%–40% of the burned energy is converted to mechanical energy, with at least 60% of the energy lost as heat. This extra heat causes body temperature to rise, which requires an increase in the sweat rate as a means of cooling down body temperature. Therefore, the two essential components of sports nutrition that Personal Trainers should focus on are the following:

1. Understanding the amount of energy needed to meet the demands of physical activity and/or exercise training
2. Finding ways to provide enough fluid at the right time to maintain body water and replace the fluid that was lost as sweat

Meeting Energy Needs for Optimal Weight and Body Composition

The mathematical assumptions that describe positive and negative energy balance may seem simple: If a person gains (by eating) more energy than is expended, the excess energy is stored as body fat in adipose tissue, and total body weight and fat will increase; consumption of less energy than a person burns results in the utilization of some body tissues to satisfy the need of energy, and body weight and fat will decrease. However, there are many physiological, psychological, and sociological factors that impact both sides of the energy balance equation. People make food choices for a variety of reasons, and several factors may determine motivation to exercise. When relating energy balance to athletes and active individuals, it's very difficult to just eat less to lose fat or eat more to gain skeletal muscle. Consistently, consuming too little energy will burn enough of your lean mass (skeletal muscles) that the rate at which calories are burned (called the "metabolic rate") will decrease. The result of a lower metabolic rate is usually higher body weight (from more body fat) because of a diminished ability to burn the energy that is consumed. On the other hand, one cannot gain skeletal muscle just by eating more. There needs to be a proper training stimulus to the skeletal muscle coupled with adequate energy and protein to allow muscular hypertrophy. Therefore, maintaining an energy-balanced state or deviating from it only slightly is an important strategy for both body weight and body composition maintenance (Fig. 6.3). Clients wishing to increase muscle mass should perform exercises needed to enlarge muscle mass and slightly increase (by 300–400 kcal) daily caloric intake. Clients wishing to decrease body fat should make only subtle decreases (no more than 300–400 kcal, depending on body size) in daily energy intake while maintaining a vigorous conditioning schedule to maintain muscle mass (4–6).

FIGURE 6.3 Meeting energy needs for optimal weight and body composition: fitness exercise class.

> Consistently, consuming too little energy will burn enough of your lean mass (skeletal muscles) that the *rate* at which calories are burned (called the "metabolic rate") will decrease.

For athletic competitors, lower weight results in lower activity-related resistance, and all sports have resistance associated with them (7). Skaters must overcome the resistance of a skate blade going over the ice, cyclists must cope with air resistance, power lifters have the resistance from weights, and divers and gymnasts experience resistance as they tumble through the air. Sports performance is related to the ability of the athlete to overcome resistance (or drag) and the ability to sustain power output by overcoming this resistance on repeated bouts for long distances. Although these two factors (overcoming resistance and sustaining power output) are clearly related to performance, they are perceived by many athletes to be in conflict — a fact that causes many athletes problems with satisfying energy needs. Athletes often view their ability to overcome resistance or drag with their ability to carry lots of muscle and relatively little fat. As fat mass does little to contribute to sports performance and may contribute to drag, this makes lots of sense. However, the *strategy* that athletes often adopt to reduce fat mass and maximize muscle mass is to follow a "diet" by dramatically lowering total energy intake. This dieting strategy is counterproductive because it restricts the intake of energy that is needed to sustain power output and may result in a lowering of muscle mass and therefore lead to impaired performance. A second category of athletes interested in body fat loss include those who are already lean but desire additional fat loss for aesthetic or perceived performance benefits or those who struggle with body image issues. Although one cannot change genetic potential for body composition, there are sound strategies that can be used to address body weight and fat loss in athletes and active individuals.

Energy balance principles include the assumption that if one consumes fewer kilocalories than expended, then the outcome will be reduced body weight. The example commonly used is that creating an energy deficit of 3,500 kcal · wk^{-1} will lead to 1 lb of body weight loss. We now know that there are many factors that impact the energy balance equation, and this assumption may not always be true. In addition, and more importantly, a common mistake that is made when working with people about their energy balance is assuming that energy balance is static rather than being dynamic. This means that as a person loses weight and becomes smaller, energy intake and expenditure must be reexamined in order to continue with desirable outcomes. Resting metabolic rate and energy expenditure due to physical activity is dependent on body weight, so as a person becomes smaller, the estimations need to be reassessed (6).

Strategies that can be used for weight management in athletes and active individuals include the following (6):

- Avoid significant energy restriction. If energy intake is restricted too much, there is a loss of lean tissue, which makes further weight management more difficult, impairs performance, and can lead to negative health consequences. Most athletes would need a minimum of 1,500 kcal · d^{-1}, but this number can be higher with larger individuals. Certainly energy intakes at or below the estimated resting metabolic rate should be discouraged.
- During energy restriction, emphasize adequate protein intake. Consuming 1.5–2.0 g · kg^{-1} body weight of protein is recommended during energy restriction in order to try and maintain as much lean mass as possible while losing body fat (6,8).
- While restricting energy intake at a safe level, a low–energy-dense diet is recommended. Foods to include and encourage are whole fruits, vegetables, whole grains, legumes and beans, low-fat dairy, and lean meats and meat substitutes.
- Food intake should be timed properly with training/activity. Making sure total daily food intake is spread out throughout the day and consumed to meet training demands will help meet energy demands of activity and provide nutrients for repair and growth of tissue. Spreading food intake throughout the day also may aid in keeping blood sugar levels steady, which may help with hunger control.
- Use caution with energy-dense beverages. Beverages are often a hidden source of sugar and calories yet often provide little satiety. Attention needs to be paid from energy consumption from smoothies, frappes, shakes, and other sweet beverages as part of the daily diet. However, carbohydrate-containing sports drinks are still warranted during lengthy and/or intense endurance training.

Carbohydrate

The word *carbohydrate* is often referred to as if it is a single compound. In fact, dietary carbohydrates come in many different forms that have different nutritional purposes. Some dietary carbohydrates are digestible, whereas others are not. Based on the chemical structure of the molecule, some are considered "complex," whereas others are "simple"; and some carbohydrates contain soluble fiber, whereas others contain insoluble fiber (Fig. 6.4). Whether simple or complex, dietary carbohydrate is ultimately digested and metabolized to its simplest form called glucose (Tables 6.2–6.4). Glucose is the form that enters the cells of the body and can then be broken down to form ATP. The storage form of carbohydrate in the body is called glycogen, which is stored in the liver and the skeletal muscles (3). Carbohydrate recommendations range from 3 to 12 g · kg^{-1} body weight with the amount dependent on the total daily expenditure, sex, activity, and environmental conditions (2).

FIGURE 6.4. Carbohydrate foods — fruits, vegetables, grains (cereals, pasta, etc.), and potatoes.

Table 6.2 Quick Facts about Carbohydrates for Athletes (2)

Recommended intake range	3–12 $g \cdot kg^{-1} \cdot d^{-1}$
Light intensity	3–5 $g \cdot kg^{-1} \cdot d^{-1}$
Moderate intensity	5–7 $g \cdot kg^{-1} \cdot d^{-1}$
High intensity	6–10 $g \cdot kg^{-1} \cdot d^{-1}$
Very high intensity	8–12 $g \cdot kg^{-1} \cdot d^{-1}$
Recommended amount before exercise	1–4 $g \cdot kg^{-1}$
Recommended amount during exercise	30–90 $g \cdot h^{-1}$
Recommended amount after exercise	1.0–1.2 $g \cdot kg^{-1} \cdot h^{-1}$ for first 4 h
Energy content	4 $kcal \cdot g^{-1}$

Adapted from Thomas DT, Erdman KA, Burke LM. Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance. *J Acad Nutr Diet*. 2016;116(3):501–28.

Table 6.3 Examples of High-Carbohydrate Snacks

Apple
Bagel
Baked corn chips
Baked potato
Banana
Beans
English muffin
Fruit cup
Fruit smoothie
Energy bar
Grapes
Mashed potatoes

Mixed berries
Oatmeal
Orange juice
Popcorn
Rice
Saltine crackers
Pasta
Whole wheat toast

Table 6.4 Common High-Carbohydrate Foods

Food and Serving	Grams of Carbohydrate	Total Calories
Sugar (1 tbsp)	12	48
Pretzel sticks (3/4 oz)	15	80
Maple syrup (1 tbsp)	15	80
Juice (1 cup)	30	160
Cola, regular (12 oz)	38	200
Apples (1 medium)	15	80
Sugar-frosted flakes cereal (1 cup)	30	160
Raisins (2 tbsp)	15	60
Orange (1 small)	15	60
Rice, white (1/2 cup)	15	80
Orange juice (1/2 cup)	15	60
Sweet potatoes (1/2 cup)	15	80
Shredded wheat cereal (1/2 cup)	15	80
Potato, baked (1/2 large)	30	160
Banana (1/2)	15	60
Carrots (1 cup raw)	5	25
Potato, mashed with milk (1/2 cup)	15	80
Cantaloupe (1 cup diced)	15	80
Tomato (1 cup raw)	5	25

Green beans (1/2 cup cooked)	5	25
Spaghetti (1 cup cooked)	30	160
Yogurt, low-fat fruit-flavored (6 oz)	27	180
Bread, wheat (1 slice)	15	80
Beans (1 cup)	30	160
Broccoli (1 cup raw)	5	25
Bagel (1)	165	76
Bread (2 slices)	135	81
Energy bar (1)	250	75
Plain popcorn (3 cups popped)	70	79

Adapted from Choose Your Foods: Food Lists for Weight Management. *Academy of Nutrition and Dietetics and American Diabetes Association*, 2019. ISBN: 978-1-58040-739-7.

Functions of Carbohydrate

Carbohydrates have a number of functions in the body, including the following:

- *Providing energy* (4 kcal · g^{-1}). Carbohydrate is the preferred fuel for the body, and it is a quick energy source.
- *Protein sparing*. This is an often overlooked, yet very important, function of carbohydrate. Because carbohydrate (glucose) is a preferred fuel, providing enough carbohydrate to meet most energy needs preserves (*e.g.*, “spares”) protein from being broken down and used as a source of energy.
- *Oxidation of fat*. It has been said that “fats burn in a carbohydrate flame.” That is, to burn fats efficiently and completely, some carbohydrates are needed.
- *Cooperative functions in the body*. They bind with proteins (glycoproteins) or lipids (glycolipids) in cell membranes and participate in cholesterol and triglyceride metabolism.
- *Storing energy*. Carbohydrate is stored as glycogen in the liver and skeletal muscle, which is an excellent storage form. Liver glycogen can

be easily converted back to glucose and used for energy, and skeletal muscle glycogen can be broken down for energy to fuel the working muscle. Total body glycogen stores range from approximately 100–500 g or 400–2,000 kcal worth of energy.

Types of Carbohydrate

Carbohydrates come in a number of forms:

- *Simple carbohydrates (sugars)*. These are sugars such as glucose, fructose (typically found in fruits and vegetables), galactose (one of the sugars in milk), sucrose (table sugar), lactose (milk sugar), and maltose (grain sugar).
- *Polysaccharides*. These are carbohydrates that contain many molecules of connected sugars. Polysaccharides can be digestible (starches such as bread, rice, and cereal) or indigestible (cellulose, hemicellulose, pectin, gums, and mucilages found in whole grains, fruits, and vegetables). Dietary fiber is a carbohydrate that cannot be digested but is useful in the diet because it may lower fat and cholesterol absorption, improves blood sugar control, and may reduce the risk of colon cancer and heart disease.

Should the focus of a client's diet be carbohydrate, protein, or fat? Many studies show that *carbohydrates are the limiting energy substrate*. That is, when carbohydrates deplete, people typically reach a point of exhaustion. For this reason, people should consume carbohydrates 3–12 $g \cdot kg^{-1}$ of body weight per day, depending on the desired intensity and duration of the exercise (2). This is a wide range that can be narrowed down a bit depending on the training volume and intensity. Athletes training at low intensity or participating in a skill-based sport fall into the 3–5 $g \cdot kg^{-1}$ range; exercising at a moderate intensity for about an hour a day requires 5–7 $g \cdot kg^{-1}$; moderate to high intensity for 1–3 $h \cdot d^{-1}$ requires 6–10 $g \cdot kg^{-1}$; 8–12 $g \cdot kg^{-1}$ is reserved for high-intensity, high-volume training of greater than 4–5 $h \cdot d^{-1}$. Although these carbohydrate recommendations are published in the joint ACSM Position Statement on nutrition and athletic performance, Personal Trainers should recommend that their client speak to a CSSD to determine the carbohydrate recommendation specific to his or her sport and training regimen.

The distribution of carbohydrate, protein, and fat was previously expressed as a percentage of total calories (*e.g.*, 60% of total calories from carbohydrate was the common recommendation). However, because high energy intakes can easily satisfy carbohydrate needs at a significantly lower proportion of total calories, it is now recommended that energy substrate distribution be expressed in grams per kilogram as expressed earlier.

Because the body's storage capacity for carbohydrates is relatively limited, carbohydrates should be provided throughout the day in small, frequent meals. A key reason for the small, frequent meal recommendation is to sustain blood sugar (glucose), which is the primary fuel for the central nervous system (brain). If the brain receives insufficient glucose, mental fatigue will result, and mental fatigue leads to muscle fatigue. Blood glucose level reaches its peak approximately 1 hour after a meal and is back to premeal levels about 2 hours after (9). This strongly suggests that meal frequency should be approximately every 3 hours to avoid the mental and muscle fatigue that could result from low blood sugar level. Specific to optimizing endurance performance, total daily carbohydrate targets should be spread out to allow adequate fuel before, during, and after training, especially endurance training. Before a bout of endurance exercise lasting an hour or more, 1–4 $g \cdot kg^{-1}$ should be consumed 1–4 hours prior to the start of the training session. During endurance activity, 30–60 $g \cdot h^{-1}$ should be consumed, and this can be up to 90 $g \cdot h^{-1}$ in highly trained endurance athletes. Usually, a liquid carbohydrate such as a sports drink is best tolerated. If carbohydrate stores are depleted and replenishment is a goal, 1–1.2 $g \cdot kg^{-1} \cdot h^{-1}$ carbohydrate is recommended for the first 4 hours posttraining and then resume the daily needs until the daily target is met. Ultimately, the specific amount and timing of carbohydrate needed is associated with the intensity and duration of physical activity, demand of the sport, carbohydrate tolerance, personal experience, gender, and the environmental conditions (cold, humid, hot, etc.). A CSSD is trained to help athletes meet total daily needs while developing specific strategies for meeting the demands of training (2).

The Glycemic Index

The glycemic index (GI) is a measure of how different consumed carbohydrate foods affect the blood sugar level. Foods are compared with the ingestion of glucose, which has an index value of 100. High-GI foods tend to raise the blood sugar quickly, whereas foods with a lower GI help maintain blood sugar, avoid an excessive insulin response that can encourage insulin resistance, and keep people feeling better longer (10). High-GI foods are recommended when glucose needs to get into the skeletal muscle cell quickly like when running a race. After exercise when glycogen replenishment is the goal, total carbohydrate is more important that the GI value of the food (11,12). Although the GI is a useful guide, Personal Trainers should be aware that different people have different responses to food and many factors may impact the GI of that food. For example, cooking, state of ripening, origin of growth, or combining a high-GI food with a lower one (*e.g.*, rice with chicken) will impact the overall glucose response. Most high-GI foods are energy dense and provide little other nutrient value than carbohydrate calories. Athletes interested in lowering either weight or body fat levels should pay attention to the energy and carbohydrate content of a food and make selections that fit into overall energy and fuel goals. Table 6.5 lists the GI of some common foods. Complete tables can be found in the scientific literature (10).

Table 6.5 High, Medium, and Low Glycemic Index Foods

High Glycemic Index (>85)	Medium Glycemic Index (60–85)	Low Glycemic Index (<60)
Glucose	All-bran cereal	Fructose
Sucrose	Banana	Apple

Maple syrup	Grapes	Applesauce
Corn syrup	Oatmeal	Cherries
Honey	Orange juice	Kidney beans
Bagel	Pasta	Navy beans
Candy	Rice	Chickpeas
Corn flakes	Whole grain rye bread	Lentils
Carrots	Yams	Dates
Crackers	Corn	Figs
Molasses	Baked beans	Peaches
Potatoes	Potato chips	Plums
Raisins		Ice cream
White bread		Milk
Whole wheat bread		Yogurt
Sodas (nondiet)		Tomato soup
Sports drinks		

From http://www.functionalhockey.com/files/GlycemicIndex.pdf

Foods with a lower GI help maintain blood sugar, avoid an excessive insulin response that can encourage insulin resistance, and keep people feeling better longer.

Protein

Proteins are complex compounds that consist of different connected amino acids, which uniquely contain nitrogen. Proteins in the body are constantly changing, with new proteins being made and old ones broken down. Growth hormone, androgen, insulin, and thyroid hormone are anabolic hormones (*e.g.*, they cause new protein to be produced). Cortisone, hydrocortisone, and thyroxin are catabolic hormones (*e.g.*, they influence the breakdown of proteins).

The protein requirement for physically active people is about double that for nonathletes (Table 6.6). The nonathlete (average) adult's requirement recommended daily allowance (RDA) for protein is 0.8 $g \cdot kg^{-1}$ of body weight, whereas the adult athlete requirement for protein ranges between 1.2 and 2.0 $g \cdot kg^{-1}$ of body weight (2). Recreational athletes or those who are more endurance training focused fall at the lower end of the range and usually require 1.2–1.5 $g \cdot kg^{-1}$, whereas athletes focusing on strength training will need at the upper end of the range of 1.5–2.0 $g \cdot kg^{-1}$. A strength-trained athlete who weighs 180 lb (about 82 kg) would require between 123 and 164 g of protein per day. At 4 $kcal \cdot g^{-1}$, this is between 492 and 656 kcal from protein per day (Fig. 6.5). Most athletes far exceed this amount of protein just from the foods they consume. Consider that the protein in a hamburger, a chicken fillet sandwich, and one cup of milk combined provides more than half the total daily protein requirement for a 180-lb (82-kg) athlete (Table 6.7). A total energy intake sufficient to allow the anabolic utilization of protein, and not burned to satisfy the energy requirement, is needed to sustain optimal performance (2).

FIGURE 6.5. Protein foods — meats, poultry, dairy (cheese, milk, yogurt), and legumes.

Table 6.6 Quick Facts about Protein for Athletes

Recommended intakes	Adult athletes: 1.2–2.0 $g \cdot kg^{-1}$ of body weight
Recommended intake postexercise for recovery	15–25 g total or 0.3 $g \cdot kg^{-1}$ of body weight

Single-dose effectiveness	Less than 40 g per serving
Energy content	4 kcal · g^{-1}

Adapted from Thomas DT, Erdman KA, Burke LM. Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance. *J Acad Nutr Diet*. 2016;116(3):501–28.

Table 6.7 Examples of Good High-Protein Snacks

Cheese
Chicken
Cooked beef, lamb, or pork strips
Milk
Yogurt
Tuna sandwich
Hamburger
Soy burger
Edamame
Hummus
Nut spreads
Cottage cheese
Turkey sandwich

In addition to daily total protein intake, timing can also be important. Spreading total daily protein grams over the day seems to be optimal to maximize digestion, metabolism, and incorporation of the amino acids into bodily tissue. For example, if the daily protein target is 130 g · d^{-1}, a good strategy would be to eat 30 g at each meal and have two snacks containing 20 g each. In order to maximize skeletal muscle protein synthesis with resistance exercise, consuming protein posttraining is necessary. There appears to be a metabolic window in the several hours postexercise where consuming amino acids triggers the protein synthesis pathways within skeletal muscle. The general recommendation is to consume 0.3 g · d^{-1} body weight postexercise, which translates into 15–25 g of protein for average athletes. Intakes greater than 40 g of protein in one sitting have not been shown to result in a further benefit of increased skeletal muscle protein synthesis.

Functions of Protein

Proteins have a number of functions in the body, including the following:

- *Enzyme and protein synthesis*. There are hundreds of unique tissues and enzymes that are proteins.
- *Transportation of nutrients to the right places*. Proteins make "smart" carriers, enabling nutrients to go to the right tissues.
- *A source of energy*. The carbon in protein provides the same amount of energy per unit of weight as carbohydrates (4 kcal · g^{-1}).
- *Hormone production*. Hormones control many chemical activities in the body, and these are made of unique proteins. For instance, insulin is an important hormone for blood glucose regulation.
- *Fluid balance*. Protein helps control the fluid balance between the blood and surrounding tissues. This helps people maintain blood volume and sweat rates during physical activity.
- *Acid–base balance*. Proteins can make an acidic environment less acidic and an alkaline environment less alkaline. High-intensity activity can increase cellular acidity (through lactate buildup), which protein can help buffer.
- *Growth and tissue maintenance*. Protein is needed to build and maintain tissue. This is one reason why the protein requirement for growing children can be double that of adults and slightly higher for athletes (13).
- *Synthesis of nonprotein, nitrogen-containing compounds*. Phosphocreatine is a high-energy, nitrogen-containing compound that can quickly release energy over a short duration for quick-burst activities (Box 6.2).

Box 6.2 Supplementation with Creatine Monohydrate

Research has shown that creatine monohydrate supplementation may improve performance in repeated high-intensity activities, particularly in athletes with marginal caloric intakes. However, the data on the safety of creatine monohydrate supplementation is incomplete and not clear. A safer strategy would be to ensure that people have adequate calorie and protein intakes.

Protein Quality

Protein quality is determined by the presence (or absence) of essential amino acids and their distribution. It is "essential" to take in these amino acids from food because the body is not capable of manufacturing them. Examples of foods containing protein with all the essential amino acids in a desirable ratio include meats, eggs, milk, cheese, and fish. Nonessential amino acids can be manufactured (synthesized) in the body, so it is not "essential" to consume foods that contain them. Most foods contain both nonessential and essential amino acids, but it is the presence of a comprehensive set of essential amino acids that makes a high-quality protein.

Most foods contain both nonessential and essential amino acids, but it is the presence of a comprehensive set of essential amino acids that makes a high-quality protein.

People frequently take protein supplements because of the convenience. These may not require refrigeration and are easily consumed during that metabolic window of protein synthesis seen postresistance training. Many of these supplements are of high protein quality but can be very expensive per meal or dose. Highly quality protein is also found in foods such as meat, poultry, fish, dairy, or eggs, but this may require some planning ahead.

Vegetarians can ensure optimal protein quality by combining cereal grains (rice, wheat, and oats) with legumes (dried beans or peas). Vegetarians are clearly at more risk for inadequate protein intake because the best source of high-quality protein is foods of animal origin (*e.g.*, meat and fish). However, with some good dietary planning, vegetarians can consume enough high-quality protein (Table 6.8).

Table 6.8 Common High-Protein Foods

Food and Serving	Grams of Protein	Total Calories
Select or choice grades of beef (3 oz)	21	135
Fish (3 oz)	21	135
Chicken or turkey without skin (3 oz)	21	135
Cheese with less than 3 g fat per ounce (1 oz)	7	45
Egg whites (2)	7	45
Cottage cheese (1/4 cup)	7	45
Sandwich meats with less than 3 g fat per ounce (3 oz)	21	135
Egg (1)	7	75
Chicken or turkey with skin on (3 oz)	21	225
Fried fish (3 oz)	21	225
Cheese with 4–7 g fat per ounce (1 oz)	7	75
Prime grades of beef (3 oz)	21	225
Sandwich meats with ~8 g fat per ounce (3 oz)	21	300
Beans (1/2 cup cooked)	7	145
Tofu (3 oz)	21	225
Peanut butter (1 tbsp)	7	100

Adapted from Choose Your Foods: Food Lists for Weight Management. *Academy of Nutrition and Dietetics and American Diabetes Association*, 2019. ISBN: 978-1-58040-739-7.

Although protein isn't the best fuel for physical activity, it is a fuel that can help satisfy energy needs if other fuels (*e.g.*, carbohydrate and fat) are inadequate. During an energy restriction, where energy availability is limited, protein in excess of the RDA but below the threshold of 2.0 $g \cdot kg^{-1}$ body weight may help to support the maintenance of lean mass by providing a source of energy. However, under such energy restrictions, it should be understood that the primary use of protein will be to support the need for energy rather than to sustain or increase the lean mass. There is no question that energy needs must be satisfied before considering the best way to distribute carbohydrate, protein, and fat.

Fat

The generally accepted healthy range of fat intake for physically active people is between 20% and 35% of total daily calories (Fig. 6.6 and Tables 6.9 and 6.10). Since sport-specific requirements for carbohydrate and protein are established, it is generally accepted practice that carbohydrate and protein needs are determined first, and the reminder of the diet then comes from fat. For someone consuming 2,500 $kcal \cdot d^{-1}$, this ranges between 56 and 97 $g \cdot d^{-1}$:

$$2{,}500 \text{ kcal} \times 0.20 = 500 \text{ kcal } (500 \text{ kcal fats} / 9 \text{ kcal} \cdot g^{-1} = 56 \text{ g})$$
$$2{,}500 \text{ kcal} \times 0.35 = 875 \text{ kcal } (875 \text{ kcal fats} / 9 \text{ kcal} \cdot g^{-1} = 97 \text{ g})$$

FIGURE 6.6. Fat foods — oil, butter, margarine, bacon, and fried foods.

Table 6.9 Quick Facts about Fat for Athletes

Recommended intake	Fat intake should provide between 20% and 35% of total calories.
Caution	Chronic consumption of intake below 20% of total kilocalories may result in a reduction of fat-soluble vitamins and essential fatty acids.
Energy content	$9\ \text{kcal} \cdot \text{g}^{-1}$

Adapted from Thomas DT, Erdman KA, Burke LM. Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance. *J Acad Nutr Diet*. 2016;116(3):501–28.

Table 6.10 Common High-Fat Foods

Food	Grams of Fat	Total Calories
Butter (1 tsp)	5	45
Margarine (1 tsp)	5	45
Mayonnaise (1 tsp)	5	45
Oil (1 tsp)	5	45
Salad dressing (1 tbsp)	5	45
Almonds (6)	5	45
Avocado (2 tbsp)	5	45
Cream cheese (1 tbsp)	5	45
Seeds (1 tbsp)	5	45
Sour cream (2 tbsp)	5	45

Adapted from Choose Your Foods: Food Lists for Weight Management. *Academy of Nutrition and Dietetics and American Diabetes Association*, 2019. ISBN: 978-1-58040-739-7.

This level of intake will provide more room in the diet for needed carbohydrates (see Tables 6.9 and 6.10). Athletes should be discouraged from chronically consuming less than 20% of total daily calories from fat because it may lead to a reduction in fat-soluble vitamins and essential fatty acids (2).

Functions of Fat

Fat has a number of important functions in the body:

- *Fat is a source of energy*. Fat provides 9 kcal · g^{-1} (compared with 4 kcal · g^{-1} from both carbohydrates and proteins).
- *Fat provides insulation from extreme temperatures*.
- *Cushion against concussive forces*. Fat protects organs against sudden concussive forces, such as a fall or a solid “hit” in football.
- *Satiety control*. Fat, because it stays in the stomach longer than other energy nutrients, makes people feel fuller longer.
- *Fat gives food flavor*.
- *Fat carries essential nutrients*. Fat-soluble vitamins (A, D, E, and K) are better absorbed with dietary fat and are storied in adipose tissue.

Classifications and Definitions of Fat

- *Fats and oils*. Fats are solid at room temperature and usually contain a high proportion of saturated fatty acids; oils are liquid at room temperature and typically (there are notable exceptions) contain a high proportion of unsaturated fatty acids.
- *Triglycerides, diglycerides, and monoglycerides*. Triglycerides are the most common form of dietary fats and oils, whereas diglycerides and monoglycerides are less prevalent but still commonly present in the food supply.
- *Short-chain, medium-chain, and long-chain fatty acids*. The most common dietary fatty acids are long chain, containing 14 or more carbon atoms. Medium-chain triglycerides (MCT oil), containing 8–12 carbon atoms, have received some attention recently as an effective supplement for increasing caloric intake in athletes. Although MCT oil may hold some promise in this area, it has not been adequately tested. Short-chain fatty acids contain 6 carbon atoms or less.

- *Polyunsaturated fatty acids (PUFA)*. These fatty acids have a tendency to lower blood cholesterol level. These fats are typically associated with vitamin E (found in vegetable and cereal oil, such as corn oil), which is essential for all. Within the PUFA category, there are two essential fatty acids called ω-6 fatty acids and ω-3 fatty acids. These must be consumed in the diet. ω-6 Fatty acids are abundant in various vegetable oils, and deficiency is not common. ω-3 Fatty acids are more limited in the diet — they are found in a certain type of marine algae and fish that consume that algae. Examples of fish rich in ω-3 fatty acids include wild salmon, herring, mackerel, trout, halibut, tuna, shrimp, snapper, anchovies, and sardines (watch sodium), and cod. Current research is underway examining the role of ω-3 fatty acids in the diet from foods and supplementation in inflammation, recovery from training, and prevention and healing from a sports-related concussion. Until more research is published, a specific recommendation cannot be made. However, including foods rich in ω-3 fatty acids as part of a balanced meal plan is encouraged.
- *Monounsaturated fatty acids*. These fatty acids tend to lower blood cholesterol level while maintaining high-density lipoprotein (good) cholesterol (found in olive oil and canola oil).
- *Saturated fatty acids*. These fatty acids tend to increase serum cholesterol (found in meats and dairy products).
- *Trans fatty acids*. These are made in a laboratory for the purpose of frying and giving taste and texture to foods. There is an abundance of evidence suggesting that these fats contribute to dyslipidemia. As a result, the amount of these trans fats is required to appear on the food label. There is no DRI for these because they are not required in the diet.
- *Low-density lipoproteins*. This is the major carrier of cholesterol and other lipids in the blood.
- *High-density lipoproteins*. These lipoproteins carry lipids away from storage and to the liver for metabolism and/or excretion. Because they are associated with removal of cholesterol, they are considered "good cholesterol."

For a 75-kg (165-lb) person consuming a 3,000-kcal diet, approximately 750 kcal would come from fat if fat contributed about 25% of total calories. Because fats provide 9 kcal · g^{-1}, this amounts to between approximately 83 g of fat per day. There has been a great deal of attention given to high-fat, high-protein, low-carbohydrate diets recently, but there is no consistent evidence that chronic use of these diets are useful for enhancing athletic performance (2).

Vitamins and Minerals

Vitamins are substances that help essential body reactions take place. The best strategy to make certain that an adequate amount of all the vitamins is consumed is to eat a wide variety of foods and consume plenty of fresh fruits and vegetables daily. Some vitamins are water soluble, whereas others are fat soluble. See Tables 6.11, 6.12, and 6.13 for a summary of major vitamins and minerals. Remember that nutrient balance is a key to optimal nutrition, so people should avoid single-nutrient supplementation unless this has been specifically recommended by a physician/primary care provider to treat an existing nutrient deficiency disease. If a nutrient supplement is warranted because of an obviously poor-quality food intake, people should try a multivitamin, multimineral supplement that provides no more than 100% of the DRI for each nutrient. The scientific literature suggests that vitamin and mineral deficiencies are uncommon for most people, but vitamins requiring attention in active individuals are vitamin D, antioxidants, and some B vitamins (4).

Table 6.11 Water-Soluble Vitamins

Vitamin and Adult Requirement	Functions	Deficiency/Toxicity	Food Sources
Vitamin C (also	■ Antioxidant	Deficiency: scurvy,	Fresh fruits and

called l-ascorbate) 75–90 mg · d^{-1}	■ Collagen formation ■ Iron absorption ■ Carnitine synthesis ■ Norepinephrine synthesis Athletic performance: conflicting study results; as antioxidant, may be useful in alleviating muscle soreness and in aiding muscle recovery	bleeding gums, fatigue, muscle pain, easy bruising, depression, sudden death	vegetables, particularly high in citrus fruits and cherries
Thiamin (also called vitamin B_1) 1.1–1.2 mg · d^{-1}	■ Oxidation of carbohydrates ■ Nerve conduction Athletic performance: conflicting study results	Deficiency: beriberi (heart disease, weight loss, neurological failure)	Seeds, legumes, pork, and enriched/fortified grains and cereals
Riboflavin (also called vitamin B_2) 1.1–1.3 mg · d^{-1}	■ Oxidation of carbohydrates and fats ■ Normal eye function ■ Healthy skin Athletic performance: Low-level supplement may be desirable for athletes involved in low-intensity, high-endurance sports.	Deficiency: swollen tongue, sensitivity to light, cracked lips, fatigue	Milk, liver, and whole and enriched grains and cereals
Niacin 14–16 mg · d^{-1}	■ Oxidation of carbohydrates and fats ■ Electron transport (energy reactions) Athletic performance: conflicting study results	Deficiency: pellagra (diarrhea, dermatitis, dementia)	Amino acid tryptophan (60:1 conversion ratio), and enriched grains and cereals
Vitamin B_6 1.3–1.7 mg · d^{-1}	■ Carbohydrate, fatty acid, and amino acid metabolism ■ Red blood cell formation	Deficiency: scaly dermatitis, microcytic anemia Toxicity: nerve damage leading to numbness and muscle weakness, depression, fatigue, skin lesions	Meats, fish, poultry, potatoes, starchy vegetables, cereals
Vitamin B_{12} 2.4 µg · d^{-1}	Coenzyme in cell synthesis, maintenance of nerve cells	Deficiency: pernicious anemia Toxicity: none reported	Animal foods, fortified cereals
Folate 400 µg · d^{-1}	Coenzymes in DNA synthesis, new cell formation	Deficiency: macrocytic anemia, smooth red	Fortified grains, green leafy

		tongue, confusion, weakness, fatigue, shortness of breath Toxicity: masks vitamin B_{12} deficiency	vegetables, legumes, seeds

Table 6.12 Fat-Soluble Vitamins

Vitamin and Adult Requirement	Functions	Deficiency/Toxicity	Food Sources
Vitamin A (retinol) ~1,000 retinol equivalents 700–900 mg $\cdot$ d^{-1} (This vitamin is potentially highly toxic if taken in large amounts.)	■ Vision ■ Growth ■ Reproduction ■ Immune function ■ Healthy skin Athletic performance: no evidence that supplementation aids performance	Deficiency: night blindness, eye disease, growth failure, unhealthy skin, susceptibility to infections Toxicity: headache, vomiting, hair loss, bone abnormalities, liver damage, death	Fish liver oils, liver, butter, vitamin A + D–added milk, egg yolk Pro-vitamin A (β-carotene) in dark-green leafy vegetables, yellow vegetables and fruits, and fortified margarines
Vitamin D (ergocalciferol and cholecalciferol) 15–20 μg $\cdot$ d^{-1}	■ Calcium absorption ■ Phosphorus absorption ■ Mineralization of bone ■ Gene expression for numerous cells ■ Inflammation Athletic performance: skeletal muscle and neuromuscular function	Deficiency: rickets in children, osteomalacia in adults, poor bone mineralization Toxicity: calcium deposits in soft tissues (blood vessels, kidneys, heart, lungs, joint tissue)	Fish liver oils, fortified (vitamins A and D) milk, skin synthesis with exposure to ultraviolet light; small amounts found in butter, liver, egg yolk, and canned salmon and sardines
Vitamin E (α-tocopherol) 15 mg $\cdot$ d^{-1}	■ Powerful antioxidant ■ Involved in immune function Athletic performance: Antioxidant properties may be	Deficiency: premature breakdown of red blood cells, anemia in infants, easy	Vegetable oils, green leafy vegetables, nuts, legumes (foods of

	useful in preventing oxidative damage and/or in muscle recovery and intestinal bacterial synthesis.	peroxidative damage of cells	animal origin are *not* good sources)
Vitamin K (phylloquinone K_1, menaquinone, menadione) 90–120 mg · d^{-1}	Involved in blood clotting (referred to as the antihemorrhagic vitamin)	Deficiency: longer clotting time	Green leafy vegetables

Data from Manore M, Thompson J. Sports Nutrition for Health and Performance. Champaign (IL): Human Kinetics; 2000; Williams MH. *Nutrition for Health, Fitness & Sport*. 6th ed. Boston (MA): McGraw-Hill; 2002; and Benardot D. *Nutrition for Serious Athletes: An Advanced Guide to Foods, Fluids, and Supplements for Training and Performance*. Champaign (IL): Human Kinetics; 2000.

Table 6.13 Minerals

Minerals and Adult Requirement	Functions	Deficiency/Toxicity	Food Sources
Calcium 1,500 mg · d^{-1}	■ Structure of bones and teeth ■ Blood coagulation ■ Nerve impulse transmission ■ Muscle contraction ■ Acid–base control Athletic performance: particularly critical in athletes to ensure adequate bone density to reduce the risk of stress fractures	Deficiency: reduced bone density, osteoporosis, stress fractures	Milk and other dairy foods, dark-green leafy vegetables, canned fish (with bones), calcium-fortified orange juice
Phosphorus 700 mg · d^{-1}	■ Structure of bones and teeth ■ Component of ATP and other energy-yielding compounds ■ Part of many vitamin B coenzymes	Deficiency (rare) may occur with large, long-term intakes of magnesium-containing antacids.	Meats, cereals, grains, and dairy products

	■ Part of DNA and RNA ■ Acid–base control		
Iron 8 mg · d^{-1} (with 18 mg · d^{-1} for women between 19 and 50 yr of age)	■ Involved in oxygen transfer to cells (hemoglobin in blood; myoglobin in muscle) ■ In numerous oxidative enzymes Athletic performance: commonly inadequate in athletes, resulting in poor performance and other health problems	Deficiency: microcytic anemia, leading to weakness, loss of energy, easy fatigue (This is the most common mineral deficiency.)	Most absorbable iron: meats, poultry, fish, egg yolk Less absorbable iron: dark-green vegetables, legumes, peaches, apricots, prunes, raisins
Zinc 8–11 mg · d^{-1}	■ Immune system ■ Wound healing ■ In more than 70 enzymes involved in energy metabolism	Deficiency: growth retardation, poor wound healing, frequent infections, muscle weakness	Seafood, organ meat, meat, wheat germ, yeast (Most plant foods are not good sources.)
Magnesium 320–420 mg · d^{-1}	■ Energy metabolism of carbohydrate and fat ■ Protein synthesis ■ Water balance ■ Muscle contractions	Deficiency: muscle weakness	Available in many foods but highest in meats, whole-grain cereals, seeds, and legumes

Data from Manore M, Thompson J. Sports Nutrition for Health and Performance. Champaign (IL): Human Kinetics; 2000; Williams MH. *Nutrition for Health, Fitness & Sport*. 6th ed. Boston (MA): McGraw-Hill; 2002; and Benardot D. *Nutrition for Serious Athletes: An Advanced Guide to Foods, Fluids, and Supplements for Training and Performance*. Champaign (IL): Human Kinetics; 2000.

The best strategy to make certain that an adequate amount of all the vitamins is consumed is to eat a wide variety of foods and consume plenty of fresh fruits and vegetables daily.

Water-Soluble Vitamins

Water-soluble vitamins, which include vitamins B and C, are vitamins for which the body has limited storage capacity. These vitamins are typically associated with carbohydrate foods, such as fresh fruits, breads and cereals, and vegetables. The B vitamins are needed for the metabolism of carbohydrates, proteins. Although deficiency of B vitamins may impair energy metabolism, consuming more than is needed does not improve metabolic processes above capacity. Some athletes, especially high-volume training endurance athletes, may have a requirement that is slightly higher than the DRI. However, due to the training demands, these individuals also need a significant amount of energy from food, and these increased vitamin needs can be met from the increased food volume (assuming quality food is consumed). Luckily, good-quality foods that are high in carbohydrates are typically also foods that provide B vitamins (*e.g.*, enriched breads, enriched cereals, and pasta) (4).

Vitamin C is a water-soluble vitamin that is often the focus of supplements taken by most people. Although vitamin C is critical to good health, people should be reminded that the DRI for vitamin C is only 75–90 mg and that level is 2 standard deviations above the average human requirement. Most supplements contain between 250 and 500 mg of vitamin C or more, providing a good deal more than is needed. On top of the vitamin C intake from foods, which is typically well above the DRI for this vitamin, supplementation makes it easy for people to get too much. Although the potential toxicity of vitamin C is relatively low, even an excess of this relatively nontoxic vitamin can increase the risk of kidney stones. People should be encouraged to have a balanced exposure to all the vitamins, a strategy that will help encourage good health and avoid problems associated with excess intake and deficiencies.

Fat-Soluble Vitamins

Fat-soluble vitamins are A, D, E, and K and are delivered with fats and oils. For instance, milk is fortified with the fat-soluble vitamins A and D, which are in the fat component (cream) of the milk. Vitamin A can be found in liver, butter, and egg yolk to a small extent. β-Carotene (precursor to vitamin A), the plant form, is abundant in fruits and vegetables, especially those that are orange. Vitamin D can be found in fatty fish and cheese. Vegetable and cereal oils are excellent sources of vitamin E, an important antioxidant that can help protect cells from becoming damaged through oxidation. This is important because physical activity increases the amount of oxygen pulled into cells, thereby increasing the risk for oxidative damage. Vitamin K is most abundant in green leafy vegetables.

Vitamin D has received much attention over the recent years because of the potential benefits in immune health and inflammation. Vitamin D insufficiency and deficiency is being studied in the athletic population, and it appears that adequate vitamin D status is required for optimal skeletal muscle function and performance. Supplements of vitamins A and D should be taken only under the advice of a physician because of their high potential toxicity. Other vitamins such as vitamin B_6 have also been shown to produce toxicity if taken in excess. As a general rule, it is generally better to derive vitamins through the consumption of a wide variety of foods rather than supplements, as supplementation may more easily result in toxicity and may also give individuals the wrong impression that a good-quality diet is unnecessary because supplements are consumed.

Minerals

Minerals are inorganic substances that are involved in water balance, nerve impulse stimulation, acid–base balance, and energy reactions (see Table 6.13). Iron and zinc are not only critically important for energy metabolism but are also among the nutrients of which people may not be consuming enough. This is particularly true of vegetarians because the best source of these minerals is red meat.

The most common nutrient deficiency in most industrialized countries is the deficiency in iron. Because of the prevalence of this deficiency, people (especially females) should periodically have a blood test to determine iron status. This test should include an assessment of hemoglobin, hematocrit, and ferritin. An assessment of iron status is particularly important for endurance athletes, vegetarians, or people who are on weight loss diets.

> The most common nutrient deficiency in most industrialized countries is the deficiency in iron.

Calcium is important for the skeletal maintenance and repair, for muscle contraction, and for normal blood clotting. Vitamin D is essential for calcium absorption, so athletes who do the majority of their training indoors and who are in weight-restricted and/or subjectively scored sports where appearance is important (*e.g.*, skating, gymnastics, and diving), where energy intake is often restricted, may be at risk for vitamin D, calcium, and energy intakes. This combination may place female athletes at risk for developing amenorrhea (absence of at least three menstrual periods in a row) and higher bone fracture risk (2).

Fluid and Hydration

Water carries nutrients to cells and carries waste products away from cells. It serves as a body lubricant and, through sweat, helps maintain body temperature. Lean tissue (muscles and organs) is more than 70% water, and about 60% of total body weight is water (7,14). A failure to supply sufficient water is more likely to cause quick death than a failure to supply any other single nutrient.

Water is lost through breathing (breath is moist), the skin (this happens even if there is no obvious "sweat"), urine, sweat, and feces. It is critically important to consume sufficient fluid to maintain body water stores, yet most people rarely stay optimally hydrated (Fig. 6.7). In fact, many people commonly wait until they become extremely thirsty (indicating a state of dehydration) before they consume fluids. Weight stability, before and after exercise, is a good indication that water needs have been met during an exercise program. People who experience significant weight (*e.g.*, water) loss during practice should learn how to drink more fluid to stabilize weight because >2% body weight loss is associated with reduced performance (14).

FIGURE 6.7. Fluid and hydration.

Meeting Fluid Needs

A key to athletic success is *avoidance* of a state of underhydration. This is not as easy as it may seem because many people rely on “thirst” as the alarm bell for when to drink. Thirst, however, is a delayed sensation that does not occur until the person has already lost 1–2 L of fluid. Because of this, people should learn to consume fluids on a fixed time interval rather than relying on thirst for when to drink. Exercising in a hydrated state allows optimal functioning of the body, whereas dehydration will result in impaired performance. As little as 2%–5% of body weight loss can have deleterious effects. Effects of dehydration include the following (2,4,7,14):

- Decreased plasma volume with subsequent cardiovascular strain
- Increased glycogen use leading to earlier fatigue
- Altered metabolic and central nervous system function
- Potentially increased risk of developing heat illness
- Impaired cognitive function
- Impaired technical skills

Severe dehydration (>6% body weight loss due to fluid) can lead to reduced cardiac output, reduced sweat production, and reduced skin and muscle blood flow. Fluid intake recommendations are as follows (2,14):

- On a regular basis, checking urine color can be helpful to detect hydration. Urine should have a clear, pale yellow color.

- Begin training in a hydrated state. The guideline is to consume 5–10 mL · kg^{-1} body weight 2–4 hours prior to exercise.
- During training, the goal is to try a match fluid intake with sweat losses. Sweat rates are often 0.3–2.4 L · h^{-1}, and it is difficult to consume and absorb enough fluid to match these losses. A general recommendation is to consume 0.4–0.8 L · h^{-1} of fluid. More detailed hydration plans can be calculated based on an individual's sweat rate with the assistance of a CSSD. Do not rely on thirst as a stimulus to drink (the thirst sensation will occur only after 1–2 L [1%–2% of body weight] has already been lost).
- Consumption of large volumes of fluid increases the risk of gastrointestinal distress, thereby affecting performance.
- Ingestion of large volumes of dilute, low- (or no-) sodium fluid may increase the risk of hyponatremia.
- If left on their own, athletes will often develop dehydration even when there are sufficient fluids nearby for them to consume.
- To ensure better athlete compliance, fluids should be cool, should taste good, and should be readily available.

> People may benefit from consuming fluids on a fixed time interval (*e.g.*, every 15–30 min during exercise) rather than relying on thirst to indicate when to drink.

To replenish fluid losses after exercise, drink as much as needed to match sweat losses. This can be most practically done by measuring body weight before and after exercise. The recommendation is to replace body weight loss with 125%–150% of the deficit. This can be done by consuming 1.25–1.5 L of fluid for each kilogram of body weight loss.

Fluid Consumption Guidelines

The ACSM guidelines are useful for avoiding dehydration, but the type of fluids consumed is also important for achieving optimal performance (2,14). In general, studies have shown that a 6%–8% carbohydrate solution that also contains between 100 and 200 mg sodium per cup, such as that found in many sports beverages, is ideal from the standpoint of gastric emptying and intestinal absorption, for reducing mental and physical fatigue during both stop-and-go sports and endurance sports, for encouraging drinking during physical activity, and for improving performance. Studies comparing 6%–8% carbohydrate solutions with water and solution with higher carbohydrate concentrations have consistently found that the lower carbohydrate solutions are best (2).

Water versus Sports Drinks

There are clear advantages of sports drinks over water for most exercising adults (15).

- Flavor or electrolytes cause people to want to drink. Beverages that make people *want* to drink help them stay well hydrated. Studies show that people drink 25% more sports drink than water, and young children will drink 90% more sports beverage than water.
- Water has no energy, whereas sports beverages contain carbohydrate. The carbohydrate helps provide muscles with needed fuel to avoid early fatigue and poor performance.
- The sodium provided by sports beverages helps maintain blood volume, a factor that is critical to maintaining sweat rates and performance. Sweat contains sodium, which water alone does not replace (Table 6.14).
- Sports drinks are not for every occasion. Generally, a sports drink would not be required in activities lasting less than 45 minutes. There may be an exception to high-intensity activity of a lesser time frame. Endurance activities lasting 45 minutes or longer require carbohydrate as a fuel source, and therefore, consuming during the activity would spare glycogen and allow for better performance.

Table 6.14	Warning Signs of Dehydration, Heat Exhaustion, and Heat Stroke: What to Do?
Dehydration with loss of energy and performance	Drink carbohydrate- and electrolyte-containing sports drinks; avoid beverages with carbonation, which can cause gastrointestinal distress.
Dehydration with muscle cramps	Immediately stop exercising and massage the cramping muscle(s); consuming a sports beverage that contains sodium may help relieve the cramp.
Heat exhaustion with dizziness, light-headedness, and cold, clammy skin	Immediately replace fluids while in a cool, shaded area until the dizziness passes; stretching may improve circulation and prevent fainting; lying with the legs elevated will improve blood circulation to the head, thereby alleviating the dizziness.
Heat exhaustion with nausea/headaches	Rest in a cool place until the nausea passes; drinking fluids to rehydrate is critical; lying down may help relieve headaches.
Heat stroke with high body temperature and dry skin	Immediately get out of the heat and seek immediate medical treatment; feeling chilly with arms tingling and with goose bumps means skin circulation has shut down and heat stroke is imminent; this is an extremely serious condition that must be immediately treated.
Heat stroke with confusion or unconsciousness	Confusion strongly suggests, and unconsciousness confirms, heat stroke. This is a medical emergency that calls for fast cooling with ice baths or any other available means to lower body temperature.

Adapted from Casa DJ, Armstrong LE, Hillman SK, et al. National Athletic Trainers' Association position statement: fluid replacement for athletes. *J Athl Train*. 2000;35(2):212–24.

Dietary Supplements and Ergogenic Aids

Dietary supplements are concentrated sources of vitamins, minerals, and energy substrates that are taken to "supplement" the nutrients derived from foods. Ergogenic aids are substances that enhance a person's athletic ability through either improvement in power or enhanced endurance. The terms *dietary supplements* and *ergogenic aids* often are used interchangeably, but they are not the same (Fig. 6.8).

FIGURE 6.8. Dietary supplements and ergogenic aids.

Ergogenic aids are substances that enhance a person's athletic ability through either improvement in power or enhanced endurance.

Dietary Supplements

Dietary supplements may be used in an attempt to promote health or to conveniently intervene in a known dietary deficiency, whereas ergogenic aids are often taken for the sole purpose of improved performance whether or not there is a known deficiency. It is common, for instance, for people with iron deficiency anemia to be prescribed iron supplements to help them complement the iron they are getting from the food they eat and build up their iron stores. The proven effectiveness for many nutritional supplements, in the face of a nutrient deficiency disorder, has been demonstrated in numerous clinical trials. However, there is no evidence in healthy people or athletes that it is useful or warranted to take high doses of dietary supplements in the absence of a known nutrient deficiency. An example of the overuse of dietary supplements is high-dose B vitamins with the belief that more will enhance energy metabolism. Many vitamin supplements marketed for athletes have far greater than 100% of the daily value (DV), and some have 1,000% or more of the DV. In fact, excess nutrients may cause toxicity or, at the very least, create the need to expel the excess nutrients. People wishing to take a nutrient supplement without the diagnosis of a specific nutrient deficiency should limit their intake to multivitamin, multimineral supplements that provide no more than 100% of the DV.

Ergogenic Aids

Ergogenic aids, on the other hand, have typically not been extensively tested for either effectiveness or safety. Quality research studies on many of these compounds are either limited or nonexistent. There is also some concern that up to 20% of ergogenic aids may contain substances that are not listed on the label and are considered banned by the World Anti-Doping Agency and other athletic organizations. Athletes are taking a high risk unless the supplements/ergogenic aids they take have been tested by independent groups (16). There are two ergogenic aids that have been clearly shown to improve a person's capacity to perform better: carbohydrates and water. Other supplements such as caffeine and creatine have been well studied and may have an ergogenic effect in some individuals. There are thousands of supplements on the market, yet the scientific evidence varies tremendously for each product. Some sports supplements have many years of research with some scientific support for their use, whereas others have little to no research but are popular due to clever marketing (Table 6.15). It is important for the Personal Trainer to use a reputable source to research any supplement before communicating this information to clients (2,17). To stay within one's scope of practice, it is best to educate the client with accurate and complete information about the supplement in question and then let the client decide on whether or not to take the product. The following organizations provide information on supplement quality and/or scientific summaries:

- National Institutes of Health Office of Dietary Supplements (https://ods.od.nih.gov/)
- NSF International (https://www.nsf.org/about-nsf)
- NSF International Certified for Sport (https://www.nsfsport.com/news-resources/certified-for-sport-app.php)

- U.S. Pharmacopeia (https://www.usp.org/about)
- Informed-Choice (https://www.informed-choice.org/)
- U.S. Anti-Doping Agency (https://www.usada.org/athletes/substances/supplement-411/)

Table 6.15 Samples of Products Commonly Sold as Ergogenic Aids

Supplement	Facts
Androstenedione	Advertised as useful for increasing muscular strength and size. It is a hormone that is used to synthesize the hormone testosterone. (Testosterone is a male anabolic steroid hormone that is known to aid in the development of muscle mass.) There may be negative side effects (increased body hair and cancer are established problems) similar to those of testosterone, but studies on efficacy and safety have not been published. This substance is banned by many professional sports organizations.
β-Alanine	May act as a buffer for acid–base disturbances in activities relying heavily on anaerobic glycolysis (*e.g.*, high-intensity activities of 60–240 s). Increases skeletal muscle carnosine levels, which acts as an intracellular buffer. May enhance training capacity but also may have side effects of paresthesia (tingling).
Caffeine	Evidence supports its usefulness for improving endurance by reducing the perception of fatigue. It is a central nervous system stimulant but has a reduced dose effect (people adapt to it, so increasingly higher doses are needed to obtain an ergogenic benefit). Lower, yet ergogenic, doses of 3–5 $mg \cdot kg^{-1}$ body weight doses are not associated with increased urine output or dehydration as long a total fluid intake is adequate.
Creatine	Creatine is synthesized from three amino acids and is part of phosphocreatine, which is a fuel used anaerobically to initiate high-intensity activity. However, stored phosphocreatine suffices to support activity for only several seconds and must be resynthesized for use in similar subsequent activities. It is hypothesized that supplemental creatine aids in this resynthesis, and some studies have shown that creatine supplementation is effective in maintaining strength/power for repeated bouts of short-duration, high-intensity activities with short recovery periods. However, creatine supplementation is associated with weight increases (from muscle, water, or both) and gastrointestinal discomfort, but this can be minimized with quality product and recommended dosages.

Ginseng	There are numerous claims for ginseng, ranging from a cure for all ills to improving energy to enhancing immune function. However, it has been difficult to do athletic performance studies with ginseng because concentrations of the active ingredient(s) vary widely within and between brands. Therefore, there is no good evidence to support supplemental ginseng as an ergogenic substance. Luckily, it also appears that ginseng consumption has little risk of producing negative side effects, with the possible exception of causing insomnia in some subjects.
l-Carnitine	This is a substance produced by the body and used to transport fat into cell mitochondria so it can be used as energy. It is theorized that taking carnitine supplements will increase the amount of fat that is moved into mitochondria, thereby increasing the total amount of fat burned and helping reduce body fat levels. There is no solid evidence that supplementary carnitine has this effect.
MCT oil	MCT oil is sold as a substance that can improve muscular development and increase the loss of body fat by increasing metabolic rate. Although there is no evidence of these effects, MCT oil may be an effective means of increasing total caloric intake in athletes with high-energy requirements who are having difficulty meeting energy needs. It is metabolized more like a carbohydrate than a fat but has a higher energy density than carbohydrates. Large intakes may be associated with gastrointestinal disturbances.
Nitrate	Increases plasma nitrate concentration, which leads to increased nitric oxide production. Increased nitric oxide results in vasodilation and reduces the oxygen cost of exercise. May enhance endurance performance in nonelite athletes. High doses from foods (*e.g.*, beetroot juice) or supplements may cause gastrointestinal distress or harmless discoloration of urine.
Pyruvic acid (pyruvate)	Pyruvate is produced from carbohydrates as a result of anaerobic metabolism and is a principal fuel leading into aerobic metabolism. It has been hypothesized, therefore, that supplemental pyruvate will enhance aerobic metabolism and promote fat loss. However, because carbohydrate intake adequately satisfies the entire need for pyruvate, it makes little sense that supplementation of pyruvate will improve performance.
Sodium bicarbonate	May act as a buffer for acid–base disturbances in activities relying heavily on anaerobic glycolysis (*e.g.*, high-intensity activities of 1–7 min). Side effects may include gastrointestinal disturbances.
ω-3 Fatty acids (fish oils, canola oils)	May be useful as an overall part of an anti-inflammatory diet. Research is investigating the role in concussion prevention and treatment in contact sports. Very limited in food sources, and therefore, most individuals do not consume adequate amounts for health.

Special Conditions

There are certain conditions that may require special nutritional attention. These include physical activity in environmental extremes (very hot, humid, cold, or high-altitude environments) and vegetarianism (2,4).

Dehydration risk is high in extremely hot and humid environments because it is difficult to evaporate sweat into an environment that is already hot and humid. Sweat becomes ineffective as a way of dissipating heat, causing a greater volume of sweat to be produced in the body's attempt to control body temperature. As a result, exercise in hot and humid environments greatly increases dehydration and heat illness risk. Specific to young athletes, they typically have fewer sweat glands and can produce less sweat per gland and therefore are likely to be at even greater risk for developing serious heat illness. Regardless, care should be taken that athletes, of any age, remain well hydrated and are frequently checked for signs of heat illness.

Dehydration risk is also high in cold weather environments because there are greater respiratory losses of water, and the clothing worn makes heat dissipation difficult, causing an increase in the sweat production. Athletes in cold weather conditions may not be as aware of the possibility of dehydration as athletes exercising in hot weather environments, making it necessary to remind them of the importance of drinking fluids in frequent intervals. High-altitude environments also tend to be cold environments, but they carry the additional problem of causing diuresis as well, particularly at altitudes greater than 2,500 m. It has been estimated that a total of 3–4 L of fluid per day would be required to maintain normal hydration in athletes who are exercising at high altitude.

Vegetarian athletes are perfectly capable of satisfying their nutritional requirements, but they should do so with the knowledge that it is more difficult to obtain satisfactory levels of, in particular, calcium, iron, zinc, protein, vitamin B_{12}, and energy. The more liberal the vegetarian intake (*e.g.*, ovo-vegetarians who consume eggs, or lacto-ovo-vegetarians who consume eggs and dairy products), the easier it is to satisfy total energy and nutrient needs. Vegetarian athletes should make certain that their intakes fully satisfy their needs either by consulting an RDN, by requesting that their physician periodically perform blood tests to determine whether at-risk nutrients are at satisfactory levels, by periodically doing a food intake assessment of nutrients consumed, or through a combination of these (2).

Practical Considerations

One Day before a Competition

Although athletes often focus on the food consumed immediately before competition, it is actually important to start preparing in advance. Suggested considerations for the day prior to competition include the following:

- Avoid high-fat foods such as fried food, chips, cake, and chocolate.
- Eat a good breakfast (*e.g.*, toast, oatmeal, cereal, milk, and fruit).
- Have sandwiches, rolls, pasta, or rice for lunch (Fig. 6.9).
- Have rice, pasta, noodles, or potatoes plus vegetables and lean meat, chicken, or fish for dinner and yogurt and fruit for dessert.
- Eat a high-carbohydrate, low-fiber snack at dinner.
- Drink an extra 16 oz (475 mL) of fluid throughout the day.

FIGURE 6.9. One day before competition, athletes should focus on foods that are relatively high in carbohydrate and relatively low in fat. Foods should be consumed in small, frequent meals rather than a single large meal.

Immediately before Exercise or Competition

The preexercise meal should focus on providing carbohydrates and fluids. Ideally, people should consume a high-carbohydrate, moderate-protein, low-fat meal 3–4 hours before exercising or competition. For a 55-kg endurance athlete, this could include a large bowl of spaghetti with a few ounces of chicken or a peanut butter sandwich and large sports drink. Light-carbohydrate snacks (*e.g.*, crackers) and carbohydrate-containing beverages can be consumed after the meal and before exercise, provided that large amounts are not consumed at one time (Fig. 6.10). Carbohydrate intake associated with performance enhancement ranges from 1 to 4 $g \cdot kg^{-1}$, with timing, amount, and food choices suited to the individual, consumed 1–4 hours prior to exercise (2). There are several goals for the preexercise meal, including the following (4):

- Making certain that athletes obtain sufficient energy to see them through as much of the exercise bout as possible
- Preventing feelings of hunger (Hungry people may be letting blood sugar get low, which is not a good way to start an exercise bout.)
- Consuming enough fluids to begin exercise in a fully hydrated state
- Consuming only familiar foods to avoid gastrointestinal distress
- Avoiding foods high in fiber or foods that cause gas (*e.g.*, broccoli, cauliflower)
- Drinking 5–10 $mL \cdot kg^{-1}$ of body weight (2–4 $mL \cdot lb^{-1}$) of water or sports beverage at least 4 hours before practice or competition

FIGURE 6.10. Immediately before exercise or competition, an athlete sipping on sports beverage.

During Exercise or Competition

Depending on the nature and duration of the exercise, consumption of carbohydrates may or may not have a significant impact on performance. During very brief exercise (<45 min), consumption of carbohydrates is not needed. However, with more sustained and higher intensity exercise (45–75 min), small amounts of carbohydrates, including utilizing a mouth rinse technique, are beneficial to performance. Evidence suggests that frequent contact of carbohydrate with the mouth can stimulate the brain and central nervous system to enhance perceptions of well-being leading to performance enhancements (18). For long-duration activities (1–2.5 h) that allow for consumption of solid foods (*e.g.*, cycling, cross-country skiing), some people prefer to periodically consume bananas, breads, and other easy-to-digest carbohydrate foods. If solid foods are consumed, there should still be ample consumption of carbohydrate-containing beverages (Fig. 6.11). The carbohydrate target should be approximately 30–60 $g \cdot h^{-1}$. For anything over 2.5 hours in duration (*e.g.*, ultraendurance exercise), a carbohydrate target of up to 90 $g \cdot h^{-1}$ is recommended (19,20). Drink 28–40 oz of fluid (sports beverages containing a 6%–8% carbohydrate solution and electrolytes are preferred) per hour. Sports drinks are recommended because they are palatable and contain multiple forms of carbohydrate that maximizes absorption in the gut. This corresponds to about 7–10 oz (200–300 mL) every 10–15 minutes, but this amount may need to be adjusted on the basis of body size, sweat rate, exercise intensity, and environmental conditions (Box 6.3) (2). This level of intake has been shown to improve time to fatigue in endurance activities. Two main goals are to avoid dehydration and to avoid the mental and muscular fatigue that can be caused by inadequate carbohydrate (4).

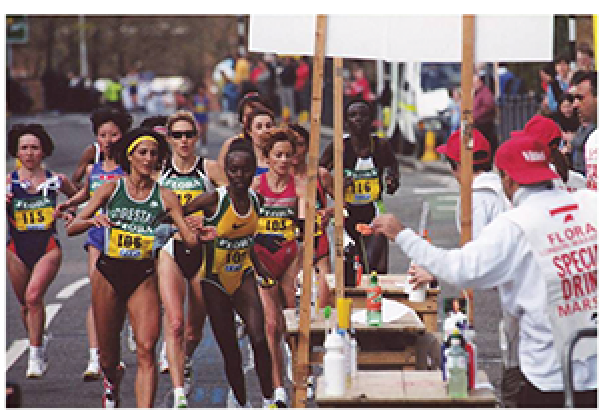

FIGURE 6.11. During competition, athletes grabbing drinks at fluid station during a race (marathon).

Box 6.3 Practical Suggestion for Assessing Fluid Intake during Exercise

Weigh an athlete before and after exercise. Weight loss indicates a less-than-optimal hydration state. Approximately 1 pint (about 600 mL) of fluid should be consumed for each pound (0.45 kg) of body weight lost during exercise.

After Exercise or Competition

When and what is consumed following exercise depends on the time and intensity of the exercise session. Consuming 1.0–1.2 g carbohydrate per kilogram during the first 4–6 hours after completion of exercise is associated with enhanced muscle glycogen recovery (2). Muscles are receptive to replacing stored glycogen following exercise because of a higher level of the enzyme (glycogen synthetase) that can enhance the conversion of carbohydrate to stored glycogen. This strategy amounts to consuming carbohydrates between 200 and 400 kcal immediately following activity and then an additional 200–300 kcal within the next several hours (Fig. 6.12). People who have difficulty eating foods immediately following exhaustive exercise should try high-carbohydrate liquid supplements (4). Some examples of high-carbohydrate foods are included in Tables 6.3 and 6.4.

FIGURE 6.12. Rehydrating and eating an energy bar after exercise.

After exercise, people should drink 125%–150% of fluid lost during activity. This is approximately 1.25–1.5 L of fluid for each kilogram of body weight lost (2). This should be consumed within 2 hours of finishing the practice or competition, with the goal of returning body weight to near-preexercise weight before the next exercise bout.

Eating on the Road

Although it may take a little more effort to maintain a proper diet while traveling, it is well worth the effort. If competition is close to the travel days, choosing foods low in fiber would be recommended. These suggestions should help your clients maintain a diet that will keep up their level (21).

1. Pack nutrient-dense foods. Examples include sports bars, dried fruits, granola bars, bagels, and canned tuna.
2. Pick up some basic foods once you arrive at your destination. Examples include fresh fruits and vegetables if there is adequate time for digestion before competition, applesauce, cheese, breads, soups, and instant oatmeal packets.
3. If eating out, order lower fat items or items listed as “healthier” options from the menu. The following are some general guidelines.

Breakfast

- Order pancakes, toast, low-fiber cereal, and juices.
- Request toast, pancakes, etc., be served with small amount of healthy fat such as avocado or nuts to keep a higher carbohydrate to healthy fat ratio.
- Choose low-fat dairy products (*e.g.*, skim or 1% milk, low-fat yogurt, low-fat cheese).
- Cold cereal can be a good breakfast or snack that can be taken with you. Choose low-fiber options to minimize digestive stress.

Lunch

- On sandwiches, look for lower fat meats such as turkey and chicken. Request it without the spread (*e.g.*, mayo, special sauce) or with small amounts of healthy fat such as avocado or hummus.
- Choose foods that are broiled, baked, microwaved, steamed, or boiled rather than fried.
- Salad bars are good options, but avoid the high-fat additions such as olives, fried croutons, nuts, and seeds.
- Baked potatoes, which are high in carbohydrates, are also good options but ordered with butter and sauces "on the side." For additional flavor, choose vegetables, beans, and small portions of cheese as a topping.
- Soups and crackers can be good low-fat meals; stay away from cream soups.
- Juices and low-fat milk are a more nutritious choice than soda pop.

Dinner

- Order high-carbohydrate foods such as pasta with tomato sauce, baked potatoes, rice, breads, vegetables, salad bars, and fruits.
- Eat thin crust pizzas with low-fat toppings such as green peppers, mushrooms, Canadian bacon, and onions. Avoid fatty buttered or stuffed crusts, meats such as pepperoni or sausage, extra cheese, and olives.
- Eat breads without butter or margarine. For additional flavor, choose small portions of avocado or hummus as a spread. Ask for salads with

dressing “on the side” so that you can add minimal amounts yourself. Ask for low-fat salad dressings.

Snacks

Have snacks such as whole-grain breads, bagels, tortillas, fruit, fruit breads, low-fat crackers, pretzels, unbuttered popcorn, fruit and nut bars, fig bars, animal crackers, fruit juice, carrot sticks, cherry tomatoes, breakfast cereal, canned liquid meals, and dried and fresh fruits.

Don’t Forget about Fluids

To prevent dehydration, you should keep well hydrated at all times, even on the road, by drinking frequently before, during, and after exercise. Drink plenty of water, even when ordering other beverages. Consider bringing a water bottle or squeeze bottle that can be refilled at a water fountain. In addition, limit caffeinated or alcoholic beverages as these are diuretics and cause fluid loss.

Understanding a Food Label (from the U.S. Food and Drug Administration, Center for Food Safety and Applied Nutrition)

Food labels can help you understand the nutritional content of a food by serving size. Each food label contains basic information on food components, such as kilocalories per serving, total fat, saturated fat, trans fat, cholesterol, sodium, carbohydrate, and protein, and also has information on nutrients that people generally have inadequate intake of, such as dietary fiber, vitamin D, calcium, iron, and potassium (22).

Each food label contains basic information on food components, such as kilocalories per serving, total fat, saturated fat, trans fat, cholesterol, sodium, carbohydrate, and protein, and also has information on nutrients that people generally have inadequate intake of, such as dietary fiber, vitamin D, calcium, iron, and potassium.

Serving Size

The serving size listed is different for each type of food to make it easier for people to understand. A typical serving size is in familiar serving size units, such as cups or pieces, and also includes the weight of the serving size in grams. In the example given here (Fig. 6.13), the serving size is 2/3 cup, which for this food has a weight of 55 g. You can also see that the label indicates that there are eight servings in the container.

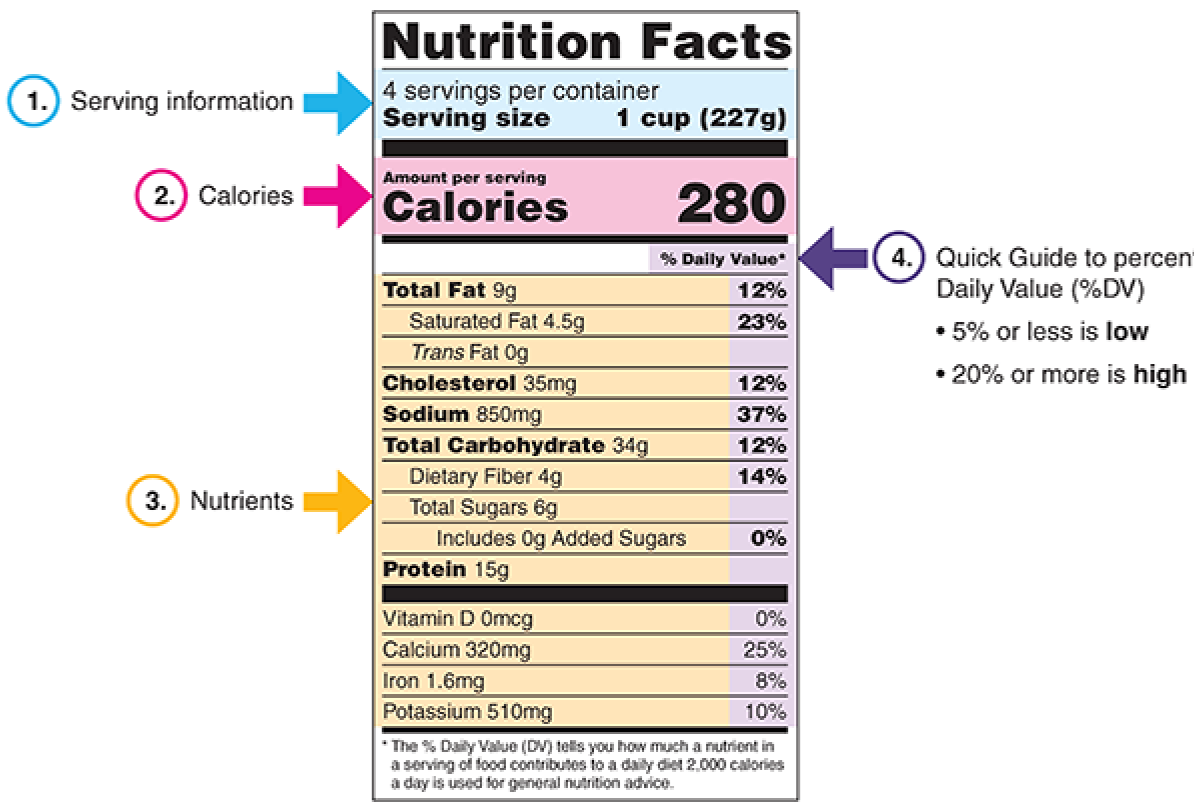

FIGURE 6.13. The food label (for more information on how to read a food label, visit the following Web site: https://www.fda.gov/food/food-labeling-nutrition).

Calories

The unit of measure for energy in a food is “calories” or “kilocalories.” This value is near the top of the “Nutrition Facts” panel and is expresses as amount per serving of the item. This number is listed in large, bold print.

Percentage of Daily Value

Each of the nutrients on a label has a recommended DV. A DV of 100% represents the recommended upper limit for total fat, saturated fat, cholesterol, and sodium, whereas 100% of total carbohydrate and dietary fiber represents the recommended minimum intake ($28\ g \cdot d^{-1}$ of fiber is the minimum). However, note that the DV is based on percentage of a nutrient that would be delivered with a 2,000-kcal diet. Many people, particularly those who are physically active, consume diets that are much higher than 2,000 kcal. Therefore, the percentage of DV must be considered in the context of the total calories consumed. Typically, 5% DV or less is considered low and 20% DV or more is considered high. Using the label in Figure 6.13, consuming one serving of this food would provide 10% of the DV for fat, which is OK. However, if a person were to consume the entire package content, which has eight servings, it would translate to 64 g of fat which is almost 100% of the DV and considered very high for a single food. Put simply, a high percentage of DV for fat means that the other foods consumed on the same day should be much lower in fat to avoid exceeding a percentage of DV of 100% for fat. The easiest way to use the percentage of DV is to compare foods that are similar in order to see which foods have the lowest fat content or the highest nutrient content.

The percentage of DV can be used to determine the relative content of the nutrients listed on the label. A percentage of DV of 20% or better for the micronutrients would imply that it is an excellent source of the nutrient. For food substances that do not have a percentage of DV, such as trans fats and sugar, use the label to compare similar products when making a purchasing decision for similar products. In general, try to avoid foods that contain trans fats and limit the intake of sugars.

Frequently Asked Nutrition Questions

Should I Take Protein Supplements?

Protein supplements are popular in most sports, at most athletic levels — from beginners to elite athletes — regardless of the goals of the people taking them. Some people take protein supplements to lose weight, some to gain weight, some to gain muscle, some to make them stronger, and some to increase endurance. Although daily protein needs can be met from food sources, protein supplements offer a level of convenience for portability and ease of consumption. The daily protein requirement for athletes is 1.2–2.0 g of protein per kilogram of body weight (2). This range is chosen as the current guideline because for most people, consuming above 2.0 $g \cdot kg^{-1}$ does not result in further increases in skeletal muscle protein synthesis. Neither of the latter two options is particularly good because people rarely wish to put on additional fat weight, and getting rid of excess nitrogenous waste can lead to extra fluid loss.

What about Creatine?

Creatine monohydrate supplements have been shown to help enhance maximum isokinetic strength and improve acute performance in both single and repeated bouts of high-intensity activity lasting less than 150 seconds. The ergogenic effects are most noticeable on those activities lasting less than 30 seconds. It may enhance performance by enhancing capacity for training, resulting in greater gains in skeletal muscle synthesis, strength, and power. However, creatine use may result in acute body weight gain of 1–2 kg or potentially gastrointestinal distress. If using creatine, the general protocol for ingestion includes an initial loading phase of approximately 20 $g \cdot d^{-1}$ for 5–7 days followed by a maintenance phase of 3–5 $g \cdot d^{-1}$ for the training period (2,17).

Should I Consume Sports Drinks or Does Water Work Just as Well?

Sports drinks contain carbohydrate and electrolytes that are useful in maintaining water and energy balance. Studies of endurance athletes, athletes in stop-and-go sports, and athletes in power sports all show that consumption of sports drinks during practice and competition does a better job of enhancing athletic performance than water alone. It should be noted that small amounts are beneficial in high-intensity endurance activities lasting 45–75 minutes. Larger quantities translating to ingestion of 30–60 g of carbohydrate per hour are recommended for endurance activities lasting 1–2.5 hours and up to 90 $g \cdot h^{-1}$ in activities longer than this (2).

Should I Stay Away from Caffeinated Beverages before a Workout?

Caffeine ingestion has been shown to be effective in enhancing performance of longer bouts of endurance as well as short-term, high-intensity activities and tasks requiring repeated sprints. People adapt to caffeine, so if you are accustomed to having a cup of coffee or a caffeine-containing cola, there should be no problem with consuming it before a workout, and it may confer an ergogenic benefit. You should never increase the consumption of a caffeinated food or beverage before exercise above a level to which you are accustomed. This could result in undesirable side effects such as tremor, anxiety, and increased heart rate (2). If caffeine is used as an ergogenic aid, the general recommended amount is 3–6 mg of caffeine per kilogram body weight taken an hour before activity (17).

Should I Skip Lunch if I'm Trying to Lower My Body Fat Level?

Lowering body fat healthfully in an athlete requires a delicate balance of fueling to maximize sports performance while creating enough of an energy deficit to promote slow fat loss. Skipping meals can lead to inappropriate substrates for training and then overall training volume may be lowered. It is recommended, if an athlete needs to lose body fat, that this be done during the off season or early precompetition phase. If this is not possible, timing strategies for food must still be followed.

Will a High-Protein, Low-Carbohydrate Diet Help Me Lose Weight?

Current scientific evidence does not support a low-carbohydrate intake for improving exercise performance. On the contrary, inadequate carbohydrate intake is almost always associated with reduced performance. High-protein, low-carbohydrate diets are typically low-calorie diets — the reason for the weight loss. However, dramatic reductions in caloric intake almost always result in a rebounding of weight when normal eating patterns resume. The best strategy for weight loss is to consume a little less than is currently needed to maintain current weight (say, about 300–400 kcal $\cdot$ d^{-1} less) and to eat small, frequent meals balanced with protein throughout the day to maintain blood sugar levels.

Should I Eat or Drink Anything during Exercise?

Maintaining a constant flow of carbohydrates to muscles and maintaining blood sugar during competition is an important strategy for success, especially in activities lasting an hour or more. Clients should consider sipping on a sports beverage during competition to achieve this result. If there are long breaks during an exercise workout, then consuming a carbohydrate snack (*e.g.*, crackers, bread) might be acceptable provided that fluid is also consumed.

I'm a Profuse Sweater and Occasionally Get Serious Cramps. Is There Anything I Should Be Doing to Avoid This Problem?

One cause of cramps are typically associated with dehydration and sodium loss. Try making certain that sufficient sodium-containing fluids (*e.g.*, sports beverages) are consumed during practice and competition as well as before an exercise bout or training session. Unless you have a history of high blood pressure, you should also consider adding a small amount of salt to the food you eat, following with plenty of water.

How Can I Tell if I'm Dehydrated?

The easiest way to tell is that your urine will be dark, and there won't be very much of it. Light-colored or clear urine is a sign of adequate hydration, whereas dark urine suggests dehydration. It takes time to rehydrate, so avoiding dehydration is the appropriate strategy.

SUMMARY

This important chapter on nutrition is not intended to have the Personal Trainer replace an RDN. There are laws in most states and around the world that protect this important discipline. The intent of this chapter is to make the Personal Trainer aware of certain nutrition-related questions that may come up in a typical training session. The Personal Trainer should be aware of the extent of information that can be distributed to clients and when it might be necessary to refer the client to an RDN. Personal Trainers should talk about nutrition because it plays such an important role in health and performance. However, they should limit nutrition discussion to include general, nonmedical nutrition information. This includes the basic roles of nutrients in the body and items published in public health guidelines. A key point if communicating general nutrient guidelines is that these are designed for health individuals. Any time a client has a disease or nutrition-related condition, this requires medical nutrition therapy and that client needs to be referred to an RDN.

In general when discussing nutrition for athletes or active individuals, Personal Trainers should be aware that athletes or active individuals have higher needs for fluids, energy, and, therefore, macronutrients. Personal Trainers should be aware of the general sports nutrition guidelines established by the Academy of Nutrition and Dietetics and the ACSM as referenced in this chapter. Sports nutrition information given outside of these general guidelines or to an athlete with a disease or medical condition should be delivered by a CSSD.

Both disciplines are encouraged to work together when a client has nutrition-related questions and is in need of a special diet for a medical condition or for a balanced weight loss program. Equally important is for the RDN to understand the scope of practice for Personal Trainers. A team approach with the Personal Trainer prescribing exercise and the RDN prescribing nutritional strategies is the recommended method to treating a client with nutrition issues.

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PART

III

Behavior Modification

CHAPTER 7

Theories of Behavior Change

OBJECTIVES

Personal Trainers should be able to:

- List reasons why it is important to use theory to guide behavior change.
- Describe ways to use theories of behavior change to develop programs addressing a variety of lifestyle changes.
- Explain the role that self-efficacy, self-monitoring, goal setting, and feedback play in behavior change.
- Describe the main ideas, important tools, strengths, and limitations of theories discussed in this chapter.
- Discuss and design tailored interventions for clients using relevant elements of theory.

INTRODUCTION

Although most Personal Trainers would be immediately encouraged by Joan's eagerness to begin and her insight into her own situation, working with this client will be challenging (Case Study 7.1). Several factors about Joan's case are characteristic of many clients who seek professional assistance with behavior change, particularly for weight management. First, Joan has slowly gained weight over the years and is currently classified as obese (1). She has high cholesterol, and because of her weight and family history, she is at an increased risk for Type 2 diabetes. Second, Joan has made numerous attempts to lose weight on her own without long-term success. She has been able to lose weight but not maintain weight loss, which is a common result for many working adults. She also has high expectations about the amount of weight to be lost within her self-imposed time frame. Finally, the demands of being a nurse and the irregularity of her work schedule impose additional barriers to adopting a consistent routine. How can a Personal Trainer help Joan achieve sustainable behavior change that will result in maintained weight loss and improvements in health? The theories presented in this chapter will help Personal Trainers assess and understand client assets and barriers, and they can guide the development of personalized plans to help them sustain their efforts on the long term.

Case Study 7.1

Reunion Weight Worries: Joan is a 43-year-old nurse and mother of two children, ages 19 and 21 years. A friend of hers recommended that she hire a Personal Trainer. Joan reports that she was never overweight when growing up, although her sister was "heavy-set" as far back as she can remember. Joan recalls that she had trouble losing the baby weight that she gained during her first pregnancy and that she has been gaining weight a little at a time over the years.

Last year, Joan attended her twenty-fifth high school reunion and felt ashamed by her weight, after which she vowed to herself that she would become healthier. Over the last year, she has tried several different diets on her own, all without lasting success. Even though she was able to lose 10–15 lb with each new dieting attempt, she has been unable to stick to her plans for longer term and thus could not keep the weight off. She reports that she enjoys exercise but that she often finds herself eating more on days when she works out and eventually loses the motivation and energy to find time in her chaotic schedule to get to the gym. After gaining back the weight from her last diet, Joan realized it was time to seek professional intervention.

Currently, Joan has high cholesterol and is concerned about a family history of Type 2 diabetes. Her current body mass index (BMI) is 31 kg $\cdot$ m^{-2} (height = 65 in; weight = 185 lb). Her self-stated goal is to lose 25 lb before her son's wedding, 2 months from tomorrow. Joan is eager to get started, and you immediately appreciate her enthusiasm, motivation, and insight.

QUESTIONS FOR CONSIDERATION

What else would you want to know about Joan? Knowing that she has tried and failed previously, what could you learn about these previous attempts that might help sustain future efforts?

The Challenge of Behavior Change

Changing behavior is challenging because so many factors play an important role — readiness for change; motivation; ability; perceived self-efficacy; and even situational factors such as scheduling, convenience, or peer influence. In addition, behaviors that have become a habit can be reinforced or discontinued due to environmental factors or policies related to physical activity (2). To make matters more complex, researchers have yet to reach a consensus regarding the way that all of these factors interact to produce behavior or behavior change. In sum, psychology is not like mathematics — the formula for one client's motivation and behavior may not be the same as for the next client. However, theories of behavior change can provide a blueprint for change. This chapter provides a description of the most prominent behavior-change theories as well as possible applications of these theories for Personal Trainers.

Changing behavior is challenging because so many factors play an important role — readiness for change; motivation; ability; perceived self-efficacy; and even situational factors such as scheduling, convenience, or peer influence.

Due to the significant health implications of overweight and obesity (3), weight management interventions that target dietary behavior and physical activity have been the focus of much research (Box 7.1). These interventions vary by modality (*i.e.*, telephone, Internet, in person), setting (*i.e.*, workplace, clinic, health center, physician, church), format (*i.e.*, individual, group), and regimen (*i.e.*, recommended dietary restriction and energy expenditure). Findings offer support for these various interventions as a successful means of helping participants attain improvements in dietary behavior and physical activity in the short term (10). Traditional behavioral weight loss programs, which encourage reduced caloric intake accompanied by increased caloric expenditure, typically result in a loss of 10% of initial body weight (11). Unfortunately, long-term findings suggest that participants who successfully complete behavioral weight management programs will gain two-thirds of their weight back within the first year following completion and almost all of it before 5-year follow-up (12). These findings indicate that even when participants are successful in initial behavior change, they may be unable to maintain changes after intervention.

Box 7.1 Did You Know?

- Learning how to use theory will help you interact with your clients more effectively and thus help them stick with their exercise goals.
- There is evidence that using a theory-based intervention significantly affects physical activity behavior (4).
- Help clients to set effective goals and monitor their own behavior and then give them timely feedback — these are proven strategies for success (5–9).

Although few studies have examined the maintenance of health behaviors independent of weight outcomes, Fjeldsoe and colleagues (10) reviewed studies of behavior change that included at least a 3-month-after assessment. Interventions included in the review targeted diet, physical activity, or both. Of the interventions included, 90% demonstrated differences in treatment and control groups at the end of the intervention. At the follow-up assessment (3 or more mo postintervention), 38% maintained differences between groups on all outcomes and 72% maintained differences by group on at least one outcome. Results such as these support the notion that although interventions have been successfully developed to result in initial health behavior change, behavior-change maintenance may be a more challenging feat. As an example, the behaviors needed to lose weight for most clients will be different from the behaviors needed to maintain that weight loss. Thus, the following question remains: How can behavior-change interventions be improved to provide long-term success?

There is currently an overabundance of available interventions targeted at individuals trying to lose weight. Although it is important to remember that every individual is unique and may require different intervention components in order to succeed, using data- or evidence-based research to inform treatment provides insight into which intervention components are most consistently associated with successful behavior change. Personal Trainers and other health providers should refer to current literature to determine which interventions are validated and thus most likely to be effective for a given client (see Box 7.2 for commonly used terms).

Box 7.2 Definition of Terms

Construct: An abstract variable that serves to explain a concept or acts as a link to explain the observed relations between independent and dependent variables.

Control and treatment groups: A control group is a group or condition with which the effects of the experimental procedure or test condition are to be compared. The treatment group, or experimental group, is a group or condition in which the subjects are assigned the experimental treatment (*e.g.*, they undergo an intervention). It is important to include both a control and a treatment group in experimental studies to ensure that the effect of the treatment was genuine and not because of a placebo effect.

Empirical: Information obtained from observation or measurement using experimentation.

Intervention: An intervention is action taken or a treatment program developed to help someone change his or her behavior. For example, physical activity interventions attempt to offer programming and information that will help participants increase their physical activity.

Mediator: A mediator is a condition, state, or other factor that is presumed to intervene between the independent variable and the outcome. In other words, a mediator is some event or manipulation that has to happen in order for behavior to change. For example, in physical activity promotion, goal setting may be a mediator that is taught as a part of an intervention to facilitate behavior change.

Meta-analysis: A meta-analysis summarizes the results of several similar studies by combining results to generate an overall effect size. The effect size examines the strength of the effect of X on Y.

Moderator: A moderator is a condition or variable (*e.g.*, age, gender) that alters or changes the relationship between X and Y by affecting the strength or direction of the results of an intervention. A statistical adjustment (*i.e.*, covariate) can be identified to minimize the impact of the moderator on a statistical analysis.

Randomization: Randomization, or random assignment, is the random allocation of sampling units (*e.g.*, participants) to conditions. This technique is considered the gold standard for designing experimental studies. If participants are randomly assigned, it is more likely that the results are due to the treatment and not because a biased sample was used.

Wait-list control group: A control group in which the subjects wait to receive the experimental treatment until after it has been administered to and found effective in the experimental group. This group serves as a control group for a period of time comparable to the experimental period. Once the experimental group is finished, this wait-list control group receives the intervention.

Source: Rosenthal R, Rosnow RL. *Essentials of Behavioral Research: Methods and Data Analysis*. 3rd ed. New York (NY): McGraw-Hill; 2008. 848 p.

Why Is Theory Important?

Imagine that an exercise intervention for a client proves to be successful in helping the client reach her goals. This intervention includes a number of different techniques, including goal setting, daily positive affirmations, problem solving, and a financial incentive. Because this intervention was so successful, it will be utilized again; however, can the most effective techniques from this intervention be specifically identified? Which techniques did not help to improve behavior? How did these techniques help the client? Did certain techniques succeed in altering specific behaviors? Should this intervention help all clients or certain subpopulations of clients? Thus, a well-developed theory provides a foundation to understand how individual factors within an intervention influence behavior (13). These theories of behavior change help to make interactions with clients more efficient and consistent because good theories inform practice. If an intervention can be replicated many times with successful results across many populations and settings, then the intervention is said to be generalizable and to have strong empirical support.

Importantly, researchers have helped to identify that theory-driven interventions are, in fact, more effective than those that are not, even if they appear to function on the same principles. Consider two strong examples. In one study, researchers completed a randomized experimental trial that compared two walking programs with different levels of theoretical fidelity. Theoretical fidelity is defined as "the level of precision in replicating theory-based recommendations" (14). In other words, the high-fidelity group followed theory, whereas the other group utilized the same techniques but did not use theory to guide the procedures. In this 1-year-long study, the high-fidelity group improved their mile times twice as much as the low-fidelity group on the 1-mile walk test, reported greater satisfaction with the program, achieved their goals more often, and had more positive expectations.

Another example directly related to Personal Training was a study that assessed 59 men and women who were overweight or obese and wanted to lose weight (15). Participants were randomized to one of three groups for 16 weeks: (a) Personal Training 2 days a week plus a 20-minute weekly educational meeting with a nutritionist who utilized an educational behavior-change program from the U.S. Department of Agriculture, (b) Personal Training 2 days a week plus a weekly 20-minute theory-driven behavior-change meeting with a lifestyle coach, or (c) a wait-list control group. Results at the 4-month mark showed that compared with the wait-list control group (who gained weight), the participants who received the theory-driven intervention lost over 4 times as much weight as the educational behavior-change group — and they kept it off at the 3-month follow-up visit (month 7; Fig. 7.1). Submaximal fitness and strength testing confirmed that both groups exhibited exactly the same improvements in strength and aerobic fitness across treatment. Results from this study made it clear that if weight loss and maintenance are goals of a behavior-change program, using theory to plan and implement an intervention is more effective than simply providing education.

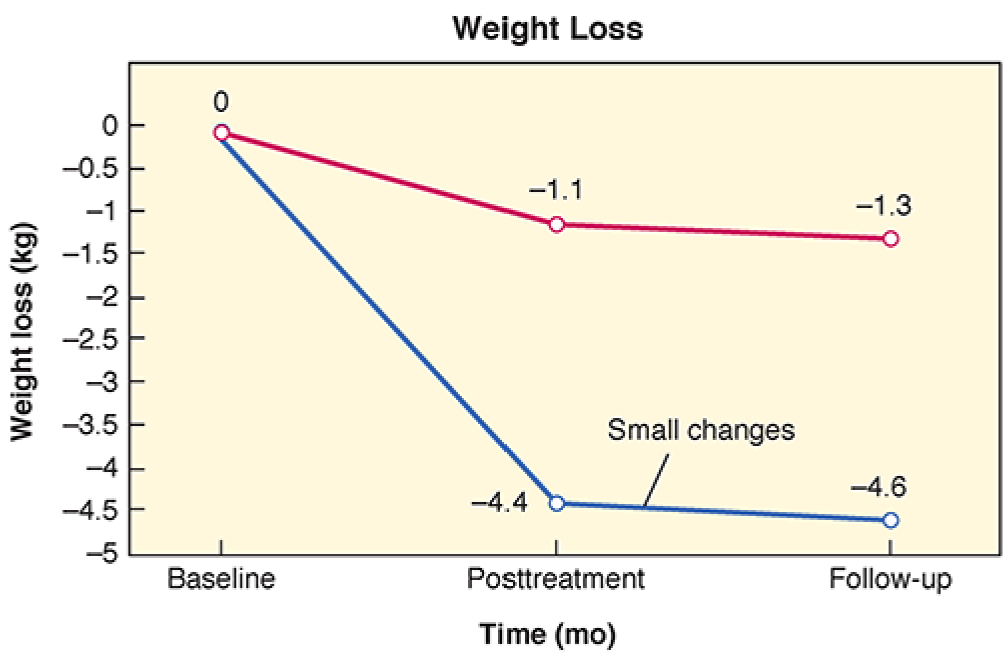

FIGURE 7.1. Weight change between two Personal Training programs with or without theory. (From Lutes LD, Winett RA, Barger SD, et al. Small changes in nutrition and physical activity promotes weight loss and maintenance: 3-month evidence from the ASPIRE randomized trial. *Ann Behav Med*. 2008;35:351–7, with permission.)

Finally, theory allows us to better understand what is known and what is yet to be learned. The systematic testing of theory allows for identification of new behavior-change constructs and replacement of elements of an intervention that are not as effective. Ultimately, theories are made to evolve and can be constantly improved. Rival theories may provide evidence for alternatives to an approach that can lead to more significant behavior change (16). In the rest of the chapter, several popular theories currently identified in the physical activity literature are explained. Most of these theories assume that humans are goal oriented and make rational decisions about their health behavior, and all of the theories integrate multiple concepts to predict physical activity behavior. One preliminary point about theories is still worth making before we take you down the theory rabbit hole, however. No matter which theory (or theories) you choose to ground your work, the trusting relationship you form with clients is still the foundation for all of your practice (14). The idea, then, is to use theories to build questions and assessment techniques that let you capture more about a person than his or her health history and fitness levels. The models presented in this chapter will help you build that framework and help make your work with clients more efficient and effective.

Theory allows us to better understand what is known and what is yet to be learned. The systematic testing of theory allows for identification of new behavior-change constructs and replacement of elements of an intervention that are not as effective.

The Transtheoretical Model

The first of the theories explained here is the transtheoretical model (TTM; also known as the stages of change model) as it relates to physical activity behavior (17,18). The TTM, first used to examine smoking cessation, is an integrative model that was developed using constructs from other known theories such as the social learning theory and the social cognitive theory (SCT) (which is presented later in this chapter). Various researchers have adapted the model to address physical activity behavior.

The TTM states that individuals' behaviors are based on their readiness or stage of change. Figure 7.2 presents the five stages of change. As a Personal Trainer, you have probably noticed that each of your clients may be at various degrees of readiness to change and that this tends to predict his or her ability to change. If this is the case, then you already understand part of the foundation of the TTM.

1. *Precontemplation*: The client has no intention to take action toward change and sees little benefit of change at this time.

2. *Contemplation*: The client sees the possible benefits of change and negative consequences of his or her behavior and is considering changes within the next 6 months.
3. *Preparation*: The client has developed a plan of action toward behavior change and intends to make changes in the immediate future (next 30 d).
4. *Action*: The client is actively making behavior changes (regularly active for less than 6 mo).
5. *Maintenance*: The client has been actively maintaining the changes made during the action stage, the new behaviors have been established for 6 months or more, and the client is now working to prevent relapse.

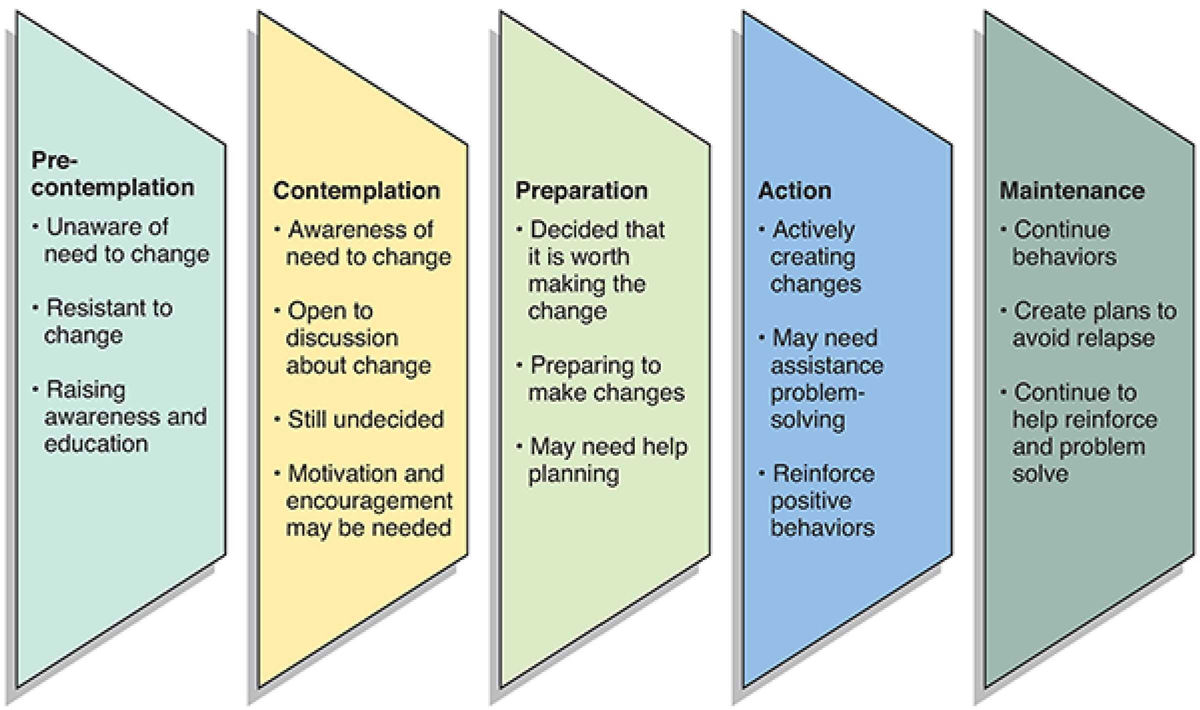

FIGURE 7.2. The stages of change from the transtheoretical model.

Although it is useful to identify a client's stage of change, the model is most helpful at identifying the specific processes (or tasks) of change that will help clients progress to the next stage. Typically, the cognitive processes are applied in the earlier stages of change, and the behavioral processes are applied in the later stages of change. Examples of cognitive processes of change, which are effectively used in the precontemplation, contemplation, and preparation stages include increasing awareness about the problems related to sedentary behavior (consciousness raising), assessing how being active or inactive affects a person's life (environmental reevaluation), evaluating oneself as an active person or couch potato (self-reevaluation), or helping clients identify moments of emotion related to physical activity (dramatic relief; see Case Study 7.2 for an example). It is worth noting that by the time a client has reached the point of reaching out to a Personal Trainer, they are at least in the preparation phase, if not already in the action phase, and therefore may differ substantially from the general population.

Case Study 7.2

Helping John Identify a Moment of Dramatic Relief: John, a 70-year-old widower, has been really busy lately volunteering at the local senior center and food pantry in his community. These commitments are starting to affect his motivation for exercise. He manages his hypertension with medication, but his energy levels lately have been low. His doctor recently suggested he walk more regularly. For a few months last year, he started to walk 1–2 days a week, but he never really got into a consistent pattern. He had a recent situation where his granddaughter wanted him to play outside with her and he kept feeling overheated and out of breath. His weight and lack of fitness played a role in his ability to play with his granddaughter.

QUESTIONS FOR CONSIDERATION

What questions could you ask John to help him identify a moment of dramatic relief? Can you think of things you could discuss that would help him reidentify his priorities, build the motivation necessary to be successful, and get his exercise program back on track?

Examples of behavioral processes of change which are most effectively used in the action and maintenance stages include removing cues for sedentary behavior (stimulus control), finding support for active behaviors (helping relationships), and reinforcing positive behaviors (reinforcement management). Some examples for using the processes of change tools with the stages of change are provided in Table 7.1.

Table 7.1 Strategies for Combining Stages of Change and Processes of Change

Processes of Change	Appropriate Stage for Use
Cognitive Strategies	
Consciousness raising (increasing awareness)	Precontemplation, contemplation, preparation
Dramatic relief (understanding emotions)	Precontemplation, contemplation, preparation
Environmental reevaluation (aware of impact on others)	Precontemplation, contemplation, preparation
Self-reevaluation (creating a new self-image)	Precontemplation, contemplation, preparation
Social liberation processes (support from others)	Precontemplation, contemplation, preparation
Behavioral Strategies	
Self-liberation (make a commitment to self)	Preparation, action, maintenance
Counter conditioning (using substitutes)	Preparation, action, maintenance
Helping relationships (finding support, trust, acceptance)	Action, maintenance
Reinforcement management (using rewards)	Action, maintenance
Stimulus control (managing the environment positively)	Action, maintenance

As clients move through the stages of change, as they develop different perspectives on behavior, and as they build change-related skills and experiences, their self-efficacy increases. Self-efficacy refers to the client's belief in his or her ability to succeed in a specific task and is an important component of behavior-change success.

Along with self-efficacy, another core concept in the TTM is "decisional balance" where clients assess the importance of the "pros" and "cons" of behavior change and work through any ambiguity (Case Study 7.3). This technique is designed to reinforce the reasons why behavior change is important while recognizing, appreciating, and ultimately working through the challenges that the client faces. It is important to give adequate time and respect to the challenges, or “cons” of behavior change; after all, increasing physical activity is difficult, and the client will appreciate that the trainer recognizes real challenges instead of downplaying them. Taking this proactive approach will help your clients build self-regulation skills so they can prevent relapse.

Case Study 7.3

Helping a Client Assess the Pros and Cons of Healthy Behaviors (A Decisional Balance Exercise): Wendy works hard and often has to work late. This schedule interferes with her ability to cook healthy dinners for her family, and in her fast-paced world, exercise is an even lower priority. On the other hand, she has high blood pressure and knows that her best strategies for lowering her blood pressure and helping her family stay healthy are taking the time to cook balanced meals and building exercise into her day.

QUESTIONS FOR CONSIDERATION

What types of questions would you ask Wendy to help her determine ways in which she could build exercise into her day? How would you help her discuss the pros and cons of changing her current behavior? What plans could you help her make to address the barriers that are present? (Remember to make your questions and responses as nonjudgmental as possible.) An example of a simple decisional balance is offered below in Figure 7.3.

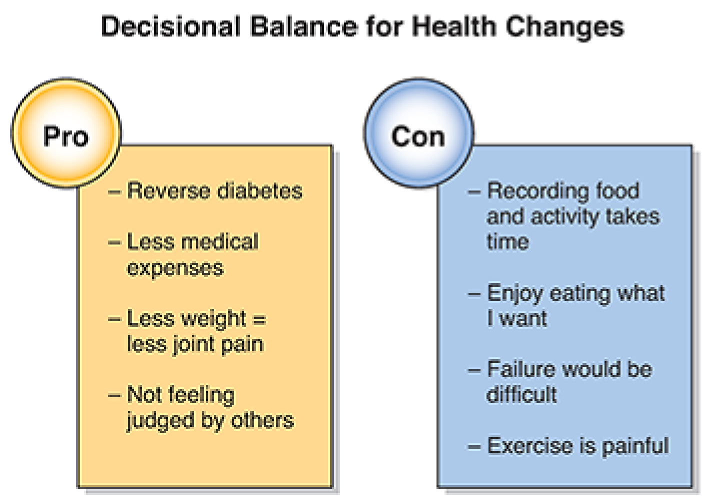

FIGURE 7.3. Decisional balance.

Personal Trainers may be tempted to advise clients how to change. However, unsolicited advice often puts the client on the defensive and increases resistance. Ironically, defensive clients are likely to argue for the reasons why they should *not* change! You are encouraged to explore Chapter 9 and the content on motivational interviewing to develop skills in this area (14). For some quick tips on how to best assist a client in working through resistance without increasing defensiveness, see Box 7.3.

Box 7.3 Tips for Avoiding Arguments and Reducing Resistance

- **Listen.** Simply repeat what you heard the person say. Avoid getting ahead of the priorities and needs expressed by the participant.
  - *"What I hear you saying is that you're stressed and increasing your exercise is not a priority right now."*
- **Make it hypothetical.** If you have encountered resistance regarding a particular issue, make the topic less threatening by turning it into a hypothetical scenario. Get the participant back to voicing the positive side of the argument for change. This will allow them to hear themselves make the arguments for change.
  - *"Suppose you made a change and are looking back on it now. How did it happen?"*
- **Acknowledge the resistance.** This may allow the participant to clarify his or her desires, which you steamrolled over in your haste to get commitment to a goal.
  - *"Sounds like talking about increasing your steps is not something you want to do."*
  - *"You have doubts that this program will work for you."*
- **Emphasize personal choice and control.** Remind them that what they do is up to them. Instead of directing clients or telling them what to do, collaborate on solutions.
  - *"It sounds like finding time to eat in the morning is hard when you are taking care of the kids. What ideas do you have for trying to solve this?"*
  - *"While I was planning on focusing on upper body today, it sounds like you also really want to work on cardio. What would be most helpful to focus on today?"*
- **Emphasize success.** Always assist clients to see the positives in what they are doing. It will help increase their confidence and understand that they can be successful.

- *"On the 1–10 scale, you said your level of motivation was 5. Why a 5 and not something lower like a 1 or 2?"*
- **Acknowledge ambivalence.** Validate client's feelings and show that you understand.
  - *"On one hand, you really value the convenience, taste, and low cost of fast food, but on the other, you're afraid if you don't stop eating this food every day that it will kill you."*
- **Match the participant's readiness.** Mismatched interventions are only fuel for resistance. Action-oriented solutions are meaningless to someone who is only contemplating change!

Consider Case Study 7.1, what stage did you choose for Joan? Upon presenting at your fitness facility, Joan had made a plan to seek your services to help her get into a structured exercise routine; she seems likely to be making changes in the immediate future. Therefore, she is in the preparation stage (Box 7.4). Note that Joan has likely been in each of these stages at some point, as is common with clients trying to achieve health behavior change. Her current stage is important in helping to guide intervention.

Box 7.4 Apply: Reunion Weight Worries

Take a moment and think back to the example of Joan in Case Study 7.1. What stage of change do you think Joan is in? Consider the following:

- Is she intending to change or not yet?
- Has she decided to change in the immediate future?
- Does she have a plan?
- Is she already making changes?

When beginning an intervention with Joan using TTM, it is important to assess her stage of readiness and complete a decisional balance exercise.

Because Joan is in the preparation/action stage, it is important to help her increase her commitment to change by utilizing consciousness raising and dramatic relief processes while working on self- and social-reevaluation processes to maximize the environment in which she is trying to change. Joan will also benefit from problem-solving skills to overcome barriers and making her goals realistic and measurable. You may consider helping Joan develop flexible goals, track her progress, and offer positive feedback.

Although the TTM is clearly useful when applied, research provides mixed results regarding its effectiveness at changing physical activity. A recent review by Romain and colleagues (19) offers ideas on how to most effectively integrate the model into research and interventions. Many studies use only parts of the theory or only cite the stages of change. However, classifying the client into a stage of change does not lead to behavior change; it is the specific processes of change utilized as a result of understanding a client's stage of change that help clients increase their physical activity. That is why many researchers believe that considering all available theories and using them in combination, when warranted, can be even more powerful.

The Health Belief Model

Like the TTM, the health belief model (HBM) (Table 7.2) (20) is a widely used theoretical approach. Developed in the 1950s, this model has been used to increase health screening behaviors, and it suggests that the main predictors of behavior change are (a) the perceived seriousness of a potential health problem (*e.g.*, heart disease) related to the behavior (*e.g.*, physical inactivity), (b) one's susceptibility to potential health consequences, and (c) the perceived benefit or belief that making the suggested behavior changes will result in decreased risk of consequences. According to the client, the cost of changing behavior should be relevant and worth the risk reduction it offers. You may have worked with clients who have said that they are exercising now because heart disease runs in their family and they are trying to avoid developing the disease themselves. Thus, this theory is most applicable to those at higher or immediate risk for identifiable chronic disease.

Table 7.2 Health Belief Model Constructs and Strategies

Construct	Exercise-Specific Definition	Change Strategy
Perceived susceptibility	Beliefs about the chances of getting a disease/condition if do not exercise	■ Explain risk information based on current activity, family history, other behaviors, etc.
Perceived severity	Beliefs about the seriousness/consequences of disease/condition as a result of inactivity	■ Refer individual to medically valid information about disease. ■ Discuss different treatment options, outcomes, and costs.
Perceived benefits	Beliefs about the effectiveness of exercising to reduce susceptibility and/or severity	■ Provide information on benefits of exercise to preventing/treating condition or disease. ■ Provide information regarding all of the other potential benefits of exercise (*e.g.*, quality of life, mental health).
Perceived barriers	Beliefs about the direct and indirect costs associated with exercise	■ Discuss Ex R_X options to minimize burden. ■ Provide information on different low-cost activity choices.
Cues to action	Factors that activate the change process and get someone to start exercising	■ Help individual look for potential cues. ■ Ask the individual what it would take for him or her to get started.
Self-efficacy	Confidence in ability to exercise	■ Assess level of confidence for different types of activity. ■ Use self-efficacy building techniques to enhance exercise confidence.

Ex R_x, exercise prescription.

Data from Prochaska JO, Velicer WF. The transtheoretical model of health behavior change. *Am J Health Promot*. 1997;12(1):38–48.

According to the HBM, the cost of changing behavior should be relevant and worth the risk reduction it offers.

The HBM has also been shown to be effective as a framework for intervention studies. One intervention targeting a group of African American breast cancer survivors offered eight weekly HBM sessions that focused on increasing the participants' perceived susceptibility and severity of breast cancer (5). During this time, participants were asked to record daily step counts using a pedometer and make weekly step goals. These women were able to significantly increase steps (baseline steps per day = 4,791; final steps per day = 8,297; $p < .001$) and decrease weight ($p = .005$). Moreover, these results continued during a 3-month follow-up. Although these results support using the HBM, this particular population may have a greater understanding of risks and benefits because they have experienced cancer and, therefore, the health risks involved in sedentary behaviors.

Unfortunately, there are some limitations to the HBM. A meta-analysis of 18 studies (including a total of 2,702 participants) found that although benefits and barriers to behavior change were predictors of intervention success, they were overall weak predictors (20). The author ultimately recommended not using HBM in behavior-change interventions due to these modest findings. Regardless of these research results, the concepts in the model can surely guide questions about your clients' health risk and the role of physical activity in reducing that risk.

To apply the HBM to Joan from the first case study in this chapter, she will be more likely to engage in long-term physical activity if she recognizes and understands her risk of illness associated with a sedentary lifestyle, accepts that this risk is serious, and believes that engaging in a physical activity intervention will reduce this risk. It is important to allow Joan to explore her beliefs about the implications of her weight status, sedentary lifestyle, and disease risk and to offer Joan some education regarding these issues and how physical activity can reduce these risks. Joan may also benefit from the use of external and verbal cues to help remind her of these risks and benefits (*e.g.*, a "run for your heart" sticky note).

In summary, the HBM can be beneficial particularly for clients who have clear, identified health risks and have strong intentions to change. However, there are other variables beyond health risk and benefits that influence intentions to change behavior, as is evident with the theory of planned behavior (TPB).

Theory of Planned Behavior

The TPB (Fig. 7.4), which was developed from the theory of reasoned action, has been used extensively in advertising, public relations campaigns, and more recently in health behavior-change efforts. The TPB suggests that intention to engage in a behavior is shaped by a client's attitudes toward the behavior (how helpful and enjoyable the behavior is perceived to be), subjective norms (social pressure), and perceived behavioral control (self-efficacy and controllability) (4,21,22). Consider Yolanda's case presented in Case Study 7.4.

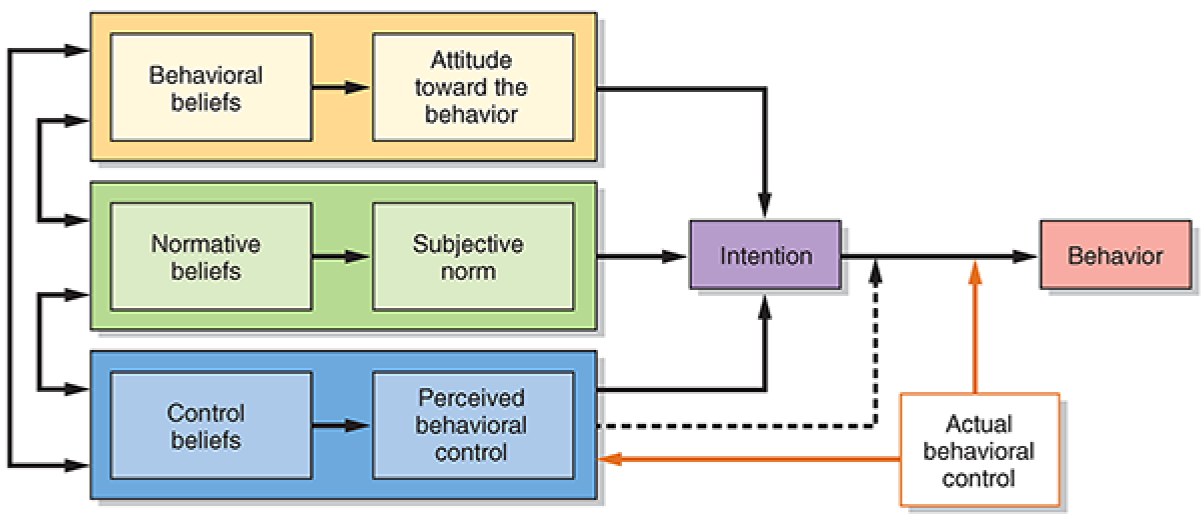

FIGURE 7.4. The TPB. (Reprinted with permission from Ajzen I. Theory of planned behavior diagram [Internet]. Amherst (MA); [cited 2019 Oct 1]. Available from: http://people.umass.edu/aizen/tpb.diag.html.)

Case Study 7.4

Sedentary Secretary: Yolanda is a 30-year-old woman who is interested in increasing her physical activity and muscle tone. She reports that she played softball in college and stayed fairly active, but now that she is out of school and works as a secretary, sitting behind a desk all day, she has struggled to maintain physical activity. Although she still has several friends who play in a recreational softball league, she has not found time to join them. Recently, her doctor diagnosed her with high blood pressure, which is what finally led her to hire a Personal Trainer.

QUESTIONS FOR CONSIDERATION

How could the TPB be applied to Yolanda's case? Are there ways you could learn about her attitudes, subjective norms, and perceived control? Can you encourage Yolanda, the former athlete, to remember her past successes and make note of current successes to increase self-efficacy and create a fun, group atmosphere that might be socially enticing?

If TPB is applied to Yolanda's case, then Yolanda is likely to engage in successful behavior change because she has enjoyed physical activity (she used to play on a sports team), she still has friends who pursue activity, and she feels that she can reverse her blood pressure through activity (she sought out a Personal Trainer). By using TPB, you may encourage her to remember past successes (however small) and record current successes to increase the number of mastery experiences, thus bolstering self-efficacy; provide fun alternative activities catered to the individual to improve attitude; and create a group-based intervention format so that she experiences additional positive social pressure. Additionally, it will be important to focus on things that make exercise convenient and in the client's control. By working to increase her perceived behavioral control, along with working on self-efficacy, the client's likelihood of sustaining her efforts would be increased.

Although TPB has been effective in behavior modification related to smoking, alcohol abuse, and eating habits (4), it remains to be seen whether the TPB can promote increased physical activity on its own. It seems that although TPB can significantly increase one's intention to exercise, this may not necessarily translate into actual behavior change. In a study utilizing pedometers, TPB predicted significant improvements in intention to walk but did not result in step count change (23). Furthermore, in one intervention targeting adolescents, TPB explained 43% of the variance in self-reported physical activity, but only 13% of activity measured on an accelerometer (24). One explanation may be that TPB only focuses on purposeful, structured activity and not daily lifestyle activity increases, which are what most objective measurements of physical activity measure. One additional criticism of the model is a lack of focus on self-regulation or behavior-change skills. Thus, researchers have introduced a new construct to TPB: implementation intention.

Implementation intention has been added to the TPB model to account for the volitional component of behavior change. Implementation intention utilizes skills that increase the likelihood that intentions are acted on. These skills include problem solving, goal setting, coping with challenges, and recording progress (6,25). Research shows that implementation intention, in addition to TPB, leads to significant behavior change above and beyond that gained by TPB alone (6,26). For example, you can help clients build up these intentions by talking with them about barriers and how to work around them and encouraging them to keep track of small gains they achieve each day/week/month during their program.

Research also shows that the ability to self-monitor may be a particularly important construct within implementation intention. In one study that assessed the relationship between aspects of self-monitoring during a weight loss intervention, researchers found that those participants who failed to self-monitor early in their attempt were less active and more likely to regain weight at 24 months (25). Thus, teaching clients about how to meaningfully translate their intentions to change into specific ways to monitor their behavior could be an important link to promote adoption and maintenance of regular physical activity. Helping clients develop plans for implementation and providing them with meaningful feedback on their physical activity is probably something you already do, and this research confirms those strategies as effective ones. Another theory that may describe some of the things you already do with clients is SCT.

Social Cognitive Theory

Bandura's SCT is perhaps the most commonly used theory in behavior change today and is based on the HBM discussed previously (27). Personal Trainers may already be using SCT techniques with clients, even if they have not learned about this theory. Although SCT does not emphasize perceived susceptibility as much as HBM, it adds several important constructs that are important for predicting behavior change. SCT states that outcome expectations (*i.e.*, what you think will happen as a result of your new behavior) and self-efficacy (*i.e.*, situation-specific self-confidence) are the most important factors in behavior change. These factors are further divided into environment (both physical and social), personal/individual (emotions, thoughts), and behavior (one's skills and abilities, past experiences) all of which that may shape expectancies. Notice in Figure 7.5, both personal factors and environmental factors lead to the behavior. The behavior can be either positive or negative, depending on the influence from the other two factors. Thus, behavior may be shaped by observational learning, reinforcement and incentives, and coping skills. All of these social- and individual-level concepts are affected by larger environmental factors such as culture, policies/laws, and built environment features.

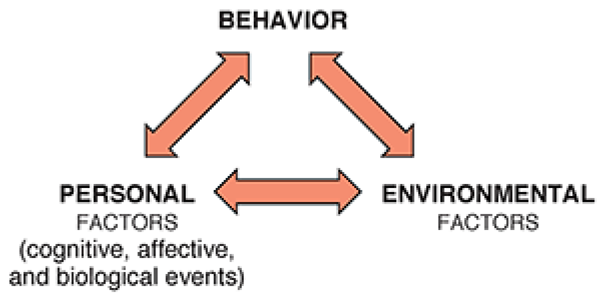

FIGURE 7.5. Basis of SCT.

SCT stands apart from other theories in that it puts great emphasis on a client's thoughts and feelings and thus emphasizes behavior at the intrapersonal level. Proponents of SCT believe that clients actively shape their lives by thinking, feeling, reflecting, and observing themselves (Fig. 7.6).

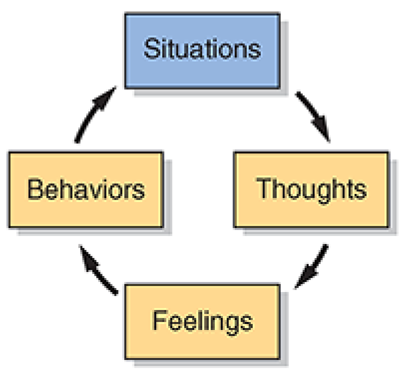

FIGURE 7.6. Thoughts, feelings, and behaviors. (Reprinted with permission from Bandura A. *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs [NJ]: Prentice Hall; 1986.)

If clients repeatedly think that they are unable to improve their weight status or that they are a "failure," they will not have positive outcome expectations (Box 7.5), will feel incompetent, and have a negative attitude toward exercise. In turn, they will be more likely to drop out of an exercise program. Furthermore, unrealistic thoughts are also not helpful to a client. For example, consider Mark (Case Study 7.5).

Box 7.5 The Power of Thoughts

Thoughts are very powerful — they can shape feelings and behaviors. Kind, realistic thoughts as a part of one's self-talk promote confidence to make positive lifestyle changes. In contrast, beating oneself up with negative thoughts reduces the confidence needed to make changes. These are called thought traps.

For example, a person who always tells himself he is fat may feel depressed and hopeless. He may then decide to give up on physical activity and healthy eating. Negative thoughts can result in a vicious cycle of self-defeat. Because of this, you may choose to use SCT techniques to help your client break the cycle and replace bad thoughts with more realistic ones.

Case Study 7.5

Mad for Muscles: Mark is an 18-year-old high school graduate who just moved to your area to begin college. He reports that he has been overweight since elementary school. He was never athletic or good at sports, and as a result, he acquired more sedentary hobbies such as video games, computer games, and social networking. Mark was often teased and bullied for his weight in school and was never chosen for any sports teams. Thus, he has always avoided sports or other physical activity. He has several close friends from high school who also enjoy video games and computer games.

Mark tells you that he has tried several popular diets and that he and his friends typically eat junk food when they hang out. Mark notes that if he suggests something active instead of their usual video games or computer games, his friends may laugh at him. As a result, Mark has not had much success with behavior change. Mark is hoping that this will be his opportunity to start fresh since he recently became a college student. He would like to lose weight and make new friends, including a girlfriend.

Currently, Mark has a BMI of 38 $kg \cdot m^{-2}$ (height = 70 in; weight = 265 lb). His self-stated goal is to lose about 20 lb before classes start (in 2 wk) and to “get buff” in order to “be attractive” to women and go on dates. Mark is eager to lose weight but seems hesitant about the structure and discipline it may require.

QUESTIONS FOR CONSIDERATION

What past experiences has Mark experienced that challenge him when trying to exercise? What types of thoughts and feelings might Mark be experiencing related to exercise? How does Mark's environment help or hinder his efforts? How might Mark become more supported socially and emotionally as he tries to exercise?

If Mark continues to think that he can lose 20 lb in just 2 weeks in addition to toning his whole body, then he is setting himself up for failure. As these types of thoughts and feelings are not helpful, it is the trainer's task to help the client identify and reframe them. More realistic thoughts and goals may help in improving the client's self-efficacy and outcome expectations. Surrounding clients with cues, social support, and education can enrich their environment and also promote further behavior change. In other words, a supportive environment increases self-efficacy and confidence, which in turn affects behaviors.

To apply SCT to Joan in Case Study 7.1, if she is confident that she can meet goals, overcome challenges, and improve her health, then she will be able to succeed in her behavior change. Thus, teaching Joan skills and self-maintenance techniques (*i.e.*, self-monitoring and planning), highlighting her successes, and offering her coping and problem-solving skills will increase her self-efficacy. Focusing on how she accomplished past successes and encouraging rewards (such as positive praise and nonfood-based self-rewards) will increase her expectancies for success.

SCT applied to Mark might look different compared to Joan. Although Joan has had success with past attempts at weight management, Mark has not. In Mark's example, place greater emphasis on building self-efficacy to change behavior, especially in the initial stages. Mark will benefit from learning self-maintenance techniques and problem-solving skills to help him manage challenges and experience success that he can build on to bolster self-efficacy. In addition, Mark will need assistance discovering enjoyable physical activities. For example, taking Mark's love for video games and pairing it with exercise (such as an interactive video game) may be the perfect way for him to be active while doing something he enjoys.

SCT has been supported by a number of research studies. One particularly noteworthy study illustrated that a 52-week online SCT intervention assessing 272 participants resulted in improvements in physical activity and physical activity related self-efficacy and self-regulation (28). Furthermore, social support, self-efficacy, outcome expectations, and self-regulation led to better results and are closely related to SCT constructs. SCT addresses goal setting — the main focus of the goal-setting theoretical model, which is described next.

Goal-Setting Theory

Although goal setting is a common construct within several theoretical models, there is considerable research documenting the effectiveness of goal setting and self-monitoring on diet exercise behaviors (7,25,29–31). Research on goal-setting theory (GST) suggests that four different mechanisms play a role in goal-related behavior change (32):

1. Goals direct attention and energy toward desired behaviors.
2. Goals lead to greater effort.
3. Goals extend the time and energy devoted to a desired behavior.
4. Goals increase the use of goal-relevant skills.

The success of goal setting is moderated or affected by the level of commitment to the change; the importance of the goal, self-efficacy, feedback on goal progress; and the attainment of the appropriate skill level to achieve the goal.

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Research in GST has provided an understanding of the type of health goals that are most effective. Research shows that individuals who develop self-selected goals are more likely to be successful than those who have goals determined from an outside source (Box 7.6) (30,32). Motivation researchers have linked this finding to lower levels of intrinsic motivation when exercisers (or athletes) feel low control over their goals and environments (8,33). As health professionals, it is tempting to push clients to certain standards or behaviors believed to be optimal. Instead, set up clients for success by collaborating with them and working within their lifestyles when setting goals. Additionally, to promote sustained intrinsic motivation, the goals need to be connected to the client's identity or an activity they truly enjoy.

Box 7.6 Client-Centered Care

When clients become collaborators in making decisions that affect their lifestyle, they are more likely to follow through with appropriate plans and goals. It is essential to actively listen and validate the client's feelings. It takes practice to resist the urge to "be an expert" and try to "fix" the client. The Personal Trainer's job is to help the clients fix themselves.

Research also illustrates that specific goals are much more effective than asking clients to "do their best." Setting an ambiguous goal does not provide the client with a concrete performance level or behavior for which to strive.

In fact, when clients are asked to "do their best," they do not perform as well as when they select a specific goal (32). Help clients avoid this goal setting trap by encouraging them to develop a way to track and measure specific behaviors. For example, a goal of "walking more" is not a specific or measurable goal, and it leaves the client without much guidance. Instead, set a goal such as "acquire 1,000 more steps a day by walking around the office building at lunch every day next week." This goal is more measurable, can be tracked with a motion sensor (such as a pedometer, accelerometer, or mobile app), and provides specific feedback to guide the client's behaviors. Furthermore, if this goal is not achieved, the client may be able to pinpoint the barriers to behavior change more accurately. Specific strategies for helping clients set effective goals are discussed in detail in a subsequent section of this chapter. In the following section, a novel model that includes goal setting in combination with elements from other theories is described.

The Small Changes Model: A Specific Application of Goal-Setting Theory

Small changes model (SCM), a new model, borrows several elements from other theories within its framework (Fig. 7.7) (34). SCM provides a practical approach to behavior change that has been successfully utilized in nutrition-based and physical activity–based interventions. SCM client goals are connected to baseline activity to help the client make realistic, attainable changes. For example, if a client is only exercising once a month, exercising every day may be a large and unrealistic goal to attain. Instead, the SCM client could slowly increase his or her number of workout sessions to a level that is realistic and maintainable as a lifestyle change.

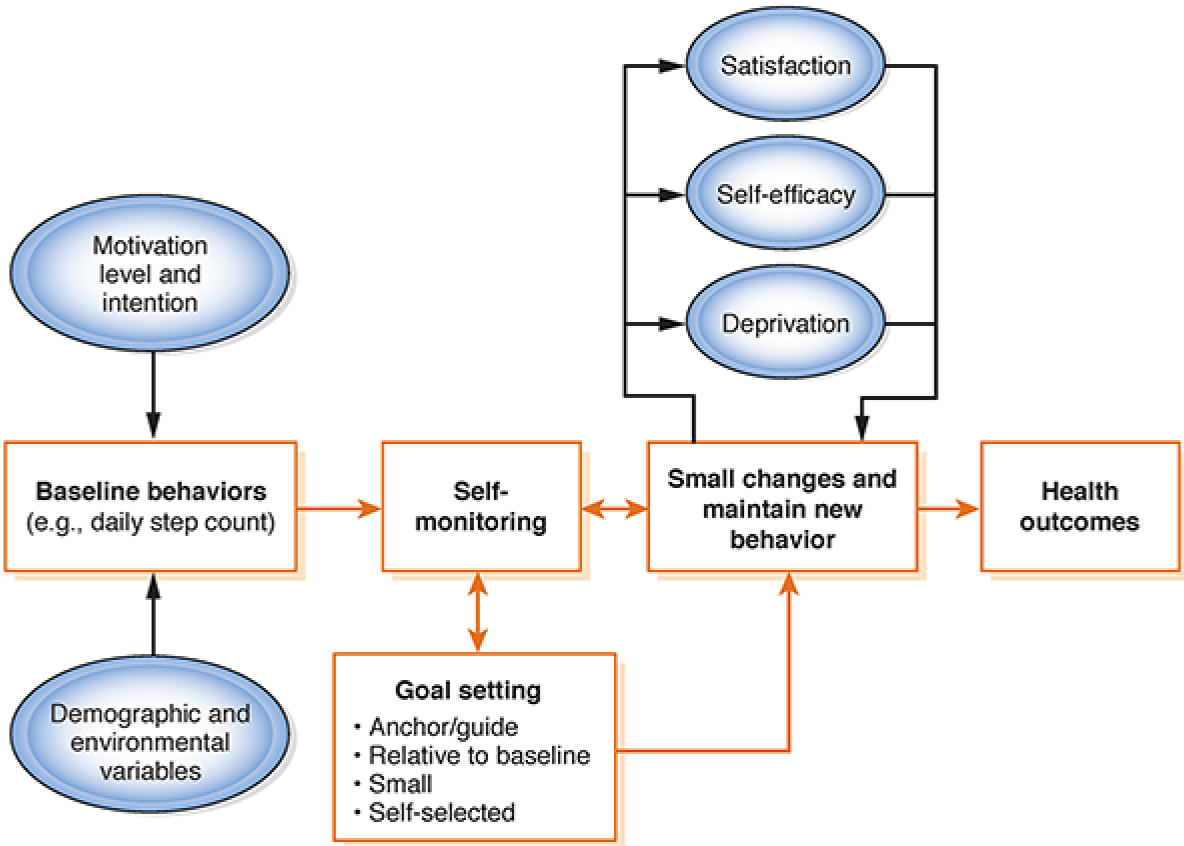

FIGURE 7.7. Small changes model. (Reprinted with permission from Lutes LD, Steinbaugh E. Theoretical models for pedometer use in physical activity interventions. *Phys Ther Rev*. 2010;15[3]:143–53.)

SCM allows clients to make small behavioral changes. The belief is that clients will maintain smaller behavior changes more easily and will continue to build on them over time. For example, research shows that although weight loss is more gradual in SCM programs than in more traditional programs, weight loss continues to occur at 3, 6, and 9 months after treatment; in contrast, clients from more traditional programs often regain weight at these time points (9,15,35).

Another aspect to SCM is that clients select their own goals (Box 7.7). This allows them to take ownership, thereby increasing their self-efficacy and intrinsic motivation. Finally, because research shows that self-monitoring is one of the key factors in behavior change (7), clients are asked to monitor their own behaviors to assist with goal setting, problem solving, feedback, and self-reward. Cognitive behavioral therapy, which emphasizes the role of thinking in our behavior, is also utilized to help clients address thoughts that may impact feelings and behaviors related to their goals. Essentially, the SCM has taken effective concepts and strategies from the previously described models and packaged them in a practical way to help clients achieve their goals. The SCM is not a new theory but an approach to working with clients that focuses on the idea that “some is better than none” instead of “meeting American College of Sports Medicine guidelines” (36) as a criteria for success. This approach is widely supported in public health and considered as an effective way to approach sedentary clients to increase their physical activity (37).

Box 7.7 Remember: Goals Should Be “SMALL”

S: Self-selected. Your goals should be your own. Choose goals that fit into your life and only change behaviors that you are willing to negotiate. Remember, being realistic, not idealistic, is key.

M: Measurable. Develop a concrete way to track your goal. Consider the question, “How will I know when my goal has been met?”

A: Action-oriented. How are you going to achieve your goals? Having an action plan allows you to complete the steps needed to make your goals a reality.

L: Linked to your life. Goals are best achieved if they work within your lifestyle and match your challenges and strengths. Are your goals designed to fit you and your everyday life?

L: Long-term. Because you want to be healthy for life, any changes you consider should be something you could see yourself doing for the rest of your life. Create lifestyle-related goals that you feel confident you can maintain.

To apply SCM to Case Study 7.1, ask Joan to complete a 1-week baseline record of her activity during which she will not try to change her behaviors. After 1 week, this baseline record would be used to learn what Joan typically eats and how active she is from day to day. Because Joan has experienced initial success in the past, she will have some idea of what works for her, and she will select goals based on these reflections, with guidance from her Personal Trainer. Goals should be small, specific, and should fit into her lifestyle. Suggest that Joan self-monitor her daily activity and slowly build on her goals.

Although the components of intervention would be similar for Mark (our college student from Case Study 7.5), how do you think his intervention would be different? For starters, his baseline levels of activity and eating habits differ from Joan's. Mark has not had success in the past with health behavior change and thus will need more guidance with goal setting and strategies for reaching goals. It is especially important for his goals to be realistic and specific so that he can experience success and self-efficacy necessary to ensure that he is able to maintain and build on his changes. Most likely, the Personal Trainer's main challenge with Mark will be helping to guide his goals and giving him permission to start small. Furthermore, both Mark and Joan will benefit from problem-solving training (*i.e.*, relapse prevention), effective coping skills (*i.e.*, building self-efficacy for overcoming barriers), and cognitive restructuring (*i.e.*, learning effecting thinking patterns to promote behavior change). Thus, it is important to remember that although each theory can be applied to various clients, each client's unique factors and situation will require the Personal Trainer to apply knowledge and skills to tailor interventions to fit the client's needs. Moreover, it is important to note that even though initial studies using the SCM have shown some potential for long-term behavior change with regard to weight management, this theory is new and more research is needed. In particular, little is known about its effectiveness in individuals with high-risk medical conditions (*e.g.*, cancer, heart disease, morbid obesity) or individuals with less developed abilities to make informed choices (*e.g.*, young children).

It is important to remember that although each theory can be applied to various clients, each client's unique factors and situation will require the Personal Trainer to apply knowledge and skills to tailor interventions to fit the client's needs.

In addition to unique personal factors, such as the ones discussed in the SCM, environmental factors also influence behavior. Even the best interventions can be supported or thwarted by the environment; therefore, researchers have developed an approach called the socioecological model (SEM).

Socioecological Model

When developing a theoretical approach to physical activity intervention, it is important to view a client not as a single independent entity but as someone within a larger social framework and infrastructure. Health behaviors are shaped not only by individual decisions but also by environmental influences. The SEM addresses this relationship: Behaviors are shaped by interpersonal interactions, the surrounding environment, community, policy, and law (Fig. 7.8) (16). For example, Joan (see Case Study 7.1) wants to make several healthy behavior changes. The environment in which she lives will strongly impact her goals, barriers, and behaviors. For example, is Joan's neighborhood safe to walk? Are there sidewalks available? Is Joan utilizing an assistance program to purchase food that limits healthy options? Is she the primary food provider in the home? Do her familial duties limit her free time? Does she have social support? All of these factors will impact Joan's behaviors and cause potential barriers to her goals if left unaddressed.

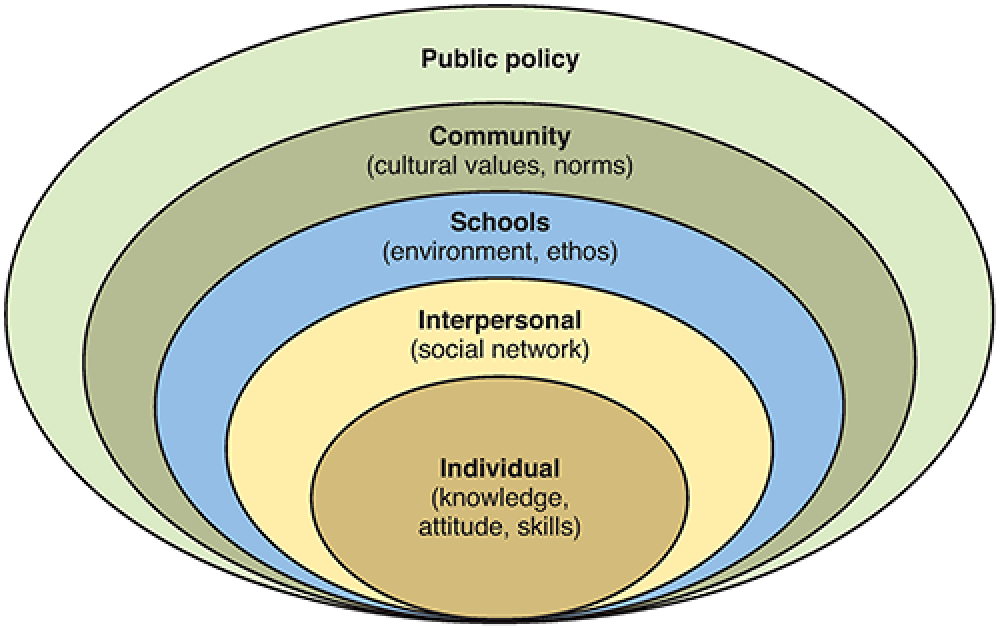

FIGURE 7.8. Socioecological model. (Adapted with permission from Lutes LD, Stein-baugh E. Theoretical models for pedometer use in physical activity interventions. *Phys Ther Rev*. 2010;15[3]:143–53.)

As a Personal Trainer, you may choose to address these interactions by creating an eco-map with your client that may highlight some barriers and supports (Fig. 7.9). Eco-maps are drawings that highlight both positive and negative connections between the client and his or her environment (38). By completing a map together, you may be able to build rapport with your client, increase awareness, plan for challenges, embrace support, promote self-reflection, and identify areas of improvement. Think of the eco-map as a tool that helps clients share their story so that a Personal Trainer may in turn help them make changes that fit within their life contexts. To make an eco-map, the client and Personal Trainer will draw a diagram. Even though the Personal Trainer may show the client an example, ultimately, the client should be responsible for completing the writing and designing of the map in order to feel in control of the process. The Personal Trainer or client may designate different styles of arrows to designate different types of relationships (see examples in Fig. 7.9). Remember, relationships are a two-way interaction; what may be helpful to one member of a relationship may not be for another. Also, the Personal Trainer should remember to include structural supports as well. Is there a recreation center nearby? This may go in the eco-map. This activity should be a collaborative one where the client explores these relationships with some guidance. The Personal Trainer may then ask, “How can we change the map to help you receive the support you need to make your changes successful?” Adding this sort of environmental assessment to your health intake process may be the entry point to a meaningful discussion of barriers and strategies necessary to be successful. For a more detailed discussion of eco-maps, see Kennedy’s review (38).

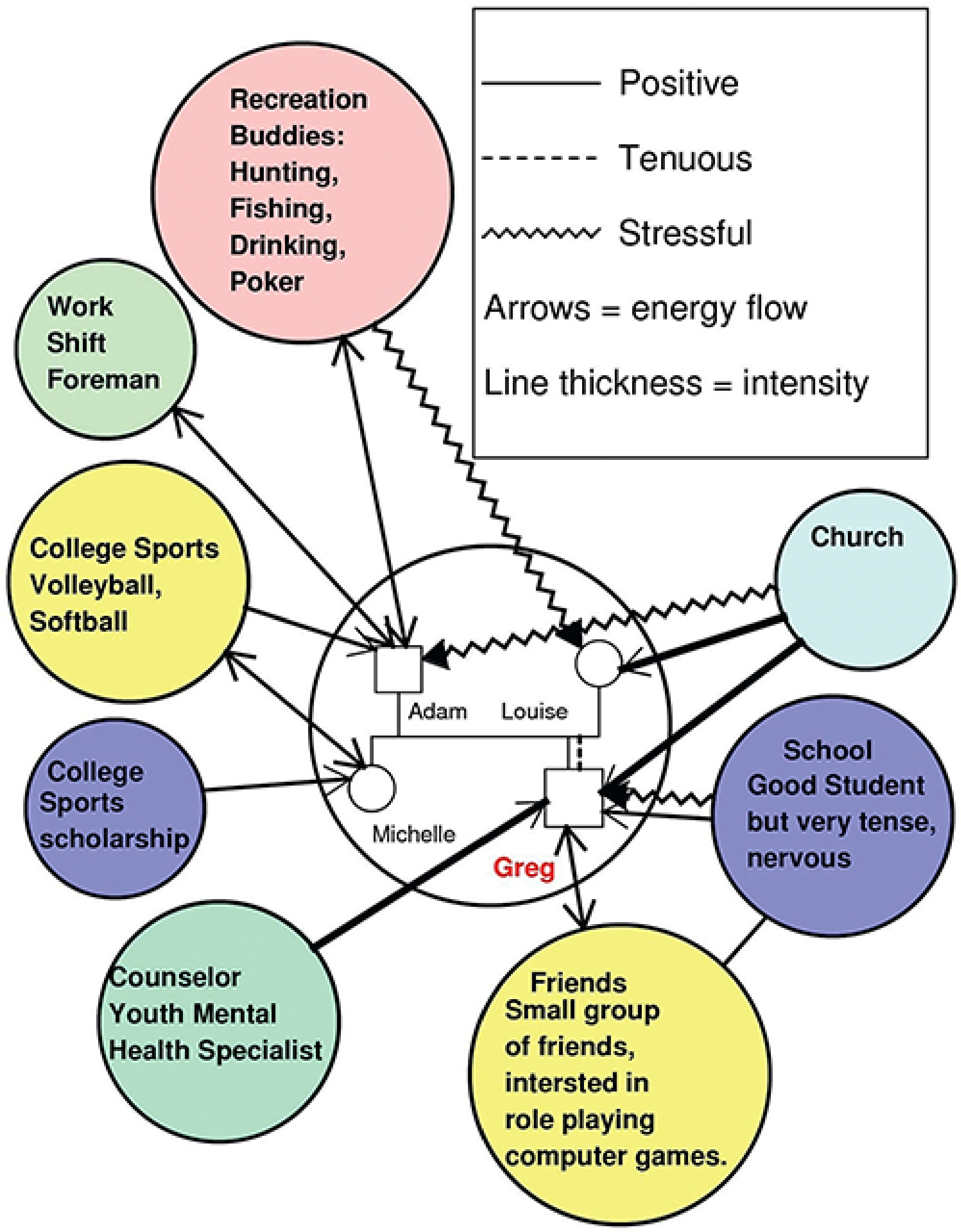

FIGURE 7.9. Sample eco-map. Sample eco-map. (Adapted with permission from Kennedy V. Ecomaps. *MAI Review*. 2010;3:1–12.)

All of the aforementioned theories and models assume the individual is responsible for, and the focus of, behavior change. These models also assume the clients behave rationally and are in control of most (or all) of their behavioral choices. The SEM leans away from that idea a bit by touching on social and environmental factors that may positively or negatively affect the client's efforts to change. Another model takes that idea to outer space, literally in one sense of the word; this theory emerged from the field of Physics.

Chaos theory has been presented as an alternative way to view behavior change by some seasoned researchers who note the faults of traditional theories as being overly simplistic (39) while failing to take in the unique timing and environmental factors at play in each person's life.

Nearly all behavior-change models rely on assumptions that our clients behave in rational and predictable ways and that their change process proceeds through a set of stages. But not all researchers believe these assumptions. An alternative view is chaos theory. Researchers who subscribe to this theory instead assume that most changes start for random or unpredictable reasons, and they can stop without a logical explanation. According to this theory, some factors may have a profound impact on a client while other factors do not. As a Personal Trainer, you can use this perspective to help shape your own attitude toward client motivation. The reasons they start and stop are not always logical, and until physical activity has a clear purpose in their lives or they have strong self-efficacy and preferences for what they like to do and when, their behavior should be considered unstable and impermanent.

Various theories of behavior change have been discussed in this chapter. Each has its unique contributions, strengths, and limitations as well as similarities with other theories. These theories help us to understand or explain behavior in the clients with whom the Personal Trainer may work. Using these theories ultimately helps the Personal Trainer make efficient use of their time spent with clients. Understanding the underlying concepts may help the Personal Trainer build trust and rapport, express empathy, bolster listening skills, and reflect on spoken or unspoken behaviors. They also assist the Personal Trainer in asking appropriate questions in order to devise goals. For a review of the highlights of each theory and its relative strengths and weaknesses, see Table 7.3.

Table 7.3 Comparison of the Behavior-Change Theories

Main Idea	Important Tools	Strengths	Limitations
Transtheoretical Model of Change			
Change is based on one's readiness to change. Clients can move through change stages using the processes of change. Personal Trainers should begin working with the client in their current stage.	Decisional balance Processes of change (*e.g.*, self-liberation, reinforcement management, dramatic relief) Self-efficacy and confidence in change "Rolling with resistance"	Helps those at all stages of readiness (no required readiness); reduces friction (client and Personal Trainer)	Research shows mixed results; may be more effective for some behaviors than others
Health Belief Model			
Behavior change is predicted by one's feeling of susceptibility to health consequences, the perceived seriousness of the consequences, and the belief that making changes will reduce the risk.	Explores health concerns and vulnerability Education Identifies barriers and benefits to change Use of external cues to remind client of risks and benefits	Clients have a greater understanding of health.	May not be as effective for clients who do not have identified health risks
Theory of Planned Behavior			
The intention to make behavior change leads to change. If a client has a positive attitude about change, feels that it is enjoyable, has feelings of controllability and self-efficacy, and recognizes that the social network values change, he or she will be more likely to change.	Enhances self-efficacy Explores attitudes related to change Introduces enjoyable activities Utilizes group activities or buddy systems Helps identify and engage social support Makes the new behavior as convenient as possible	TPB treatments significantly increase intention.	"Intention–behavior gap"; intention does not always lead to behavior.
Social Cognitive Theory			
Outcome expectations and self-efficacy are the most important factors for behavior change. The	Utilizes role models Self-monitoring, planning, and problem	Considers client's environment,	Many factors to consider in

physical and social environment is key. One’s skill set, reinforcement and incentives, coping skills, experiences, and thoughts and feelings determine change.	solving Increases social support Skill development, self-efficacy Utilizes environmental cues and reinforcements Break thought chains (stop negative thoughts, feelings, and behaviors) Recognizes past successes	thoughts, and feelings toward behavior change	one treatment program
Goal-Setting Theory			
Setting goals leads to behavior change. Particularly, setting goals that are specific, measurable, realistic, and time specific lead to behavior-change success. Also important to change is self-efficacy, feedback, skill level, and the perceived importance of the goal.	Self-directed goals Utilizes recording and monitoring tools Problem-solving skills Feedback Allows client to express reasons to change Reviews past successful goals and “what worked” Regular goal setting Long-term goals and short-term goals	Gives clients a concrete plan for change May be utilized within other theories	May not address factors such as thoughts, emotions, and environment
Small Changes Model			
Behavior change is achieved through setting realistic, maintainable goals that are small, relative to baseline activity, and cumulative. Combines components such as goal setting, feedback, and self-monitoring to yield achievement of initial goals and increases in self-efficacy to further behavior change.	Self-selected goals Goals are relative to baseline. Goals are small. Utilizes monitoring tools and feedback Problem-solving skills Goals are linked to lifestyle and maintainable across time.	Promotes gradual and cumulative behavior change while increasing self-efficacy	New theory with only a handful of studies to date. Moreover, little is known about its effectiveness for certain groups of people.
Socioecological Theory			
Behavior change is a result of not only the individual factors but also	Addresses barriers and highlights supports Creates an eco-map	Recognizes that clients are affected by	The environmental structure

the social structure, environment, community, policy, and law.	Works with social network, teachers, bosses, political leaders, and city planners to affect change Helps clients explore and asks for social support Implements cues in the environment for change Allows clients to share cultural and community practices	their greater environment	(including community, policy, and law) can be very difficult to change, and change is slow at best.

Data from Rosenstock IM, Strecher VJ, Becker MH. Social learning theory and the health belief model. *Health Educ Q*. 1988;15(2):175–83.

Putting Theory into Practice

The described theories provide a number of empirically supported, valuable tools to help clients with behavior change. For instance, research strongly supports the use of self-monitoring, goal setting, and feedback as tools that effectively aid participants in increasing physical activity when included as part of a physical activity intervention (7,19,25,29,30). The following section reviews some of these techniques to make them easier to utilize with clients in the future.

Self-Monitoring

Self-monitoring refers to the practice of tracking one's own behavior for the dual purpose of increasing awareness and monitoring progress. This process can take many forms. For example, self-monitoring may mean writing exercise in a planner, getting on the scale weekly, entering food intake into a tracking Web site, or wearing a wearable activity tracker. Self-monitoring plays an important role in physical activity intervention. In fact, a meta-regression including 122 research studies and 44,000 participants concluded that self-monitoring was the most influential predictor of successful behavior change for physical activity (40). Researchers found that interventions including self-monitoring with at least one other technique (intention formation, goal setting, feedback, review of goals) were more effective than those that did not. Similarly, a study of physical activity and weight loss maintenance behaviors concluded that consistent users of self-monitoring early in the attempt were linked to higher moderate and vigorous physical activity and greater weight loss maintenance at 24 months (25). Self-monitoring is an important tool in increasing physical activity because its use increases client awareness of behavior, offers accountability, provides information for the Personal Trainer on the client's behavior outside of meetings, allows for goal setting and tracking progress, provides an opportunity for feedback, and is a skill that a client can use on their own after intervention. This monitoring can take several forms, including traditional paper-and-pencil forms and smart phone applications linked to activity trackers. For the self-monitoring process to be effective in promoting awareness, the form of monitoring should be used daily and linked with some sort of feedback mechanism such as weekly review with a Personal Trainer.

The Use of Physical Activity Trackers and Mobile Apps

One of the drawbacks of self-monitoring is that it is often subjective. In other words, it involves the client's self-report and "best guess" of the amount of activity completed. Physical activity trackers such as pedometers, activity trackers/smart watches, and smartphone-linked mobile apps provide a less subjective measure of physical activity. In recent years, smart watches and wearable technology have become more affordable and accessible for the exercising population. Systematic reviews of this technology have shown some modest but mixed effects. For example, a 2015 systematic review and meta-analysis of mobile phone apps for weight loss and physical activity found a modest positive effect for weight loss (about 2 lb) compared to a control group (41). However, this review found no significant improvement in physical activity levels across the 12 studies included. Researchers have also found a wide range of adherence to the use of these monitoring devices (in adults), from 40% to 86% (42). Some encouraging evidence comes from a 2016 systematic review of 27 studies that used applications to improve physical activity, diet, or sedentary behavior (43). The authors found improvements in physical activity levels in two-thirds of included studies, with stronger effects in interventions that targeted multiple behaviors (*i.e.*, diet and physical activity together) and in some participants who reported higher usage of the app.

Applying Health Behavior Theories When Setting Goals with Your Clients

As previously discussed, goals are typically more effective if they are client selected. Clients will take more ownership of goals that they have chosen for themselves. As a Personal Trainer, how can you allow clients to set their own goals while ensuring they choose effective ones? You can teach your client the important components of an effective goal and then help them to mold their goals appropriately. Also, keep in mind that there is some evidence that helping clients set small goals on the short term may set them up for long-term success. It is also critical to goal-setting effectiveness for clients to select a way to monitor their progress on a daily or weekly basis and for the Personal Trainer to build in a feedback mechanism to keep them aware of and accountable to their goals. Personal Trainers may have already learned about how to set specific and measurable goals with their clients and how to provide regular feedback along the way. Clients will also need help creating specific plans for when and where they will be physically active and identifying what barriers may get in the way. If not, additional details are available in Chapters 8 and 9. Consider Mark's example. How can Mark set goals related to his amount, frequency, duration, or intensity of exercise if he does not keep track of what, when, and how much exercise he achieves? In addition, it is much easier to provide feedback to Mark regarding his progress if you have a physical record of his exercise and whether or not he met his goals. Similarly, setting goals would not be of much use to Mark without keeping record to determine if he met his goals and then receiving feedback, whether positive or negative, or both.

Providing Feedback to Clients

Feedback not only is necessary for effective goal setting but has also been labeled an important component of physical activity behavior change. In a study to determine factors involved in behavior change, researchers found that both telephone and print feedback increased the likelihood of physical activity behavior change (44). In a recent study, researchers found that after providing in-person group weight management using small changes, a 6-month telephone follow-up period with a feedback component resulted in continued weight loss across the follow-up program — almost doubling their initial weight loss (35). Therefore, not all contact has to be in person to be effective. Personal Trainers can remember to utilize the telephone, e-mail, or texting as an effective alternative resource for providing feedback. It is important to find the most preferred way (besides in-person feedback) that your client expects and likes.

Customizing to a Population

Although many studies describe the efficacy of interventions tailored to special populations such as the elderly, children, those with physical limitations such as arthritis, and various cultures, a discussion of each of these is beyond the scope of this chapter. However, it is important for Personal Trainers to understand each client's unique needs based on any combination of factors relating to age, physical ability, gender, culture, or other individual factor as well as being open to modifications based on preference or perceived need. Whereas the Personal Trainer is an expert in physical activity, clients are experts on themselves. Sometimes, tailoring to meet a client's need or preference may not seem the best or may go against the Personal Trainer's beliefs. In such cases, Personal Trainers will want to carefully consider the pros and cons of including such preferences from a health/fitness as well as relational perspective using experience and expertise to guide clients to a compromise that both the client and Personal Trainer can feel comfortable implementing.

Rapport

One of the most fundamental components of a successful intervention is rapport. Rapport refers to a sense of trust, respect, or confidence that a client holds for their Personal Trainer. Experts say that rapport with a client is the first step to behavior change and adherence (45). Often, rapport building is the first task of a Personal Trainer, preceding other interventions. Although a client may have initial respect for you as a Personal Trainer because of the title, respect and confidence is earned based on your skill and prescribed intervention. For ideas on how to build rapport, consider the following:

- Be sure to display/communicate your credentials.
- Confirm your professionalism by dressing and acting professionally.
- Highlight things that you have in common such as likes, dislikes, or experiences (show that the two of you relate to each other).
- Affirm any client strengths that you have noted.
- Empathize with their struggles/feelings.
- Self-disclosure: Share relevant struggles you have had in the past; take sincere interest in your client — people can detect insincerity.
- Nonverbal cues: Have good eye contact, open posture, and appropriate facial expressions.
- Remain nonjudgmental and open-minded. Be aware that some clients who are overweight or obese may experience social stigma in exercise environments (46), and this can contribute to negative experiences.
- Be a mindful and active listener and remain present in the moment.
- Offer explanations for the components of intervention.
- Continuously ask your clients how they feel about the information you are providing them.

Lessons Learned

Although there is no prescription guaranteed to help a client to achieve and maintain physical activity behavior change, the discussed theories and their components have been empirically tested and shown to increase the likelihood of success. At the same time, Personal Trainers must be wary of presuming that what works for one client will work for every other client. As such, it is important to be flexible and open-minded, with a willingness to tailor interventions to each client's unique needs. The task of the Personal Trainer is to incorporate empirically supported components of physical activity change into each client's intervention in the way that will most benefit that particular client. Consider the examples in Case Studies 7.6 and 7.7.

Case Study 7.6

Overweight Sedentary Teenager: Sydney is a 16-year-old girl who is overweight and inactive. Her physician has strongly suggested that she actively try to lose some weight because of the concern that her family has a history of Type 2 diabetes and heart disease. Sydney tells you that she spends most of her free time listening to music, watching movies with friends, or reading a book. She plays clarinet in the school band but has never liked sports. In the initial meeting, she is timid and appears self-conscious but is amenable to your suggestions. She admits that although she is "not good" at sports or exercise, she is a highly self-motivated person and is driven to accomplish goals and finish what she starts.

QUESTIONS FOR CONSIDERATION

What questions would you ask Sydney to learn more about her potential for physical activity? What types of physical activity do you think she would like? How would you use goal setting and feedback to help Sydney reach her goals?

Case Study 7.7

Overweight Active Teenager: Michael is a 17-year-old boy who is overweight but muscular. He reports that he not only plays football and is active at practice but also has a big appetite. He is seeking the assistance of a Personal Trainer because his coach wants him to shave time off of his quarter mile over the summer. He also needs help improving his cardiovascular fitness and sticking to his routine. In the initial meeting, Michael is jovial and a little sarcastic. He says, "I am competitive but lazy."

QUESTIONS FOR CONSIDERATION

What questions would you ask Michael to learn more about what motivates him for physical activity? What types of physical activity or exercise do you think he would like? How would you use goal setting and feedback to help Michael reach his goals?

Case Studies 7.6 and 7.7 illustrate different referral reasons and client factors. Recognizing these differences can help Personal Trainers to tailor interventions to each client's needs. Although both Sydney and Michael will benefit from goal setting and feedback, the style with which feedback is successfully and effectively delivered will likely vary between the two cases. In addition, Personal Trainers will need to utilize different strategies with Sydney and Michael in order to develop rapport. For example, talking with Sydney about playing clarinet in her high school band will most likely build rapport; however, that same discussion may not get very far with

Michael. What are some other ways in which the interventions for Sydney and Michael might differ?

Michael will need more accountability than some because of his self-reported tendency to not complete tasks. Also, there may be additional challenges that Michael is facing besides his reported "laziness." Explore whether laziness may be a cover for issues such as anxiety, pain, etc. Michael may also respond well to challenge and competition — even if it is with himself and his past performance. Measurable, short-term goals and self-monitoring will be especially useful for Michael and should be emphasized. On the other hand, Sydney will need specific feedback in order to learn how to exercise in a way that is effective for her. Time and extra care will need to be spent building rapport so that she believes and trusts in the intervention and in herself. Attending to Sydney's past successes will help to build self-efficacy, and allowing her to choose her own activities will give her ownership of something she previously "did not like." Self-monitoring will likely be an effective tool for Sydney because she is conscientious and will likely be good at recording, which will build feelings of self-efficacy. Goal setting will also vary, based on each client's unique short- and long-term goals as well as situational constraints, such as schedule, family situation, influence of friends, or access to facilities. What are some additional ways in which a Personal Trainer would tailor an intervention differently for Sydney or Michael?

SUMMARY

As one can easily gather after reading this chapter, there are many different theories of behavior change, each with its own unique strengths and weaknesses. Although there is some overlap across theories, each represents a unique foundation and combination of principles and components (for a review, refer to Table 7.3). Although research exists to support various theories, it is up to the Personal Trainer to interpret empirical support and use expertise, combined with the skills discussed in this chapter. In this way, appropriate decisions can be made regarding which principles or components to apply with each individual client based on his or her unique needs and situational factors.

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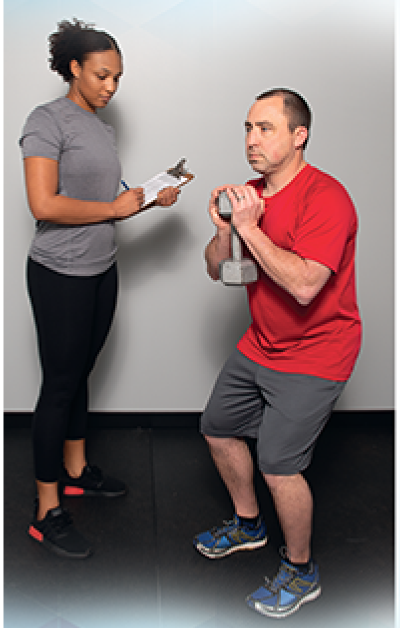
CHAPTER

8

Adherence to Exercise: Helping Your Client Stay Active



OBJECTIVES

Personal Trainers should be able to:

- Identify factors that contribute to client adherence to exercise and apply appropriate behavior change strategies to promote adherence among clients.
- Understand and apply health behavior change models to support and facilitate exercise adherence and apply appropriate strategies to build clients' self-efficacy and motivation related to exercise based on current skills, knowledge, and current level of motivation.
- Identify barriers to exercise and assist clients in developing strategies to overcome these barriers and avoid relapse.
- Develop skills to encourage clients to self-regulate their exercise and effectively collaborate with the client to set behavioral goals.
- Recognize clients' need for social support, create a supportive environment, and teach clients how to access additional forms of support.
- Identify and apply innovative strategies and new/novel behavioral theories clients can use to adhere to exercise, such as technology, active transportation, or community-based programs.
- Set effective client-oriented specific, measurable,

INTRODUCTION

Behavior-change theory, covered in Chapter 7, helped clarify why some people are inactive, others start and stop exercise repeatedly, and still others are able to continue an exercise program indefinitely. This chapter takes behavior-change theory one step further and focuses on tactics to increase client adherence to exercise.

One of the biggest frustrations of Personal Trainers is failing to persuade their clients to adhere to a program that took a significant amount of time to develop. Although psychological benefits such as improved mood, improved sleep, and reduced stress can be seen within a few bouts of exercise, the physiological health benefits of regular exercise (*i.e.*, hypertrophy, weight loss) are often not realized until at least 6 months of continuous participation (1,2). Thus, researchers often equate *adherence* with the maintenance stage of the transtheoretical model's (TTM) stages of change (3–5). Therefore, in this chapter, adherence refers to at least 6 months of continuous participation in exercise.

> Physiological health benefits of regular exercise are often not realized by clients until at least 6 months of continuous participation.

As a Personal Trainer, a large portion of the job is to equip clients with the skills necessary to adhere to exercise. Adherence is important because approximately 50% of people who begin an exercise program drop out within the first 6 months (6). This chapter focuses on identifying factors that contribute to exercise adherence and on designing and implementing strategies that will enhance adherence to exercise. The case studies in this chapter illustrate the factors related to exercise adherence and how strategies can be applied to each client in helping him or her adhere.

Because clients may have different physical, psychological, and environmental obstacles to (and reasons for) exercise (7,8), understanding the attitudes, values, meanings, and experiences that each client associates with exercise and applying appropriate strategies accordingly is extremely important to a client's continued success in an exercise program (9). For example, a client may have no problem scheduling time to exercise but may lack the supportive environment necessary to adhere to exercise, or vice versa. Mastering the ability to "read" clients and teach them to apply strategies to maintain a routine is critical to the Personal Trainer's ability to help clients succeed. However, to master the ability to "read" a client, the Personal Trainer must acknowledge that the client's decision to participate or not participate in a particular activity is complex. Behavioral economics is a conceptual model which allows for a better understanding of factors associated with one's decision-making process. This model suggests that one's preference to participate in an activity is continuously influenced by factors such as social norms, past experiences/behavior, cultural influences, and even how decisions are worded as positive or negative experiences (*i.e.*, framing) (10–13). Trainers who are able to understand these concepts and master the skills necessary to reduce barriers, promote positive environments, and optimize clients' emotional and physical workout experience will not only help clients adhere to exercise but will also improve their own reputations as trainers. Table 8.1 identifies numerous factors that may impact adherence, such as outcome expectancy values, major life events, and intensity of exercise (5,14).

Table 8.1 Factors Related to Adherence

Factors	Definition	Examples
Self-efficacy[a]	Individual's confidence to successfully complete exercise	Mastery experiences such as overcoming barriers; vicarious experiences such as observing role model successfully

		complete behavior; verbal persuasion through positive social support and self-talk; visualization of successfully completing their exercise routine; enhancing emotional and physiological well-being through managing stress and other external lifestyle factors
Motivation[a]	Extrinsic — exercising in order to achieve an outcome: weight loss or appearance	Positive social support that hold client accountable for behavior; self-regulation (see the following)
	Intrinsic — exercising because the activity is satisfying in itself: enjoyment or accomplishment	Enhancing one's competency through mastery experiences; improving autonomy by allowing client to have input into his or her own program/routine; promoting relatedness by making exercise program custom to the client's routine, barriers, and goals
Perceived barriers[a]	Numerous factors that impair individual's belief that they can exercise	Improving self-efficacy and intrinsic motivation through previously mentioned techniques to enhance the client's ability to overcome barriers such as stress, perceived lack of time, fatigue; using time management and goal setting strategies to identify potential barriers and then come up with ideas to overcome them before the client faces them
Self-regulation[a]	Strategies for planning, organizing, and managing exercise activities to "stay on track"	Identifying environmental factors such as access to gym facility to plan programming specific to your client's resources; helping client identify times of day that are more accessible for working out than others; finding social support for client to hold them accountable
Social support[a]	Exchange of aid or assistance among individuals or groups within a social network; includes emotional, informational, instrumental, companionship, and validation support	The Personal Trainer can help their client find family, friends, neighbors, coworkers, other clients, or a social media network that provides positivity and accountability for others.

Environment[a]	May include access to facilities, weather, neighborhood environment, or where the exercise takes place	The Personal Trainer can be sure to personalize the exercise/physical activity program to his or her client's local neighborhood, gym, or home resources to enhance probability of client's adherence.
Outcome expectancy values	How much the individual values the expected outcome	Assisting the client in writing a list of expected outcomes from his or her exercise participation and how the client prioritizes these outcomes based on his or her values/beliefs
Duration and intensity	Length of time spent active and how hard the client works	Exercise intensity can directly impact one's positive/negative feelings during exercise. By allowing the client to self-select the intensity, increase the autonomy in the program, and identify specific physiological thresholds for the client will help the Personal Trainer personalize intensity and duration of exercise programs to maximize adherence.
Major life events	Events in a client's life that impact his or her daily routine (*i.e.*, getting married, death in the family)	Helping the client plan around major life events or build social supports/self-regulation strategies to anticipate such events will help make alterations to the client's typical schedule more manageable.
Program tailoring	Having a program that is in accordance with the client's preferences and goals	Allowing the client to have some say in his or her programming will increase autonomy and relatability. Knowing more about the client and his or her lifestyle will help make a tailored exercise program and make it more realistic.
Core affect	The most basic element of all valenced responses (*e.g.*, pleasure/displeasure)	Acknowledging what clients enjoy or dislike will help the Personal Trainer identify aspects of the exercise program to include or avoid to maximize pleasure during an exercise session to increase possibility for adherence.
Enjoyment	A positive emotion, a positive affective state	The more a client enjoys exercise, the more likely he or she is to be intrinsically motivated and stick with an exercise program. By including tailored programming, appropriate social support, and other techniques mentioned in this table, one can maximize techniques to

	assist the client in his or her exercise goals.

[a]Discussed in this chapter.

> Understanding the attitudes, values, meanings, and experiences clients associate with exercising and then teaching them the appropriate strategies to adhere to exercise based on these factors will contribute to the success of both the client and the Personal Trainer.

Approaches to promoting exercise adherence that do *not* include theory-based cognitive and behavioral strategies may not be as successful as those rooted in theory (14,15). The following section discusses two of the strongest theory-based concepts related to exercise adherence: self-efficacy and motivation for exercise (5,16). After these concepts are introduced, strategies to help clients improve their self-efficacy and motivation and thereby exercise adherence are discussed. The final section of this chapter introduces additional innovative strategies the Personal Trainer can use to further improve clients' exercise adherence and overall physical activity.

Self-Efficacy and Motivation in Relationship to Exercise Adherence

Self-Efficacy and Exercise Adherence

Research in physical activity and exercise has identified self-efficacy as one of the most consistent predictors of exercise adherence among adults (17–19). Self-efficacy refers to an individual's confidence in his or her ability to successfully complete a specific behavior (20). Self-efficacy for a specific behavior influences the activities in which that individual chooses to participate. In other words, the higher the self-efficacy, the more effort an individual puts forth toward the activity, and the more persistent he or she is in participating in the behavior — despite barriers and failures (16). Main sources of self-efficacy include one's vicarious experiences (*i.e.*, observing others), verbal persuasion/encouragement, physiological arousal/emotional state, and own mastery experiences. When working with clients to build self-efficacy, it is important for the Personal Trainer to understand that self-efficacy may impact clients' abilities to complete tasks (exercise), overcome barriers, and achieve goals. Later in this chapter, strategies to help clients improve their self-efficacy are discussed. These strategies include teaching clients how to overcome barriers, regulate exercise behaviors, and access social support. These strategies can help clients develop their self-efficacy and motivation for exercise and may, therefore, help them to adhere to exercise (5,16).

> Self-efficacy, a strong predictor of exercise adherence, refers to an individual's confidence in his or her ability to successfully complete a specific task or adhere to a specific behavior.

Motivation and Exercise Adherence

Motivation toward a behavior can be classified on a continuum of extrinsic (least autonomous form) to intrinsic (most autonomous form), which is closely related to the reinforcing value of a behavior (19). In general, the reinforcing value of an activity is influenced by the accessibility (how much work is required to participate) and the rewards one associates with it. For many, participation in a Personal Training exercise session may not be considered highly accessible because it could require travel to a fitness center, bringing and changing into appropriate clothing/shoes, as well as additional scheduling and time management of their daily tasks, all of which could reduce the overall reinforcing value of exercise. This is especially true when one may weigh the options of working out against a highly desirable, accessible, and typically rewarding (*e.g.*, relaxation, comfort) sedentary behavior such as watching television (TV). In regard to rewards, for the average adult, exercise may result in immediate discomfort (*e.g.*, sweating) and delayed benefits (*e.g.*, weight loss). These delayed benefits could result in a client's decision to drop out of an exercise program, especially if motivation toward the behavior is low to begin with.

In terms of motivation to exercise, many clients may be highly extrinsically motivated at the start of an exercise program (*e.g.*, strong desire to lose weight). However, if his or her main goal is to dazzle classmates at a 20-year class reunion, what will continue to motivate him or her after the event is over? When clients are extrinsically motivated, they participate in exercise to achieve external outcomes, such as weight loss and appearance. Extrinsic motivators do appear to be successful at helping individuals start exercise programs but do not typically result in long-term adherence once the event, objective, or goal has been obtained (16). Alternatively, when clients are intrinsically motivated, they participate in exercise to achieve internal outcomes, such as enjoyment of the activity itself, the feeling of accomplishment after the workout is completed, or the challenge it provides.

Both extrinsic and intrinsic motivations are associated with the self-determination theory (SDT). SDT suggests that certain psychological needs have to be satisfied in order to become intrinsically motivated. These needs are the following: autonomy (the desire to be responsible for choosing the behavior in which you participate), relatedness (the desire to be connected to others and feel understood by others), and competence (the belief that you are able to complete a specific behavior in order to reach your goal) (21,22). SDT works on a continuum where motivation can range from not having any motivation to being entirely intrinsically motivated. Research has shown that intrinsic motivation and more internalized (*i.e.*, autonomous) forms of extrinsic motivation contribute to exercise adherence (23,24). In other words, clients who value and enjoy exercise and find exercise personally challenging are more likely to adhere to exercise (25,26).

In most cases, a client will initially be more extrinsically motivated than intrinsically motivated to participate in exercise. Therefore, strategies that shift individuals' motivations toward intrinsic motivation and autonomy may be essential components of each client's training program (26). The Personal Trainer can help clients increase their intrinsic motivation for exercise by improving their feelings of autonomy (*e.g.*, letting clients take an active role in designing their exercise plan), relatedness to others (*e.g.*, striving to know clients better by being an empathetic and active listener; see Chapter 9), and competence (*e.g.*, helping clients to slowly and successfully maintain all aspects of their exercise regimen). Later in this chapter, information is provided relative to encouraging clients to be autonomous, feel connected with others, and improve their competence by teaching strategies for overcoming barriers, setting their own goals, monitoring their exercise, and associating with supportive people and environments.

Strategies for Increasing Exercise Adherence

It is logical that building a client's self-efficacy and intrinsic motivation may contribute to his or her adherence to exercise. In order for the Personal Trainers to understand *how* they can impact a client's self-efficacy and intrinsic motivation for exercise, they must first understand the basics of the theories they are rooted in. According to the self-efficacy theory, mastery experience, vicarious experiences, verbal persuasion, and one's emotional/physiological state contribute to one's self-efficacy (27). Mastery experiences provide the client with a direct experience in successfully completing a skill or habit. The more one can master a skill/habit, the greater the self-efficacy for that task will become. Personal Trainers can help clients master the act of exercise in many ways including helping them overcome barriers and have enjoyable exercise sessions under their supervision. Personal Trainers can also help their clients by connecting them with social support, which would provide vicarious experiences for their clients. Watching others successfully go to the gym and create healthy habits can help improve their client's self-efficacy. Personal Trainers could also use technology and social platforms to act as a role model, demonstrating their own exercise and physical activity habits for clients starting with them.

Furthermore, using positive talk in the gym as well as helping the client find social support who will also provide positive verbal persuasion is another strategy Personal Trainers can use to build their client's self-efficacy. Lastly, in order to enhance their client's emotional and physiological states, Personal Trainers should consider self-regulation techniques for their clients to help them meet their exercise behavior goals.

In addition to self-efficacy, such strategies can be used to improve the three psychological needs associated with the SDT including competency, autonomy, and perceived relatedness to improve one's intrinsic motivation. Given the relationships among these two factors (self-efficacy and intrinsic motivation) of adherence, the Personal Trainer can use a multitude of strategies to target these factors. As mentioned in the preceding text, strategies Personal Trainers can use to target main sources of self-efficacy and psychological needs associated with the SDT include teaching clients how to overcome barriers, regulate exercise behaviors, and access social support. This section outlines (a) these specific theory-based adherence strategies, (b) the strategies' relationships to self-efficacy and motivation for exercise, as well as (c) examples of application of these strategies to case studies. The tables in this chapter outline additional strategies Personal Trainers can use to help their individual clients adhere to exercise.

> Effective strategies for improving adherence include overcoming barriers to exercise, self-regulating exercise, and accessing social support for exercise.

Overcoming Barriers

Barriers are specific to each client and represent individuals' perceived obstacles to exercise (28). Clients may simply not know how to overcome barriers or may have low self-efficacy for overcoming barriers. Personal Trainers can help their clients overcome barriers to exercise by ensuring clients understand their personal benefits of exercise and perceived barriers to exercise. Using the benefits and barriers each client identifies, the Personal Trainer and client can work together to develop strategies the client can use to overcome each barrier and successfully adhere to exercise. The following sections provide more information on the Personal Trainer's role in helping clients understand their benefits of exercise, their barriers to exercise, and ways to overcome barriers.

Benefits of Exercise

Individuals who perceive that the benefits of exercise outweigh the barriers to exercise are more likely to continue to exercise (29–31). The Personal Trainer may initially teach the client about the physiological and psychological benefits of exercise when clients are adopting exercise. Chapter 13 more thoroughly describes the benefits clients may receive from participation in exercise. When focusing on exercise adherence, the Personal Trainer and his or her client may need to periodically review the client's perceived benefits because these may change over time (4,32). For example, a client initially focused on exercise for weight loss may begin to understand the emotional benefits, such as increased happiness or quality of life (33), after participating in exercise for several weeks or months. Although continued acknowledgment of the client's perceived benefits of exercise is important, a Personal Trainer should also acknowledge that individuals who are more intrinsically motivated will likely adhere better to exercise. Therefore, the focus for clients who are working on adhering to exercise (as opposed to adopting exercise) should primarily be on reinforcing intrinsic and direct effects of exercise while also identifying barriers to continued exercise and developing strategies to overcome these barriers. The Personal Trainer's guidance in relation to overcoming barriers may be crucial to the clients' adherence to exercise.

Barrier Identification

It is important for the Personal Trainer to note that, like benefits, barriers may differ between clients depending on various factors such as gender, age, weight status, fitness level, and history with exercise. Barriers may be personal, social, or environmental in nature (34) and include obstacles such as a perceived lack of time, motivation, confidence, or social support; family and social expectations; temptations and high-risk situations (*e.g.*, friends inviting a client out for dinner/drinks during scheduled gym time); and an inability to prioritize one's own needs over the needs of others (34–36). After achieving a better understanding of clients' personal benefits of exercise, and their values surrounding those benefits, the Personal Trainer can not only identify possible barriers to exercise but also show them that, with some effort and commitment by the client, barriers can be overcome. By prioritizing the importance of their client's values, the Personal Trainer can reinforce the client's motivation with a greater potential for adherence to exercise. Clients who are able to increase their self-efficacy for overcoming barriers during exercise programs are more likely to adhere to exercise (19,37–39). The following paragraphs outline the three major categories of barriers to exercise — personal, social, and environmental — and strategies the Personal Trainer and his or her clients can use to overcome these barriers.

Personal Barriers

Personal barriers are individual-level barriers that may be internal or behavioral (31). Examples of personal barriers include perceived lack of time, boredom, lack of motivation, injury, and relying only on extrinsic motivation for exercise. Although perceived barriers differ among individuals, lack of time is one of the most commonly cited barriers to exercise despite the average American adults spending >50% of their leisure time watching TV (2).

To increase overall participation and reduce dropouts, the Personal Trainer can develop strategies with his or her clients to help identify availability throughout their day and better manage time; assist clients with goal setting to increase enjoyment and motivation; and teach clients about fitness concepts, benefits of exercise, as well as the dangers of inactivity to increase knowledge. The Personal Trainer can also express empathy and assure clients of his or her fitness credentials and take clients through programs slowly if clients have a fear of injury or are recovering from an injury or illness. Additionally, Personal Trainers can help clients build their self-efficacy through intrinsic goal setting and accomplishment of these goals, mastery experiences, positive social persuasion, improving emotional states, and social modeling. Goal setting is discussed in-depth later in this chapter.

First, providing clients with opportunities to successfully complete challenging but attainable tasks and goals can help them to master experiences, thereby increasing their self-efficacy for exercise. It is important for these mastery experiences to be achieved early on in programming to build confidence. After these tasks have been successfully accomplished, more challenging goals can be set to continue with progress. For example, when developing a workout for a client, the Personal Trainer might challenge the client while still considering the client's current fitness level and preferences. Performing the task (*e.g.*, the workout) successfully can strengthen a client's self-efficacy; however, the Personal Trainer must also use caution when challenging clients because failing to master tasks can weaken a client's self-efficacy (20). In an effort to help one master the exercise experience, it is important for the Personal Trainers to view the exercise experience from their client's perspective. Although many Personal Trainers may enjoy exercise, a growing body of literature suggests that variables such as exercise intensity and body mass index (BMI) may significantly impact how a client feels during exercise, particularly an untrained individual. Recent evidence suggests that exercise intensities which exceed ventilatory threshold, even at moderate intensities, may elicit negative feelings for some clients (40). Given that intensity has been found to be strongly related to exercise adherence rates (4,8) and that moderate intensity is very commonly prescribed in exercise programs, it becomes essential for the Personal Trainer to individualizing exercise prescriptions in order to maximize psychological variables such as positive core affect and enjoyment of exercise in order to promote adherence to programs (1,41). Furthermore, individuals who are overweight (BMI >25 kg m^{-2}) may experience greater feelings of displeasure during exercise compared to those with a BMI <25 kg m^{-2}, especially if that exercise is prescribed at higher than the client's preferred, self-selected intensity for a given activity (42). To help identify an exercise intensity that is both physiologically stimulating to meet the client's goals and behaviorally manageable and enjoyable, the Personal Trainer may consider allowing clients to self-select their intensities because recent studies have suggested benefits to this technique including better adherence to exercise programs (19,20) more pleasurable responses during exercise (8,9) as well as reinforcing the autonomy of the client to increase likelihood of continued future participation. Given that most individuals tend to self-select exercise intensities that are slightly below their ventilatory threshold (7,14), the Personal Trainer may be able to avoid some of the negative feelings experienced during exercise that are commonly reported to be elicited by higher exercise intensities. It should be noted that not all adults will report feelings of displeasure during high-intensity exercise and that due to the independent benefits of vigorous exercise, Personal Trainers should not avoid prescribing such intensities altogether. In fact, strategies that combine moderate and vigorous intensities in the same exercise session have been successful in maintaining a pleasurable experience during exercise while also increasing physiological demand to meet goals and obtain health benefits (7). These findings highlight the importance of skilled Personal Trainers and their responsibility to personalize exercise programs while also taking into consideration the pleasure and/or displeasure one may experience during exercise. These experiences represent a significant potential personal barrier to exercise that are predictive of physical activity levels 6 and 12 months after an exercise intervention (19).

Second, one of the Personal Trainer's most important roles is often as the client's motivator. Persuading the client to believe that he or she is capable of accomplishing tasks can help the client to build his or her self-efficacy for overcoming barriers. For example, verbally persuading a client that he or she can successfully incorporate exercise into his or her daily routine, despite time barriers, may help the client build confidence to overcome barriers and continue to participate in exercise (20). For example, asking your clients to recall a time that they recently changed an aspect to their routine could help them realize that change is possible. Finally, providing the client with anecdotal examples of other clients' experiences or the Personal Trainer's own experiences related to overcoming barriers can serve as forms of social modeling that can help clients build their self-efficacy. For example, if a client can relate to, or even have a conversation with, someone similar who has successfully overcome barriers, he or she may feel more capable of overcoming his or her own barriers, thereby increasing self-efficacy and exercise adherence (20). Specific examples illustrating how the Personal Trainer can use goal setting, mastery experiences, social persuasion, as well as social and self-modeling to help clients build their self-efficacy and overcome personal barriers are located in Table 8.2.

Table 8.2 Personal, Social, and Environmental Barriers to Exercise

Barrier	Strategies to Overcome Barrier
Personal	
Lack of time	■ Ask clients to document how they use their time for 1 wk and identify areas where they can incorporate exercise. ■ Encourage clients to use active transportation and make active lifestyle choices (*e.g.*, bike to work, take the stairs, park further away from stores, lunch or dinner walk, walking meeting). ■ Explain to clients that several smaller bouts of exercise (10 min each) are as effective as one longer bout of exercise. ■ Work with clients to help them schedule exercise in their schedules that is realistic (can reduce inactive time such as watching TV and replace it with a walk or other exercises).
Lack of motivation	■ Discuss with clients their reasons for hiring a Personal Trainer and for exercising. ■ Encourage clients to use self-regulating strategies, such as stimulus control, to make it easier for them to be active. ■ Help clients to find activities in which they enjoy participating.

	■ Discuss with clients why physical health and psychological health are important for them and ask them whether their current behavior is focused on their health. ■ Discuss intrinsic and extrinsic motivations and their consequences on maintenance of exercise.
Lack of energy	■ Discuss with clients the benefits of exercise, including increased energy. ■ Ask clients what time of day they think they could consistently participate in exercise. ■ Discuss clients' diet with them to ensure that they have energy for exercise. ■ Encourage clients to employ strategies, such as driving straight to the gym from work. ■ Have clients record their energy level before and after exercising and compare their energy level on days they exercise vs. on days they do not exercise.
Lack of knowledge about exercise	■ Use "teaching moments" during clients' exercise programs to increase their knowledge of fitness concepts to increase intrinsic motivation by increasing competence. ■ Direct clients to specific sources (*e.g.*, online, books, handouts, blogs, videos). ■ Do a visit of the gym and highlight other opportunities for being active. ■ Asking what exercise means to clients and adjust potential misconceptions. Many people think exercise is at the gym, but activities such as walking, gardening, or doing chores are also forms of physical activity.
Dislike of sweating or vigorous exercise	■ Encourage clients to exercise for longer durations at lower intensities. ■ Ensure that clients understand that exercising at lower intensities can still provide health benefits. ■ Teach clients about the benefits of vigorous exercise. ■ Slowly integrate high-intensity exercises into clients' programs to build their intrinsic motivation for vigorous exercise. ■ Change the perception of sweating as a mechanism to cool down the body and a sign that clients worked hard and will experience health benefits faster and that using wipes and changing a shirt can be fast and easy.
Physical barriers (*e.g.*, obesity, injury, disease)	■ Help clients start slow and increase their exercise gradually. ■ Provide clients with workouts that do not exacerbate any preexisting or past conditions. ■ Discuss with clients the benefits of exercise because physical barriers may be accompanied by fear.

	■ Develop goals with clients and discuss with them the plan to achieve these goals.
Biological barriers (*e.g.*, puberty, pregnancy, aging)	■ Understand that certain biological changes may affect clients' current or past participation in exercise. Tailor exercise programs to meet clients' needs and refer to an exercise specialist when necessary. ■ Refer to exercise guidelines regarding specific conditions. ■ Tailor exercise programs to meet the clients' needs and work directly with the clients' health care provider. ■ Refer to a medical provider when necessary.
Poor body image	■ Discuss with clients the health and psychological benefits of exercise as opposed to weight loss/maintenance. ■ Help clients develop goals and rewards not related to weight loss. ■ Encourage clients to recognize qualities they like about themselves, including body and nonbody-related attributes. ■ Discuss the concept of body composition and the fact that the balance muscle mass/fat mass is more important than the total weight.
Extrinsic motivation	■ Clients with extrinsic goals may be discouraged by lack of results or become complacent once extrinsic goals are met. Help clients to develop their intrinsic motivation for exercise. ■ Make clients aware of the long-term effectiveness of intrinsic goals compared to the short-term effectiveness of extrinsic goals, such as weight loss. ■ Recognize that most people have both intrinsic and extrinsic goals, but intrinsic goals are more prevalent in regular exercisers.
Past experience(s) with exercise	■ Discuss with clients their past experiences (both good and bad) with exercise before starting a training program and show empathy with those past experiences. ■ Consider each client's past experiences in developing exercise programs to ensure that programs and goals support the development of self-efficacy and motivation. ■ Concentrate on what successes clients previously had with exercise or a similar behavior change to help increase a level of mastery and self-efficacy.
Fear of injury	■ Make clients aware of credentials and credentials of related fitness professionals (*e.g.*, group exercise instructors). ■ Communicate with clients throughout the exercise program. ■ Slowly progress clients as their fitness levels increase. ■ Provide a safe environment and spot clients in the first few trials.

Social	
Family/friend/work obligations	■ Encourage clients to have serious discussions with family and close friends to discuss their needs and goals. ■ Teach clients how to access the tangible social support they may need to allay these obligations. ■ Discuss priorities with clients to identify any instances in which obligations are self-imposed (*e.g.*, saying “yes” to everyone who asks). ■ Discuss ways to include physical activities throughout the day with others, such as walking meetings, lunch walk/run, and play with family members.
Lack of social support	■ Encourage clients to have serious discussions with family and close friends to discuss their needs and goals. ■ Ask clients to identify the social support they need to exercise. Then, discuss various methods of accessing this support. ■ Help clients to identify activities they can do with their friends and family, that is, activities their friends and family enjoy.
Culturally inappropriate activities and gender role expectations	■ Gender roles can vary by family, age, and culture. Be aware of differences in obligations between men and women. Help clients to develop strategies for overcoming barriers that fit into their lifestyle and belief system.
Environmental	
Lack of access to programs or facilities; cost of programs and facilities	■ Give clients active transport, lifestyle, home, and outdoor activity ideas they can use outside of training sessions. ■ Prepare clients to become independent in their exercise behaviors, including teaching them about relapse prevention. ■ Help clients become aware of free exercise opportunities within the community. ■ Provide clients with the names of exercise DVDs they can use at home.
Safety concerns — absence of sidewalks or bike lanes, unsafe neighborhood, heavy traffic	■ Help clients identify parks or other quiet places in which they can exercise. ■ Use strategies for accessing social support to help clients learn how to enlist friends/family to exercise with them. ■ Provide clients with a list of affordable home equipment options and provide exercises that can be used with the equipment. ■ Provide examples of body weight exercises and exercises that can be done with simple household items.
Bad weather	■ Teach clients to develop contingency plans so that they have backup plans for each workout.

	■ Teach clients how to plan for varying weather conditions. Discuss with them the appropriate clothing/apparel they should wear in extreme temperatures.
Lack of shower facilities	■ Provide clients with low-intensity activity options and activities they can do in short bouts. ■ Discuss options to bring an extra set of cloth and use of cleaning wipes.

Social Barriers

Social barriers are barriers that arise in relation to an individual's social network. A social network refers to the group of significant individuals (*e.g.*, close family and friends) in the client's social life (43). Examples of social barriers include caregiving (especially childcare), lack of social support, and sociocultural barriers, such as cultural values regarding gender roles and accepted behaviors. One strategy that Personal Trainers can use is teaching clients home-based exercises or how to engage family members in activity to alleviate barriers related to caregiving. For examples, the Personal Trainer could suggest that the client include his or her family in an evening walk, play tag/sports at a park, or even go to a local pool to swim laps. Additionally, understanding what types of social support clients need and teaching them how and where to access this support within or outside of their social networks may help them achieve the support required to adhere to exercise. A client's coworker, neighbor, or even another client of the Personal Trainer are great examples of possible social support opportunities.

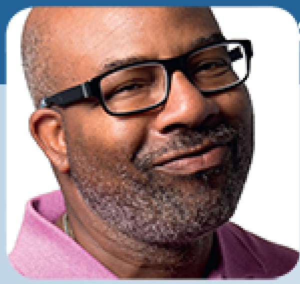
Environmental Barriers

Environmental barriers are physical barriers, often outside of the individual's control, that prevent him or her from being active. Examples of environmental barriers include lack of access to exercise facilities, bad weather, and safety concerns (*e.g.*, absence of sidewalks or bike lanes, crime) (34,44). Developing programs that include physical activity outside of the gym may provide a positive alternative to increase physical activity levels for a client who reports access issues. The Personal Trainer can use the self-regulation strategies presented in this chapter including identifying environmental factors (*i.e.*, access to gym facility), helping clients identify times of day that are more accessible, and finding social support for their clients in order to hold them accountable and to help them successfully plan for exercise in anticipation of barriers that may upset their exercise routine. Safety can be a major concern for clients living in all different types of areas (44); therefore, in addition to identifying social support for exercise, the Personal Trainer can help clients find safe walking and cycling routes, structured community-based programs, and exercise partners whom they can participate in exercise with. Additional strategies on how the Personal Trainer can help teach clients how to use their physical environment to increase their activity instead of viewing the environment as a barrier are provided at the end of this chapter in the "Innovative Strategies to Increase Adherence" section.

> Barriers may be personal, social, or environmental. Individuals who are able to increase their self-efficacy for overcoming barriers may be more likely to adhere to exercise. Strategies for overcoming barriers to exercise should be tailored toward each client's specific barriers.

Table 8.2 lists examples of personal, social, and environmental barriers commonly reported by adults and strategies to help clients overcome these barriers. It is important to note that the Personal Trainer can use similar strategies for targeting different types of barriers. For example, helping clients to build self-efficacy by mastering experiences may be a strategy used for personal, social, and environmental barriers alike. More specifically, partnering two clients with similar fitness levels may help address the social barriers while also providing opportunities for verbal persuasions and vicarious experiences for your clients, two important sources of self-efficacy. Creating a similar table with clients may help them identify their individual barriers to exercise and strategies for overcoming these barriers.

Barriers to exercise may also change over time within the same client; therefore, periodically using the table to reevaluate barriers with clients may help them develop new strategies for overcoming barriers. The bottom line is that individuals who are able to successfully overcome barriers will develop high self-efficacy for overcoming barriers and become more likely to continue to exercise over time (37). An example of how to help a client overcome barriers to exercise is found in Case Study 8.1.



se Study 8.1

Increasing Adherence by Identifying Barriers to Exercise (and Solutions): Noah is 52 years old and recently received a free Personal Training session from a raffle drawing at work. Although Noah was active in high school and college, playing intramural sports, he has a hard time obtaining more than 7,000 steps per day due to his sedentary, full-time job. After work, Noah spends most of his time driving his kids to various after-school activities and has found that staying active himself isn't as easy. Due to these challenges, Noah does not regularly exercise and has put on a considerable amount of weight since college. This additional weight gain has made the few attempts at exercise he has made very uncomfortable and unenjoyable. Additionally, he is often pressured by his friends to go out for drinks on weekends, so it's hard for him to stay on track. Noah's father just had a heart attack, which has made him realize he needs to prioritize his health and get active.

QUESTIONS FOR CONSIDERATION

What types of questions can you ask Noah to learn more about why he has so much trouble adhering to exercise? What barriers do you think play a role in his inability to adhere to exercise? How would you start working with him? Are there things you can teach him that may help improve his adherence (*e.g.*, identifying time management issues, self-regulation strategies)? What strategies can you use to get him to be intrinsically motivated?

Exercise Self-Regulation

Although a client's motivation for exercise is an important predictor of exercise adherence, motivation alone is often not enough to succeed in adhering to exercise (45). Developing additional skills related to exercise self-regulation is necessary to increase exercise adherence. Individuals may *intend* to exercise, but the emergence of barriers and non–exercise-related temptations can make it difficult for them to choose exercise (46). Exercise self-regulation involves strategies for planning, organizing, and managing exercise activities in order to "stay on track." Exercise self-regulation strategies include planning exercise, setting exercise-related goals, self-monitoring exercise behavior, and preventing relapse (45).

Planning Exercise

As mentioned earlier, barriers to exercise can be serious inhibitors to exercise adherence. Therefore, in addition to learning strategies for overcoming barriers, clients must learn how to develop a plan for exercise (47). Planning is extremely important because it can help clients get into the habit of exercising regularly, and regular exercise contributes to a simultaneous increase in both self-efficacy and exercise adherence (5,39). Additionally, understanding clients' weekly schedule and commitments and helping them find the best or most realistic days/times to exercise may assist in their exercise adherence.

There are several strategies that can be used to plan for exercise. Specifically, the Personal Trainer can teach clients how to (a) manage their time in order to schedule exercise, (b) develop backup plans in case of unavoidable conflicts, (c) plan their workouts *before* arriving at the gym, (d) implement cues to action to control outside stimuli (*i.e.*, temptations and barriers) and make adherence easier, and (e) identify a variety of ways to be active. Furthermore, bouts of physical activity (*i.e.*, 10-min walks, three times a day) versus continuous exercise may be a positive alternative to increase physical activity levels for a client who has a busy schedule. Time management is extremely important because clients may tell the Personal

Trainer that they do not have enough time for exercise. Asking clients to keep a log of how they spend their time for a day, few days, or an entire week may help them identify areas during the day in which exercise can be incorporated (48). Because life can be unpredictable at times, backup plans are essential to a client's exercise plan. Backup plans make it easier for a client to adhere because plans B and C are in place *before* plan A fails. Additionally, if a client does not have a workout plan before exercising, it may be difficult for him or her to meet exercise goals. The Personal Trainer can help clients understand the importance of having a plan for each workout. For some, scheduling exercise before an activity that requires intense cognitive demand such as a difficult class, job interview, or major work commitment may help improve time commitment challenges. For others, exercise can be scheduled at the end of the workday to defuse stress and reenergize for the evening. Helping identify a client's preference for, resources, and perceived barriers to exercise will help enhance time management and overall adherence.

Next, clients can practice stimulus control by putting planned cues to action in place to overcome barriers to exercise. Stimulus control refers to the idea of modifying the client's environment so that it is conducive to making choices that support exercise (7). For example, a client who lacks motivation for exercise might lay his or her exercise clothes out before going to bed at night as a positive cue for exercising. Additionally, one may set his or her alarm clock with motivational music or set the phone/alarm further away from the bed to encourage him or her to get up and moving first thing in the morning. Likewise, a client reporting lack of time as a major barrier to exercise may need help in identifying points during the day when he or she can exercise. It is most important for the Personal Trainer to work with clients to develop specific strategies to control stimuli in order to help them successfully adhere to exercise. Finally, resources can be provided to help clients identify a variety of ways they can become active, such as choosing group fitness classes, enrolling in community programs, registering for events (*e.g.*, a 5K run), or enlisting friends to exercise with them. Find out what planning strategies each client needs and use the earlier ideas — with other newly developed strategies — to help clients successfully plan exercise.

Teach clients how to (a) manage their time in order to schedule exercise, (b) develop backup plans in case of unavoidable conflicts, (c) plan their workouts *before* arriving at the gym, (d) control stimuli to make adherence easier, and (e) identify a variety of ways to be active.

Avoiding Relapse

Chapter 7 describes how individuals move through the stages of change within the TTM as they consider exercise behavior. Ideally, individuals move through these stages of behavior change, ultimately reaching maintenance (*i.e.*, adherence) (33). However, even after reaching the maintenance stage of change, psychological factors and high-risk situations, such as expectations of exercise, life events (*e.g.*, births, death in family), holidays, and injuries; decreased social support; change in access to exercise opportunities; and decreased motivation for exercise can impact continued adherence to exercise (3,49,50). Factors such as these may cause a lapse (brief period of 2 or more wk without exercise) or relapse (complete return to sedentary behavior) in exercise adherence (51). Most adults encounter lapses at some point during their participation in exercise (52), and it is important to notify this to the client to normalize it. The psychological impact of relapse can negatively influence self-efficacy (53). Therefore, talking to clients about relapse *before* it occurs may better prepare them to maintain their participation in exercise (51). Teaching clients that lapses and relapses do not equal failure may not only help them to stay active but may also help them to maintain their self-efficacy and reduce negative cognitive and affective states (4). One important strategy for relapse prevention is minimizing abstinence violation effect, which results in such negative psychological and emotional states when someone lapses from a personal commitment or previously set goal. Instead of allowing individuals to feel like they have lost control of their goals, the Personal Trainer can help them cope with negative feelings by reinterpreting a missed exercise session as normal and use it as a learning experience for clients, so they can better self-regulate. Understanding the fact that clients may move forward and backward along the TTM is important for the client and Personal Trainer to understand. Part of the role of the Personal Trainer is being able to provide strategies to prevent any backward slide or relapse in order to assist the client in staying on track with the exercise.

> To help clients adhere to exercise and avoid relapse, Personal Trainers should discuss potential situations *before* they occur in order to prepare the client for high-risk situations.

Personal Trainers can help clients commit to an exercise regimen by teaching them the importance of remaining vigilant in their self-regulation of, and participation in, exercise (4). Although a client may come to his or her initial Personal Training session with extrinsic goals such as weight loss, it is important for the Personal Trainer to educate the client about weight, body composition, diet, and exercise. Specifically, that body composition is more important than weight and that the decrease in fat and increase in muscle mass may result in a limited weight change unless diet changes are also made. Discussing realistic expectations for exercise with clients and working with clients to set other *intrinsic* goals will be important for the improvement of the client's self-efficacy and prevention of relapse (51). Personal Trainers can also ask clients to identify situations that may lead to lapse or relapse and work with clients to develop plans for staying active in these situations. The commitment to exercise the client develops will encourage forming habits related to regular exercise and ultimately limit his or her potential for lapse and/or relapse (4). In addition, if a client plans to discontinue Personal Training in the near future, the Personal Trainer might discuss how exercise can be continued without his or her help. Using strategies related to self-regulating exercise and overcoming barriers will equip clients with the coping skills they may need to effectively deal with relapse if or when it occurs (3).

Goal Setting

Goals give action and meaning to behavior, in addition to directing behavior (47). Furthermore, goals tend to increase effort and lead to greater persistence. Goal setting must be a collaborative partnership between the Personal Trainer and client. Giving clients the opportunity to make decisions about their goals related to exercise helps them increase their autonomy related to exercise and their competence in goal setting, thus increasing their self-efficacy and helping them to become more intrinsically motivated for exercise. Teaching clients how to properly set goals is especially important if their initial motivations for hiring a Personal Trainer are extrinsically focused (*e.g.*, weight loss, appearance).

A client who focuses on exercising for extrinsic reasons may struggle to adhere to exercise because of lower levels of self-efficacy and satisfaction as a result of not meeting extrinsic goals (*e.g.*, not losing the weight they intended to lose) or of losing motivation after meeting extrinsic goals (*e.g.*, losing the weight they intended for a one-time event/reason). Clients often do not know what to do next because they have lost the weight they set out to lose and often fall into relapse because of this extrinsic orientation toward exercise (47). In addition, individuals with extrinsic goals may not value exercise over other intrinsically motivated behaviors or preferred leisure pursuits, such as spending time with family and friends or watching TV (34,53) and may, therefore, choose other behaviors before exercise. Alternately, a client who is intrinsically motivated to exercise (*i.e.*, enjoyment, feeling good) is more likely to continue exercise participation long term because they experience satisfaction by just participating and are not focused on results (5,47,54).

The best way for the Personal Trainer to help clients become intrinsically motivated for exercise and set intrinsically motivated goals that will work is to use the SMART goal principle (7). The SMART goal principle suggest that goals should be specific, measurable, achievable, relevant, and time-sensitive (34,55). A goal is specific in that it states *exactly* what the client aims to achieve (*e.g.*, I will participate in a *triathlon*). A goal is measurable in that it can be quantified (*e.g.*, I will run *four times* this week). The achievability of a goal is also related to how realistic the goal is for each particular client. For example, a client with extrinsic motivations for exercise may tell his or her Personal Trainer that he or she wants to lose a significant amount of weight during a short period of time. It is the Personal Trainer's responsibility to educate his or her clients about realistic goals and physiology behind safe and effective weight loss in order to help clients build and/or maintain their self-efficacy toward goal setting. A goal is relevant if it is related to the overall goal set by the client (*e.g.*, I will *run* four times a week to be ready for the *triathlon*). Finally, a goal is time-sensitive in that it has a target end date (*e.g.*, I will participate in a triathlon *in 6 mo*). The time-sensitivity of a goal is also related to its achievability (55). The Personal Trainer can help clients understand that reaching exercise related goals will take time and commitment. Setting SMART goals will help clients more effectively plan and monitor exercise, and, as they develop goal-setting skills, they may feel more autonomous and successful as exercisers (47,56,57).

> Give clients the opportunity to make decisions about their goals related to exercise to help them increase their autonomy related to exercise and their competence in goal setting. Teach clients how to set SMART goals: specific (precise, specific), measurable (quantifiable), achievable (action oriented, what needs done), relevant (realistic, achievable), and time-sensitive (realistic time frame).

The SMART goal philosophy can be applied to the development of long-, mid-, and short-term goals. Long-term goals represent the client's overall objective for hiring a Personal Trainer and for exercise, whereas short-term (1–2 wk) and midterm (several weeks) goals serve as intermediary objectives through which the overall long-term (several months) goal can be achieved (4). Each exercise program should include teaching the client to recognize the importance of starting slowly using short-term goals that are conducive to the long-term goal (4). For example, for a client who wishes to participate in a triathlon in 6 months, short-term goals related to the frequency, duration, and intensity of running, cycling, swimming, and resistance training are key to the client's achievement of his or her long-term goal. It is also essential that the Personal Trainer and client periodically reevaluate goals, the client's progress toward goals, and his or her motivations for exercise. With this information in hand, Personal Trainers can modify or refocus short-term goals (and sometimes long-term goals), which is essential for a client's continued progress, achievement of long-term goals, and ultimately adherence (58).

Self-Monitoring

Monitoring behavior, including the thoughts and feelings that an individual associates with exercise, can help a client stay on track and adhere to exercise (45). Several tools, including wearable technology, mobile phone applications, the Internet, workout logs, and heart rate monitors, may help clients adhere to exercise (59). Monitoring tools, such as pedometers, show some evidence as motivators for exercise; however, their effectiveness in promoting exercise adherence is equivocal (60). One of the primary issues with these devices is that their initial impact on behavior tends to fade quickly. One possible way to combat this is to supplement such tools with social support for additional accountability. Online/virtual support communities are great resources for the Personal Trainer to use with clients in order to help connect them with others how have similar goals and interests.

When working with clients, the Personal Trainer can develop a self-monitoring plan that fits into each client's lifestyle. For example, clients may not be willing to commit to recording their exercise in a workout log, but they may find it easy to work with a mobile phone application in which they can view exercise time, distance traveled or step counts, and average heart rate. Many fitness professionals use the Internet to stay connected with clients (61). This not only provides clients with additional social support but also allows them to use online tools, such as blogs and online workout logs, to interact with other clients and monitor their workouts and progress. More information on how to use the Internet to support exercise adherence is provided at the end of this chapter in the “Innovative Strategies to Increase Adherence” section. It is important that the Personal Trainer discusses self-monitoring options with clients to determine which methods of self-monitoring are most appropriate for them. An example of how to use self-monitoring and other self-regulation strategies can be viewed in Case Study 8.2.

Case Study 8.2

Increasing Adherence by Identifying Life Circumstances (Environmental Factors): Johanna has recently noticed a rapid, unexplained weight gain. Upon follow-up with her medical provider, she was diagnosed with hypothyroidism. With this new diagnosis, she often gets down on herself because she isn't happy with her body and the way it looks. Johanna decided to hire a Personal Trainer to help her get in shape and help combat some of symptoms associated with this condition. She was hoping that her husband would join with her, but he does not think that he or Johanna needs to change. During the initial stages of Johanna's program, she told the Personal Trainer that her husband does not agree with her decision to hire a Personal Trainer because it costs too much; she also mentioned that sometimes she doesn't exercise because her husband wants her to watch TV instead or she gets really busy at work. Johanna had some success initially with weight loss, and she likes group exercise classes, but she is discouraged with how much effort it takes to lose such a small amount of weight. Johanna is concerned that her busy work schedule will prevent her from being able to fully commit and stick with an exercise routine long enough to be able to see her desired health benefits.

QUESTIONS FOR CONSIDERATION

What factors are playing a role in Johanna's lack of success with her exercise program? What can you do to help her increase her adherence to exercise?

Strategy: Exercise Self-Regulation

Johanna's job (*i.e.*, time and motivation) and lack of social support are serious barriers to her adherence to exercise. Although she *intends* to exercise to help combat her weight gain possibly associated with her hypothyroidism, she does not have the proper planning tools in place to follow through with her intentions to exercise. Teach Johanna how to plan for exercise. She may need to make a daily schedule, employ strategies such as going straight to the gym after work, or participate in exercise at home or at work some days of the week.

Johanna's self-esteem and poor body image may be discouraging her from exercise. Revisit Johanna's motivations for exercise and encourage her to consider other goals in addition to weight loss with that will be as beneficial (if not more beneficial) to her health, such as meeting new people, relieving stress, and feeling good. Having Johanna reflect on her experiences after each group classes could help her identify benefits outside of weight loss. Specifically, having her write what how she felt in the next hours after the exercise class could expand her perception of exercise benefits.

Strategy: Social Support

Johanna isn't getting the support she needs to be active from her husband. Consider encouraging Johanna to have a serious conversation with her husband about how important staying active is to her and her health and that she needs his support in order to be successful.

Talk to Johanna about how she can access other sources of social support as well. She mentioned that she enjoyed a group fitness class. Encourage her to introduce herself to the instructor and/or enlist a friend to attend classes with her. Building relationships with the instructor or other participants might give Johanna the accountability she needs to keep attending the class.

Self-regulation allows clients to plan, organize, and manage exercise activities. Setting intrinsically motivated goals with clients help them adhere to exercise better as compared to setting extrinsically motivated goals. Finding self-monitoring options, such as online workout logs, that work for each client may help them to better self-regulate their exercise.

Social Support

Social support includes an exchange of aid or assistance among individuals or groups within a social network (43). Research has shown that high levels of social support for exercise lead to higher levels of self-efficacy, which, in turn, lead to increased participation in exercise (45). In fact, like self-efficacy, social support is one of the most consistent predictors of exercise participation (31,43) and can be separated into four types: (a) emotional, (b) tangible, (c) informational, and (d) appraisal. Emotional support refers to encouragement, empathy, caring, and concern (*e.g.*, praising a client for his or her effort, sympathizing for muscle soreness); tangible support refers to material aid in order to provide an individual the opportunity to exercise (*e.g.*, shoes, gym membership, spotting a client); informational support refers to advice or information given in regard to exercise (*e.g.*, a smart phone application that prescribes an exercise plan for a client who travels often); and appraisal support refers to providing information that can be used to evaluate progress and to validate that a client's thoughts ("this is difficult"), emotions ("I am feeling out of shape and it makes me sad"), and challenges are normal (*e.g.*, a client participating in a group exercise with similar people provides companionship and a sense that he or she is not alone in the struggle to maintain exercise) (43). The Personal Trainer may be responsible for providing the client with all four types of support. One client may need more informational support, whereas another client may need more appraisal support. Understanding a client's social support needs related to exercise will not only prepare the Personal Trainer to effectively provide the support the client needs to adhere to exercise, but it will also help the Personal

Trainer guide the client in developing strategies for accessing additional social support outside of the Personal Training session. Social support beyond the Personal Trainer–client relationship is essential to a client's continued participation in exercise. Strategies that may help clients feel more supported in their participation in exercise include identifying their social support needs, creating a supportive training environment, and teaching the client how to actively access additional social support (*e.g.*, group exercise classes, community-based programs).

Social Support Needs

Before teaching clients how to access social support, it is important that they understand what kind of social support they need to adhere to exercise. Table 8.3 includes examples of the different types of social support. Use this table to teach clients about the different types of social support and provide them with examples. For example, emotional support may involve spousal support for taking time to exercise or a friend accompanying a client to the gym. Tangible support may involve help with childcare, household duties, or costs to participate in exercise programs. Informational support may include knowledge and skills the Personal Trainer provides clients or information and referrals from the Personal Trainer regarding something that has been read on the Internet or in a fitness magazine. Appraisal support includes constructive feedback from the Personal Trainer or from significant individuals regarding progress and normalization the experiences of challenge. Help clients identify which types of support they find the most valuable, which types they currently have, and which types they do not have but need to access in order to adhere to exercise. Research shows that the main source of support for both men and women is their spouse or significant other (9,29); however, clients will certainly come from varying backgrounds. Therefore, knowing and understanding clients' social support needs can help the Personal Trainer and client develop a plan for accessing additional social support if necessary.

Table 8.3 Examples of Support

Type of Support	Example
Emotional support	■ Spouse taking a walk with the client and showing empathy and praise for the client's effort ■ Friend periodically calling to encourage sticking with a workout program ■ Group fitness instructor praising clients at the end of the class for their effort and talking to them individually to show care and empathy ■ Workout partners or buddy systems that provide encouragement and caring to the client
Tangible support	■ Spouse offers to cook dinner while your client works out. ■ Family member offers to watch the kids while your client works out. ■ Friend offers to pick up the dry cleaning to give your client more time to work out. ■ Spotting a client
Informational support	■ E-mails from health Web sites about how to incorporate exercise into your client's life ■ Handouts from a Personal Trainer on new exercise routines ■ Magazine subscription that provides your client with monthly information on exercise ■ Posters and informational bulletin boards
Appraisal support	■ Spouse who praises your client on the progress your client has made ■ Client seeing that other people are also struggling during exercise and recognizing that he or she is not alone ■ Comparing initial with current fitness data and highlighting the progress made by the client

Social support is an important predictor of exercise adherence and includes four types: (a) emotional, (b) tangible, (c) informational, and (d) appraisal support. Knowing what kind of support a client needs from the Personal Trainer and from other individuals in his or her social network is critical to his or her continued participation in exercise.

Creating a Supportive Environment

The Personal Trainer is responsible for providing clients with an environment that supports the fulfillment of their needs related to autonomy, relatedness to others, and competence. In order to foster autonomy, Personal Trainers can provide an environment in which clients are given the opportunity to make some of their own decisions in regard to their exercise programs. This can also include warm-up and cool-down options. This collaboration may help a client build autonomy and intrinsic motivation for exercise. Positive reinforcement and emphasizing the fun, challenge, and competence about exercise will increase intrinsic motivation. Furthermore, if clients do not feel understood in relation to their goals, needs, and reactions to successes and failures, the effectiveness of the Personal Trainer, as an exercise leader, may be diminished (21). Clients may lose some of their motivation to exercise and their self-efficacy for exercise due to a lack of relatedness to others. Individuals who work with positive and enthusiastic Personal Trainers whom they trust have greater self-efficacy than individuals who are expected to exercise on their own (5). Finally, asking clients to do challenging, but realistic, tasks and exercises within exercise sessions can help them to build competence and self-efficacy for exercise (5,17,20).

Accessing Social Support

Having social support increases the likelihood of adhering to exercise (43); however, what can be done if a client does not have social support? A client may hire a Personal Trainer because he or she is lacking social support somewhere in his or her life. Clients may need informational support from Personal Trainers because they simply do not know what to do, or they may need emotional support because they lack the motivation to be active on their own. Regardless of their reasons for hiring a Personal Trainer, to ensure that they adhere to exercise, it is essential that they learn *how* to access social support. Teaching clients how to access social support such as colleagues at work with similar interests, family and friends who may attend group exercise classes, neighbors, or even community members who are part of local running/cycling groups can help them to develop self-efficacy and, ultimately, increase exercise adherence (17,54).

A Personal Trainer who provides an environment that fosters clients' autonomy, relatedness to others, and competence may improve their clients' adherence to exercise.

Clients may need to have serious discussions with significant individuals in their social networks (such as spouses or bosses) to make them aware of the importance of exercise in their lives and to express their need of social support. Clients may need to be counseled as to how to begin such discussions, and Personal Trainers may need to help them identify the support they may need from each individual. Additionally, some of the strategies used for exercise planning, such as joining group fitness classes or enlisting a friend as an exercise partner, can also provide clients with the social support they need to adhere to exercise.

Community programs or sport leagues are an additional avenue that clients can use to find support. Many communities have clubs for most active interests, such as walking clubs, running groups, golf leagues, cycling clubs, and volleyball clubs. Additionally, communities offer sport leagues in softball, basketball, soccer, and hockey, to name a few. Using existing programs that are delivered in group settings may provide additional social support. The client's enjoyment of spending time with others may also positively impact adherence (14). Online communities and online/mobile supplements to Personal Training programs are another source of social support that may help clients adhere to exercise because they are promising approaches for clients with low levels of social support (62). Obviously, the Personal Trainer provides some social support; however, clients should be encouraged to find other resources to help support their exercise adherence. An example of how the Personal Trainer can encourage clients to access additional support can be seen in Case Study 8.2.

Many clients hire Personal Trainers because they do not have the social support they need to adhere to exercise. Teaching clients *how* to access social support within their social networks or home communities, or even online, may help them to develop self-efficacy and successfully adhere to exercise.

Innovative Strategies to Increase Adherence

Due to the complexity of factors that contribute to adhering to an exercise program, Personal Trainers can employ additional innovative strategies to make adhering to exercise easier for their clients. Activities often viewed as distractions from or barriers to exercise can be used to support exercise. For example, wearable technology and the Internet have become staples within everyday life and continue to evolve rapidly, making them important avenues for helping clients adhere. Additionally, most people have increasing demands on their time (perhaps one reason why some hire Personal Trainers); therefore, Personal Trainers can help clients to most effectively use their time by teaching them how to use their physical environment for exercise. This section introduces two innovative methods, the Internet and the physical environment, to help clients adhere to exercise. However, the Personal Trainer can establish innovative strategies of his or her own based on each client's needs, advances in technology, the community-specific physical environment, or other innovations of which the Personal Trainer is aware.

Using the Internet to Promote Exercise Adherence

Use of the Internet and mobile technology has grown rapidly worldwide, with 73% of Americans, men and women alike, have a desktop or laptop computer, 68% have a smartphone, and 45% have a tablet (63). More importantly, the Internet has become a significant source of health information among these users (61,63). In addition to using the Internet to support the behavior change strategies discussed in this chapter, such as overcoming barriers, goal setting, self-monitoring, and accessing social support (59,61), the Internet also provides Personal Trainers the opportunity to provide clients with Web-based interactive tools, refer clients to credible Web sites for additional exercise information, interact with clients remotely between Personal Training sessions (64), and set up Personal Trainer blogs to which clients can subscribe. More specifically, Personal Trainers can use the Internet for online coaching of clients (*e.g.*, via e-mail or chat rooms); to provide peer support and chatting opportunities among clients (*e.g.*, discussion boards, blogs, and chat rooms), video demonstrations of exercises, online journaling for clients, and self-monitoring tools (*e.g.*, online exercise/diet logs); and to distribute newsletters to clients (61).

> The Personal Trainer can use the Internet for online coaching of clients and to provide additional support for clients, video demonstrations of exercises, online self-monitoring tools, and newsletters. Personal Trainers are encouraged to creatively use innovations in Internet technology to help their clients adhere to exercise.

Advancements in wireless technology also provide Personal Trainers with opportunities to reach clients via their mobile phones or tablets. These devices can be used not only for communication with clients but also to provide clients easy access to some of the tools listed earlier, such as exercise tracking tools and videos of exercises. Personal Trainers can talk to their employer about what online features their training facility already provides or can individually develop online opportunities for their clients.

Using the Physical Environment to Promote Exercise

One often overlooked strategy for adherence is the use of the environment to facilitate exercise. Using the physical environment includes using the surroundings in which clients live, exercise, and interact (10). Two examples of how to use the environment to facilitate exercise are active commuting and exercising outdoors.

Active Commuting

Active commuting (*i.e.*, cycling or walking to work) is a potential strategy to help clients meet physical activity recommendations and positively impact their health (42,65,66). Clients who feel time is a barrier may find active commuting to be a feasible option when (a) much of their commuting time is spent in traffic or (b) they are able to add only a minimal amount of time to their commute. Clients who are environmentally conscious may be especially interested in active commuting because active commuting is seen as a way to improve air quality (67).

Personal Trainers whose clients are interested in active commuting but have not tried it before may need to improve their clients' confidence for overcoming barriers, such as rain, detours, and fatigue (41). When clients feel actively commuting to work is not an option, the Personal Trainer can also suggest cycling or walking to nearby businesses to complete errands or when visiting friends. If clients do not have a bicycle, many cities in the United States are now creating bike share programs where clients, for a small fee, can pick up and drop off a bicycle in different parts of the city (68). Additional strategies the Personal Trainer can encourage clients to use to actively use their environment include parking farther away, using the stairs, exiting public transportation a stop earlier than needed, taking walking breaks at work, walking meetings, lunch walk, and body weight exercises in the office.

Personal Trainers can encourage clients to use the physical environment with the following strategies: actively commuting to work; cycling/walking to complete errands or when visiting friends; or parking farther away, using the stairs, and taking walking breaks at work.

Exercising Outdoors

In addition to using the environment to actively commute, the Personal Trainer can use the environment to improve clients' enjoyment of exercise. Compared to exercising indoors, being active outdoors in a natural environment improves mental well-being and relaxes the attention muscle (69). Creating workouts for clients using the outdoor environment and encouraging clients to exercise on their own outdoors may decrease their feelings of depression, anger, and hostility and/or increase feelings of enjoyment and intention to be active again (69–71). Exercising outdoors may also give clients a break from the monotony of exercising indoors. To help clients stay motivated for exercise, encourage them to become involved in a variety of activities in different environments (50). Using different environments may also help clients overcome barriers related to time, access to facilities, or lack of money for membership fees. If your client has access to a safe outdoor environment, this can be a great alternative to an expensive gym. If recommending this option for a client, a Personal Trainer should be sure to provide them with the knowledge to exercise safely in outdoor conditions (heat, cold, humidity, etc.), including recommendations for proper clothing and hydration.

SUMMARY

Approaches to promoting exercise adherence that do not include theory-based cognitive and behavioral strategies may not be as successful as those rooted in theory. Adhering to exercise is a difficult process, and clients will need the Personal Trainer's help developing the necessary skills as well as an appropriate, individualized exercise program for their client to be successful. In this chapter, two theory-based concepts that are strongly related to exercise adherence were discussed: self-efficacy and motivation for exercise. In addition, several strategies were introduced that may help improve a clients' pleasure, enjoyment, self-efficacy, and motivation for exercise, all of which may ultimately lead to improved exercise adherence. These strategies include overcoming barriers, self-regulating exercise behaviors, and accessing social support. Through identifying the benefits of and barriers to exercise, clients can be taught how to overcome their barriers. Clients who plan their own exercise, set goals, monitor their exercise behaviors, and avoid relapse will be more autonomous and better able to regulate their own exercise participation. Providing clients with a supportive environment and teaching them how to access additional support may provide the encouragement they need to adhere to exercise. In addition, using innovative strategies, such as the Internet and active commuting, may provide clients with unique tools to maintain exercise. Every client with whom the Personal Trainer works with will have different levels of self-efficacy and motivation for exercise. Clients will also have different values, backgrounds, and perceptions of exercise. Personal Trainers are encouraged to assess the needs of each client to determine what strategies will most effectively help each client successfully adhere to exercise.

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CHAPTER 9

Eliciting Positive Perceptions and Behaviors: Coaching Techniques

OBJECTIVES

Personal Trainers should be able to:

- Describe the Personal Trainer's role in coaching.
- Understand the elements necessary for effective coaching.
- Be aware of verbal and nonverbal client behaviors.
- Provide appropriate responses to client behaviors.
- Understand several techniques used by effective Personal Trainers including
  - Active listening
  - Empathy and nonviolent communication
  - Rapport development
  - Appreciative inquiry
  - Motivational interviewing
  - The 5 As model of behavior change counseling
- Identify ways that behavior change (*i.e.*, more physical activity) may positively and negatively affect the client's lifestyle and schedule.
- Identify ways to use technology and alternative Personal Training methods when face-to-face Personal Training is not convenient or possible.
- Recognize that clients have different visual, auditory, and kinesthetic learning styles.

INTRODUCTION

Personal Trainers take on many roles, including sharing knowledge of training techniques and programs and serving as an ally, confidant, and motivator. They strive to help clients build awareness, set goals, and ultimately find their own solutions to problems and issues. Personal Trainers should not "diagnose" health issues or problems, but instead, they should help clients explore ways to find solutions to the various challenges they will encounter. Personal Trainers also should serve as a resource and conveyor of knowledge. When client needs to go beyond the scope of practice for a Personal Trainer, the Personal Trainer should be a resource for appropriate referrals. The skills and competencies covered in this chapter can help Personal Trainers continue to develop as effective professionals.

Coaching Techniques

Two of the most essential abilities of a Personal Trainer include strong verbal and nonverbal communication. Effective communication skills enable Personal Trainers to apply behavior change theories as ways to increase adherence and motivation. With effective coaching skills, Personal Trainers can provide social support and professional expertise along with increasing the client's perceived ability to achieve goals and obtain optimal satisfaction and personal fulfillment (1). The ability to connect and effectively communicate with a client can increase the likelihood of overall client success. Information related to the initial consultation between a Personal Trainer and client is provided in Chapter 10.

Specifically, this chapter includes descriptions and examples of successful strategies that are considered best practices for coaching to elicit positive behavioral outcomes in clients (*e.g.*, active listening, empathy, rapport development, appreciative inquiry (AI), motivational interviewing (MI), and the 5 As model of behavior change counseling). This chapter concludes by describing alternative methods of communication that can be used in addition to in-person coaching in order to improve the Personal Trainer's ability to reach and interact with the client.

Active Listening

Active listening is a communication form that is described as a set of verbal and nonverbal skills necessary for communication in successful family, business, and therapeutic relationships. Active listening can consist of nodding the head, making eye contact, and restating important information. Active listening also involves clarifying, repeating, and summarizing what the client has said (2,3). A Personal Trainer who effectively uses active listening skills demonstrates unconditional acceptance and unbiased reflection relative to the client's experience. Personal Trainers will be more effective if they work to understand clients' interpretations of their experiences without imposing personal points of view, experiences, or preconceived notions of the client's situation (4).

> Active listening involves the listener giving the speaker oral and nonverbal feedback to indicate attention and understanding. The listener accepts what the speaker is saying at face value without inserting personal interpretation.

There are other strategies that should be considered when employing active listening. A Personal Trainer should refrain from using metaphors (*e.g.*, a figure of speech or a statement in which the literal meaning of the word is quite different from the intent). Although using images, comparisons, and descriptions may be considered by some to be effective strategies to further explain or describe experiences, it is important to recognize that all metaphors are not well understood by all cultures and may have varied meanings between different age, gender, ability, and other diverse groups (Box 9.1). Misunderstandings may result from differences in language styles, vernacular, and popular culture and can be avoided by simply taking all verbal and nonverbal cues from the patient/client without interjecting confusing language or images.

Box 9.1 For Example: Metaphors

The metaphor, "It's like a walk in the park," to some, may produce images of an easy or invigorating physical activity, performed in a lush green environment that is supportive of healthy social and recreational activities. To others, parks may produce images of abandoned property littered with weeds, garbage, and criminal activities. Also, not everyone can walk even short distances with ease, and so this metaphor also could fill the client with feelings of inadequacy, failure, or resentment.

To be an effective communicator, avoid using slang, metaphors, and other forms of language that might confuse or alienate clients, especially with clients from a culture different from yours.

Davidson and Versluys (5) propose four elements of active listening: listening to the spoken statements of the client, observing nonverbal communication, listening to the context of the clients' apprehensions, and listening to the context of the clients' statements that may need to be challenged (Box 9.2). The first element involves listening to the spoken statements of the client which may require the Personal Trainer to reflect on the client's verbal communications. Reflection involves the Personal Trainer carefully paraphrasing what has been communicated without misinterpreting or changing the meaning of what the client said. It is important that the

Personal Trainer receive affirmation that the reflection correctly interprets the client's thoughts (Box 9.3).

Box 9.2 The Four Elements of Active Listening

- Listening to spoken statements
- Observing nonverbal cues
- Understanding contextual anxiety
- Identifying statements that indicate teaching and learning opportunities

Box 9.3 For Example: Interpreting Client's Thoughts

If a client indicates that she loves the pain and discomfort that accompanies exercise, a Personal Trainer would likely need to gather more information about exactly what the client means. Here, it would be appropriate to learn if the client is describing delayed-onset muscle soreness, identifying sensations that she enjoys when pushing her body to perform strenuous activities, recounting a past experience that involved improper training techniques and resulted in pain but was enjoyable to her, or whether the client is simply being sarcastic.

The second element is observing nonverbal communication, which involves paying close attention to the client's facial expressions, eye movements, speech patterns, vocal inflections, posture, and body movements. For example, consider the client who mumbles, have poor posture, and fails to make eye contact, is he or she resentful, shy, or simply sleep deprived (or some other reason)? If the Personal Trainer is unsure of the meaning of nonverbal communication, it is important to ask the client for clarification and not to simply assume understanding. This attempt at seeking clarification shows that the Personal Trainer values the client's experience and is taking time to understand his or her perspective (6). Making eye contact, exhibiting appropriate facial expressions, and taking notes are some ways to demonstrate interest and compassion.

The third element of active listening is listening to the context of a client's apprehensions or anxieties. Many times, a person's verbal communication has two components. The first is the actual meanings of the words the person uses. The second is the person's feelings or attitudes that underlie the content (Box 9.4) (7). It is useful for Personal Trainers to pay attention to both the words and the total meaning of the message that the client is attempting to convey. Anytime the words and meaning appear not to match, the Personal Trainers can ask for clarity in a compassionate way and continue to build their relationship with each client.

Box 9.4 For Example: Understanding Apprehensions and Anxieties

Suppose during an appointment with a Personal Trainer, an obese client says, "I'm here because I want to be healthier." This statement does not necessarily imply that the client understands the need for weight loss or is expressing a desire to lose weight. Instead of saying, "Let's get you on a reasonable exercise and nutrition program to help you lose weight," an appropriate follow-up statement by the Personal Trainer might be "Many people view being healthy in a variety of ways, and you can be healthy at any size. Help me understand what being healthy means to you." There are many useful resources for Personal Trainers and their clients at the Association for Size Diversity and Health's Web site (http://www.sizediversityandhealth.org) that relate to these issues of communicating effectively and accepting all shapes and sizes.

The final element of active listening involves listening to the content of a client's statements that may eventually need to be challenged. Clients appreciate having their knowledge respected regardless of their level of education. Using both closed-ended and open-ended questions, along with reflective active listening statements, are ways to learn about the client. Close-ended questions are questions that can be answered with a yes or no and are most appropriately used to clarify information. Open-ended questions allow the client to tell his or her story. For example, in an initial appointment, it may be appropriate for the Personal Trainer to say, "Tell me about some of your previous experiences with exercise or health behavior change." The Personal Trainer should also ask about hesitations or concerns the client may have about implementing a new nutrition or exercise program. Throughout the interaction, the Personal Trainer should use reflective listening in techniques to connect with the client. Reflective listening involves paraphrasing what the client has said to both ensure that the Personal Trainer is understanding what the client is saying and demonstrate engagement. It is important that the Personal Trainer praises the client for the correct information conveyed and then respectfully but completely addresses misinformation or myths that the client discusses during an appointment. The client who indicates she loves the pain and discomfort that accompanies exercise could present the opportunity for the Personal Trainer to remind the client that in order for exercise to result in positive outcomes, pain and discomfort are not required. Clients appreciate health and fitness professionals who have a solid, current education and a strong knowledge base and who use language that is honest and easy to understand (7).

The client who indicates she loves the pain and discomfort that accompanies exercise could present the opportunity for the Personal Trainer to remind the client that in order for exercise to result in positive outcomes, pain and discomfort are not required.

Active listening will help the client establish trust and an understanding of the Personal Trainer's roles and responsibilities. During the course of active listening, a Personal Trainer can help the client understand when he or she can assess the problem or when the client will need to be referred to another health care provider (Box 9.5). The Personal Trainer should communicate with the client the role that Personal Training can take within a larger wellness team that is available to address problems related to physical fitness. Through active listening, the Personal Trainer will learn whether the focus should be motivational, directional, supportive, and/or influential.

Box 9.5 For Example: Referral to a Health Care Provider

The Personal Trainer could help a client determine that he avoids physical activity due to a fear of falling. Subsequent tests could reveal that the client has poor balance. The Personal Trainer has assessed one potential cause of low physical activity (a balance problem). As a result, the Personal Trainer could help the client implement a balance training program. However, if balance training does not appropriately address the problem and the client continues to experience frequent falls, the Personal Trainer should refer the client to a primary care provider because there may be other underlying medical issues related to poor balance.

Although challenging, the client will benefit from unconditional and compassionate attention from the Personal Trainer. Learning techniques for asking open-ended questions (rather than yes/no questions) and utilizing reflective listening should deepen the Personal Trainer's understanding of the client's beliefs or feelings, although they may add time to your intake sessions. The extra time will be well worth it because your relationship and trust may build more quickly by taking this approach.

Empathy

When establishing a connection with a client, it is important for the Personal Trainer to not only be an active listener but to also show empathy. Empathy is often described as being affective and cognitive. Affective empathy demonstrates the Personal Trainer's ability to respond to the client's emotions with a similar emotion. To be cognitively empathetic indicates the Personal Trainer can intellectually identify with a client's perspective (7) and also appreciate the emotions they are experiencing. The conditions described as being necessary to elicit client change include honesty, mutual respect, effective communication, and warm responsiveness to the client (8). When Personal Trainers consistently demonstrate the aforementioned qualities, they are considered empathetic.

> Establishing an emotional connection with the client involves not only active listening but also displaying empathy or a warm responsiveness to the client's needs or concerns.

A link has been established between client satisfaction, adherence to a plan for behavior change, and the communication style of the person providing counseling or coaching (9). The quality of the relationship between a health professional and client is influential on health outcomes (10). For example, Kim and colleagues (11) showed that empathy significantly influences patient compliance and suggested that a feeling of partnership mediated this response. Empathy may result in the willingness of the Personal Trainer and client to be receptive to each other and evolve into a relationship of accountability, understanding, and success. Thus, although active listening and open-ended questions are useful, it is most important that the client feel you care about them as a person — this outcome is achieved through being empathetic to the client's unique situation.

Gender, age, ability, religion, education, income, and culture may influence empathy. It is not always possible or necessary for Personal

Trainers to be able to put themselves in the clients' situation, but it is helpful to make a genuine attempt to try to understand the client's point of view based on both his or her current situation and past experiences (Box 9.6). Simultaneously, the Personal Trainer should not try to manipulate the client's beliefs. That is, if beliefs of the client prohibit him or her from consuming certain foods (*e.g.*, vegetarian), the Personal Trainer must work within those restrictions instead of trying to convince the client that certain dietary practices (*e.g.*, no animal protein) produce adverse performance results.

Box 9.6 For Example: Empathy

For example, the Personal Trainer may prescribe rest or a change in exercise regimen for a client who exhibits signs of overtraining. The client may resist for a variety of reasons including exercise addiction, the need for social relationships that only exist in the exercise setting, or the fear of performance decrement that is frequently associated with rest. In this situation, an empathetic Personal Trainer may sit down with the client and openly discuss these issues and negotiate a compromise with the client that may reduce the risk of overtraining while allowing the client to maintain some of the benefits of the program. Demonstrating empathy is a useful and proven strategy for building successful relationships in a health care setting (11).

Developing Rapport

Rapport development with a client helps the Personal Trainer do a better job of partnering with the client to evaluate and address the problem. By demonstrating professionalism, enthusiasm, and skill, Personal Trainers will begin to motivate clients to work toward their goals. If the Personal Trainer also displays compassion and support while using active listening skills, rapport will be built quickly.

When developing a rapport with a client, the Personal Trainer must not only be keenly sensitive to the client but also demonstrate a strong sense of self-awareness. Sometimes, previous experiences should be incorporated into a conversation, and sometimes, they simply do not apply. Personal Trainers' extensive fitness experience, for example, could actually negatively affect rapport building with a client who does not identify as an active or fit person (see example in Case Study 9.1).

Case Study 9.1

Finding Motivation: For a few weeks now, a Personal Trainer has been training Eleanor, a 46-year-old mom and a cook at a local rural elementary school, who struggles with obesity and her ability to maintain regular physical activity because "it's just not for her." She has a predictable schedule working from 6 a.m. to 2 p.m. but struggles to find the motivation and time to exercise on a regular basis. Her community has limited access to gyms or safe outdoor alternatives for walking. She finds walking laps around the small playground at school boring and doesn't really enjoy the gym atmosphere. She knows she "needs to improve her health" based on a family history of diabetes, cancer, and heart disease. Although she likes her Personal Trainer, a young fit woman, she also mentions that "she couldn't possibly understand" her situation.

QUESTIONS FOR CONSIDERATION

What kinds of questions should the trainer ask Eleanor to build rapport and understand her unique situation?

When this Personal Trainer discusses exercise plans with Eleanor, it is important to “seek first to understand and then to be understood.” What about exercise does she not identify with? What have some of her previous experiences been like (positive and negative)? What might be similar or different now? How would being more active affect her weekly schedule, her daily energy, and her long-term health? What significant barriers stand in her way, and what strategies might help her prevent those barriers from derailing her plans? Developing a rapport with, and empathy toward, the client should make Personal Training easier and more rewarding. Finding common ground with Eleanor will be important to sustaining the relationship and her motivation to adhere to the exercise plan.

It is helpful for the Personal Trainer and client to establish awareness of how improvements in the client’s health/performance should cause beneficial outcomes that could be coupled with potential casualties (Box 9.7). Communicating about this information and developing trust in order to identify problems and solutions is a necessary component of maintaining rapport with a patient/client.

Box 9.7 For Example: Rapport

Personal Trainers are often quite comfortable talking about various physical activity pursuits, weightlifting techniques, and competitive sport endeavors because these activities connect to their core identity as active persons. Some clients may also enjoy talking about these topics areas; however, they may have other important areas of interest, hobbies, and values. Exercise may just be a means to an end for them, and that's OK. One way to build rapport with a client who is not passionate about physical activity is to connect the client's health and physical activity to his or her hobbies or values. For example, an achievement-oriented lawyer may appreciate the idea that her colleagues and clients will think she is strong and fit. A family-oriented dad, however, may be more motivated to play with his kids and model a healthy lifestyle for them. Building rapport with clients and "walking in their shoes" will help Personal Trainers turn exercise into a meaningful or purposeful activity.

Appreciative Inquiry

A fourth skill that Personal Trainers should develop is AI. AI is an approach used for motivating change that focuses on exploring and amplifying strengths. AI is traditionally used in business settings with considerable success in increasing productivity, cooperation, effectiveness, and employee and client satisfaction (1,12). It can also be applied by Personal Trainers in counseling/coaching situations. The AI framework is based on the belief that organizations or individuals are driven by their focus on and understanding of core values; goals are pursued and realized as a result of the potential positive outcomes. The approach is a specific application of goal setting theory that integrates personal values. AI has five phases of development: define, discover, dream, design, and deliver (12). These phases are cyclical beginning with defining what is to be learned about the process, discovering what may work best, dreaming of how the plan will work, designing with the client the plan, and delivering the eventual plan using both short- and long-term goals.

AI is best used when a client does not have a clear focus; needs support for learning and development; and/or wants to discuss new experiences, values, conditions, or even wishes. With AI, variables or characteristics that can be improved are identified, and the client's short- and long-term goals are generated and established. A timeline for progression toward and achievement of goals is determined, and a commitment to positive goals is agreed on. Defining the change process should involve writing down this information so that the Personal Trainer and client can remember what was defined and adhere to the agreements (13).

Discovery involves helping the client identify his or her personal best. This inventory can be used to determine what is already good in the client's life, how current qualities or situations should be valued and celebrated, and ways in which these qualities can help the client achieve new goals (Box 9.8) (13). This asset-based approach to coaching gives value to the skills and experiences a client brings into each consultation and sets a foundation for success.

Box 9.8 For Example: Appreciative Inquiry

A client has recently lost his spouse, and his children and grandchildren are concerned about his well-being; his physician has recommended an exercise program to improve both physical and psychological health. The Personal Trainer can help him by celebrating the memories of his wife, appreciating the concern of his children, and encouraging him to maintain independence by remaining both physically and socially active through exercise.

When clients are encouraged to express their beliefs of what they can achieve in the context of the current situation, the Personal Trainer is helping to fulfill that dream. Here, it is important to use positive language such as "I will be able to complete an 8-minute mile," instead of "I won't be the last one to finish the race." Positive words promote positive attitudes and positive outcomes. This component of AI helps the client describe an ideal self in the short and long term (13).

Together, the Personal Trainer and client should design a plan. This process involves developing actions that support the steps needed to achieve the client's vision. The Personal Trainer is responsible for offering a variety of options to the client while employing active listening to construct an appropriate plan. Again, the Personal Trainer should help the client create short- and long-term goals that are consistent with the client's ideal vision.

Delivery is the last component of AI. Delivery should not be viewed as the final stage of the goal-setting process because the client is encouraged to achieve both short- and long-term goals. It is possible that the client will become complacent or even regresses after the process of AI is complete (see Chapter 8 for information on relapse prevention). For this reason, it is important for the Personal Trainer to help the client develop a plan to sustain the achieved goal and set and reach new goals (13). As with any goal setting plan, success will be more likely if the Personal Trainer helps the client integrate self-monitoring and daily or weekly evaluation of each goal.

Motivational Interviewing

MI helps a client commit to changing an unhealthy behavior using more client-centered counseling by combining empathetic counseling and a direct approach to decisive change (14,15). The overall goal of MI is to explore and resolve any ambivalence from the client, to encourage the client's change talk, and to reduce the amount of resistance talk. Ambivalence refers to when a client has mixed feelings about making a behavior change. Change talk is the dialogue that the client engages in that expresses their desire to change and conveys their rationale for wanting to change (*e.g.*, what benefits they will receive), whereas resistance talk is how clients express the negative aspects to making a change (*e.g.*, what they will have to give up to make this change).

Rollnick and colleagues (15) suggest that rather than try to implore the client to change her work schedule or quit her job, a more effective strategy would be to avoid confrontation and help the client identify what parts of her life can be changed and the best strategies for her to make those changes. They describe MI as being direct, client-centered counseling that elicits behavior change by helping the client discover and decipher ambivalence. The Personal Trainer encourages the client to talk about what needs to be changed in the context of the client's desires and abilities. In some instances, the client may not recognize the process of behavior change or may not believe that behavior change is necessary or desirable in the current situation (16). In this instance, the Personal Trainer should respond with active listening, so the client can hear what is being said (Box 9.9).

Box 9.9 For Example: Motivational Interviewing

A Personal Trainer may ask, "You mentioned that missing your workouts is the source of your frustration, and yet you still seem motivated and talk about achieving your goals?" A typical response from a client might be "My job is causing me to miss workouts and my boss is the source of my frustration." In this case, the Personal Trainer might rephrase the client's response: "Ok, let me see if I understand what you are telling me. You are missing your workouts because you work long hours at your job, and there's no time to fit in exercise?" These discussions allow the client to be autonomous and make decisions about possibly adjusting goals or his or her own attitude or behavior. The Personal Trainer is simply a guide.

The overall goal of MI is to let the client lead his or her own change process. Personal Trainers can help resolve any ambivalence from the client, encourage the client's change talk, and reduce the amount of resistance talk.

At this point, the Personal Trainer should consider a brief intervention that involves working with the client to explore values and motivations. The Personal Trainer should guide the client to choose whether, when, and how to change.

MI is different from the client-centered counseling technique of active listening because it allows the Personal Trainer to give more direction. MI is appropriate when the client has a need to plan a strategic change. The directive to change may come from a primary care provider or clinician, the client's spouse or family member, or the client. This approach will be most helpful when working with clients who are "stuck" in amotivation or ambivalence. The unique aspect of MI is the orientation toward trying to solve the problem. MI puts the client in the driver's seat while the Personal Trainer points out the discrepancies in the client's thinking/behavior and provides navigation directions. Examples of MI are provided in Table 9.1 (17).

Table 9.1 Comparison of Motivational Interviewing and Advice Giving

	Motivational Interviewing	Advice Giving
Counseling aim	Explore why the individual isn't sure he or she wants to exercise and build his or her motivation to want to change.	Persuade the individual that he or she needs to change and start exercising by providing an Ex R_X.
Client	Help the individual explore why he or she is inactive, how he or she might begin exercising, and how exercising is	Explain that someone who is inactive may be at increased risk for disease (*e.g.*, diabetes mellitus, CVD).

	consistent with personal values; use empathy.	
Information presentation	Neutrally explain discrepancies between current activity level and recommended levels and allow client to react.	Give the evidence for why being inactive increases the risk of disease.
Questioning approach	Open-ended questioning to encourage exploration of thoughts and feelings regarding physical activity	Leading questions to have the individuals "prove" to themselves the risks of their inactivity and why they should be active
Dealing with resistance	Use reflection to try to acknowledge the individual's point; resistance is a sign that a new approach is needed; acknowledge that ambivalence to change is normal.	Have counterarguments ready and "correct" any misconceptions.
Summarizing	Use their language to summarize both the pros and cons of exercising.	Summarize the dangers of staying inactive and steps the individuals should take to be active.

Ex R_x, exercise prescription; CVD, cardiovascular disease.
Reprinted from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 10th ed. Philadelphia (PA): Wolters Kluwer; 2018.

There are several techniques that can be used to help explore the client's ambivalence and help the client see the discrepancies between his or her current behaviors and long-term goals. A first tool might be helping the client to list out pros and cons for both making and not making a change. This can help shift the decisional balance toward behaviors that will ultimately help the client achieve his or her long-term goals. Next, a Personal Trainer might encourage the client to craft a general vision statement about what he or she wants to achieve in relation to health and wellness, with long-term goals that directly support this statement. Then, the Personal Trainer may ask the client to assess how ready, willing, and able he or she is to work toward these goals in tangible ways (*e.g.*, on a 1–10 scale). If the client reports low values, he or she may need to revise his or her long-term goals. Once these long-term goals are defined, short-term goals that work toward these long-term goals can be defined.

Case Study 9.2

Motivational Interviewing: Carol, who signed up for her insurance-sponsored weight management program, is having trouble attending the facility consistently. This program provides a financial incentive in a reduced membership fee for regular attendance and keeping her meetings with professionals like you. In her intake, she expressed strong motivation to exercise more to lose weight (along with committing to diet changes), but her work and family schedules seem to be taking priority over her health behaviors. She struggles to meet the requirement of 3 days per week attendance at the facility to keep her benefit.

QUESTIONS FOR CONSIDERATION

What other questions could you ask Carol to help her find some answers to her dilemmas (*e.g.*, not having enough time in the day, multiple competing priorities, and how to achieve her long-term weight loss goals)? How could you point out to her the discrepancy between her goals (increase physical activity) and her behavior (low attendance)? How would you encourage her to explore or explain her ambivalence? Pay attention to the specific language you use because this is an important facet of MI.

The 5 As Model of Behavior Change Counseling

The 5 As model of behavior change counseling is an evidence-based approach used to change a variety of less than desirable health behaviors (18). This model can accompany MI and has been used most frequently in primary care but is appropriate for most health promotion settings (18). The 5 As include assessing, advising, agreeing, assisting, and arranging.

Assessing involves measuring the client's beliefs, behaviors, and motivations. A Personal Trainer should *advise* the client based on health risks and behaviors. Next, the Personal Trainer and client can together *agree* on a set of short-term and long-term realistic goals. Then, the Personal Trainer *assists* the client with anticipating barriers and developing a specific plan to help the client avoid or at least effectively respond to barriers. *Assisting* the client may involve understanding his or her ability, comfort level, and access to available resources. The Personal Trainer may need to assist the client in developing an exercise or other behavior change plan. Finally, assisting may simply involve referring the client to another professional or resource. The final step involves *arranging* subsequent sessions with the client as a method of support. This could involve arranging an appointment with the Personal Trainer or a different provider, such as a health and fitness professional.

Frequent follow-up contact is an essential part of this behavior change method and can be provided in the form of telephone counseling, support groups, walking clubs, weigh-ins, and/or educational classes. Follow-up contact can either be short term (1–2 wk after establishing goals) for initial behavior change or twice a month for long-term maintenance of behavior change. It is important that the Personal Trainer receive feedback and frequent updates from the client in order to achieve and maintain behavior change. The 5 As model of behavior change is intended to use the Personal Trainer to strengthen the client's self-management skills until he or she achieves and is able to independently maintain the desired behavior change (19) (Box 9.10).

Box 9.10 The 5 As

The 5 As of behavior change counseling could be used in this way:

- A weight management program could consist of the initial identification of overweight and obese patients/clients and referral for advanced assistance if warranted (*advise*).
- An initial interview or survey could include identification of client weight history, current weight-related lifestyle behaviors, weight-related knowledge, self-monitoring, motivation, confidence, and demographic characteristics (*assess*).
- The Personal Trainer and client would identify appropriate weight loss strategies and goals (*agree*).
- Ongoing support would be given from the Personal Trainer as the client worked toward the established goals (*assist*).
- The Personal Trainer would continue to identify opportunities and access to the determined weight loss strategies and resources (*arrange*).

Can Positive Behavior Changes Cause Problems for Clients?

If a client is comfortable with his or her current psychological, physical, or disease state, then behavior change could be a threat to his or her current status. It is important to recognize that increased physical activity or exercise can potentially have negative influences on one's quality of life. Some potential negative factors related to physical activity include sweating, body odor, and muscle soreness; additionally, adding exercise could result in a loss of time and increase in injury risk. Other potential negative aspects of exercise that should be addressed include the potential need for resources such as exercise location, space, or money. There are also emotional reasons that a client may not participate in physical activity including fear of embarrassment, failure, or, as described in the previous paragraph, threats to personal relationships.

It is helpful for the Personal Trainer to identify potential problems that may occur as a result of exercising and then proactively work with the client to arrive at solutions. Some of these barriers may be unexpected, just as jealousy or sabotage by a loved one who is not interested in changing their habits. Other barriers such as time to attend get to the facility, feeling tired after work, or lack of social support may be easier for the client to predict.

Additionally, family members or friends don't always respond positively when one of their loved ones loses weight or becomes more physically active. These changes in physical fitness, appearance, and eating habits can change the dynamics within a relationship or family for better or worse. As the client observes these changes and "improves" his or her lifestyle, check in with the client to see if any unintended consequences have emerged. Each client's journey will be a little different but is always useful to check in about work and family dynamics to see if there have been any perceived positive or negative changes.

It is the responsibility of the Personal Trainer to proactively educate the client about these potential obstacles, work with the client to identify those events that are applicable to the client's life, and then proactively create action plans to overcome those barriers and help the client remain physically active. If these barriers are identified together before they occur, you can help the client prevent relapse (see Chapter 8 for additional details).

Other Methods of Communication

The previous sections have addressed verbal and nonverbal communication while in the physical presence of the client. There are also situations where the Personal Trainer is not in the presence of the client.

A Personal Trainer can communicate with clients via phone calls, print materials, e-mail, and other Web-based materials. These forms of communication may be helpful when face-to-face meetings are not convenient or possible.

The following paragraphs will describe special considerations when Personal Training occurs from a distance. To provide additional support to the client between appointments, it is often helpful for the Personal Trainer to use supplemental materials or support.

Phone Calls

Extra support could occur in the form of phone calls, which simply serve as reminder contacts prior to the initial and/or subsequent appointments. The Personal Trainer may call to remind the client of the day and time that an appointment has been scheduled or check to see how the client is managing prescribed activities. If the Personal Trainer uses phone calls as a support mechanism, it is important to confirm that the client has a phone and that it is okay to be contacted at the provided phone number. When making phone calls to a client, the Personal Trainer should be aware of the need to be respectful of the time of day and the length of the call. The Personal Trainer should also consider privacy issues including whether a discussion can occur in the presence of others or whether/when it is appropriate to leave a detailed message. The Personal Trainer's phone number should be recognizable to the client. For example, many organizational phone lines appear on the caller ID as a number that is different than the number of the phone from which the call is being made. In this situation, the client should be told in advance what number or organization name will appear on the caller ID and whether it is possible to return a call to that number. The Personal Trainer may also want to consider using a written script when making initial calls and reminder messages. This outline may help to relay information in a complete, clear, and concise manner. Finally, it is important for the Personal Trainer to remember that there may be a prevalence of phone number instability in younger, transient, and low socioeconomic populations. With these groups, it is often helpful to have alternative contact information.

Print Materials

Although electronic communication is widely accepted and popular, the need for print material still exists in some situations. Paper is a useful way to display information in waiting areas. It is also useful when a client is unable to access Web-based material because there is not public Internet access on site or the client does not have Internet access at home. Print materials are a useful visual aid that can help a client learn, remember, and track progress.

Using Electronic Media

Web-based materials are also useful visual aids. According to the Pew Research Center (20), nearly 90% of the U.S. adults use the Internet. The number of people with Internet access in all populations is growing, including older adults. It's important to note, however, the related rise in smartphone use, with 20%–25% of American adults using only a smartphone to access the Internet versus having Internet or broadband service at home (20).

The benefit of using Web-based materials to supplement coaching is that these materials provide an opportunity for the Personal Trainer to direct clients to trusted Web sites for health information. It allows the Personal Trainer to provide the most current information that is most appropriate for each individual. It is always necessary for the Personal Trainer to frequently visit recommended sites because Web addresses and information frequently change or may not be updated in a timely or appropriate manner.

Using electronic media for coaching is a useful way to contact clients who may have limited access to a Personal Trainer because of time, distance, or travel limitations. There are several Web sites available to help a Personal Trainer supplement in-person activities. Additionally, there are several computer Web-based programs and smartphone applications that can be purchased to supplement face-to-face business. Again, it is important for the Personal Trainer to thoroughly review and evaluate Web sites and applications before using them for supplemental support.

Personal Trainers may consider e-mailing educational and support materials to clients. Here, it is important to treat e-mail in the same manner as information shared over the phone, in print, or on the Web. Similar to phone call situations, the Personal Trainer should gain client approval to communicate via e-mail. The client should be informed about what type of information will be sent through e-mail, from whom the e-mail will come, and whether it is possible for the client to respond to the e-mail address from which the information is received. E-mails also should be reviewed for accuracy and appropriate messaging. Finally, e-mail messaging is generally an unsecure form of communication, and it is important for a Personal Trainer to refrain from e-mailing personal health or other information to his or her clients.

As electronic devices become more accessible and user-friendly, the potential opportunities to use these methods of communication for coaching will be enhanced (2). An early randomized controlled trial compared face-to-face lifestyle modification counseling, telephone counseling, e-mail counseling, and no contact. In this 2004 study, Internet-based technology was not an effective substitute for human contact (2). Since that time, technology has evolved substantially, and some Web-based applications or smart phone applications may appeal to clients. The best use of technology may be as a supplemental tool that Personal Trainers use to support behavior change without replacing human interaction. This approach has been adopted in health care settings with a strong application in rural areas (21).

Videoconference technology has also been used to deliver health-related services. One study successfully delivered Tai Chi Quan to older adults via videoconference. This intervention was delivered three times per week for 15 weeks and found that participants were able to operate the videoconference. Additionally, fear of falling declined and balance was improved (22). Laflamme and colleagues (23) compared videoconferencing and face-to-face visits to evaluate the medical decisions of physicians and their interactions with residents living in nursing homes. In this study, face-to-face interviews were more effective than videoconferencing, but the physicians found videoconferencing to be a valuable supplementary tool in patient care. Finally, Digenio and colleagues (24) designed a randomized controlled trial to compare the use of e-mail, phone, and face-to-face counseling methods in a sample of 376 patients with obesity. All treatment groups improved their quality of life and lost significant weight at 6 months, and telephone contact was equivalent to face-to-face counseling as long as there was a high frequency of contact. Interestingly, the face-to-face group had the highest use of the study's Web site, which indicated higher levels of engagement and self-monitoring. This engagement and self-monitoring could lead some clients to sustain their efforts long term, but these outcomes were not evaluated in this study.

Videoconferencing and telephone contact enable the Personal Trainer to not only supervise the client but also demonstrate exercise and other activities without a travel requirement. Personal Trainers may also consider videoconferencing in a group format. Videoconferencing may expand the reach of Personal Training by reducing the need for transportation and lessening the effect of some environmental barriers. Just like group Personal Training, the use of telemedicine technology may allow Personal Trainers to expand their reach in a cost-effective way (25). In order to maximize accessibility in this format, it is best practice to use a service that can provide closed-captioning during these sessions.

Information technology continues to evolve, become more simplified, and spread at a rapid pace. Widespread broadband and videoconferencing capabilities are becoming much more common in health care settings and companies such as Peloton (biking) are changing the fitness market by merging group training with interactive video technology delivered to homes. Physicians and other primary care providers who provide patient care through videoconferencing may have a need to refer their patients to Personal Trainers who provide care and support through distance technology as well.

Similar to the other communication methods, e-coaching and texting can potentially provide increased contact and support when the client and the

Personal Trainer are in locations that are not conveniently accessible to one another. When using these methods of communication, special consideration should be given to people with vision, hearing, and cognitive impairments as well as those who speak a primary language that is not English. Special attention also should be paid to ensure that materials are culturally appropriate and easy to understand. There are resources available to make telephone, paper, and electronic forms of communication accessible to these special populations as well (26,27).

SUMMARY

Health coaching provides Personal Trainers a chance to help clients achieve both short- and long-term goals that involve maintenance or improvements in physical condition, physical performance, or general well-being (28–31). Health coaching occurs through organization and planning that result in a partnership between the Personal Trainer and client. The partnership is ever-evolving, unique to each client, and intended to help the client set and achieve goals within his or her own personal context. The role of the Personal Trainer is to provide social support, education, and an appropriate amount of motivation within the framework of the client's desires, abilities, and personal experiences. Health coaching can be delivered in a variety of settings to an extremely diverse population. Special considerations should be made by the Personal Trainer to ensure that the delivery process, method, and location are appropriate for and easily accessible to the clients.

Coaching is a relatively new approach to enhancing client care outside of the traditional health care setting and may be a viable solution to improving overall health and fitness outcomes while reducing overall health care costs (29).

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PART IV

Initial Client Screening

CHAPTER 10

The Initial Client Consultation

OBJECTIVES

Personal Trainers should be able to:

- Learn the attributes of relationship marketing and how it pertains to the initial and ongoing appointments with the client.
- Understand the critical attributes for providing exceptional customer service and hospitality.
- Learn the nonverbal communication skills needed to successfully engage the client during any appointment.
- Become familiar with client-centered approach to health and fitness coaching.
- Understand the elements and value of the initial client contact as a precursor to the initial client consultation.
- Understand the components and preparation for the initial client consultation, how to structure the appointment, and the precedence it sets for the duration of the client–Personal Trainer relationship.
- Learn strategies for recommending and selling appropriate Personal Training packages and obtaining client commitment.

INTRODUCTION

Within the initial client consultation, the Personal Trainer establishes precedence for the type of working relationship that will ensue. Therefore, it is critical that a sound foundation is built to facilitate a trusting, respectful, and mutually rewarding professional relationship. This chapter is designed to expose the Personal Trainer to both behavioral and business aspects of communication that should be used in the initial meeting with the client and beyond. Specific attributes for the initial client contact and initial client consultation are detailed, along with the rationale for why these appointments are structured in a systematic and comprehensive manner. There are likely program and process differences between Personal Trainers who work in a commercial club, private gym, or corporate fitness facility; yet, there are more commonalities that exist in the profession. Although the chapter is written to address universal professional themes, at times differentiating between settings, each Personal Trainer is encouraged to adapt the content accordingly to the work environment and the relationship built with the client.

Aspects of Successful Client Relations

The profession of Personal Training is centered on a strong relationship between the client and the Personal Trainer. Although relationship dynamics vary from client to client, there are some behaviors that the Personal Trainer should exhibit as a foundation for business development. For example, customer service and hospitality are essential to demonstrate continuously to garner client trust and respect. Incorporating relationship marketing concepts will further enhance the Personal Trainer's communication style and assist in conveying to the client that the relationship is of great value and importance.

In addition, being aware of nonverbal communication skills and using a client-centered approach to coaching are important.

> The Personal Trainer can and should create a strong framework for attracting and retaining long-lasting client–Personal Trainer relationships.

Customer Service and Hospitality

Personal Trainers, similar to a variety of health care providers, are in the service management industry. Clients seek out a Personal Trainer because they desire a service that will assist and guide them in a direction that is compatible with their health and fitness goals. Similar to those who seek out a clergy member to assist with spiritual goals or call on a financial advisor to guide in monetary matters, people will seek out the services of a Personal Trainer. The Personal Trainer should recognize this entrusted opportunity — to guide and to make a direct positive impact on another person's life — as an honor and a special privilege. Author and restauranteur Danny Meyer (1) firmly espouses that it takes both great customer service and hospitality to rise to the top of any service field and that distinguishing between the two is critical for success.

Meyer (1) refers to customer service as the delivery of technical processes or preplanned behaviors that are to be performed in a certain manner toward the client. In other words, these actions can be described as a monologue between the business provider and the customer. Customer service is exhibited by simply delivering a standard of service that meets the client's needs and expectations. However, it should be noted that clients do not seek or expect mediocre service (2). Therefore, it is recommended that the Personal Trainer continually perform at a higher level and cater to the unexpected needs to accommodate the discerning client (3). Examples of exceptional customer service include the following:

- Make a courtesy call 24–48 hours prior to meeting.

- Be on time, or early, for appointments.
- Be 100% prepared for all appointments.
- Respond to phone, text, and e-mail messages promptly and courteously.
- Demonstrate organization and reliability and always follow up on what has been promised.
- Provide fitness training programs that are based on science or credible resources.
- Answer client's questions concisely and accurately within the scope of practice.
- Refer clients to appropriate professionals when the issue is outside of the scope of practice.
- Listen to client concerns, respond with sincerity, and solicit feedback.
- Speak respectfully to the client and of others.
- Dress appropriately and professionally.

A commitment to customer service should be a consistent practice to establish the Personal Trainer's reputation as a business professional. Consistently performing these actions will undoubtedly make an impression on the client and set the groundwork for a successful Personal Training business.

The principle of hospitality is also centered in customer service (2); however, it takes the concept a step further by providing a "holistic approach to meeting customers' needs within the context of a personal relationship and experience." Where customer service focuses on meeting the client's rational needs and expectations, hospitality also addresses the client's emotional needs by demonstrating graciousness, caring, and thoughtfulness (1). This emotional element is what creates an "experience" and establishes true client loyalty. This trend is strengthening, such that 89% of hospitality companies are competing primarily on the basis of delivering a distinctive customer experience, with every interaction both online and offline (3).

Although most commonly associated with the hotel or restaurant industry, hospitality is a focal point for companies in the health and fitness industry as well (4). One such fitness management company identified caring and serving the client so vital that it was stated as one of four operating missions of the organization. In conjunction, the company offers a hospitality-based employee training program that drives satisfaction ratings, which has proven to be a distinguishing factor among competitors and is a key component in attracting and retaining world-class clients. Addressing hospitality outside of the hotel and restaurant industry, a business consultant who assists organizations in enhancing their customer experience aptly titled an article "No Matter What Business You're in . . . You're in the Hospitality Business" (4).

By many definitions, hospitality is centered on the intangible and emotionally driven behaviors that demonstrate to the clients that they are special and cared for by the Personal Trainer. Where customer service is a monologue, hospitality is a dialogue, conveying that the client's needs are the priority in an interactive communication (1). Warmth, friendliness, kindness, and the instinct to want to do the right thing for the client are ultimately at the core of hospitality. Additionally, authentic communication, which centers on reducing formality and expanding creativity in order to allow for an approachable intimate connection with a client may be particularly helpful with millennials and boomer populations (5). Exhibiting hospitality often equates to clients enjoying themselves, and as a result, they yearn to have the experience again and will share it with others. The net result of sharing with others, known as word-of-mouth advertising, cannot be understated because it leads to client loyalty and referrals that are paramount to the success of a Personal Trainer in business.

> Hospitality is centered on the intangible and emotionally driven behaviors that demonstrate to the clients that they are special and cared for by the Personal Trainer.

According to Meyer (1), professionals who create a hospitality experience typically possess the following traits:

- *Optimistic warmth*: genuine kindness, thoughtfulness, and a sense that the glass is always half full
- *Intelligence*: open-mindedness and an insatiable curiosity to learn
- *Work ethic*: a natural tendency to do something as well as possible
- *Empathy*: an awareness of, care for, and connection to how others feel and how the individual's actions affect others
- *Self-awareness and integrity*: understanding what makes a person tick and a natural inclination to be accountable for doing the right thing

A Personal Trainer possessing the aforementioned traits will innately be able to exhibit the following examples of hospitality:

- Greet the client with an appropriately firm handshake, authentic smile, eye contact, and addressing the client by name.
- Convey that the client's best interest is in mind under any circumstance.
- Address client requests and do what is possible to make them happen.
- At the end of a session, sincerely thank the client for his or her time and provide verbal positive reinforcement for completing the exercise routine.
- Make follow-up calls/e-mails to see how the client feels after a Personal Training session.
- Send a handwritten card to thank the client after an initial appointment or when a significant goal has been reached.
- Search for opportunities to go above and beyond what is expected.

The Personal Trainer should strive to embrace and exhibit both customer service and hospitality. Establishing a habit of providing consistent and reliable service, as well as taking the extra steps to demonstrate to the clients that they are cared for, will make an indelible impression. Many clients are more interested in knowing how much the Personal Trainer cares than in knowing how much the Personal Trainer knows. Conveying this will allow the Personal Trainer to experience not only the joy of giving and the pride that accompanies it but also the rewards of client satisfaction and allegiance as well.

Relationship Marketing

The principle of marketing is central to any successful business and incorporates many of the concepts from customer service and hospitality. Considered a continuing and relevant trend in marketing, relationship marketing is a vital component in the service industry and encourages thinking and acting like the customer to secure and retain a trusting and loyal long-term relationship (2). Although similar, hospitality and relationship marketing are not mutually exclusive and actually should be carried out simultaneously. The primary goal of marketing is to bring the buyer (client) and the seller (Personal Trainer) together, the strategies of which are worthy of the Personal Trainer's attention leading into the initial client consultation.

What differentiates this new paradigm of relationship marketing from conventional marketing is that first, a personal relationship with the customer should take precedence, and sales will follow, and second, retaining existing clients should take precedence over seeking new customers (Box 10.1). In contrast, traditional marketing places great emphasis on the constant hunt for new sales to new customers. Although traditional marketing has its place in the business of Personal Training, relationship marketing concepts certainly have notable implications for the Personal Trainer as well.

Box 10.1 Principle of Relationship Marketing

- A personal relationship with the customer should take precedence, and sales will follow.
- Retaining existing clients should take precedence over seeking new customers.

Adapted from Kandampully JA. *Services Management: The New Paradigm in Hospitality*. Upper Saddle River (NJ): Prentice Hall; 2007. 378 p.

The first premise of relationship marketing is to emphasize the personal relationship with the client, which is supported by the idea that customers have a deep desire to trust the business provider and are inherently loyal (2). Customers have also been found to be loyal to those who trust them, so it is crucial that the Personal Trainer interact with the client in a way that reinforces this trust. As a result, the Personal Trainer will be rewarded with the client's desire to maintain the working relationship. On the other hand, even though clients resist changing business providers, as is the case with dentists or doctors, they will seek another provider if this trust is abused (6). Relating to the client will facilitate a mutual desire to have a trusting, loyal, and long-lasting working relationship.

Relating to the client will facilitate a mutual desire to have a trusting, loyal, and long-lasting working relationship.

The second premise of relationship marketing is to focus on retaining existing clients as opposed to only seeking new clients. Research indicates that retained customers are very profitable over time because they are directly related to increased purchases and referrals, are less sensitive to price changes, and they have lower operating costs (to maintain existing clients vs. marketing for new clients). Maintaining customers, or minimizing defections, becomes paramount when understood that in the United States, it is common for businesses to lose an average of half of its customers each 5 years. However, businesses can double their profits if those customer losses are cut by only 5% (*e.g.*, from 50% loss to 45%) (7). Additionally, traditional business research estimates that attracting a new client costs 5 times more than keeping an existing one (6,8). As such, it is in the best interest of the Personal Trainer to survey departing clients in order to understand the reasons for leaving. If the factors are controllable, the Personal Trainer should take action with existing clients to minimize these defections in the future.

The Personal Trainer should pay close attention to relationship marketing as a means to success. Favorable word-of-mouth advertising, perhaps the most cost-effective marketing strategy in business, has the opportunity to flourish if the Personal Trainer is meeting expectations and nurturing the client relationship. Furthermore, when the broader business concepts of customer service, hospitality, and relationship marketing are integrated, the Personal Trainer will be better equipped to face the challenges that inherently exist in the business world. Considering that 25%–50% of business operating costs stem from poor service, or not performing up to par the first time, it behooves the Personal Trainer to be attentive to the facets that enhance service quality right from the start (6). When putting these conceptual tools into action prior to and during the first client meeting, the Personal Trainer will have a greater capacity to not only survive but also excel in attracting and retaining clients as well.

The Power of Nonverbal Communication

Because the client–Personal Trainer relationship is crucial for success, every facet of relationship building is important, and the spoken word is only part of the communication puzzle. Much can be learned about people by observing their nonverbal cues because most people are not good at concealing emotions (9). In some business encounters, watching nonverbal cues is believed to be more reliable and essential to understanding another person than listening to speech because body language accounts for between 60% and 80% of the impact made on another person (10,11). For example, if there seems to be a discrepancy between one's speech and body language, the listener will likely place more value in the body language of the communicator. Therefore, knowledge of body language is invaluable for success in both personal and professional relationships. Not only can a Personal Trainer learn to become a more effective nonverbal communicator, but learning these cues will enhance the ability to understand the client as well.

Watching nonverbal cues is believed to be more reliable and essential to understanding another person than listening to speech because body language accounts for between 60% and 80% of the impact made on another person.

Body language such as posture, eye contact, feet and leg behaviors, and facial expressions speak volumes about an individual's thoughts and emotional state. For example, posture and stance are strong indicators of how engaged a person is in a job and if he or she believes in the product or service being sold. Simply observing a person's stance can quickly determine energy, confidence, and sense of power in a position (12). Facial expressions can provide some body language clues, though. In particular, a person is said to lack sincerity or truthfulness if there is a contradiction between words and facial expressions. Additionally, facial expressions from emotional responses come and go quickly; therefore, a person who holds an expression for an extended period of time may not be exhibiting a genuine emotion (13).

Although a powerful tool, interpreting body language is a science that has evolved over time and still holds some disagreement among experts. For example, it has been thought that people who stand while holding their hands behind their back exude power; however, it has also been found that observers think these people are untrustworthy. Additionally, individuals who are unable to make eye contact have been thought to be lying; yet, this can also be interpreted as nervousness (10). Nonetheless, it may be helpful to "study" your client because cultural differences may affect the interpretation of body language. For example, in some cultures, direct eye contact may be interpreted as rude, emphasizing the importance of understanding the client's background.

These and other body language distinctions can be used to provide the Personal Training client with tailored customer service and hospitality. For example, the Personal Trainer should be observant of the client when the client is walking into the facility, office, or on the exercise floor. Upon meeting, if the client has slouching posture, crossed arms, and shifty eye contact, this may indicate nervousness and insecurity. The Personal Trainer should take extra steps to maintain a warm and patient demeanor while explaining what to expect during the meeting and give the client opportunities to express concern or ask questions. In another scenario, if the client's facial expression indicates confusion while hesitantly performing a new exercise, he or she may not verbalize the need for assistance. In response, the Personal Trainer should take the initiative to demonstrate the exercise again, reiterate movement cues, and provide positive reinforcement of what the client is doing correctly to increase confidence of the skill.

On the other hand, the Personal Trainer must be aware that his or her nonverbal communication is being observed and equally has an impact. For example, imagine a client enthusiastically describing how he or she felt after the last training session while the Personal Trainer is leaning against the exercise machine looking off in another direction. How would this make the client feel? Similarly, imagine a client performing an exercise and inquiring if the movement is being done correctly, only to discover that the Personal Trainer is preoccupied with watching television or glancing at the mobile phone. How would this make the client feel? Apathy and divided attention are attributes of neither customer service, hospitality, nor the client-centered approach and should be avoided at all costs, or trust will diminish. The Personal Trainer must exercise self-awareness at all times when working with clients to ensure that positive nonverbal communication is being expressed. Accordingly, cell phones and other personal communication devices should be left off the exercise training floor such that your first priority is the client with whom you are working.

Exhibiting positive body language can certainly be a powerful business tool. Consider that the actions a businessperson exhibits within the first 15 seconds of walking into a room will likely make or break a sale even before talking begins (12). However, others may form up to 90% of an opinion about a person in the first 4 minutes, with 60%–80% of the impact from nonverbal cues (11). Regardless of the type of business, this kind of influence is very valuable and has been shown to be a function of a person's body language. With all else being equal, those who have positive body language tend to be more successful. Below are some behaviors that increase one's body language attractiveness and can improve nonverbal communication skills (11,12):

- *Appearance and physique*: Maintain good hygiene along with a healthy and fit appearance. Clothing colors are also influential. For example, these are the specific messages that some colors can convey: red (power, danger, force, passion), orange (excitement, encouragement), yellow (happiness, energy, intelligence), green (harmony, safety), blue (trust, confidence, peace), purple (luxury, creativity), white (safe, purity), and black (power, mystery, aggressive, unsafe) (14). Depending on the kind of message the Personal Trainer wants to convey to a client on any particular day, uniform colors can have a powerful influence on the relationship with the client.
- *Eye contact*: The more frequent eye contact the better, although staring for more than a few seconds at a time can be uncomfortable for the client and may be construed as flirtatious. Frequent blinking conveys a wandering mind or one that wants to interrupt; therefore, blink less. The goal is to provide the amount of eye contact that makes the client most comfortable.
- *Facial expressions*: Smile often with animation (*e.g.*, nodding) suggests you are happy and engaged. Widening the eyes and raising eyebrows express interest and surprise. On the contrary, narrowing the eyes or lowering the eyebrows can mean disgust, anger, or sadness.
- *Head movements*: Keep chin up and nod "yes" when speaking and tilt the head to show interest when listening.
- *Gestures*: Be expressive with hands and body movements without exaggeration. Keep fingers closed when gesturing, hands below chin level, and avoid arm or feet crossing.
- *Posture*: Sit and stand erect when speaking and lean forward to show interest when listening. Leaning back is perceived as informal.

- *Proximity and orientation*: Be as close as possible without crowding the client. A comfortable range is between 1.5 and 4 ft (0.46 and 1.22 m); yet, it is important to read the client's body language and adjust accordingly. If the client moves back, don't step forward again.
- *Timing and synchronization*: Speed up activities (*i.e.*, moving from exercise to exercise) but not to the point of ineffectiveness.
- *Nonverbal aspects of speech*: Balance the need to listen with the need to talk. Letting the client do the talking can often lead them to provide information that otherwise might have been missed. Additionally, it is important to subtly mirror the body language of the client while speaking or listening to further enhance comfort levels.

These categories of behavior increase the attractiveness of a person to others, which can assist in enhancing communication between two people. In short, possessing enthusiasm can quickly lead to all the behaviors listed without consciously having to focus on each point. Conscious awareness can not only enhance the Personal Trainer's ability to exhibit these traits but also improve the ability to identify them in others.

The Client-Centered Approach to Coaching

In conjunction with exhibiting acts of customer service and hospitality, there are motivational and behavioral change coaching skills that will further enhance the client–trainer relationship if taken into account. These fundamental skills will increase the trainer's understanding of the client in a collaborative framework; therefore, increase the trainer's ability to affect behavior change. Also referred to as the "patient-centered approach," the motivational interviewing skills of rapport building and exhibiting active, empathic listening are central to keeping the client's perspective at the forefront (9). Although this style of relationship building takes more time in the initial client consultation and beyond, the partnership approach will likely yield more positive results. For example, when used by physicians, the results include higher client satisfaction and improved compliance along with reduced concerns and improved health outcomes (15). Contrary to the style of many Personal Trainers, this approach does not encourage giving unsolicited advice. Although it is beneficial under some circumstances, Mason (9) found that advice giving can hinder behavior change because it can be perceived as condescending and undermines the client's intelligence and sense of autonomy. Telling a client what to do may lead to resentment, so it is important for the Personal Trainer to think twice before attempting an unwelcome verbal monologue of directions. Clearly, a client seeks a Personal Trainer for motivation and advice, but the way in which it is done should be considered, and the client-centered approach provides the context for such communication. Therefore, adopting a motivational interviewing method, which is both collaborative and directive, will enhance intrinsic motivation toward healthy behavior change.

A client-centered approach uses motivational interviewing skills of rapport building and active, empathic listening as central themes in keeping the client's perspective at the forefront.

Rapport Building

The first element of the client-centered approach is establishing rapport, which is developed by building a trusting and respectful relationship with the client. Starting the working relationship in this manner is critical and can readily be accomplished by asking open-ended questions (Box 10.2). For example, simply asking the client to describe a typical day will give the Personal Trainer information that may be useful in guiding the client to more healthful eating or exercise habits (9). For this type of rapport building to be effective, the Personal Trainer must keep in mind that open-ended questions are meant to gather information rather than be an interrogation. Asking simple noninvasive questions can help the Personal Trainer get a better understanding of the client. This process should take approximately 3–5 minutes and can start by simply asking, "Can you tell me about a recent typical day for you from beginning to end, so I can get a clearer picture of what it looks like?" or "The last time you worked out, what did you like or dislike about it?" If the clients feel that they are being judged, they will be less likely to elaborate, so it is important to allow the clients to speak freely without interrupting to point out problem areas. Ideally, the Personal Trainer will be speaking 10%–15% of the time and be focused on pacing the conversation, asking the clients to elaborate when necessary (9).

Box 10.2 Summary of Client-Centered Techniques

- Ask simple, open-ended questions (*i.e.*, questions that elicit details instead of yes-or-no responses).
- Listen and encourage with verbal and nonverbal prompts.
- Clarify and summarize. Check your understanding of what the client said and check to see whether the client understood what you said.
- Use reflective statements. This involves repeating and paraphrasing what the client has said to encourage elaboration in order to bridge the gap between what the client is saying and the meaning behind the statements.

From Mason P. *Health Behavior Change: A Guide for Practitioners*. 3rd ed. Warsaw (Poland): Elsevier; 2019. 240 p.

Exhibiting Empathy

Another way of establishing rapport is to demonstrate empathy. As Daniel Goleman (16) outlines, emotional empathy is one of three distinct kinds of empathy. Emotional empathy is most effective for mentoring and managing clients and is the ability to feel what someone else feels. Emotional empathy requires someone to recognize his or her own feelings in order to understand others and fortunately can be developed as a skill. Additionally, empathic concern is another form of empathy and is very important for those providing health services. It is the ability to sense what another person needs and physiologically has its roots in what compels a parent to care for a child (16). Individuals often feel a kinship with others who can relate to them or who have had similar experiences. One way of demonstrating empathy is through active listening, by repeating what was said, or paraphrasing, in order to encourage the client to elaborate and further understand themselves (9). As an example, a client may volunteer information about his or her exercise habits over the years and state that he or she is reluctant to get in shape for fear of experiencing more injuries. In this case, the Personal Trainer may ask, "So that I understand you, fear of injuries has kept you from engaging in a regular exercise routine. Is that correct?" Paraphrasing, rather than just repeating the client's words, reaffirms to the client the Personal Trainer was listening intently and understands.

Active Listening

Attempting to understand the underlying meaning of what a client is saying is referred to as active listening. Although requiring more skill and practice, because it often requires searching to understand the underlying meaning of words or phrases, this technique further enhances rapport and demonstrates empathy through the use of clarifying, reflective statements (9). Using the example earlier, the Personal Trainer may say, "It sounds like you are hesitant to exercise regularly at this time (reflective statement). Many people are hesitant to exercise after an injury (empathetic statement). Can you tell me about your specific concerns (open-ended question)?" This nonjudgmental style of communication tells the client that the Personal Trainer understands the emotions that the client may be experiencing while providing an additional opportunity for the Personal Trainer to learn more about the client and keeping the conversation focused on important distinctions. This process will help garner mutual trust, enhance the client's self-awareness, and provide the Personal Trainer with more insight as to what will help facilitate healthful behavior change.

Building rapport, exhibiting empathy, and listening actively will help build an effective communication bridge between the client and the Personal

Trainer. A summary of the three motivational interviewing techniques can be seen in Box 10.2, whereas Box 10.3 lists the indicators that the client-centered approach is being used. Additional guidance on various motivation and behavioral modification tools can also be found in Chapter 7.

Box 10.3 Indicators that the Client-Centered Approach Is Being Used

- The Personal Trainer is speaking slowly.
- The client is talking more than the Personal Trainer.
- The Personal Trainer can summarize the client's main concerns and aspirations in relation to behavior change.
- The Personal Trainer is listening intently and providing information to help the client make decisions.
- The client appears to understand that responsibility for change lies with him or her (*e.g.*, the Personal Trainer used language such as "Your options are . . . " or "It is your decision on next steps.").

From Mason P. *Health Behavior Change: A Guide for Practitioners*. 3rd ed. Warsaw (Poland): Elsevier; 2019. 240 p.

Preceding the Initial Client Consultation

Generating Clients

One of the pressing issues in any business is attracting new customers or clients. Some Personal Trainers may have the luxury of working in a facility where clients are continually being referred, in which case the Personal Trainer has to focus only on client retention, using concepts stated previously. However, in many cases, the responsibility is on the Personal Trainer to not only retain clients but seek and secure new ones as well.

Following are the strategies to generate new clients that can be applied to corporate, private, or commercial club settings.

Word-of-Mouth Advertising

One of the most cost-effective and powerful methods of marketing is word-of-mouth referrals from satisfied clients. Oftentimes, these referrals will be unsolicited without any effort needed on behalf of the Personal Trainer. On the other hand, the Personal Trainer may also want to express to existing clients that new clients are desired and that referrals are appreciated. In this case, the Personal Trainer may want to advertise a client referral program in which the existing client receives a complimentary fitness assessment or receives a discount on future sessions for each referred new client.

Fitness Floor Exposure

Personal Trainers working with clients on the floor are a walking advertisement of their style and services. For this reason, it is important to consistently exhibit professionalism and provide focused attention while training an existing client. Potential clients will likely not be attracted to Personal Trainers who appear distracted, disinterested, or not respectful of the client being trained. However, keeping an approachable disposition and making friendly eye contact with other members between exercises are certainly encouraged. If not working with a client, Personal Trainers may want to walk the fitness floor and make themselves available for questions, which may lead to more interest and Personal Training inquiries. Examples such as wearing a shirt that has the words "Personal Trainer" largely displayed can assist in distinguishing the Personal Trainer from other staff, or setting up a demonstration table in the front lobby can help bring exposure to the services they provide. The more exposure a Personal Trainer has with members increases their chances of parlaying that into Personal Training.

Complimentary Consultations

Although some may be of the opinion that offering free services devalues a service overall, occasionally marketing complimentary initial client consultations may be a strategy that can differentiate one Personal Trainer or club over another and lead to more clients.

Front Desk Contacts

Depending on the size of the club and member inquiry process, the front desk staff or receptionist may be the first individual to field a question about Personal Training services. The process may dictate that staff refer member inquiries to the Personal Trainer directly or to a Personal Training director first. In either case, it is important for the Personal Trainer to develop a strong working relationship with the "gatekeeper" staff and routinely communicate if new clients are desired. Stating availability, training style, and desired client special populations of interest may also be valuable reminders to the staff. Brochures, promotional flyers, and digital signage should also be displayed at a front desk or central location whenever possible with particular attention given to design and layout because it is a professional reflection on the Personal Trainer.

Professional Networking and Referrals

Personal Trainers should be part of an integrated community network of mutually referring health care professionals including, but not limited to, doctors (medical, chiropractic, naturopathic), physical therapists, certified athletic trainers, exercise physiologists, massage therapists, acupuncturists, wellness coaches, and registered dietitians. Retail fitness, nutrition, and health food stores, as well as local service professionals such as real estate and insurance agents and accountants, are viable referral sources. The Personal Trainer may want to join a professional networking group to facilitate these relationships in the community or make personal office visits and ask whether it is possible to display business cards or brochures while providing referrals in return.

Internet and Social Media Marketing

Increasing the number of exposure points will certainly enhance the consistency of new client interest, and in today's economy, Internet presence is paramount. It appears that all population demographics are increasingly using the Internet to obtain information and to socially connect; therefore, it is recommended that the Personal Trainer possess a personal Web site, use the club's Web site, or be active on one of the variety of social network sites. Creating and maintaining a Web site blog is another strategy, which may help not only attract but also retain clients by facilitating a continual dialogue. Web site content should highlight areas of expertise and training style and include client success stories or testimonials with relevant images (be sure prior permission is obtained, for confidentiality protection). In addition, using other social media sites such as Facebook, Instagram, LinkedIn, Twitter, or YouTube may be other outlets to increase exposure. These sites can be used to share positive status updates, special events, or incentives for clients and potential clients. However, if these sites are used, it is important to keep content as professional as possible. Consumers are savvy to research the Internet presence of a potential business contact, so special consideration should be given on the images and content posted in order to avoid an unwanted perception.

Although an important part of a marketing strategy, the fitness professional should not be reliant solely on social media to grow the business, recognizing that delivering personalized memorable experiences are truly key to client retention. Furthermore, a positive customer experience which will attract and retain clients is multifunctional and not only takes into account technology and social media but must also be balanced with marketing, operations, human resources, strategy, and design (3).

Initial Client Contact

It is advisable that the Personal Trainer have a process to screen and take new clients. Not only will this assist the Personal Trainer in gathering and organizing critical information about a potential client, but, perhaps more importantly, it is also the first opportunity to make an impression on the client by demonstrating organization, care, and professionalism. A flowchart of the recommended initial client-contact process is shown in Figure 10.1. This process may occur in person, over the phone, or via e-mail. Regardless of the communication method, great care should be taken to ensure that all elements of customer service, hospitality, and the client-centered approach are being incorporated when interfacing with the client (Fig. 10.2).

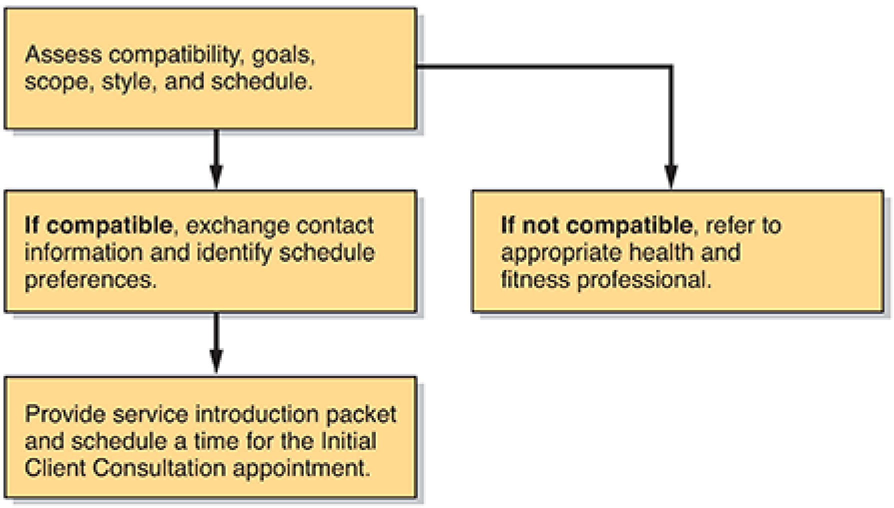

FIGURE 10.1. Initial client contact process.

FIGURE 10.2. Greeting a client.

Initial Client-Contact Process

A more detailed description of the initial client-contact process (see Fig. 10.1) is outlined as follows:

- Assess compatibility and refer as needed.
- Discuss the client's health and fitness goals and any relevant health conditions/limitations and ensure experience and scope are sufficient to meet the client's needs.
- Discuss experience, training style, and educational background and ensure that it is both adequate and appealing to the client.
- State the fee structure and ensure that it is agreeable to the client.
- Discuss the client's schedule preferences and assess compatibility for ongoing appointments.
- Refer to an alternate Personal Trainer or other health care professional if goals and interests are not compatible or if outside scope of practice or expertise.
- Exchange contact information.
  - Exchange phone numbers and e-mail addresses while identifying the preferred method of communication.
- Schedule the initial client consultation.
  - Schedule a mutually agreeable appointment for the initial client consultation if there is clear compatibility and interest between both parties to proceed.
  - Explain clearly what to expect and how to prepare for the initial client consultation in terms of appropriate dress, nutrition and hydration preparation, avoiding significant exertion prior, and what the appointment will include.
- Provide a service introduction packet.
  - Contents of the packet are intended to be returned prior to the next appointment and may include the following: Health/Medical History Evaluation Form, Medical Clearance Form if necessary (see Chapter 11 for sample forms), and Informed Consent. Additionally, the Client–Personal Trainer Agreement (see "Components of the Consultation" section) should be given to the client to be completed and returned at the next appointment. These forms may be distributed in hard copy directly or soft copy forms can be sent electronically to

the client based on preference. The Personal Trainer will instruct the client to complete the forms and return them at the next meeting.

- Provide additional information on a Web site dedicated to the service introduction, which may contain supporting marketing materials such as client testimonials, health care professional endorsements, and Personal Trainer publications or press clippings.
- Contents of the packet intended for review may include a business card, Personal Trainer bio and welcome letter, facility brochure, and training services pricing structure.

Client Intake Form

The aforementioned process should be used in conjunction with the client intake form, which is used to obtain the critical client contact information (Fig. 10.3).

New Client Intake Form

Contact Information

Date: _____ _____Phone _____ In-Person

Name:

____

Address:

____

Preferred method of contact:

_____ Phone (home): ________________

_____ Phone (cell): ________________

_____ Email: ______________________

Training Schedule Interest (circle all that apply):

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
am	am	am	am	am	am	am	am
midday	midday	midday	midday	midday	midday	midday	midday
pm	pm	pm	pm	pm	pm	pm	pm

Health and Fitness Information

General Health and Fitness Goals (check all that apply):

- ☐ strength
- ☐ endurance
- ☐ sport performance
- ☐ physical appearance
- ☐ disease management
- ☐ stress management
- ☐ weight management
- ☐ energy/vitality

Health or other Fitness Professional(s) treating client:

____

____

Medical Considerations/Limitations:

____

____

MD Release Form Needed: _____ Yes _____ No

MD Name/Phone Contact (if necessary):

____

Action Items

Referral to Health of Fitness Professional: _____ Yes _____ No

Referral:

____

If compatible:

MD Release Form (if necessary) Date Sent: ____________ Rec'd: ____________

Initial Client Consultation Date: ________________

Service Introduction Packet Delivered: _____ In-Person _____ Email _____ Mail

Comments:

____

____

FIGURE 10.3. Example of a new client intake form.

Preparing for the Initial Client Consultation

The initial client contact is the precursor to the initial client consultation and is a valuable springboard for the next meeting when set up correctly. First, it is important that the Personal Trainer remind the client the day and time of the next meeting and the time allotted for the appointment. Next, it should be clearly articulated what the next appointment will include, the recommended attire, necessary equipment, and if a hydration bottle is needed. The client should also be reminded to complete and return the necessary forms and to contact the Personal Trainer if any questions or concerns arise. The Personal Trainer should take exceptional care in departing with the new client by making eye contact and shaking hands, walking the client to the door, and then thanking the client by name while genuinely expressing that the next visit is eagerly awaited. Ideally, if the Personal Trainer exhibits traits of outstanding customer service, hospitality, and relationship building in this initial meeting, the client will be motivated and inspired to return for the next visit.

The Personal Trainer should take exceptional care in departing with the new client by making eye contact and shaking hands, walking the client to the door, and then thanking the client by name while genuinely expressing that the next visit is eagerly awaited.

Initial Client Consultation

Up to this point, much of the groundwork has been laid in preparation for the initial client consultation. Indeed, some of the most important work in a Personal Trainer's profession is in establishing rapport, creating a comfortable and welcoming environment, and inspiring motivation in a client. What remains are the more technical elements that a consultation may include.

Consultation Location and Confidentiality

Of utmost importance is the location of the client consultation because it sets the tone for information sharing and relationship building. The Personal Trainer must view this experience through the eyes of a new client and create a hospitable and private environment accordingly. Discussion of personal and confidential health information must be held in the strictest confidence and taken seriously. Additionally, it is common for new clients to feel uneasy about themselves and their health and fitness status, and a fitness center environment may exacerbate those insecurities. Although not all clients will externally exhibit such sensitivities, it is best to err conservatively. Therefore, creating a welcoming and nonjudgmental atmosphere in a private space should be a priority.

Specifically, the consultation and assessment should be in an enclosed room or remote space within the facility so that verbal communication is not clearly discernible to other clients. The space should be free from distracting background noise or music, along with any visual distractions that could hinder a focused conversation between client and Personal Trainer. The area should be clean and organized, comfortably accommodate two to four chairs, and have a desk or table wide enough for the Personal Trainer to review or explain documents. The area should have good lighting and proper ventilation. In accordance with American College of Sports Medicine (17) recommendations, the assessment area should maintain a comfortable temperature between 68° F and 72° F (20° C and 22° C), with humidity below 60%. If it is not possible to have a separate room to conduct the initial consultation, sitting with the client facing away from other clients may be advisable to maximize privacy and prevent voices from carrying.

Introduction and Consultation Agenda Review

As previously discussed, the Personal Trainer should warmly welcome the client upon first sight with a handshake and smile and engage in light conversation to put the client at ease. Next, the Personal Trainer should lead the client to the private consultation area and review the sequence and content of the initial client consultation. Even though the Personal Trainer has previously outlined the process in the initial client contact, it is recommended that a step-by-step review of the process again be provided at this point. For example, the Personal Trainer may say:

> I'm so glad that you have taken this step toward enhancing your health and fitness and I'm eager for us to get started. First, I'd like to outline what this appointment will include so that you know what to expect and to see if you have any questions or concerns. Does that sound alright with you?

If concerns are expressed, address them and then continue accordingly.

> We will begin by reviewing the paperwork that you were asked to complete (Personal Trainer–Client Agreement, Health/Medical History Evaluation Form [and/or Physical Activity Readiness Questionnaire], Informed Consent, and Medical Clearance Form as needed). Then, I'd like to hear more about your health and fitness goals and interests. This will help me get to know you better and help us determine which fitness assessments we should perform. Finally, we will conduct the fitness assessments, discuss the results, and discuss an action plan together. Do you have any questions before we begin?

Not only does clearly defining the structure of the appointment lessen anxiety, but it also provides an opportunity for the client to express concerns or feelings about performing a given part of the assessment. For example, a client may be uncomfortable with the prospect of a caliper body-fat composition test if self-conscious about a weight problem. This provides the Personal Trainer an opportunity to empathize with the client and modify or eliminate a test as appropriate. If a client expresses any trepidation about a test, the Personal Trainer should immediately honor the request without any pressure. During this trust-building time, the benefit of expressing understanding will far outweigh the cost of convincing a client to do something with which he or she is uncomfortable.

Components of the Consultation

Once the stage has been set for the appointment, the Personal Trainer can continue with carrying out the key components of the consultation. This includes reviewing the documents that were given to the client during the initial client contact. Ideally, the client will have already completed the forms so that more time can be spent on getting to know the client, performing assessments, and goal setting; otherwise, it is important to note that these elements may be provided over the course of one or two appointments, depending on the time availability and appointment structure of the Personal Trainer's club or facility. Either way, the following elements should be included.

Personal Trainer–Client Agreement

It is very important to review expectations between the client and the Personal Trainer before joining in a business relationship. For example, cancelled or no-show appointments have financial ramifications for both parties, and so, ensuring mutual understanding is critical from the start. The document can be adapted to include other essential business expectations (Fig. 10.4). Be sure to retain a copy of this document for yourself and give a copy to the client.

Personal Training Client Agreement

I, ______________________________, have read and agree to the following:
(Client Name – Print)

I have volunteered to participate in a program of physical exercise under the instruction of
______________________________. Training may include, but is not limited
(Personal Trainer Name – Print)

to, cardiovascular training, muscular fitness training (including muscular strength, muscular endurance, and power), flexibility training, and balance training.

I will schedule appointments directly with my Personal Trainer for times that are agreed upon by both parties. Contact information has been provided to each party. I understand that the Personal Trainer is not authorized to share that information with anyone else.

That I will arrive for my appointment on time and properly dressed for exercise. That arriving late will results in an abbreviated training session.

Training sessions are private (one-on-one sessions) and will be one hour long.

That my progress will be based on my commitment to follow the program as instructed by the Personal Trainer, and that the Personal Trainer cannot guarantee results, but that my desire to work hard, and that effective communication with the Personal Trainer will improve the chance of success.

That I will communicate relevant information to my Personal Trainer that may influence the training session and/or program (changes in health, occurrence of symptoms, medications).

Cancellation Policy: I understand that, should the need arise, I will contact the Personal Trainer about cancelling a training session no less than 24 hours prior to the scheduled appointment to avoid being charged the full amount for the training session.

No Show Policy: I understand that if I do not show up for my scheduled session, I will be charged the full amount for the training session.

I understand that if the Personal Trainer does not show up for the scheduled appointment, or does not contact me more than 24 hours prior to the scheduled session, the Personal Trainer will schedule an additional training session at no cost.

I understand that I can communicate any customer service issues to the Personal Trainer and/or the training facility manager.

Client Signature: ______________________________ Date: __________

Personal Trainer Signature: ______________________________ Date: __________

FIGURE 10.4. Example of Personal Training client agreement. (Adapted from Plus One Health Management, Inc., New York [NY]: 2008, with permission.)

Health/Medical History Evaluation Form and/or PAR-Q+

Discussing the client's current health status and history is important in getting to know his or her areas for improvement as well as limitations. This information will further assist the Personal Trainer in assessing risk and whether a Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) and/or Medical Clearance Form is necessary to proceed (see Chapter 11 for more detailed guidance on the use of a Health/Medical History Evaluation Form and/or PAR-Q+).

Medical Clearance Form

If determined through the use of the Health/Medical History Evaluation Form or PAR-Q+ that the client should see a physician before starting either a moderate- or high-intensity exercise routine, it is imperative to have this document signed by both the client and the physician. It may provide important restriction information that should be taken into account during program testing and design (see Chapter 11 for more detailed guidance on the use of a medical clearance procedures).

Informed Consent

From an ethical and legal perspective, it is important that the client understand the risks and benefits of performing assessments and engaging in a guided exercise program. Reviewing the informed consent verbally with the client at the onset allows opportunities for inquiries, serves as a document of understanding, and should be signed by the client (see Chapter 11 for more detailed guidance on the use of an informed consent).

Client Goals

Using the information from the client intake form (see Fig. 10.3) as a guide, the Personal Trainer should ask additional questions about the client's health and fitness goals to get more specific responses as well as timelines that the client seeks for achievement. Motivational interviewing techniques will help to identify intrinsically motivated goals through a collaborative discussion (see Chapter 8 for more detailed guidance on goal setting).

The Personal Trainer should ask additional questions about the client's health and fitness goals to get more specific responses as well as timelines that the client seeks for achievement.

Health and Fitness Assessment

Once any health limitations or restrictions are ascertained and goals identified from the aforementioned process, it is time to perform the fitness assessment. Even though a general overview of the tests to be performed is explained at the beginning of the consultation (Fig. 10.5), it is advised to thoroughly explain and demonstrate each assessment immediately prior to it being performed to further minimize any anxiety or confusion that the client may have. Selecting and explaining tests that emphasize a balanced program is important and may include resting heart rate and blood pressure as well as body composition, cardiovascular fitness, strength, endurance, range of motion, functional movement, and anthropometric and postural measures (see Chapter 12 for more detailed guidance on health and fitness assessments).

FIGURE 10.5. Client consultation.

Assessment Results and Action Plan

Upon the completion of any assessment, most clients are eager to receive the results. If the results can be given immediately after the tests, it enables the client and the Personal Trainer to begin taking action toward mutually identified goals. It is important to share the results in a positive manner, emphasizing that the results are a baseline with which to measure progress over time. Based on the results, a referral to a physician or other health care professional may be needed for a medical release. In this case, the Personal Trainer should print the findings on the form so that the client can deliver the information to the health care professional to review.

Recommending Appropriate Personal Training Packages

At this time, based on the findings of the assessment and verbalized goals, the Personal Trainer should detail a recommended action plan for training with the client. The appointment frequency and number of sessions purchased should be determined by the client's needs and goals. For example, if an experienced client wants to learn new exercise movements to supplement his or her current routine of $4\ d \cdot wk^{-1}$, then the Personal Trainer likely should recommend meeting only once a week. On the other hand, a new client who is unfamiliar with exercise not only needs to learn how to perform exercise movements safely and with good form but may also need assistance in establishing an exercise habit. In this case, to facilitate learning and encourage an active lifestyle, the Personal Trainer may want to suggest training two to four times per week for 4–16 weeks. This will help the client begin to perfect and memorize the movement patterns and build the foundation for habitual exercise.

Unfortunately, a problem occurs when the beginning exerciser purchases too few sessions. As a result, the sessions occur so infrequently that the client does not have the opportunity to memorize and perform the movement patterns correctly. The disappointed client then feels that the Personal Trainer or training itself is not successful. For this reason, the Personal Trainer should be clear with the client at the beginning and recommend the exercise program that the client needs to succeed. Otherwise, it does the client a disservice if the Personal Trainer is making recommendations solely on monetary concerns versus what will help the client reach individual goals. Thus, the importance of clarity when recommending Personal Training packages during the initial client consultation becomes apparent and will ultimately help the Personal Trainer succeed in being truthful and realistic about progress.

Obtaining Client Commitment

Obtaining client commitment through the act of purchasing a package of training sessions can be an act fraught with anxiety for many Personal Trainers. Making recommendations is one part of the equation; yet, "landing the sale" is another aspect that does not always come easily. Ideally, the selling process at this point of the initial client consultation should be a positive one for both parties. After developing rapport during the initial client contact, along with a thoughtful, caring, and educational approach to the initial client consultation, the client's purchase of a Personal Training package will be a natural step in the process of obtaining exercise and fitness training.

> After developing rapport during the initial client contact, along with a thoughtful, caring, and educational approach to the initial client consultation, the client's purchase of a Personal Training package will be a natural step in the process of obtaining exercise and fitness training.

The Personal Trainer should keep in mind that the client needs the help of a Personal Training professional and that this is the primary reason that the client has sought out Personal Training services. The Personal Trainer should focus the client's attention on the service, instruction, motivation, guidance, enthusiasm, safety, and education that he or she will receive from the Personal Training experience. The Personal Trainer may also remind the client of the value of Personal Training by the increased sense of self-esteem and the benefits of feeling healthier and being in better shape to actively enjoy life.

One approach to the sale of training sessions is to review the Personal Training packages that the facility offers and to point out the most commonly purchased package by clients and why. For example, the Personal Trainer can tell the client that most of beginning training clients purchase package A and train 2 $d \cdot wk^{-1}$. The Personal Trainer could ask, "Would you like to purchase that package?" or "How would you like to proceed?" This approach can help move the client toward purchasing a package of sessions. Common objections to Personal Training package purchases may arise from the client because of money, time, procrastination, and/or other conflicts. Thus, the Personal Trainer should be prepared to respond and anticipate possible objections. It is important to remember that pressuring a client into an exercise program to which he or she is not willing or is unable to commit could be a pitfall rather than a success story for both the client and the Personal Trainer. On the contrary, the Personal Trainer should maintain a positive attitude, relax and listen to what the client has to say, and then evaluate the objection and respond with empathy and truthfulness.

When the client commits, the Personal Trainer should not act surprised with the sale but rather express positive reinforcement and have the client review and sign all required agreements or contracts. If a commitment is not obtained from the client, the Personal Trainer should maintain a positive perspective and remember that not everyone is going to seek services after the initial client consultation. Demonstrating professionalism, the Personal Trainer should recommend other sources to the client to enhance health and fitness. Based on this customer-focused behavior, the client may likely refer friends or family members or decide to give Personal Training another chance in the future.

Leading into the Next Client Appointment

Ideally, throughout both the initial client contact and consultation, the Personal Trainer will have exhibited outstanding customer service and hospitality, along with positive nonverbal communication. In addition, behaviors to enhance the concepts of relationship marketing and the client-centered approach to coaching should have been conscientiously demonstrated.

After the initial client consultation is complete, all the necessary paperwork has been reviewed, and a goal-setting action plan has been discussed, the next appointment should be confirmed. At that time, the Personal Trainer should express gratitude to the client for his or her time and display eagerness for the next visit. As a token of hospitality, the Personal Trainer should send a follow-up note or phone call to the client to compliment him or her on the successful step toward health and fitness while reminding the client of the next appointment and how to prepare.

> The Personal Trainer should express gratitude to the client for his or her time and display eagerness for the next visit.

As was discussed in the "Relationship Marketing" section, it is important for businesses to continually evaluate success in order to minimize the percentage of "defections" or those clients who do not return. Appropriately at this time, the Personal Trainer should reevaluate how the meeting went. Whether it ended in a large package purchase or not, the Personal Trainer should spend time mentally reviewing and then write down the positives and negatives that occurred in the consultation. The Personal Trainer should work on the areas of communication skills or approach that may need improvement. Additionally, the Personal Trainer may want to consider sending a quick and simple online survey garnering feedback about the session. All these actions combined will certainly help facilitate a successful beginning to a long-lasting client relationship and set the standard for future client interactions.

SUMMARY

There are several points of client contact leading up to the initial client consultation appointment that set the groundwork for a successful client–Personal Trainer relationship. This includes contact when attempting to generate new clients, the initial client contact when identifying compatibility, and the initial client consultation itself. Every stage of the relationship is critical, so attention to detail should be paid to effective communication throughout the process. Demonstrating exceptional customer service, hospitality, and positive nonverbal cues from the onset not only communicates pride in professionalism but speaks to the respect and high regard placed in the client as well. Furthermore, a focus on relationship marketing coupled with a client-centered approach engenders trust between the parties. Finally, the Personal Trainer should demonstrate professionalism during the initial client consultation by using appropriate information-gathering tools and testing protocols while communicating skillfully about health and fitness results and the respective Personal Training action plan.

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CHAPTER 11

Preparticipation Physical Activity Screening Guidelines

OBJECTIVES

Personal Trainers should be able to:

- Understand the process and outcomes of the American College of Sports Medicine (ACSM) preparticipation physical activity screening.
- Explore the importance of and issues with preparticipation physical activity screening as well as investigate the various tools that may be used including the Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) and a Health History Questionnaire.
- Determine course of action with a client once the risk has been established.
- Discuss the concept of absolute and relative contraindications to exercise testing.

INTRODUCTION

Ever since the increased promotion of physical activity in modern times, there has been an emphasis on preparticipation physical activity screening to ensure that the risks of increased physical activity do not outweigh the benefits of this healthy behavior (1). The process of preparticipation physical activity screening has been increasingly professionalized over the years since its introduction. The American College of Sports Medicine (ACSM) is perhaps the best known organization in the area of preparticipation physical activity screening in the United States. The ACSM formally titled this process *risk stratification* in the 1990s in *ACSM's Guidelines for Exercise Testing and Prescription* (*GETP*), fourth edition, publication. This process was retitled *risk classification* in 2013 (2). With the release of the tenth edition of *GETP* in 2017, there were some substantial changes to the preparticipation physical activity screening process including the elimination of the *risk stratification/classification* terminology (including low-, moderate-, and high-risk strata) and the nonuse of adding/subtracting ACSM risk factor thresholds for overall risk classification. These changes were continued into the latest edition of *GETP* (3). This is discussed further in this chapter.

The preparticipation physical activity screening process is also intimately tied to the contraindications for graded exercise testing discussed later in this chapter. This chapter explores the preparticipation physical activity screening concept, so the ACSM Certified Exercise Physiologist® (ACSM-EP®) and ACSM Certified Personal Trainer® (ACSM-CPT®) can make informed decisions about the readiness of an individual to undertake a physically active lifestyle.

Importance of Preparticipation Physical Activity Screening

In order to reduce the likelihood of occurrence of any untoward or unwanted event(s) during a physical activity program, it is prudent to conduct some form of preparticipation physical activity screening on a client (4). Preparticipation physical activity screening, along with cardiovascular risk factor assessment discussed later in this chapter, may also be the first step in a health-related physical fitness assessment. Preparticipation physical activity screening involves gathering and analyzing demographic and health-related information on a client along with some medical/health assessments such as the presence of signs and symptoms in order to aid decision making on a client's physical activity future (3). The preparticipation physical activity screening is a dynamic process in that it may vary in its scope and components depending on the client's needs from a medical/health standpoint (*e.g.*, the client has some form of cardiovascular, metabolic, and/or renal [CMR] disease) as well as the presence of signs and symptoms suggestive of CMR disease (*e.g.*, chest pain of an ischemic nature) and the physical activity program status (the client currently participates in moderate physical activity for the past 3 mo).

The following is a partial list of the reasons why it is important to first screen clients for participation in physical activity programs (3,5):

- To identify those with medical contraindications (exclusion criteria) for performing physical activity
- To identify those who should receive a medical/physical evaluation/exam and clearance prior to performing a physical activity program
- To identify those who should participate in a medically supervised physical activity program
- To identify those with other health/medical concerns (*i.e.*, orthopedic injuries, etc.)

History of Preparticipation Physical Activity Screening

There are several national and international organizations that have made suggestions about what these preparticipation physical activity screening guidelines should be including the ACSM (1,2,6,7). However, it is helpful to remember that these are just guidelines or suggestions. The prudent ACSM-EP or ACSM-CPT should devise a preparticipation physical activity screening scheme that best meets the needs of the client(s) and environment(s).

For instance, the U.S. Surgeon General in the 1996 report on *Physical Activity and Health* stated that (4)

> Previously inactive men over age 40, women over age 50, and people at high risk for CVD [CVD is an abbreviation for cardiovascular disease] should first consult a physician before embarking on a program of vigorous physical activity to which they are unaccustomed. People with disease should be evaluated by a physician first.

In addition, a summary of the "cautions" listed on many pieces of exercise equipment as well as in exercise books and videos is to

- "First consult your physician before starting an exercise program."
- "This is especially important for
  - Men ≥45 years old; women ≥55 years old
  - Those who are going to perform vigorous physical activity
  - And for those who are new to exercise or are unaccustomed to exercise"

There is one major set of formal screening guidelines for individuals who wish to embark on a physical activity program. This set comes from the ACSM. The ACSM has published this set in their popular and often revised text, *GETP*, starting with their fourth edition in 1991. Several other professional organizations including the American Heart Association (AHA) have also published and revised their own set of preparticipation physical activity screening guidelines. The AHA guidelines were published most recently in their journal *Circulation* in 2001 (2,8).

As stated earlier, the ACSM, through its *GETP* text, has addressed preparticipation physical activity screening (4). In the past, the ACSM has listed these preparticipation physical activity screening guidelines often under the moniker, "risk stratification." Through the first eight editions (although risk stratification did not appear formally in the first three editions) of the *GETP*, there have been several revisions made to this risk stratification section. The ninth edition of the *GETP* terms this process as *risk classification*. The tenth edition of *GETP* has put forth major changes to the preparticipation physical activity screening process (2). We would categorize the revisions made to the *GETP* preparticipation screening process as mostly an elimination of the "strata" or levels used as well as the elimination of the use of the ACSM risk factor thresholds for this process. In the place of the ACSM risk factor thresholds is the dependence on the physical activity history of the participant as well as the presence of CMR disease and the presence of signs and symptoms suggestive of CMR disease (3).

Levels of Screening

According to the ACSM, there are two basic approaches to preparticipation physical activity screening (3). One of these approaches can be performed by the individual wishing to become more physically active without direct input from an exercise professional (self-guided screening). The other approach involves interaction with an exercise professional such as an ACSM-EP or ACSM-CPT (professionally supervised screening). These two levels of screening are not mutually exclusive; for instance, an individual may first use the self-guided method before seeking an ACSM-EP or ACSM-CPT for professional guidance in preparticipation physical activity screening.

Self-Guided Screening

Self-guided approaches to preparticipation physical activity screening has been suggested by many organizations from the ACSM to the AHA as a minimum or starting point for the individual who wishes to increase his or her physical activity (2). The Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) has been suggested for use in self-guided screening and is discussed next.

Physical Activity Readiness Questionnaire for Everyone

The Health History Questionnaire (HHQ) is generally thought of as being a comprehensive assessment of a client's medical and health history. Because the HHQ can be more information than is needed in some situations, the original Physical Activity Readiness Questionnaire, or PAR-Q, was developed in Canada to be simpler in both scope and use (9). The original PAR-Q contains seven YES/NO questions that have been found to be both readable and understandable for an individual to answer. The PAR-Q was designed to screen out those clients from not participating in physical activities that may be too strenuous for them. The PAR-Q has been recommended as a minimal standard for entry into moderate-intensity exercise programs. Thus, the PAR-Q may be considered a useful tool for individuals to gauge their own "medical" readiness to participate in physical activity programs (3). However, because the PAR-Q may be best used to screen those who are at high risk for exercise complications and thus may need a medical exam, it may not be as effective in screening low- to moderate-risk individuals (7). Thus, the PAR-Q has recently morphed into the PAR-Q+ with some word changes among the seven YES/NO questions to better classify all individuals (Fig. 11.1) (3).

2021 PAR-Q+

The Physical Activity Readiness Questionnaire for Everyone

The health benefits of regular physical activity are clear; more people should engage in physical activity every day of the week. Participating in physical activity is very safe for MOST people. This questionnaire will tell you whether it is necessary for you to seek further advice from your doctor OR a qualified exercise professional before becoming more physically active.

GENERAL HEALTH QUESTIONS

Please read the 7 questions below carefully and answer each one honestly: check YES or NO.	YES	NO
1) Has your doctor ever said that you have a heart condition ☐ **OR** high blood pressure ☐?	☐	☐
2) Do you feel pain in your chest at rest, during your daily activities of living, **OR** when you do physical activity?	☐	☐
3) Do you lose balance because of dizziness **OR** have you lost consciousness in the last 12 months? Please answer **NO** if your dizziness was associated with over-breathing (including during vigorous exercise).	☐	☐
4) Have you ever been diagnosed with another chronic medical condition (other than heart disease or high blood pressure)? **PLEASE LIST CONDITION(S) HERE:** ________	☐	☐
5) Are you currently taking prescribed medications for a chronic medical condition? **PLEASE LIST CONDITION(S) AND MEDICATIONS HERE:** ________	☐	☐
6) Do you currently have (or have had within the past 12 months) a bone, joint, or soft tissue (muscle, ligament, or tendon) problem that could be made worse by becoming more physically active? Please answer **NO** if you had a problem in the past, but it **does not limit your current ability** to be physically active. **PLEASE LIST CONDITION(S) HERE:** ________	☐	☐
7) Has your doctor ever said that you should only do medically supervised physical activity?	☐	☐

If you answered NO to all of the questions above, you are cleared for physical activity.
Please sign the PARTICIPANT DECLARATION. You do not need to complete Pages 2 and 3.

- Start becoming much more physically active – start slowly and build up gradually.
- Follow Global Physical Activity Guidelines for your age (https://www.who.int/publications/i/item/9789240015128).
- You may take part in a health and fitness appraisal.
- If you are over the age of 45 yr and NOT accustomed to regular vigorous to maximal effort exercise, consult a qualified exercise professional before engaging in this intensity of exercise.
- If you have any further questions, contact a qualified exercise professional.

PARTICIPANT DECLARATION
If you are less than the legal age required for consent or require the assent of a care provider, your parent, guardian or care provider must also sign this form.

I, the undersigned, have read, understood to my full satisfaction and completed this questionnaire. I acknowledge that this physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if my condition changes. I also acknowledge that the community/fitness center may retain a copy of this form for its records. In these instances, it will maintain the confidentiality of the same, complying with applicable law.

NAME ________________________ DATE ____________

SIGNATURE ________________________ WITNESS ____________

SIGNATURE OF PARENT/GUARDIAN/CARE PROVIDER ________________________

If you answered YES to one or more of the questions above, COMPLETE PAGES 2 AND 3.

Delay becoming more active if:

- You have a temporary illness such as a cold or fever; it is best to wait until you feel better.
- You are pregnant - talk to your health care practitioner, your physician, a qualified exercise professional, and/or complete the ePARmed-X+ at www.eparmedx.com before becoming more physically active.
- Your health changes - answer the questions on Pages 2 and 3 of this document and/or talk to your doctor or a qualified exercise professional before continuing with any physical activity program.

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FIGURE 11.1. First page of the the Physical Activity Readiness Questionnaire for Everyone (PAR-Q+). (Reprinted with permission from the PAR-Q+ Collaboration and the authors of the PAR-Q+. See http://eparmedx.com for the most current annual update of the PAR-Q+.)

Thus, at the minimum, a prudent ACSM-EP or ACSM-CPT should consider suggesting to the clients that they fill out a PAR-Q+ (Figs. 11.1 and

11.2) prior to participation in any self-guided physical activity program (3,10).

2021 PAR-Q+

FOLLOW-UP QUESTIONS ABOUT YOUR MEDICAL CONDITION(S)

1. Do you have Arthritis, Osteoporosis, or Back Problems?
If the above condition(s) is/are present, answer questions 1a-1c — If **NO** ☐ go to question 2

1a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
1b.	Do you have joint problems causing pain, a recent fracture or fracture caused by osteoporosis or cancer, displaced vertebra (e.g., spondylolisthesis), and/or spondylolysis/pars defect (a crack in the bony ring on the back of the spinal column)?	YES ☐ NO ☐
1c.	Have you had steroid injections or taken steroid tablets regularly for more than 3 months?	YES ☐ NO ☐

2. Do you currently have Cancer of any kind?
If the above condition(s) is/are present, answer questions 2a-2b — If **NO** ☐ go to question 3

2a.	Does your cancer diagnosis include any of the following types: lung/bronchogenic, multiple myeloma (cancer of plasma cells), head, and/or neck?	YES ☐ NO ☐
2b.	Are you currently receiving cancer therapy (such as chemotheraphy or radiotherapy)?	YES ☐ NO ☐

3. Do you have a Heart or Cardiovascular Condition? This includes Coronary Artery Disease, Heart Failure, Diagnosed Abnormality of Heart Rhythm
If the above condition(s) is/are present, answer questions 3a-3d — If **NO** ☐ go to question 4

3a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
3b.	Do you have an irregular heart beat that requires medical management? (e.g., atrial fibrillation, premature ventricular contraction)	YES ☐ NO ☐
3c.	Do you have chronic heart failure?	YES ☐ NO ☐
3d.	Do you have diagnosed coronary artery (cardiovascular) disease and have not participated in regular physical activity in the last 2 months?	YES ☐ NO ☐

4. Do you currently have High Blood Pressure?
If the above condition(s) is/are present, answer questions 4a-4b — If **NO** ☐ go to question 5

4a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
4b.	Do you have a resting blood pressure equal to or greater than 160/90 mmHg with or without medication? (Answer **YES** if you do not know your resting blood pressure)	YES ☐ NO ☐

5. Do you have any Metabolic Conditions? This includes Type 1 Diabetes, Type 2 Diabetes, Pre-Diabetes
If the above condition(s) is/are present, answer questions 5a-5e — If **NO** ☐ go to question 6

5a.	Do you often have difficulty controlling your blood sugar levels with foods, medications, or other physician-prescribed therapies?	YES ☐ NO ☐
5b.	Do you often suffer from signs and symptoms of low blood sugar (hypoglycemia) following exercise and/or during activities of daily living? Signs of hypoglycemia may include shakiness, nervousness, unusual irritability, abnormal sweating, dizziness or light-headedness, mental confusion, difficulty speaking, weakness, or sleepiness.	YES ☐ NO ☐
5c.	Do you have any signs or symptoms of diabetes complications such as heart or vascular disease and/or complications affecting your eyes, kidneys, **OR** the sensation in your toes and feet?	YES ☐ NO ☐
5d.	Do you have other metabolic conditions (such as current pregnancy-related diabetes, chronic kidney disease, or liver problems)?	YES ☐ NO ☐
5e.	Are you planning to engage in what for you is unusually high (or vigorous) intensity exercise in the near future?	YES ☐ NO ☐

2021 PAR-Q+

6. Do you have any Mental Health Problems or Learning Difficulties? This includes Alzheimer's, Dementia, Depression, Anxiety Disorder, Eating Disorder, Psychotic Disorder, Intellectual Disability, Down Syndrome
If the above condition(s) is/are present, answer questions 6a-6b — If **NO** ☐ go to question 7

6a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
6b.	Do you have Down Syndrome **AND** back problems affecting nerves or muscles?	YES ☐ NO ☐

7. Do you have a Respiratory Disease? *This includes Chronic Obstructive Pulmonary Disease, Asthma, Pulmonary High Blood Pressure*

If the above condition(s) is/are present, answer questions 7a-7d — If **NO** ☐ go to question 8

7a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
7b.	Has your doctor ever said your blood oxygen level is low at rest or during exercise and/or that you require supplemental oxygen therapy?	YES ☐ NO ☐
7c.	If asthmatic, do you currently have symptoms of chest tightness, wheezing, laboured breathing, consistent cough (more than 2 days/week), or have you used your rescue medication more than twice in the last week?	YES ☐ NO ☐
7d.	Has your doctor ever said you have high blood pressure in the blood vessels of your lungs?	YES ☐ NO ☐

8. Do you have a Spinal Cord Injury? *This includes Tetraplegia and Paraplegia*

If the above condition(s) is/are present, answer questions 8a-8c — If **NO** ☐ go to question 9

8a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
8b.	Do you commonly exhibit low resting blood pressure significant enough to cause dizziness, light-headedness, and/or fainting?	YES ☐ NO ☐
8c.	Has your physician indicated that you exhibit sudden bouts of high blood pressure (known as Autonomic Dysreflexia)?	YES ☐ NO ☐

9. Have you had a Stroke? *This includes Transient Ischemic Attack (TIA) or Cerebrovascular Event*

If the above condition(s) is/are present, answer questions 9a-9c — If **NO** ☐ go to question 10

9a.	Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer **NO** if you are not currently taking medications or other treatments)	YES ☐ NO ☐
9b.	Do you have any impairment in walking or mobility?	YES ☐ NO ☐
9c.	Have you experienced a stroke or impairment in nerves or muscles in the past 6 months?	YES ☐ NO ☐

10. Do you have any other medical condition not listed above or do you have two or more medical conditions?

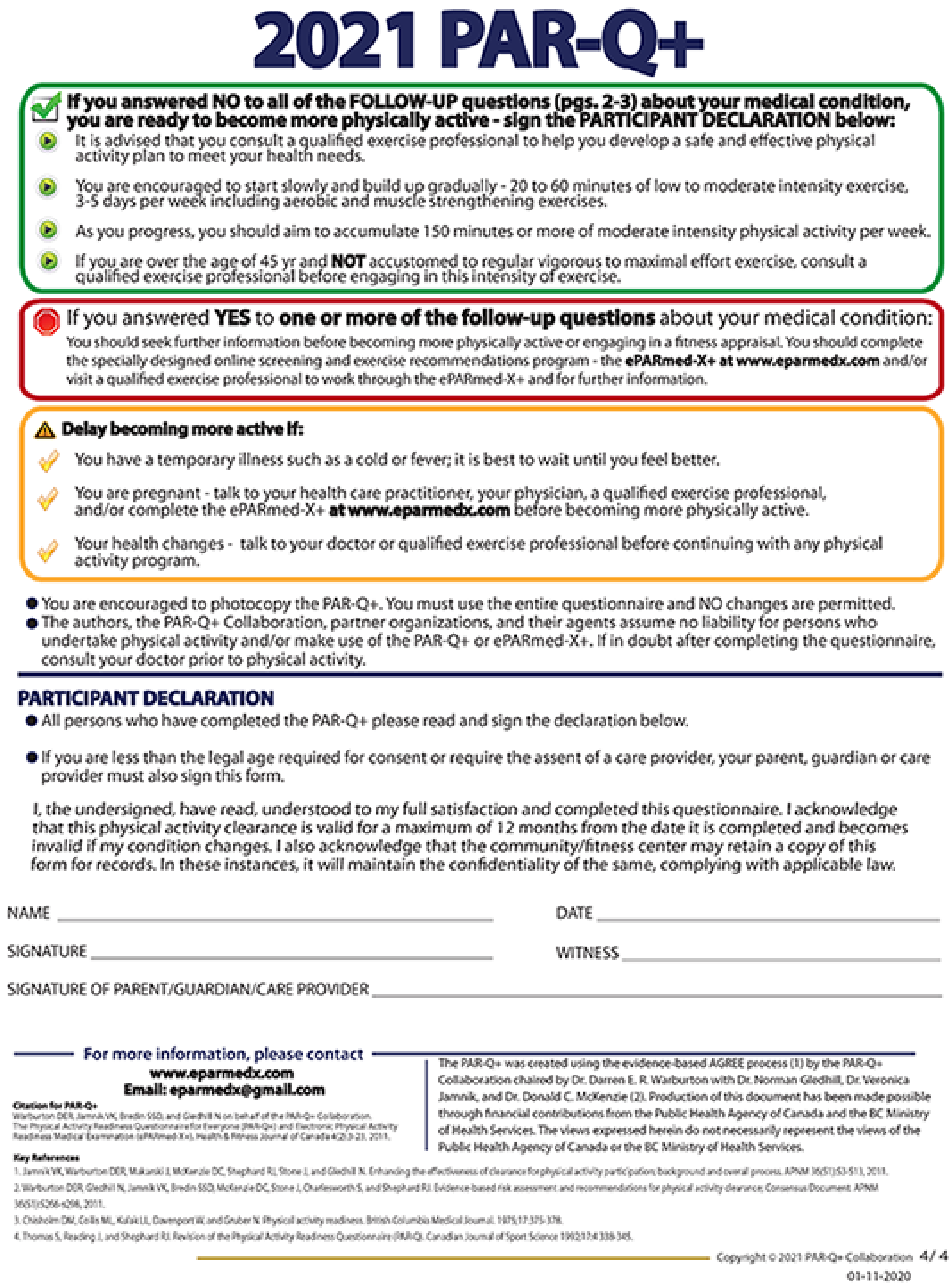
If you have other medical conditions, answer questions 10a-10c — If **NO** ☐ read the Page 4 recommendations

10a.	Have you experienced a blackout, fainted, or lost consciousness as a result of a head injury within the last 12 months **OR** have you had a diagnosed concussion within the last 12 months?	YES ☐ NO ☐
10b.	Do you have a medical condition that is not listed (such as epilepsy, neurological conditions, kidney problems)?	YES ☐ NO ☐
10c.	Do you currently live with two or more medical conditions?	YES ☐ NO ☐

PLEASE LIST YOUR MEDICAL CONDITION(S) AND ANY RELATED MEDICATIONS HERE: ______________________________

____

GO to Page 4 for recommendations about your current medical condition(s) and sign the PARTICIPANT DECLARATION.



2021 PAR-Q+

If you answered NO to all of the FOLLOW-UP questions (pgs. 2-3) about your medical condition, you are ready to become more physically active - sign the PARTICIPANT DECLARATION below:

- It is advised that you consult a qualified exercise professional to help you develop a safe and effective physical activity plan to meet your health needs.
- You are encouraged to start slowly and build up gradually - 20 to 60 minutes of low to moderate intensity exercise, 3-5 days per week including aerobic and muscle strengthening exercises.
- As you progress, you should aim to accumulate 150 minutes or more of moderate intensity physical activity per week.
- If you are over the age of 45 yr and **NOT** accustomed to regular vigorous to maximal effort exercise, consult a qualified exercise professional before engaging in this intensity of exercise.

If you answered **YES to one or more of the follow-up questions** about your medical condition:
You should seek further information before becoming more physically active or engaging in a fitness appraisal. You should complete the specially designed online screening and exercise recommendations program - the **ePARmed-X+ at www.eparmedx.com** and/or visit a qualified exercise professional to work through the ePARmed-X+ and for further information.

Delay becoming more active if:

- You have a temporary illness such as a cold or fever; it is best to wait until you feel better.
- You are pregnant - talk to your health care practitioner, your physician, a qualified exercise professional, and/or complete the ePARmed-X+ **at www.eparmedx.com** before becoming more physically active.
- Your health changes - talk to your doctor or qualified exercise professional before continuing with any physical activity program.

- You are encouraged to photocopy the PAR-Q+. You must use the entire questionnaire and NO changes are permitted.
- The authors, the PAR-Q+ Collaboration, partner organizations, and their agents assume no liability for persons who undertake physical activity and/or make use of the PAR-Q+ or ePARmed-X+. If in doubt after completing the questionnaire, consult your doctor prior to physical activity.

PARTICIPANT DECLARATION

- All persons who have completed the PAR-Q+ please read and sign the declaration below.
- If you are less than the legal age required for consent or require the assent of a care provider, your parent, guardian or care provider must also sign this form.

I, the undersigned, have read, understood to my full satisfaction and completed this questionnaire. I acknowledge that this physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if my condition changes. I also acknowledge that the community/fitness center may retain a copy of this form for records. In these instances, it will maintain the confidentiality of the same, complying with applicable law.

NAME ______________________ DATE ______________________

SIGNATURE ______________________ WITNESS ______________________

SIGNATURE OF PARENT/GUARDIAN/CARE PROVIDER ______________________

For more information, please contact
www.eparmedx.com
Email: eparmedx@gmail.com

Citation for PAR-Q+
Warburton DER, Jamnik VK, Bredin SSD, and Gledhill N on behalf of the PAR-Q+ Collaboration. The Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) and Electronic Physical Activity Readiness Medical Examination (ePARmed-X+). Health & Fitness Journal of Canada 4(2):3-23, 2011.

The PAR-Q+ was created using the evidence-based AGREE process (1) by the PAR-Q+ Collaboration chaired by Dr. Darren E. R. Warburton with Dr. Norman Gledhill, Dr. Veronica Jamnik, and Dr. Donald C. McKenzie (2). Production of this document has been made possible through financial contributions from the Public Health Agency of Canada and the BC Ministry of Health Services. The views expressed herein do not necessarily represent the views of the Public Health Agency of Canada or the BC Ministry of Health Services.

Key References
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FIGURE 11.2. The PAR-Q+ follow-up questions about medical conditions. (Reprinted with permission from the PAR-Q+ Collaboration and the authors of the PAR-Q+. See http://eparmedx.com for the most current annual update of the PAR-Q+.)

The PAR-Q has been found to be a useful tool (6). In one article by de Oliveira Luz and colleagues (6), the PAR-Q was found to have a high (89%)

sensitivity (producing many true positives) for picking up potential medical conditions that might impact an individual's exercise responses in older subjects. However, it should be noted that the specificity (or true negatives) of the PAR-Q in this subject pool was estimated at 42% (6). Thus, the PAR-Q may be quite good at detecting potential problems in clients before they occur in an exercise setting, but the form may also wrongly identify clients as having a potential problem when, on further evaluation, there is no need for concern. This may not be a bad situation as the form errors of the side of caution. The prudent ACSM-EP or ACSM-CPT may therefore need to intervene in such cases as well as involve further health care professionals.

Because there are some potential problems noted with the PAR-Q as far as its ability to discern if an individual's potential adverse medical condition(s) might impact his or her exercise response, a more complete PAR-Q+ was developed recently. However, because the PAR-Q+ is a more recent development, there is no data available related to its effectiveness. It has been suggested by Jamnik and colleagues (5) that a qualified health/fitness professional (ACSM-EP or ACSM-CPT) may, using ACSM preparticipation physical activity screening process, perform a thorough screening process.

ePARmed-X+Physician Clearance Follow-Up Questionnaire

The ePARmed-X+Physician Clearance Follow-Up Questionnaire was developed also in Canada as a tool that a physician can use to refer individuals to a professionally supervised physical activity program and make recommendations for that program. This form was designed to be used in those cases where a YES answer on one of the seven questions in the PAR-Q+ necessitates further medical clearance using the self-guided method. It is also worth noting, that not although required, the ePARmed-X+Physician Clearance Follow-Up Questionnaire (see www.eparmedx.com) could be used for medical clearance in a professionally supervised preparticipation physical activity screening.

Professionally Supervised Screening

Self-analysis of risk for physical activity is important with the large number of individuals who are currently not physically active but hopefully will become more active soon perhaps by self-guidance. Thus, they will need to, or should, use some means to determine their physical readiness, like the PAR-Q+. However, many individuals will seek the knowledge and guidance of an ACSM-EP or ACSM-CPT for this service. Professionally supervised screening, under the guidance of an ACSM-EP or ACSM-CPT, should include the following components: (a) informed consent process, (b) preparticipation physical activity screening, (c) health history, and (d) cardiovascular risk factor analysis (and possibly medical clearance, if warranted) while following the ACSM preexercise evaluation process (3). The ACSM-EP or ACSM-CPT may be involved in professional screening at the "lower" levels of risk (*i.e.*, general nonclinical population who does not meet any of the ACSM risk factor thresholds), whereas professionals such as the ACSM Certified Clinical Exercise Physiologist® (ACSM-CEP®) will be more likely involved with individuals at higher risk levels (who meet more than one ACSM risk factor threshold). In the following section, we discuss the informed consent process, HHQ, and the medical evaluation/clearance.

Informed Consent

The informed consent process is the first step when working with a new patient or client and must be completed prior to (a) the collection of any personal and confidential information, (b) any form of fitness testing, or (c) exercise participation. The informed consent should be written to "inform" the participant of any personal and confidential information that will be collected and how it will be stored as well as the purpose(s) of, and risks involved with, any of the exercise testing and exercise program participation. Remember, it is equally as important to present the benefits of exercise (as well as the risks) so that the participant can make an informed decision about participation.

Although the consent form is a legal document, its contents should be verbally explained to the participant and should include a statement indicating the individual has been given an opportunity to ask questions about the preparticipation physical activity, exercise testing or fitness assessment, or the exercise program and has been given sufficient information to provide an informed "consent." Any questions asked by the participant and the response provided by the ACSM-EP or ACSM-CPT should be included on the signed informed consent document. The consent form must indicate the participant is free to withdraw at any time. Also, all reasonable efforts must be made to protect the privacy of individual's health information (*e.g.*, medical history, test results) as described in the Health Insurance Portability and Accountability Act (HIPAA) (3,11). The participant's signature on the informed consent document indicates that the participant has been adequately "informed" of the risks and benefits involved and have given his or her "consent" to proceed. A sample consent form for exercise testing is provided in Figure 11.3. However, it is advisable to check with those responsible for legal decisions in your facility to determine the most appropriate informed consent process for your needs. Sample forms should not be adopted unless approved by legal counsel and/or the appropriate institutional review board.

Informed Consent for an Exercise Test

1. **Purpose and Explanation of the Test**
   You will perform an exercise test on a cycle ergometer or a motor-driven treadmill. The exercise intensity will begin at a low level and will be advanced in stages depending on your fitness level. We may stop the test at any time because of signs of fatigue or changes in your heart rate, electrocardiogram, or blood pressure, or symptoms you may experience. It is important for you to realize that you may stop when you wish because of feelings of fatigue or any other discomfort.

2. **Attendant Risks and Discomforts**
   There exists the possibility of certain changes occurring during the test that increase risk. These include abnormal blood pressure; fainting; irregular, fast, or slow heart rhythm; and, in rare instances, heart attack, stroke, or death. Every effort will be made to minimize these risks by evaluation of preliminary information relating to your health and fitness and by careful observations during testing. Emergency equipment and trained personnel are available to deal with unusual situations that may arise.

3. **Responsibilities of the Participant**
   Information you possess about your health status or previous experiences of heart-related symptoms (*e.g.*, shortness of breath with low-level activity; pain; pressure; tightness; heaviness in the chest, neck, jaw, back and/or arms) with physical effort may affect the safety of your exercise test. Your prompt reporting of these and any other unusual feelings with effort during the exercise test itself is very important. You are responsible for fully disclosing your medical history as well as symptoms that may occur during the test. You are also expected to report all medications (including nonprescription) taken recently and, in particular, those taken today to the testing staff.

4. **Benefits to be Expected**
   The results obtained from the exercise test may assist in the diagnosis of your illness, in evaluating the effect of your medications, or in evaluating what type of physical activities you might do with low risk.

5. **Inquiries**
   Any questions about the procedures used in the exercise test or the results of your test are encouraged. If you have any concerns or questions, please ask us for further explanations.

6. **Use of Medical Records**
   The information that is obtained during exercise testing will be treated as privileged and confidential as described in the Health Insurance Portability and Accountability Act of 1996. It is not to be released or revealed to any individual except your referring physician without your written consent. However, the information obtained may be used for statistical analysis or scientific purposes with your right to privacy retained.

7. **Freedom of Consent**
   I hereby consent to voluntarily engage in an exercise test to determine my exercise capacity and state of cardiovascular health. My permission to perform this exercise test is given voluntarily. I understand that I am free to stop the test at any point if I so desire.

I have read this form, and I understand the test procedures that I will perform and the attendant risks and discomforts. Knowing these risks and discomforts, and having had an opportunity to ask questions that have been answered to my satisfaction, I consent to participate in this test.

Date	Signature of Patient
Date	Signature of Witness
Date	Signature of Physician or Authorized Delegate

FIGURE 11.3. Sample of informed consent form for a symptom-limited exercise test. (Reprinted from ACSM's Guidelines for Exercise Testing and Prescription, 11th edition, figure 2.1).

When any participant information is being used in a research setting, this should be indicated during the consent process and reflected on the informed consent form, and applicable policies for the testing of human subjects must be implemented. Health care professionals and research scientists should obtain approval from the participant and the institutional review board when conducting an exercise test for research purposes.

It is imperative that personnel are properly trained and authorized to carry out any emergency procedure and use any equipment identified in the informed consent. Written emergency policies and procedures should be in place, and emergency drills should be practiced at least once every 3 months or more frequently when there is a change in staff (11).

Health History Questionnaire

An HHQ is necessary to use with a client to establish his or her medical/health risks for participation in a physical activity program as well as to collect various demographic data (7,12). The HHQ, along with other medical/health data, is also used in the process of exercise preparticipation physical activity screening. The HHQ should be tailored to fit the needs of the program as far as asking for the specific information needed from a client. In general, the HHQ should minimally assess a client's (3)

- Family history of CMR disease
- Personal history of various diseases and illnesses including CMR disease
- Surgical history
- Past and present health behaviors/habits (such as history of cigarette smoking and physical activity)
- Current use of various drugs/medications
- Specific history of various signs and symptoms suggested of CMR disease among other things

The current edition of the *GETP* contains a more detailed list of the specifics of the health and medical evaluations (including desirable laboratory tests) (3). Again, the prudent ACSM-EP or ACSM-CPT should tailor the HHQ to the client's specific needs. A sample HHQ is included in this chapter (Fig. 11.4).

HEALTH HISTORY QUESTIONNAIRE

NAME_______________________________AGE________DATE__________DATE OF BIRTH______________
First M.I. Last day/month/yr day/month/yr

ADDRESS____
Street City/State/Zip

TELEPHONE (home)____________________(business)____________________(cell)____________________

OCCUPATION____________________________PLACE OF EMPLOYMENT____________________________

MARITAL STATUS: (circle one) SINGLE MARRIED DIVORCED WIDOWED

SPOUSE:________________________________

EDUCATION: (check highest level) ELEMENTARY______ HIGH SCHOOL______ COLLEGE______

GRADUATE_________

ETHNICITY:____________________________ PERSONAL PHYSICIAN____________________________

LOCATION_______________________________

Reason for last doctor visit?__________________________ Date of last physician exam__________________

Have you previously been tested for an exercise Program? YES _____ NO _____ YEAR(s) _____

LOCATION OF TEST__________________________

Person to contact in case of an emergency___________________________ Phone #______________________

(relationship)________________________________

PLEASE CHECK YES or NO

PAST (Have you ever had?)	YES	NO
High blood pressure	☐	☐
Heart problems	☐	☐
Disease of the arteries	☐	☐
Varicose veins	☐	☐
Lung disease	☐	☐
Asthma	☐	☐
Kidney disease	☐	☐
Hepatitis	☐	☐
Diabetes	☐	☐
Orthopedic problems	☐	☐
Arthritis	☐	☐

FAMILY (Have any immediate family or grandparents had?)	YES	NO
Heart attacks	☐	☐
High blood pressure	☐	☐
High cholesterol	☐	☐
Stroke	☐	☐
Diabetes	☐	☐
Congenital heart defect	☐	☐
Heart operations	☐	☐
Early death	☐	☐
Other family illness ____________		

PRESENT SYMPTOMS (Have you recently had?)	YES	NO
Chest pain/discomfort	☐	☐
Shortness of breath	☐	☐
Dizzy spells	☐	☐
Skipped heart beats	☐	☐
Trouble sleeping	☐	☐
Ankle swelling	☐	☐
Leg pain/cramping	☐	☐
Frequent headaches	☐	☐
Frequent colds	☐	☐
Back pain	☐	☐
Orthopedic problems	☐	☐

(FOR STAFF COMMENTS)

HEALTH HISTORY QUESTIONNAIRE

HOSPITALIZATIONS: Please list recent hospitalizations (Women: do not list normal pregnancies)

Year Location Reason

Any other medical problems/concerns not already identified? Yes_____ No_____ (Please list below)

Have you ever had your cholesterol measures? Yes_____ No_____; If yes, (value)_____ (Date)_____

Are you taking any Prescription or Non-Prescription medications? Yes_____ No_____ (include birth control pills)

Medication Reason for Taking For How Long?

Do you currently smoke? Yes_____ No_____ If so, what? Cigarettes_____ Cigars_____ Pipe_____

How much per day: < .5 pack_____ 0.5 to 1pack_____ 1.5 to 2 packs_____ > 2 packs_____

Have you ever quit smoking? Yes_____ No_____ When?_____ How many years and how much did you smoke?__________

Do you drink any alcoholic beverages? Yes_____ No_____ If Yes, how much in 1 week?

Beer_________(cans) Wine_________(glasses) Hard liquor_________(drinks)

Do you drink any caffeinated beverages? Yes_____ No_____ If Yes, how much in 1 week?

Coffee_________(cups) Tea_________(glasses) Soft drinks_________(cans)

ACTIVITY LEVEL EVALUATION

What is your occupational activity level? sedentary______; light______; moderate______; heavy______

Do you currently engage in vigorous physical activity on a regular basis? Yes_____ No_____

If so, what type?____ How many days per week?_________

How much time per day? (check one) < 15 min_____ 15–30 min_____ 30–45 min_____ > 60 min_____

Do you ever have an uncomfortable shortness of breath during exercise? Yes_____ No_____

Do you ever have chest discomfort during exercise? Yes_____ No_____ If so, does it go away with rest?_________

Do you engage in any recreational or leisure-time physical activities on a regular basis? Yes_____ No_____

If so, what activities?____

On average: How often?_______________times/week; For how long?_______________time/session

HEALTH HISTORY QUESTIONNAIRE

Are you currently following a weight reduction diet plan? Yes_____ No_____ Name:____________________

If so, how long have you been dieting? _____months Is the plan prescribed by your doctor? Yes_____ No_____

Have you used weight reduction diets in the past? Yes_____ No_____; If yes, how often and which type(s)?

____

Please indicate the reasons why you want to join the exercise program.

To lose weight __________ Doctor's recommendation__________ For good health __________ Enjoyment__________

Release of tension__________ Improve physical appearance __________ Other ____________________

FOR STAFF USE:

____

____

FIGURE 11.4. HHQ used at East Stroudsburg University.

Medical Examination/Clearance

A medical examination led by a physician (or other qualified health care professional) may also be necessary or desirable to help evaluate the health and/or medical status of your client prior to a physical activity program. The suggested components of this medical examination can be found in the most current edition of the *GETP* (3). In addition to a medical examination, it may be desirable to perform some routine laboratory assessments (*i.e.*, fasting blood cholesterol and/or resting blood pressure) on your client prior to physical activity programming (7). Clients who are at a higher risk for exercise complications (those who show signs or symptoms suggestive of CMR disease) may need (it is recommended) a medical clearance prior to participation in a physical activity program.

Preparticipation Physical Activity Screening Process

Preparticipation screening is a process to determine if a person could or should benefit from more intensive medical screening prior to starting an exercise program. The process for screening prior to participation in a physical activity program had been altered significantly with the publication of *GETP*, tenth edition (2). Essentially, only three items need to be considered to complete the process, as is displayed in Figure 11.5. In addition, the ACSM preparticipation physical activity screening algorithm can be found in Figure 11.6. The first item to consider in the process is the individual's past physical activity history. The individual can be queried about his or her physical activity history using the HHQ and/or by questioning. Next, the individual should be evaluated for the presence of known CMR disease. This, too, can be assessed using the HHQ and/or by questioning. Last in the process is the assessment of the individual's presence of signs and symptoms that can be suggestive of CMR disease. The ACSM in its recent *GETP* provides a form for the assessment of all three of these components of the process. This form can be found in Figure 11.7 (3).

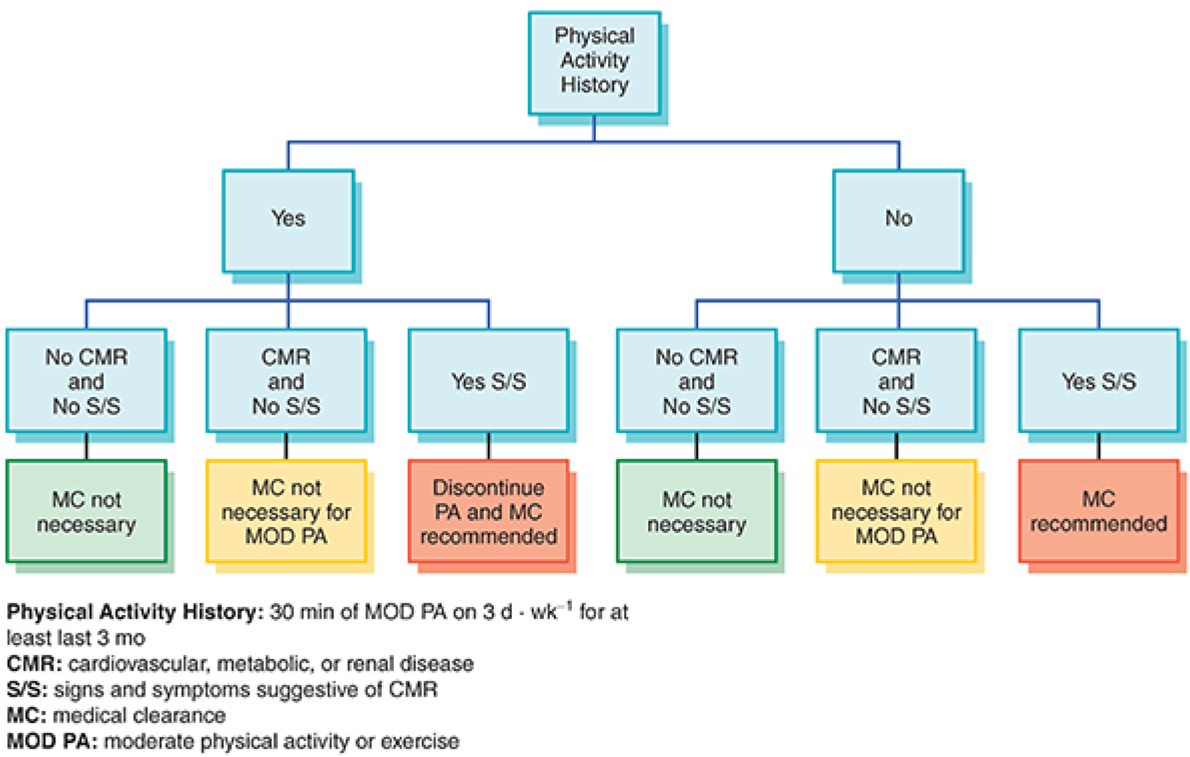
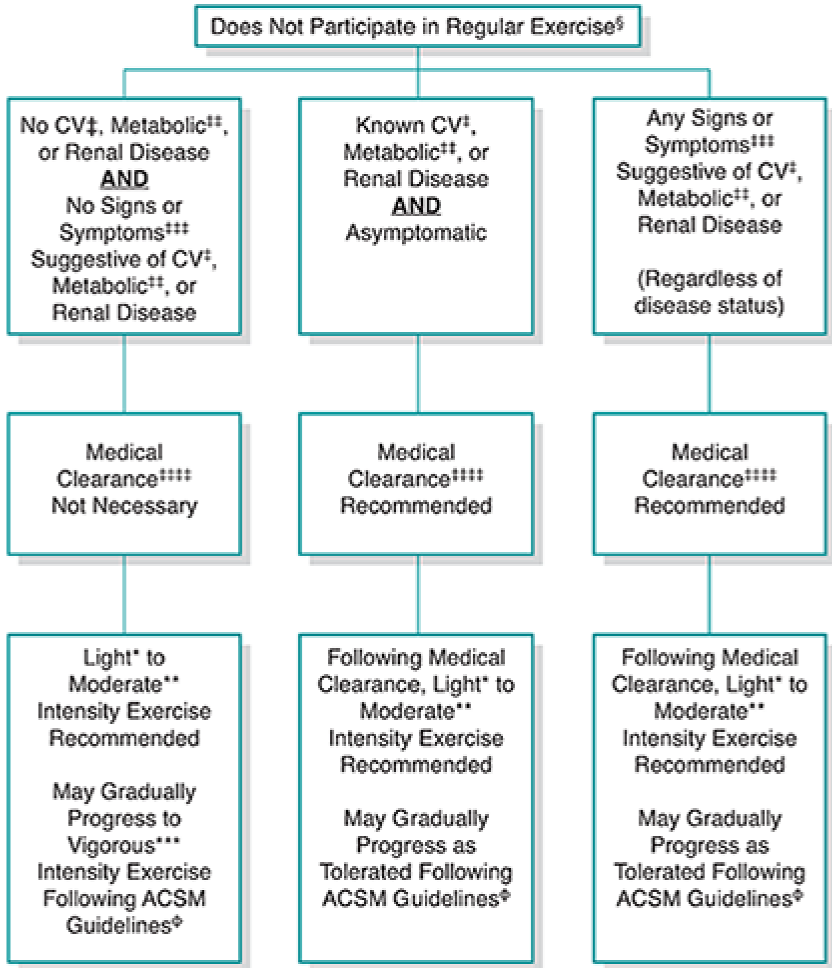
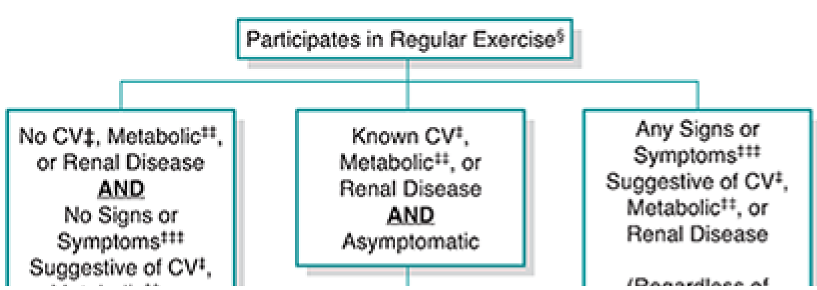
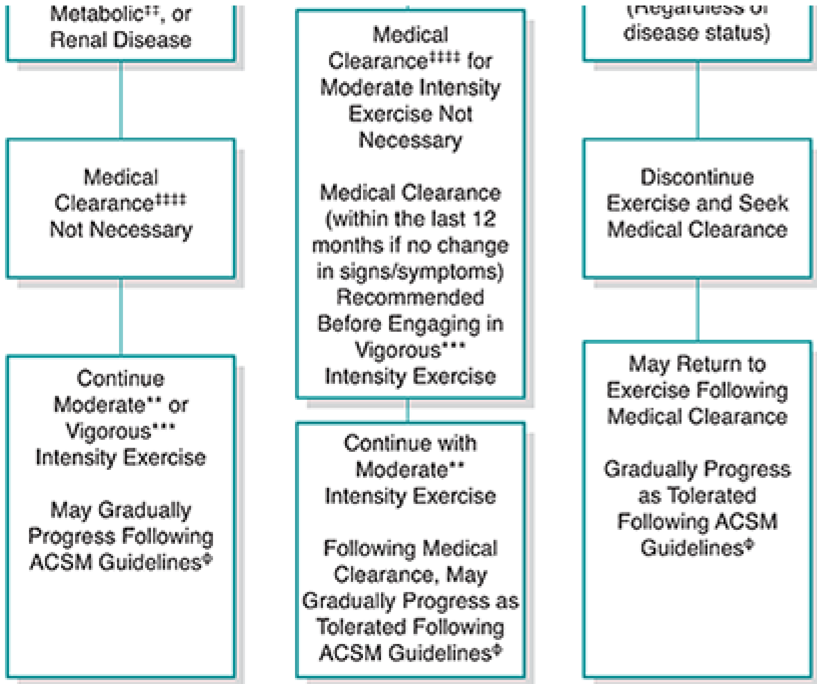


FIGURE 11.5. Decision tree for preparticipation screening; simplified algorithm.



§Exercise Participation	Performing planned, structured physical activity at least 30 min at moderate intensity on at least $3\ d \cdot wk^{-1}$ for at least the last 3 mo
*Light Intensity Exercise	30%–39% HRR or $\dot{V}O_2R$, 2–2.9 METs, RPE 9–11, an intensity that causes slight increases in HR and breathing
**Moderate Intensity Exercise	40%–59% HRR or $\dot{V}O_2R$, 3–5.9 METs, RPE 12–13, an intensity that causes noticeable increases in HR and breathing
***Vigorous Intensity Exercise	≥60% HRR or $\dot{V}O_2R$, ≥6 METs, RPE ≥14, an intensity that causes substantial increases in HR and breathing
‡Cardiovascular (CV) Disease	Cardiac, peripheral vascular, or cerebrovascular disease
‡‡Metabolic Disease	Type 1 and 2 diabetes mellitus
‡‡‡Signs and Symptoms	At rest or during activity. Includes pain, discomfort in the chest, neck, jaw, arms, or other areas that may result from ischemia; shortness of breath at rest or with mild exertion; dizziness or syncope; orthopnea or paroxysmal nocturnal dyspnea; ankle edema; palpitations or tachycardia; intermittent claudication; known heart murmur; unusual fatigue or shortness of breath with usual activities.
‡‡‡‡Medical Clearance	Approval from a health care professional to engage in exercise
ΦACSM Guidelines	See the most current edition of *ACSM's Guidelines for Exercise Testing and Prescription*





§Exercise Participation	Performing planned, structured physical activity at least 30 min at moderate intensity on at least 3 d · wk⁻¹ for at least the last 3 mo
*Light Intensity Exercise	30%–39% HRR or $\dot{V}O_2R$, 2–2.9 METs, RPE 9–11, an intensity that causes slight increases in HR and breathing
**Moderate Intensity Exercise	40%–59% HRR or $\dot{V}O_2R$, 3–5.9 METs, RPE 12–13, an intensity that causes noticeable increases in HR and breathing
***Vigorous Intensity Exercise	≥60% HRR or $\dot{V}O_2R$, ≥6 METs, RPE ≥14, an intensity that causes substantial increases in HR and breathing
†Cardiovascular (CV) Disease	Cardiac, peripheral vascular, or cerebrovascular disease
‡‡Metabolic Disease	Type 1 and 2 diabetes mellitus
‡‡‡Signs and Symptoms	At rest or during activity. Includes pain, discomfort in the chest, neck, jaw, arms, or other areas that may result from ischemia; shortness of breath at rest or with mild exertion; dizziness or syncope; orthopnea or paroxysmal nocturnal dyspnea; ankle edema; palpitations or tachycardia; intermittent claudication; known heart murmur; unusual fatigue or shortness of breath with usual activities.
‡‡‡‡Medical Clearance	Approval from a health care professional to engage in exercise
ΦACSM Guidelines	See the most current edition of *ACSM's Guidelines for Exercise Testing and Prescription*

FIGURE 11.6. The ACSM preparticipation screening algorithm. HR, heart rate; HRR, heart rate reserve; METs, metabolic equivalents; RPE, rating of perceived exertion; $\dot{V}O_2R$, oxygen uptake reserve. (Reprinted from Riebe D, Franklin BA, Thompson PD, et al. Updating ACSM's recommendations for exercise preparticipation health screening. *Med Sci Sports Exerc*. 2015;47(11):2473–9.)

Exercise Preparticipation Health Screening Questionnaire for Exercise Professionals

Assess your client's health needs by marking all *true* statements.

Step 1

SIGNS AND SYMPTOMS
Does your client experience:
____ chest discomfort with exertion
____ unreasonable breathlessness
____ dizziness, fainting, blackouts
____ ankle swelling
____ unpleasant awareness of a forceful, rapid or irregular heart rate
____ burning or cramping sensations in your lower legs when walking short distance
____ known heart murmur

If you **did** mark any of these statements under the symptoms, **STOP**, your client should seek medical clearance before engaging in or resuming exercise. Your client may need to use a facility with a **medically qualified staff**.

If you **did not** mark any symptoms, continue to steps 2 and 3.

Step 2

CURRENT ACTIVITY
Has your client performed planned, structured physical activity for at least 30 min at moderate intensity on at least 3 days per week for at least the last 3 months?

Yes ☐ No ☐

Continue to Step 3.

Step 3

MEDICAL CONDITIONS
Has your client had or do they currently have:
____ a heart attack
____ heart surgery, cardiac catheterization, or coronary angioplasty
____ pacemaker/implantable cardiac defibrillator/rhythm disturbance
____ heart valve disease
____ heart failure
____ heart transplantation
____ congenital heart disease
____ diabetes
____ renal disease

Evaluating Steps 2 and 3:

- If you **did not mark any of the statements in Step 3**, medical clearance is not necessary.
- If you marked Step 2 "**yes**" and **marked any of the statements in Step 3**, your client may continue to exercise at light to moderate intensity without medical clearance. However, medical clearance is recommended before engaging in vigorous exercise.
- If you marked Step 2 "**no**" and **marked any of the statements in Step 3**, medical clearance is recommended. Your client may need to use a facility with a **medically qualified staff**.

FIGURE 11.7. Preparticipation physical activity screening questionnaire for exercise professionals. (Reprinted from New Preparticipation Health Screening Recommendations: What Exercise Professionals Need to Know. *ACSM's Health & Fitness Journal*. 2016;20(3):22–7.)

It is important to note that the process of ACSM preparticipation physical activity screening has been divorced from the concept of the need for and supervisory qualifications of a graded exercise test and other health-related physical fitness assessments. Recent professional society opinions and research have devalued the use of graded exercise testing for many adults as part of the diagnostic workup for cardiovascular disease (3). Thus, preparticipation physical activity screening is about participating in a physical activity program not about exercise testing. We discuss all three components of the preparticipation physical activity screening process in the following section.

Physical Activity (or Exercise) History

Individuals who currently engage in physical activity are considered to be at lower risk for a cardiovascular event during exercise than those who are sedentary. Individuals are considered to be currently engaged in physical activity if they have been performing planned, structured physical activity of at least 30 minutes at a moderate intensity, at least 3 $d \cdot wk^{-1}$, for the last 3 months. These criteria are based on the dose of physical activity that is necessary to lower one's risk, according to ACSM. Moderate-intensity physical activity has several descriptors associated with it including exercise at a level that is between 40% and 59% of the individual's heart rate reserve or maximal oxygen uptake reserve. Moderate-intensity physical activity or exercise is further described as between 3 and 5.9 metabolic equivalents (METs) and at a rating of perceived exertion (RPE) of around 12–13 on the traditional 6–20 scale. Also, moderate-intensity causes noticeable increases in heart rate and breathing (3).

Known Cardiovascular, Metabolic, and/or Renal Disease

Clients with any of the CMR diseases are at a higher risk for an untoward event during exercise. Thus, the presence of a CMR disease will influence the level of preparticipation physical activity screening. A listing of the specific diseases and/or conditions covered are as follows:

- Heart attack
- Heart surgery, cardiac catheterization, or coronary angioplasty
- Pacemaker/implantable cardiac defibrillator/rhythm disturbance

- Heart valve disease
- Heart failure
- Heart transplantation
- Congenital heart disease (congenital refers to birth)
- Diabetes, Types 1 and 2
- Renal disease such as renal failure

Note the absence of pulmonary diseases from this list of diseases and/or conditions. Pulmonary disease has been shown to be less likely to cause untoward events during exercise than CMR disease and thus has been removed from the list (3).

ACSM Major Signs or Symptoms Suggestive of Cardiovascular Disease

There are several outward signs or symptoms that may indicate a client has current CMR disease. These signs and symptoms can be found in the following sections along with further discussion of these signs or symptoms. If a client has any of these signs or symptoms, then he or she is considered at a higher risk, and it is recommended that the individual seek medical clearance before participation in a physical activity program. It is important to remember that these signs or symptoms must be interpreted within the clinical context in which they appear because they are not all specific for CMR disease (3).

Discussion of ACSM Signs or Symptoms

There are nine signs and symptoms suggestive of CMR disease, which include the following:

- Pain or discomfort in the chest, neck, jaw, arms, or other areas that may be due to ischemia or lack of oxygenated blood flow to the tissue, such as the heart (13). Remember that chest pain or angina is not always located in the chest area of a client. Women in particular may experience low back pain or feelings of indigestion as opposed to chest pain. Some key features of this pain that favors an ischemic origin include the following:

    - Character: The pain is felt as constricting, squeezing, burning, "heaviness," or "heavy feeling."
    - Location: The pain is substernal, across the midthorax, anteriorly; in one or both arms or shoulders; in neck, cheeks, or teeth; or in forearms, fingers, and/or in the interscapular region.
    - Provoking factors: The pain comes on with exercise or exertion, excitement, other forms of stress, cold weather, or after meals (3).
- *Dyspnea* is the medical term for shortness of breath (13). Dyspnea is expected in most individuals during moderate to severe exertion such as stair climbing. However, shortness of breath at rest or with mild exertion may indicate cardiac and/or pulmonary disease and should be examined by a physician. Dyspnea (defined as an abnormally uncomfortable awareness of breathing) is one of the principal symptoms of cardiac and pulmonary disease. It commonly occurs during strenuous exertion in healthy, well-trained individuals and during moderate exertion in healthy, untrained individuals. However, it should be regarded as abnormal when it occurs at a level of exertion that is not expected to evoke this symptom in a given individual. Abnormal exertional dyspnea suggests the presence of cardiopulmonary disorders, in particular, left ventricular dysfunction or chronic obstructive pulmonary disease (3).
- Syncope, or fainting, and dizziness during exercise may indicate poor blood flow to the brain due to inadequate cardiac output from a number of cardiac disorders (13). However, syncope and dizziness upon sudden cessation of exercise is relatively common even among healthy individuals due to a sudden decrease in venous return and consequent reduction in blood flow to the brain. Cardiac disorders that are associated with syncope and dizziness are potentially life-threatening and include severe coronary artery disease, hypertrophic cardiomyopathy, aortic stenosis, and malignant ventricular dysrhythmias. Although dizziness or syncope shortly after cessation of exercise should not be ignored, these symptoms may occur even in healthy individuals as a result of a reduction in venous return to the heart (3).

- Orthopnea refers to trouble breathing while lying down. Paroxysmal nocturnal dyspnea refers to difficulty breathing while asleep, beginning usually 2–5 hours after the onset of sleep, which may be relieved by sitting on the side of the bed or getting out of bed (13). Both are indicative of poor left ventricular function. Patients with these conditions often report sleeping in recliners to lessen the symptoms of this disorder. Orthopnea is relieved promptly by sitting upright or standing. Although nocturnal dyspnea may occur in individuals with chronic obstructive pulmonary disease, it differs in that it is usually relieved following a bowel movement rather than specifically by sitting up (3).
- Ankle edema, or swelling, that is not due to injury is suggestive of heart failure, a blood clot, insufficiency of the veins, or a lymph system blockage (13). Generalized edema (known as anasarca) occurs in individuals with the nephrotic (from the kidneys) syndrome, severe heart failure, or hepatic (from the liver) cirrhosis. Bilateral ankle edema that is most evident at night is a characteristic sign of heart failure or bilateral chronic venous insufficiency. Unilateral edema of a limb often results from venous thrombosis or lymphatic blockage in the limb (3).
- Palpitations and tachycardia both refer to rapid beating or fluttering of the heart (13). The client may report a feeling of unpleasantness associated with the unusual heart rhythm. Palpitations (defined as an unpleasant awareness of the forceful or rapid beating of the heart) may be induced by various disorders of cardiac rhythm. These include tachycardia, bradycardia of sudden onset, ectopic beats, compensatory pauses, and accentuated stroke volume resulting from valvular regurgitation. Palpitations also often result from anxiety states and high cardiac output (or hyperkinetic) states, such as anemia, fever, thyrotoxicosis, arteriovenous fistula, and the so-called idiopathic hyperkinetic heart syndrome (3).
- Intermittent claudication refers to severe calf pain when walking (13). This pain indicates a lack of oxygenated blood flow to the working muscles similar in origin to chest pain. The pain does not occur with standing or sitting, is reproducible from day to day, is more severe when

walking upstairs or up a hill, and is often described as a cramp, which disappears within 1–2 minutes after stopping exercise. Coronary artery disease is more prevalent in individuals with intermittent claudication. Patients with diabetes are at increased risk for this condition (3).

- Heart murmurs are unusual sounds caused by blood flowing through the heart (13). Although some murmurs may be innocent, heart murmurs may indicate valvular or other cardiovascular disease. From an exercise safety standpoint, it is especially important to exclude hypertrophic cardiomyopathy and aortic stenosis as underlying causes because these are among the more common causes of exertion-related sudden cardiac death. Unless previously diagnosed and determined to be safe, all murmurs should be evaluated by a physician (3).
- Unusual fatigue or shortness of breath that occurs during light exertion or normal activity and not during strenuous activity (13). Although there may be benign origins for these symptoms, they also may signal the onset of or change in the status of cardiovascular and/or metabolic disease (3).

When Should You Seek Medical Clearance

Figure 11.5 illustrates an attempt to simplify and clarify some of the decisions aided by the ACSM preparticipation physical activity screening process. The ACSM-EP or ACSM-CPT should always keep in mind that the ACSM preparticipation physical activity screening process is a guideline and may need to be modified based on several issues such as local medical practice or custom.

Essentially, Figure 11.5 represents a paradigm shift in preparticipation screening from previous ACSM screening paradigms, and we have chosen to simplify and colorize the figure to aid the ACSM-EP or ACSM-CPT with this decision tree. Medical clearance, which may include a medical examination by a health care professional including a physician, is suggested and recommended to be a part of the preparticipation physical activity screening workup if your client has signs and symptoms suggestive of CMR disease. We have denoted this outcome using the color red in Figure 11.5. In fact, individuals who meet these criteria (signs and symptoms suggestive of

CMR disease) should only participate after getting medical clearance to do so. Individuals who may be free of signs and symptoms but have the presence of CMR disease may benefit from medical clearance, and thus, we have used the color yellow for caution in Figure 11.5. This is appropriate for clients who currently do not participate in a physical activity program. However, in most “apparently healthy” clients (free of CMR disease and signs and symptoms suggestive of CMR disease), it is acceptable to get them started in a moderate-intensity physical activity program without the need for previous medical clearance. We have used the color green for this outcome in Figure 11.5.

As you can see in Figure 11.5, the current physical activity history of a client does influence these decisions. For instance, if your client has not been physically active in the recent past (last 3 mo), then you are more likely to recommend medical clearance to start a low to moderate physical activity program, whereas the previously physically active client may be able to proceed to a more moderate to vigorous physical activity program.

The prudent ACSM-EP or ACSM-CPT would always err on the side of caution when there are uncertainties and request full medical clearance. The ePARmed-X+Physician Clearance Follow-Up Questionnaire may be used for medical clearance.

Vigorous exercise is often defined as greater than or equal to 60% of your client’s functional capacity (≥6 METs, ≥14 on a 6–20 RPE scale, and cause substantial increases in heart rate and breathing), whereas low to moderate exercise programs would be less than 60% of functional capacity (14–17).

Two previous features of the ACSM risk stratification/classification process were the use and supervision of graded exercise testing. Nondiagnostic exercise testing is generally performed for exercise prescriptive and/or functional capacity purposes, whereas diagnostic exercise testing may be performed to assess the presence or impact of cardiovascular disease (18). Submaximal exercise testing may also be useful in individualizing your client’s exercise prescription as well as gaining functional capacity information as is discussed in other chapters of this textbook. Research and expert opinion has recently questioned the value of the diagnostic exercise test (15,19).

The supervision criterion of exercise testing has also undergone much revision in recent years. Training in exercise testing administration is required and includes certification in emergency care (*i.e.*, AHA Advanced Cardiac Life Support Certification) as well as experience in exercise testing interpretation and emergency plan practice (15,19,20).

Thus, a competent ACSM-EP or ACSM-CPT may oversee the judicious use of the preparticipation physical activity screening and graded exercise test for exercise prescription purposes in the lower risk clients. However, other personnel may need to become involved if the preparticipation physical activity screening suggests the need for medical clearance (3,20).

American Association of Cardiovascular and Pulmonary Rehabilitation Risk Stratification

Other professional organizations have also published guidelines that address risk stratification and preparticipation physical activity screening (3,11,16,21–23). Most prominently among these are AHA and American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR). Similar to the recent changes in ACSM preparticipation exercise screening, other guidelines have been modified to reduce impediments to begin or continue safe and effective exercise programming.

The AACVPR has contributed to the field of preparticipation physical activity screening and risk stratification with guidelines revised most recently in 2012 (3,4,11,18). The AACVPR risk stratification scheme continues to utilize low-, moderate-, and high-risk categories to identify level of risk of physical activity triggering an untoward event.

Overall health risk exists as a continuum from apparently healthy to known disease. The AACVPR risk stratification scheme thus may serve as a nice bridge to ACSM preparticipation by offering services and programming to more “risky” or diseased clients as might be found in clinical exercise programs such as cardiac rehabilitation or medical fitness facilities, perhaps supervised by an ACSM-CEP. The AACVPR risk stratification guidelines are listed in Box 11.1 (3,23).

Box 11.1 American Association of Cardiovascular and Pulmonary Rehabilitation Risk Stratification Algorithm for Risk of Event

Patient is at **HIGH RISK** if ANY ONE OR MORE of the following factors are present:

- Left ventricular ejection fraction < 40%
- Survivor of cardiac arrest or sudden death
- Complex ventricular dysrhythmias (ventricular tachycardia, frequent [> 6/min] multiform PVCs) at rest or with exercise
- MI or cardiac surgery complicated by cardiogenic shock, CHF, and/or signs/symptoms of post-procedure ischemia
- Abnormal hemodynamics with exercise, especially flat or decreasing systolic blood pressure or chronotropic incompetence with increasing workload
- Significant silent ischemia (ST depression 2mm or greater without symptoms) with exercise or in recovery
- Signs/symptoms including angina pectoris, dizziness, lightheadedness or dyspnea at low levels of exercise (< 5.0 METs) or in recovery
- Maximal functional capacity of less than 5.0 METs
    - If measured functional capacity is not available, this factor can be excluded.
- Clinically significant depression or depressive symptoms

Patient is at **MODERATE RISK** if they meet neither High Risk nor Low Risk standards:

- Left ventricular ejection fraction = 40–50%
- Signs/symptoms including angina at “moderate” levels of exercise (60–75% of maximal functional capacity) or in recovery
- Mild to moderate silent ischemia (ST depression less than 2mm) with exercise or in recovery

Patient is at **LOW RISK** if ALL of the following factors are present:

- Left ventricular ejection fraction > 50%
- No resting or exercise-induced complex dysrhythmias
- Uncomplicated MI, CABG, angioplasty, atherectomy, or stent:
  - Absence of CHF or signs/symptoms indicating post-event ischemia
- Normal hemodynamic and ECG responses with exercise and in recovery
- Asymptomatic with exercise or in recovery, including absence of angina
- Maximal functional capacity at least 7.0 METs
  - If measured functional capacity is not available, this factor can be excluded.
- Absence of clinical depression or depressive symptoms

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Challenges of ACSM Preparticipation Physical Activity Screening

Perhaps the greatest challenge of ACSM preparticipation physical activity screening is overlooking a sign or symptom of ongoing cardiovascular disease, potentially leading to the client experiencing a cardiac event during a supervised exercise session. Although the incidence of such events is rare, the prudent ACSM-EP or ACSM-CPT should exercise caution in minimizing such risk (24–27). To reduce the risk of such an event, the ACSM-EP or ACSM-CPT should obtain as much medical history information as possible through the HHQ and client interviews. When in doubt, particularly in a more medically challenged client who may be at a higher risk, the ACSM recommends consulting with a health care professional for advice on how to proceed. Remember, it is better to be conservative and prudent than to endanger the client's health (15).

Of course, the conservative approach to preparticipation physical activity screening must be balanced by the public health argument of putting up too many obstacles or barriers to participation in front of the client, potentially resulting in driving the client away from adopting a physically active and healthy lifestyle. Thus, the client might be encouraged to begin a low- to moderate-intensity program, where the overall risks of untoward events are minimal, before he or she undergoes further medical evaluation and clearance (3). It is perhaps important for all individuals beginning a physical activity program that the initial intensity be low to moderate and increase gradually in a progressive overload fashion as discussed in other chapters in this text and the *GETP* (2,3,28).

Recommendations versus Requirements

It is important to remember that the goal of *GETP* is to provide direction on how to screen participants and proceed with physical activity programming. In all cases, the ACSM-EP or ACSM-CPT should exercise caution and use his or her best judgment when handling an individual client. When in doubt, referring a client for a medical evaluation and clearance is always in good judgment.

The ACSM preparticipation health screening protocol was assessed in a recent article by Price and colleagues (29) and demonstrated a reduction in medical clearances versus the previously used system presented in the ninth edition of *GETP* in a younger population. To date, there are no published reports on the effectiveness of the AACVPR risk classification scheme. Thus, although it is prudent to recommend that the ACSM-EP or ACSM-CPT follow the preparticipation screening scheme, it may be difficult to suggest this as a requirement to follow for a quality exercise program because it is lacking an evidence base (5).

Contraindications to Exercise Testing

The process of evaluating risk (through a medical exam/health history and the ACSM preparticipation physical activity screening) may identify clinical characteristics of an individual that make physical activity risky and, thus, contraindicated. There are a host of clinical characteristics that have been identified and published by ACSM (as well as other organizations, such as the AHA) that are termed *contraindications*. These contraindications generally refer to exercise testing. This list can be found in Box 11.2 (3). As you can see, many of these contraindications are cardiovascular disease related and only revealed by consultation with a physician and likely sophisticated medical testing. However, the resting blood pressure relative contraindication criterion (>200 mm Hg systolic blood pressure or 110 mm Hg diastolic blood pressure) is likely to be known by the ACSM-EP or ACSM-CPT during basic health-related physical fitness testing.

Box 11.2 Contraindications to Symptom-Limited Maximal Exercise Testing

Absolute Contraindications

- Acute myocardial infarction within 2 d
- Ongoing unstable angina
- Uncontrolled cardiac arrhythmia with hemodynamic compromise
- Active endocarditis
- Symptomatic severe aortic stenosis
- Decompensated heart failure
- Acute pulmonary embolism, pulmonary infarction, or deep venous thrombosis
- Acute myocarditis or pericarditis
- Acute aortic dissection
- Physical disability that precludes safe and adequate testing

Relative Contraindications

- Known obstructive left main coronary artery stenosis
- Moderate to severe aortic stenosis with uncertain relationship to symptoms
- Tachyarrhythmias with uncontrolled ventricular rates
- Acquired advanced or complete heart block
- Recent stroke or transient ischemia attack
- Mental impairment with limited ability to cooperate
- Resting hypertension with systolic >200 mm Hg or diastolic >110 mm Hg
- Uncorrected medical conditions, such as significant anemia, important electrolyte imbalance, and hyperthyroidism

Reprinted with permission from Fletcher GF, Ades PA, Kligfield P, et al. Exercise standards for testing and training: a scientific statement from the American Heart Association. *Circulation*. 2013;128(8):873–934.

What Does Contraindication Really Mean?

A contraindication is a clinical characteristic that may increase the risk associated with the participation in physical activity and/or exercise testing. For example, if an individual has unstable angina, or chest pain (unstable angina refers to chest pain that is not well controlled or predictable), then he or she may experience ischemia during exercise that could lead to a myocardial infarction, or heart attack. Although it is important to note that the incidence of cardiovascular complications is rare during exercise, a prudent ACSM-EP or ACSM-CPT would be advised to follow the contraindications listed to minimize this incidence (3,4,28). As previously discussed, many of the contraindications listed are uncommon, but the ACSM-EP or ACSM-CPT should protect the individual from all known and likely risks.

Absolute versus Relative

The list of contraindications is often divided between those that are as either absolute or relative. Absolute refers to those criteria that are absolute contraindications; individuals with these biomarkers should not be allowed to participate in any form of physical activity program and/or exercise test. However, those individuals with clinical contraindications that are listed as relative may be accepted or allowed into a physical activity assessment and/or program if it is deemed that the benefits for the individual outweigh the risks to the individual (4,28). For instance, if a client has a resting blood pressure of 210/105 mm Hg, it may be decided by a medical director and/or physician to allow the client to enter into the physical activity program because the benefits to the individual may outweigh the risks of exercising with this particular relative contraindication.

Repurposing Risk Factor Assessment and Management

As mentioned previously, the ACSM CVD risk assessment is no longer a mandatory component for determining if medical clearance is warranted before individuals begin an exercise program. However, identifying and controlling CVD risk factors remains an important objective of disease prevention and management. Therefore, under the current recommendations, the ACSM-EP or ACSM-CPT is encouraged to complete a CVD risk factor analysis with the patients and clients. The goal has simply shifted from using the ACSM CVD risk factor assessment as a tool for preparticipation health screening and risk stratification to identifying and managing CVD risk in patients and clients. As addressed later in this textbook, CVD risk factors may significantly impact exercise prescription.

Another important reason to provide CVD risk assessment is to help educate and inform the client about his or her need to make lifestyle modifications such as increasing physical activity and incorporating more healthful food choices in his or her diets.

ACSM Atherosclerotic Cardiovascular Disease Risk Factor Assessment and Defining Criteria

Using the client's health history (and basic health evaluation data such as resting blood pressure), simply compare your client's information to the list of the ACSM CVD risk factor criteria to determine which ones the client meets. Meeting one or none of these indicates a low risk of future cardiovascular disease, whereas the presence of two or more risk factors indicate an increased risk of disease. Note that only one positive factor is assigned per ACSM CVD risk factor criteria. For example, in obesity, a body mass index (BMI) greater than 30 kg · m^{-2} and a waist circumference of 105 cm (for men) would count as only one positive risk factor. Likewise, having both high systolic and high diastolic resting blood pressure readings would result in only one positive factor. If a client is taking a medication for hypertension or high cholesterol, he or she is considered positive for the associated risk factor regardless of his or her actual resting blood pressure or blood cholesterol measurements. There is also one negative factor (having a high high-density lipoprotein cholesterol [HDL-C]) that would offset one positive risk factor. The following is a detailed list of the ACSM atherosclerotic CVD risk factors and defining criteria (3):

- Client's age of 45 years or older for males and 55 years or older for females (4)
- Family history of specific cardiovascular events including myocardial infarction (heart attack), coronary revascularization (bypass surgery or angioplasty), or sudden cardiac death. This applies to first-degree relatives only. First-degree relatives are biological parents, siblings, and children. The risk factor criteria are met when at least one male relative has had one of the three specific events prior to age 55 years or before age 65 years in a female relative (30).
- If the client currently smokes cigarettes, quit smoking within the last 6 months, or if he or she is exposed to environmental tobacco smoke. Secondhand smoke exposure can be assessed by the presence of cotinine in your client's urine (8,31).
- A sedentary lifestyle is defined as not participating in a regular exercise program or not meeting the minimal recommendations of 30 minutes or more of moderate-intensity physical activity (40%–59% $\dot{V}O_2R$) on at least 3 $d \cdot wk^{-1}$ for at least 3 months (32).
- Obesity is defined as a BMI ≥30 $kg \cdot m^{-2}$ or a waist circumference of greater than 102 cm (~40 in) for men and greater than 88 cm (~35 in) for women. If available, body fat percentage values could also be used with appropriate judgment of the ACSM-EP or ACSM-CPT (8).
- Hypertension refers to having a resting blood pressure ≥130 mm Hg systolic or ≥80 mm Hg diastolic or if the client is currently taking any antihypertensive medication. Importantly, these resting blood pressures must have been assessed on at least two separate occasions (18,33,34).
- Dyslipidemia refers to having a low-density lipoprotein cholesterol (LDL-C) ≥130 $mg \cdot dL^{-1}$ (3.37 $mmol \cdot L^{-1}$), an HDL-C of <40 $mg \cdot dL^{-1}$ (1.04 $mmol \cdot L^{-1}$), or if the client is taking a lipid-lowering medication. Use ≥200 $mg \cdot dL^{-1}$ (5.18 $mmol \cdot L^{-1}$) only if the total serum cholesterol measurement is available (35). Also, LDL-C is typically not measured but rather estimated from HDL-C, total cholesterol (TC), and triglycerides (35).

- Diabetes is defined as having a fasting blood glucose ≥126 mg · dL^{-1} (7.0 mmol · L^{-1}) or 2-hour plasma glucose values in oral glucose tolerance test (OGTT) ≥200 mg · dL^{-1} (11.1 mmol · L^{-1}) or glycated hemoglobin (HbA1C) ≥6.5% (21).
- HDL-C has a cardioprotective effect so is considered a negative risk factor if ≥60 mg · dL^{-1} (1.55 mmol · L^{-1}). HDL-C participates in reverse cholesterol transport and thus may lower the risk of cardiovascular disease.

Comparing the client's personal data to the ACSM atherosclerotic CVD risk factor criteria outlined earlier will help the ACSM-EP or ACSM-CPT to educate the client about his or her current health risk and evaluate the effectiveness of the exercise protocol at managing and/or attenuating this risk.

Case Study 11.1

The following is a listed case study using one individual (Hollie Lankford) for the purpose of exploring further the processes of ACSM preparticipation physical activity screening and ACSM atherosclerotic CVD risk factor assessment. Refer to the preparticipation screening simplified algorithm (see Fig. 11.6) for guidance while reviewing this case study.

ACSM Preparticipation Physical Activity Screening Case Study: Hollie Lankford, a 42-year-old female, decides she wants to begin exercising in your program. As the ACSM-EP or ACSM-CPT, you administer your ACSM preparticipation physical activity screening protocol. She is 5 ft 6 in tall and weighs 188 lb. Ms. Lankford provides you with the following information: Her father died of a heart attack at the age of 56 years. Her mother was put on medication for hypertension 10 years ago at the age of 62 years. She presents with no signs or symptoms of CMR disease. After 24 years of smoking one pack of cigarettes per day, she quit smoking 3 years ago. Her percent body fat was measured at 34% via skinfolds. Fasting blood chemistries revealed a TC of 190 mg · dL^{-1}, an HDL-C of 72 mg · dL^{-1}, and a resting blood glucose of 84 mg · dL^{-1}. Her resting heart rate was measured at 70 bpm, and resting blood pressure was measured at 142/82 mm Hg and 144/84 mm Hg on two separate occasions. She reports that she works in a sedentary office job and sits at her desk all day. She complains that being in a high management position is stressful and doesn't have time to exercise during her workday. She reports routinely walking her dogs approximately ½ mile each morning and ¼ mile each evening. Hollie states that she drinks one glass of wine most evenings before bed. Ms. Lankford has been diagnosed with rheumatoid arthritis, which she reports is not made worse by exercise. In addition, Hollie sustained a musculoskeletal injury to her low back last year that forced her to miss

1 wk of work; however, she reports that her low back area has been problem free for the last 7 mo.

Follow the ACSM preparticipation physical activity screening algorithm (see Fig. 11.6) for the individual in this case study to determine the need for a medical evaluation and for prescribed exercise intensity before beginning an exercise program.

Physical Activity History: She walks her dogs daily for a total of approximately ¾ mile and thus is not considered physically active as defined by the ACSM.

Presence of Cardiovascular, Metabolic, and/or Renal Disease: None noted

Major Symptoms or Signs Suggestive of Cardiovascular, Metabolic, and/or Renal Disease: None noted

ACSM Preparticipation Physical Activity Screening Status: Medical clearance is not necessary prior to starting a physical activity program of light to moderate intensity. She may progress to more vigorous-intensity exercise following *GETP* (3,28). As an ACSM-EP or ACSM-CPT, you may want to conduct exercise tests for prescriptive purposes while being careful not to exacerbate Hollie's previous back injury. A physical activity program should be recommended that incorporates strengthening her core and lower back muscles.

ACSM CVD Risk Factors and Defining Criteria

	ACSM Risk Factors	Comment
	Age	42 years old (below criteria of 55 yr old)
	Family history	Father had heart attack (MI) at 56 years old (was not before 55 yr old); mother with hypertension doesn't count
	Cigarette smoking	Quit smoking more than 6 mo ago, so not a risk factor
+	Sedentary lifestyle	Walking dogs ¾ mile daily does not equal 30 minutes and, therefore, is not considered physically active.
+	Obesity	BMI = 30.34 $kg \cdot m^{-2}$ (above 30 $kg \cdot m^{-2}$ is obese)
+	Hypertension	Systolic blood pressure = 142/82 mm Hg and 144/84 mm Hg (considered hypertensive)

	Dyslipidemia	TC = 190 mg · dL^{-1} (below criteria level of 200 mg · dL^{-1})
	Diabetes	FBG = 82 mg · dL^{-1} (below criteria level of 126 mg · dL^{-1})
−	*High* HDL-C	HDL = 72 mg · dL^{-1} (60 mg · dL^{-1} and above is considered a negative risk factor)
2	(+) Risk factors	3 positive risk factors − 1 negative risk factor = 2

ACSM Risk Factor Analysis: Hollie has a risk factor profile that includes hypertension, obesity, and a sedentary lifestyle. Her high HDL-C decreases her overall risk for CVD. Thus, a prudent ACSM-EP or ACSM-CPT should stress to this client the importance of adopting a physically active lifestyle with an initial moderate-intensity exercise program. In addition, Ms. Lankford should consult with appropriate health care professionals regarding her diet and possible medical intervention for hypertension.

SUMMARY

Preparticipation physical activity screening is a process that may include health/medical history and informed consent of an individual client. The process is one where the client is prepared for the upcoming physical activity program. Although there are several examples or models that can be followed for the preparticipation physical activity screening process, the bottom line is the need to evaluate a client's medical readiness to undertake the physical activity program planned for him or her. Thus, the preparticipation physical activity screening gives the relative assurance that the client is ready and able to participate in the rigors of the physical activity training process. It is thus important that the ACSM-EP or ACSM-CPT perform the preparticipation physical activity screening on the client.

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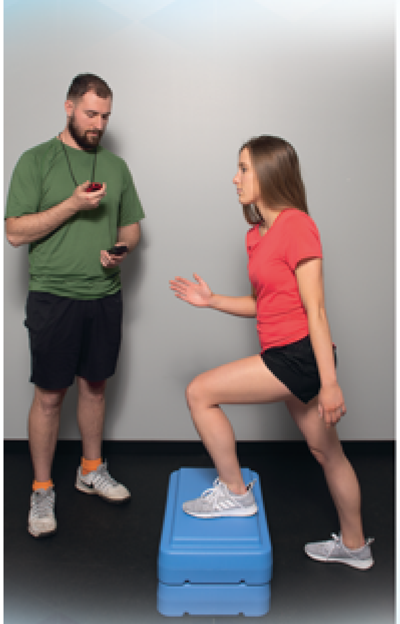
CHAPTER

12

Client Fitness Assessments



OBJECTIVES

Personal Trainers should be able to:

- Perform a basic client needs analysis.
- Construct an appropriate, effective, and sequential fitness assessment battery.
- Present information on how to perform basic health-related physical fitness assessments common to the field of Personal Training. These include the following:
  - Resting heart rate and blood pressure
  - Anthropometrics and body composition: height, weight, body mass index, circumference measurements, skinfold assessment, and bioelectrical impedance analysis
  - Cardiovascular: field tests, step tests, treadmill tests, and cycle ergometer tests
  - Muscular fitness (muscular strength and muscular endurance): one repetition maximum bench press, multirepetition maximum (multirep max) bench press, and push-up test
  - Flexibility/mobility: sit-and-reach test, Functional Movement Screen
  - Senior Fitness Tests

Development of an Individualized Fitness Assessment Battery

A comprehensive, individualized fitness assessment should be conducted prior to the designing of a training program and the physical training of a fitness client. Depending on the setting, any number of assessments may be performed in order to evaluate the competency of various aspects of physical fitness. Once the need for medical clearance has been eliminated by taking the client through the appropriate recommended screening protocols (see Chapter 11), or the client has received medical clearance from his or her primary care physician, a fitness assessment should be scheduled and conducted.

Proper construction of a client-appropriate fitness assessment battery will not only enhance client comfort but will also increase test validity and data accuracy. By analyzing medical history forms and questionnaires, then conducting a client needs analysis (see the following text), specific assessments should be selected that are most appropriate for the individual. For example, if a client has no experience with resistance training, the one repetition maximum (1-RM) muscular strength assessment may not be an appropriate option. Considerations such as these should be used to develop an individualized fitness assessment and effective training program.

Performance of Needs Analysis

Although traditionally performed with athletic populations, a basic needs analysis should be performed with all populations prior the development of a fitness assessment battery. This will help the Personal Trainer determine specific needs that individual clients may have. A needs analysis can be defined as the process involving the evaluation of the movement, fitness, and injury prevention needs of a client. The needs analysis can therefore be divided into three categories — the movement analysis, the physiological analysis, and the injury analysis (1).

The movement analysis should consist of definition of all movement patterns and muscular actions associated with physical activities performed by the client. If there is no specific sport focus, or in addition to a specific sport focus, movements important to the client may consist of basic functional movements such as squatting (rising from a chair), unilateral hip extension (climbing stairs), upper body horizontal pulling (starting a lawnmower), and so on. The competency with most of these basic functional movements may be quantified using the Functional Movement Screen (FMS), which is discussed later in this chapter.

The physiological analysis refers to the determination of physiological systems and/or elements of fitness that may be important to the client, in terms of both health and performance. If the client wishes to train for a certain sport, there may be specific elements of fitness that should be assessed for optimal training. For example, if a female client, age 52 years, wishes to train for and complete a sprint distance triathlon, cardiovascular fitness, and thus the cardiorespiratory system, will be a major focus of both assessment and training. In the event that there is no specific sport focus for the client, the physiological analysis should focus on fitness components that positively influence activities of daily living (ADL) and health (*e.g.*, body composition, cardiovascular endurance, muscular strength, muscular endurance, and flexibility).

Lastly, the injury analysis will focus on two aspects. First, any past or current acute injury(s) experienced by the client should be noted with consideration of how this may affect assessment and programming choices. For example, a client with a history of rotator cuff injury may require avoidance of barbell bench press–based assessments and exercises. Second, eliminating risk of future injury should be a priority for a fitness professional.

Along with an increase in sedentary behavior is a concurrent increase in the prevalence of chronic musculoskeletal injury among the general population. In 2013 alone, there were more than 10 million doctor visits for lumbar spine and shoulder symptoms (2). Therefore, in addition to the prudent practice of avoiding acute injury during training, it is recommended that the avoidance of exacerbation of common chronic musculoskeletal injury, such as lower back pain, be a priority as well.

Once the client needs analysis is performed, an appropriate, individualized fitness testing battery should be developed considering the information gathered during the needs analysis, as well as client training background/experience, equipment, space, and time available.

Sequence of Fitness Assessments and Pretest Instructions

Specific testing protocols are described later in this chapter, but the general sequence of testing should follow as such:

1. Resting cardiovascular measurements
2. Anthropometrics and body composition analysis
3. Cardiorespiratory fitness (CRF) assessment
4. Muscular fitness assessment
5. Flexibility and/or functional movement assessment

Additional fitness characteristics may be tested if warranted. For example, if working with a youth athlete, then these may include vertical jump (or other anaerobic power test), agility, muscular power, and/or anaerobic capacity tests (1). Also, in the case of an elderly client, elements from the Senior Fitness Test (SFT) (described later in the chapter) may be prudent to include in lieu of some of the tests listed earlier. After creating the testing battery, general descriptions of the chosen protocols and explicit instructions for the exercise testing session should be communicated to the client, preferably in writing well in advance of the testing session (3). A description of the test protocols can alleviate client anxiety and enhance preparation. General and specific instructions for each test will not only enhance client preparation but also increase test validity and data accuracy (3). Specific instructions may include, for example, the description of proper attire for a hydrostatic weighing test (tight-fitting swim wear or compression garments) or a skinfold assessment (shorts and a tank-top or t-shirt). General instructions are much more likely to be warranted, and a suggested list (3) is provided here:

- Clients should refrain from ingesting food, alcohol, caffeine, and/or using tobacco within 3 hours of testing.
- Clients should refrain from participating in vigorous exercise the day of testing and possibly the day before.
- Proper attire should be worn to allow for freedom of movement. Layers may be recommended to assist in temperature regulation. Proper foot wear (*e.g.*, athletic shoes) should be encouraged. Attire recommendations may also be made based on a specific test, as described earlier.
- Clients should be encouraged to maintain medication regimen (if applicable) on the normal schedule so that exercise responses (*e.g.*, heart rate [HR]) will be consistent to those obtained during training. If warranted, a list of medications used by the client should also be obtained prior to testing in order for any potential interference to the normal exercise response to be anticipated.
- Lastly, clients should be instructed to adequately hydrate during the 24-hour period prior to the exercise testing session.

Fitness assessments should be scheduled to allow for an appropriate time duration to thoroughly explain, conduct, and interpret test results. Sixty to 75 minutes, for example, will allow for adequate time to perform the fitness assessment without rushing while simultaneously allowing time for client questions. Many clients, particularly novice exercisers, will be anxious during this process, so slowing down and encouraging questions will assist in alleviating anxiety. Likewise, a setting for the assessment should be chosen (if possible) that will further ease potential client anxiety. If a designated assessment room is not available, find a quiet corner of the facility to allow for some degree of privacy. Room temperature (ideally 68° F to 72° F), humidity (<60%), and adequate ventilation should be considered to aid in client comfort during the fitness assessment. Finally, the test administrator should do his or her part to assist in reducing client anxiety by remaining calm and demonstrating relaxed confidence throughout (3).

Resting Cardiovascular Measurements

Heart Rate: Resting, Exercise, and Recovery

HR refers to the number of times the heart beats or contracts, usually reported in beats per minute (bpm). Although there is no known or accepted standards for resting heart rate (RHR), RHR is often considered an indicator of CRF because it tends to decrease as fitness level increases.

There are also no standards for exercise HR, but the HR response to a standardized exercise workload is an important fitness variable and the foundation for many cardiorespiratory endurance tests, particularly submaximal CRF prediction tests. HR response to submaximal exercise is also typically viewed as an indicator of CRF as with increased levels of fitness, HR at any given level of submaximal exercise will decrease as fitness increases. Similarly, recovery HR is also considered to be an excellent index of CRF and is used as a variable in some CRF tests (*e.g.*, Queens College Step Test). It is important to note, however, that certain medications may affect both RHR and HR response to exercise. For example, β-blockers, often prescribed for hypertension, will significantly decrease RHR and may affect and/or limit exercise HR response (3). This supports the importance of collecting medical history information during the preparticipation process.

Measurement of Heart Rate

There are multiple methods for measuring HR, including manual palpation at various anatomical sites, auscultation using a stethoscope, and the use of HR monitors or electrocardiogram (ECG).

Palpation of Pulse

The three commonly used anatomical sites for measurement of HR using palpation are the following (4):

- *Radial*: Using the tips of the index and middle fingers, apply light pressure against the radial artery, located in the groove on the anterior surface of the lateral wrist, in line with the base of the thumb. The radial palpation site is shown in Figure 12.1.
- *Brachial*: Located in the groove between the triceps and biceps muscles on the medial side of the arm, anterior to the elbow (see Fig. 12.1). This site is also used for the auscultation of blood pressure (BP).
- *Carotid*: may be more easily located than the radial pulse while being slightly more invasive. Press fingers *lightly* along the medial border of the sternocleidomastoid muscle in the lower neck region, on either side of the larynx. Avoiding heavy pressure near the carotid sinus area can help avoid the reflexive slowing of HR and/or drop in BP by activation of the baroreceptor reflex (see in the following text). The carotid palpation site is shown in Figure 12.1 and should be used only if you or the client fails to feel the pulse at the radial or brachial sites.

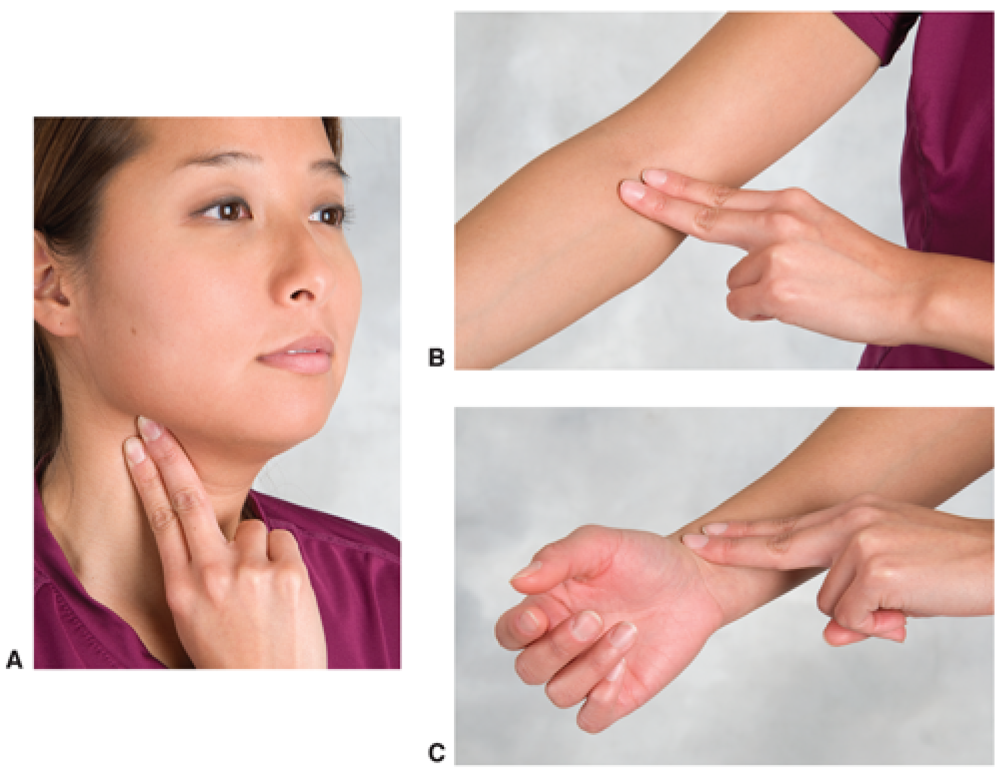


FIGURE 12.1. Locations for pulse determination. **A.** Carotid. **B.** Brachial. **C.** Radial.

The procedure for pulse measurement via palpation is as follows (4):

1. Locate anatomical site.
2. Gently press down with the two fingers (index and middle) over palpation site.
3. Count the number of pulsations for a specific time period (*e.g.*, 10, 15, 30, or 60 s) based on the activity occurring. If measurements are being taken during resting conditions, 30- or 60-second count times are appropriate; for exercising measurements, shorter intervals are recommended. Begin counting the first pulsation as 0 when timing is initiated simultaneously or, if a lag time occurs after the start time and the first pulsation, begin with the number 1.
4. Determine HR based on the number of pulsations in a given time period. Accuracy of HR increases with longer palpation times.
   - 10 seconds = multiply number of pulsations by 6
   - 15 seconds = multiply number of pulsations by 4
   - 30 seconds = multiply number of pulsations by 2

The method of HR palpation of the pulse can be mastered through practice and should be taught to clients. Some clients, as a result of anatomical aberrations (*e.g.*, excess subcutaneous fat stores), may be more difficult to palpate. Although the carotid artery location may be easier to palpate, this measurement site may lead to an underestimation of the HR due to the baroreceptors in the carotid sinus region often becoming stimulated when touched (5). This may reflexively reduce the client's HR as the baroreceptors perceive a false increase in BP. The baroreceptor reflex becomes a more important issue with HR counts longer than 15 seconds. Therefore, during pulse counts 30–60 seconds in duration, the radial and brachial arteries are the locations of choice for palpation.

The palpation of RHR is more accurately achieved using a full 60-second count. However, a 30-second time period may be sufficient for the count (which would then be multiplied by 2 to obtain HR in bpm). When true resting conditions are present, there should be little fluctuation in HR, thus making the 60-second count quite accurate. Therefore, when taking resting cardiovascular measurements, an effort should be made to simulate resting conditions as much as possible. Ways to promote this include client sitting quietly with feet on floor and back supported for 5 minutes prior to measurement, avoidance of stimulants such as caffeine and tobacco for at least 30 minutes prior to measurement, and avoidance of vigorous exercise prior to measurement. If these suggestions are impractical, or to get a more accurate measure of true RHR, the client may be instructed to measure RHR upon waking in the morning. When acute fluctuations in HR are present, such as during exercise, recovery from exercise, or when promoted by anxiety, stimulants, or body position change, a shorter time duration for HR palpation (*e.g.*, a 15 s count) may provide a more accurate measurement of the acute HR.

Measurement of Exercise Heart Rate

Using the palpation method, measure the number of beats felt in a 10- or 15-second period and multiply by 6 (for 10 s) or 4 (for 15 s) to calculate HR in bpm. Because HR may fluctuate during exercise and decrease rapidly during recovery, shorter duration counts are typically used during and postexercise, allowing for a more instantaneous and accurate measurement compared to longer duration counts in this situation. When counting the exercise HR for a period of less than 1 minute, you should start the time period and the beat count at zero at the first beat felt (5).

The use of HR monitors has increased in popularity because these devices have become more available and affordable. Some monitors are prone to error; however, newer technology has resolved the reliability problem previously associated with many of these monitors. HR monitors that use a chest electrode strap have considered to be more accurate than other types of devices (5). When placing an electrode strap on a client or oneself, be sure the aspect of the strap that is in contact with the chest is properly placed (just below the sternum, tight fitting, and wetted slightly to enhance conduction and increase accuracy of measurement). Soapy solution or ultrasound gel may also increase conduction. When using a chest electrode strap, one should also be aware of the possibility of interference from electrical equipment is close proximity to the device (*e.g.*, treadmills, video screens) (5).

The use of wrist-worn wearable technology for the tracking of activity patterns in general, and HR in particular, has become more common in recent years due to increased availability, versatility, and ease of use. Although a chest electrode strap-based HR monitor requires both the proper placement of the strap and the use of a watch or other device capable of displaying the actual HR, the wrist-worn wearable technology is contained solely within a watch.

These devices commonly use a technique known as photoplethysmography to interpret HR by passing light into the wrist in order to quantify blood flow and calculate HR using an algorithm programmed into the device (5). This technique is similar to that which is used during pulse oximetry (6). Although early versions of this technology were not found to be reliable during exercise (7), recent evidence suggests improved accuracy of many of these devices when compared with ECG monitoring (6) during exercise of varying intensities, including maximal exercise (8). It is recommended that a chosen wrist-wearable device be one that has been validated in comparison to ECG monitoring (5).

Maximal Heart Rate

Maximal heart rate (HR_{max}) is a useful number to know for both exercise testing and exercise prescription. As described later in this chapter, most submaximal CRF tests have a test termination criteria of 85% HR_{max}. As the only way to measure HR_{max} is to exercise a client to his or her maximal exercise capacity, and this is impractical for both clinical and unfit populations, HR_{max} is often predicted using simple formulas. The most common, proposed by Fox et al. (9), only requires client age to be plugged into the following equation:

$$\text{Age-predicted } HR_{max} = 220 - \text{age}$$

Although this formula is widely used due to its simplicity, it can underestimate or overestimate HR_{max} by up to 10 bpm (10). In an effort to improve accuracy, particularly in specific populations, additional equations have been developed (3,10). Although these equations cannot currently be recommended for universal application, they may be applicable with certain populations and can be seen in Table 12.1 (3,11).

Table 12.1 Commonly Used Equations for Estimating Maximal Heart Rate

Author	Equation	Population
Åstrand	$HR_{max} = 216.6 - (0.84 \times \text{age})$	Men and women age 4–34 yr
Tanaka et al.	$HR_{max} = 208 - (0.7 \times \text{age})$	Healthy men and women
Gellish et al.	$HR_{max} = 207 - (0.7 \times \text{age})$	Men and women in an adult fitness program with broad range of age and fitness levels
Gulati et al.	$HR_{max} = 206 - (0.88 \times \text{age})$	Asymptomatic middle-aged women referred for stress testing

From American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2022. 548 p.

Blood Pressure: Resting and Exercise

The measurement of BP is an integral component of a resting health-related physical fitness assessment. BP is the force of blood against the walls of the arteries and veins created by the heart as it pumps blood to every part of the body. BP is typically expressed in millimeters of mercury. BP is a dynamic variable with regard to location (*e.g.*, artery vs. vein and the level in an artery). Personal Trainers are most concerned with arterial BP at the level of the heart. This arterial, heart-level BP is the one typically measured at rest and during exercise (5). Definitions of BP are listed as follows, and more discussion concerning the regulation of BP can be found in Chapter 5.

- Systolic blood pressure (SBP) is the maximum pressure in the arteries when the ventricles of the heart contract during a heartbeat. The term derives from systole or contraction of the heart. The SBP occurs late in ventricular systole. SBP is thought to represent the overall functioning of the left ventricle and is thus an important indicator of cardiovascular function during exercise. SBP is typically measured from the brachial artery at the heart level and is expressed in units of millimeters of mercury.
- Diastolic blood pressure (DBP) is the minimum pressure in the arteries when the ventricles relax. The term is derived from diastole or relaxation of the heart. The DBP occurs late in ventricular diastole and reflects the peripheral resistance to blood flow in the arterial vessels. DBP is typically measured from the brachial artery at the heart level and is expressed in units of millimeters of mercury.

"Hypertension," or high BP, is a condition in which the resting BP, either SBP or DBP or both, is chronically elevated above the optimal or desired level. The standards for classifying resting hypertension are presented in Table 12.2. *Hypotension* is the term for low BP, and there are no accepted standards for a value that classifies an individual with hypotension. Hypotension exists medically if the individual has symptoms related to low BP such as light-headedness, dizziness, or fainting (12). However, although there are classifications for hypertension, the Personal Trainer is not permitted to make a clinical diagnosis, instead they may refer the client to a health care professional for follow-up. BP is typically assessed using the principle of indirect auscultation. Auscultation involves the use of a BP cuff, a manometer, and a stethoscope. Measurement of BP is a fundamental skill and is covered in detail in this chapter (13).

Table **Classification of Resting Blood Pressure for**

12.2	Adults (15)	
Classification	**Systolic (mm Hg)**	**Diastolic (mm Hg) (Fifth Phase)**
Normal	<120	<80
Elevated BP	120–129	<80
Hypertension		
Stage 1	130–139	80–89
Stage 2	≥140	≥90
Hypertensive crisis	≥180	≥120

Reprinted from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2018.

Adapted from National Institutes of Health. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults [Internet]. Bethesda (MD): National Institutes of Health. Available from: https://www.ncbi.nlm.nih.gov/books/NBK2003/pdf/Bookshelf_NBK2003.pdf.

Measurement of Blood Pressure

BP measurement is a relatively simple technique and may be used in risk stratification, as discussed elsewhere in this text. Hypertension cannot be diagnosed from a single measurement; serial measurements must be obtained on separate days. The BP of a client should be based on the average of two or more resting BP recordings during each of two or more visits (3).

> Hypertension cannot be diagnosed from a single measurement; serial measurements must be obtained on separate days.

For accurate resting BP readings, it is important that the client be made as comfortable as possible. To accomplish this, take a few minutes to talk to the client after having him or her sit in a chair. Make sure the client does not have his or her legs crossed. Also, be sure to use the correct size of BP cuff. Choosing the correct cuff size is addressed later in this chapter. As with many other physiological and psychological measures, clients may experience “white coat syndrome” during the measurement of BP. White coat syndrome refers to an elevation of BP resulting from the anxiety or nervousness associated with being in a doctor’s office or in a clinical setting (*e.g.*, clinician wearing a white lab coat). Thus, having a client in a relaxed state is important when taking a resting BP measurement.

Korotkoff Sounds

The skill of BP measurement can only be obtained through practice. One of the most difficult aspects of BP measurement for the inexperienced Personal Trainer is the ability to hear the sounds associated with the BP while filtering out extraneous noises such as those made by the measurement device (*e.g.*, hoses knocking together) and/or ambient room noise. In order to gain proficiency with the measurement of BP by auscultation, the Personal Trainer must be able to isolate the specific sounds of the blood as it makes its way from an area of high pressure to that of lower pressure as the air is let out of the pumped-up cuff. These sounds are known as Korotkoff sounds. The sounds can be divided into five phases (Box 12.1) (12).

Box 12.1 Korotkoff Sounds

- Phase 1: the first sound or the onset of sound. Sound resembles a clear, repetitive tapping. The sound may be faint initially and gradually increase in volume to phase 2. Phase 1 represents SBP.
- Phase 2: soft tapping or murmur-like sound; often longer than phase 1 sounds and may have a swishing component. The phase 2 sounds are typically 10–15 mm Hg after the onset of sound in phase 1.
- Phase 3: Sounds transition to a high-pitch loud tapping and are both more crisp and loud than phase 2 sounds.
- Phase 4: Sounds become muffled, less distinct and audible, and may be described as soft or blowing.
- Phase 5: complete disappearance of sound; usually occurs within 8–10 mm Hg of sound (phase 4) and is considered DBP

Adapted from American College of Sports Medicine. In: Bayles MP, Swank AM, editors. *ACSM's Exercise Testing and Prescription*. Philadelphia (PA): Wolters Kluwer; 2018. p. 70.

Instruments Used for Blood Pressure Measurement

A sphygmomanometer consists of a manometer and a BP cuff. The prefix *sphygmo* refers to the occlusion of the artery by a cuff. A manometer is simply a device used to measure pressure. Two common types of manometers are available for BP measurement: mercury (Fig. 12.2) and aneroid (Fig. 12.3). Mercury is the standard type used for accuracy; however, because of the toxic nature of mercury, aneroid sphygmomanometers are becoming more common in the workplace.

FIGURE 12.2. Sphygmomanometer, gravity mercury. Freestanding pressure manometer of the gravity mercury type, which uses the height of a mercury column in a glass tube to indicate cuff pressure.

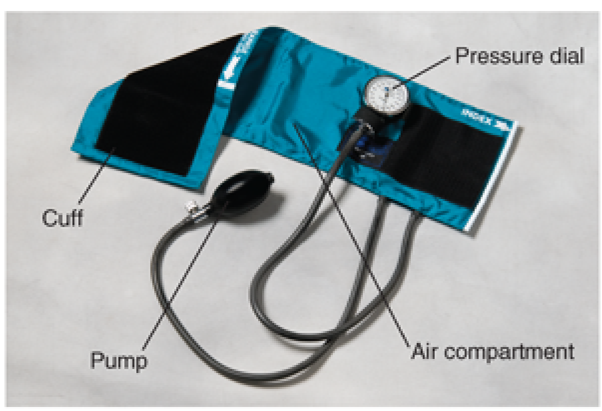


FIGURE 12.3. Aneroid sphygmomanometer and BP cuff.

Position the manometer at your eye level to eliminate the potential for any reflex errors when reading either the mercury level or the needle if using the aneroid manometer. This is very important. Aneroid manometers are usually of a dial type (round), whereas mercury manometers are usually of a straight tube/column type. The cuff typically consists of a rubber bladder and two tubes, one to the manometer and one to a hand bulb with a valve that is used for inflation. The bladder must be of appropriate size for accurate readings. The sizing of a BP cuff should as follows:

- Width of bladder = 40%–50% of upper arm circumference
- Length of bladder = almost long enough (~80%) to circle upper arm

Three BP cuff sizes are commonly used in the health and fitness field: a pediatric or child cuff for small arm sizes (13–20 cm [5–8 in]), a normal adult cuff for arm size between 24 and 32 cm (9 and 11 in), and a large adult cuff for larger arm sizes (32–42 cm [12–16 in]). Note that the bladder does not run the entire length of the cuff. There are index lines on many of the newer sphygmomanometer cuffs to help "fit" the cuff for a client's arm circumference. In general, the appropriate BP bladder should encircle at least 80% of the arm's circumference. A cuff that is too small in length or width will generally result in a BP measurement that will be falsely high.

The cuff should be positioned at the level of the heart; if below the level of the heart, the BP reading will be falsely high. The cuff must be applied snugly or tightly. If the cuff is too loose, the BP measurement will typically be falsely high.

Equipment used in the measurement of BP is widely available commercially and varies greatly in quality. BP sphygmomanometer units can be purchased in most drug stores, from various health and fitness commercial catalogs, and at medical supply stores. Stethoscopes are also widely available and vary in quality. A high-quality stethoscope is worth the investment to help in hearing clear Korotkoff sounds (14). Electronic BP machines are increasingly available, with industrial models becoming commonplace in clinical settings. Commercial models have become widely available and relatively inexpensive and allow for self-monitoring of BP. Many of these models have been shown to provide reasonably accurate readings (14).

Resting Blood Pressure Measurement Procedures

1. Measurement should begin after at least 5 full minutes of quiet, seated rest. The client should be free of stimulants (nicotine products, caffeine products, recent alcohol use, or other cardiovascular stimulants) for at least 30 minutes prior to the resting measurement. In addition, your client should not have exercised strenuously for at least the prior 60 minutes.
2. Prior to beginning measurement, it is important to position the BP device, the stethoscope, and the client properly, thus promoting the best opportunity to hear the BP and see the manometer scale. With the client in the proper position (supine, seated, or standing; for the purposes of this description, the client will be in a seated position), position yourself on the correct side of the client while ensuring the manometer is in full visibility. Take control of the client's arm while having it supported by some piece of furniture. If nothing is available on which to support client's arm, clamp lower arm between your torso and upper arm. Place the stethoscope earpieces into ears or headset around neck for later insertion into ears. If the earpieces are angled, be sure to insert them angled toward your face. Additionally, if possible, the room noise should be at a minimum and the temperature should be comfortable (21° C to 23° C [70° F to 74° F]). If you have some form of sinus congestion, your ability to hear the BP sounds may be diminished. Clearing your throat before attempting a BP measurement may be helpful.
3. During seated BP measurement, the client should be seated with the back well supported, the feet flat, the legs uncrossed, and the arm free of any clothing and relaxed. A short sleeve can be rolled up to expose the upper arm, but if a long sleeve shirt is being worn, the client will likely need to remove the arm being measured from the shirt/sleeve. As previously mentioned, ensure that the arm is supported in some way. If the client supports his or her own arm, the constant isometric contraction by the client may elevate the DBP.
4. It matters little which arm is chosen for the resting BP measurement; however, it is important to use the same arm for both resting and exercise measurements. The American Heart Association recommends

that you measure both right and left arm BPs on your client on the initial evaluation and the arm with the higher pressure be chosen. However, if BP is normal in the right arm, it tends to be normal in the left arm. Conventionally, the left arm is typically used.

5. Palpate the client's brachial artery and then center the rubber bladder of the BP cuff over the brachial artery. The lower border of the cuff should be 2.5 cm (1 in) above the antecubital fossa or crease of the elbow. Be sure to use the appropriate-size BP cuff, as discussed previously.
6. Secure the fully deflated BP cuff snugly around the arm, tight enough so that it will not slide down the arm, with the cuff positioned at heart level for optimal accuracy.
7. Firmly place the bell of the stethoscope just below the antecubital space over the brachial artery. Avoid contact between the bell and the BP cuff and ensure the bell is flush against the skin. Secure bell to arm using your index and middle fingers, rather than the thumb in order to avoid hearing your own pulse. Figure 12.4 depicts how the client's arm should be positioned with the BP cuff and stethoscope.
8. If stethoscope earpieces were not previously inserted, do so. Close the valve on the sphygmomanometer by turning it clockwise and then rapidly inflate cuff pressure to one of the following, depending on the situation/client:
   - 20–30 mm Hg above the SBP, if known
   - Up to 140–180 mm Hg for a resting BP
   - Up to 30 mm Hg above disappearance of the radial pulse if you palpate for radial pulse first. This is called the palpation method. Many educators favor the palpation method when the technician is first learning BP measurement to "feel" for and then listen to the SBP.
9. Immediately begin deflation of cuff by opening the valve (turning counterclockwise) and releasing the pressure slowly at a rate of 2–3 mm Hg per second. Proper rate of deflation is one of the most difficult aspects of BP measurement and will require practice to learn. This is important because rapid deflation leads to underestimation of SBP and

overestimation of DBP, whereas slow deflation increases client discomfort during the measurement due to prolonged occlusion of blood flow. Slowing the deflation rate slightly to 2 mm Hg per second when in the anticipated range of the systolic to diastolic BP can be helpful but be mindful of not closing the valve back off completely — allow for a steady, if slow, drop in cuff pressure.

10. Note the presence of the Korotkoff sounds, as described earlier, and record measures of SBP (indicated by the first Korotkoff sound) and DBP (typically indicated by the last Korotkoff sound) in even numbers. Always round off upward to the nearest 2 mm Hg. Always continue to listen to any BP sounds for at least 10 mm Hg below the fifth phase (to be sure you have correctly identified the fifth phase).
11. Open valve fully to rapidly deflate the cuff to zero after the DBP is obtained.
12. At least two measurements should be taken, at least 60 seconds apart, and the average of the measurements should be taken. If two measurements are not within 5 mm Hg of one another, a third measurement should be taken.

FIGURE 12.4. Position of the stethoscope head and BP cuff.

Visit thePoint to watch video 12.1 about BP measurement.

Normative data (15) presented in Table 12.2 for resting BP are for those older than 18 years. To use these norms, individuals should not be taking any antihypertensive medications and should not be acutely ill during the measurement. When SBP and DBP fall into two different classifications, the higher classification should be selected. This classification is based on two or more readings taken at each of two or more visits after an initial BP screening. Generally, these norms are revised periodically. Refer to Box 12.2 for common errors and sources of error during BP measurement.

Box 12.2 Common Sources of Error during Blood Pressure Measurement

- Inaccurate sphygmomanometer
- Incorrect cuff size
- Ability of technician to hear Korotkoff sounds
- Improper valve manipulation
- Rate of inflation or deflation of cuff pressure
- Improper stethoscope placement or pressure
- Improper cuff placement (*i.e.*, heart level, lined up over artery)
- Failure to support arm of patient
- Experience level of technician
- Background noise
- Certain physiological abnormalities (*i.e.*, damaged brachial artery, subclavian steal syndrome, arteriovenous fistula)

Adapted from American College of Sports Medicine. In: Bayles MP, Swank AM, editors. *ACSM's Exercise Testing and Prescription*. Philadelphia (PA): Wolters Kluwer; 2018. p. 54.

Anthropometrics and Body Composition Analysis

It is important to both include and distinguish between anthropometric measurements and body composition analysis during a comprehensive fitness assessment. Anthropometrics can be defined as those that give information about the external proportions of the body (5), such as height, weight, body mass index (BMI), and specific anatomical circumferences (most commonly measured are the waist and hip circumferences). These measurements fail to give any information regarding the internal composition of the body yet are quite useful for many reasons, including ease of administration even in large groups, lack of specialized skill or equipment needed, and usefulness in other fitness variable calculations. These are also measurements that clients can be taught to perform on their own, aiding in the tracking of progress and accountability.

Body composition analysis, on the other hand, does give indirect measurements or estimations regarding the internal composition of the body, most importantly, fat mass (FM) and fat-free mass (FFM). Body composition tests are typically not self-administered by clients due to the need for specialized equipment and administration skill and are therefore a skill that Personal Trainers should acquire and offer to clients. Tests that are discussed in this chapter — skinfold assessment, bioelectrical impedance analysis (BIA), briefly hydrostatic weighting, dual-energy x-ray absorptiometry (DXA), and ultrasound — are important for monitoring progress during a fitness program; body weight may change minimally during participation in a resistance training program, but percent body fat may change more substantially. Although there is no consensus as to the exact body composition measurement in relation to optimal health, a %BF range of 12%–23% for males and 17%–26% for females has traditionally been viewed as acceptable (3). For clients with a more specific athletic focus, body composition norms for specific sports may be referenced (1).

Body composition can be defined as the relative proportion of fat and fat-free mass in the body (percent body fat).

Height and Weight

Height may be measured using a stadiometer or tape measure (if stadiometer not available). In either case, instruct the client to remove shoes and stand as straight as possible with heels together and eyes focused straight ahead. If using a stadiometer, client should be facing away from the device. Record the height in both inches and centimeters.

- 1 in = 2.54 cm
- 1 m = 100 cm
- For example: 6 ft = 72 in = 183 cm = 1.83 m

Weight, or body mass, should be measured on a calibrated scale. Clients should remove shoes, and excess clothing (when practical and possible) and empty out pockets. Due to fluctuations in hydration during the course of the day, it is best to measure body weight at a consistent time of day (*e.g.*, early in the morning) for the purposes of tracking weight loss, gain, or maintenance (12). Weight measured in pounds may require conversion to kilograms for use in certain calculations.

- 1 kg = 2.2 lb
- For example: 187 lb = 85 kg

Traditionally, an individual's height and weight would be compared with one of several available height–weight tables, producing a descriptive ranking (*e.g.*, *underweight*). However, criticism over the validity of height-weight tables (including the use of a select group of individuals and the imprecise concept of "frame size") has led to reduced use of such tables in most professional settings in favor of more advanced anthropometric and body composition assessments.

Body Mass Index

BMI is similar to the aforementioned height-weight tables in that it provides a score based on an individual's weight relative to height. The BMI score is a proportion and is calculated using a simple formula, and this score can be compared to the normative data chart (displayed in the following text) for a classification of disease risk. The BMI equation is as follows:

- BMI (kg · m -2) = weight (kg) / height (m^2)
- For example, an individual who weighs 150 lb and is 5 ft 8 in tall has a BMI of

$$5 \text{ ft } 8 \text{ in} = 173 \text{ cm} = 1.73 \text{ m} = 2.99 \text{ m}^2 \text{ and } 150 \text{ lb} = 68.18 \text{ kg}$$

- BMI = 68.18 / 2.99 = 22.8 kg · m^{-2}

An advantage of BMI calculation is that it does not require any specialized equipment or skill to determine. It can be a useful tool when working with individuals remotely when body composition measurements are not practical or with large groups of individuals because it is useful for quantifying designations of overweight or obesity in large populations (12). The major shortcoming with BMI is that it is not a method of body composition analysis and therefore does not quantify FM or FFM directly. This can present an issue for many populations including athletes who presumably who have a high amount of FFM because BMI does not differentiate between FM and FFM or addresses those who are really tall. For example, a study involving professional American football players found that the vast majority were designated as overweight or obese according to BMI but were considered healthy when actual body composition was assessed using air displacement plethysmography (16). Finally, BMI scores can be used to predict %BF, but the high standard error (±5%) suggests that other methods of body composition assessment should be used (3). Standards and norms for BMI are presented in Table 12.3 and Figure 12.5.

Table 12.3 Classification of Risk Based on Body Mass Index (BMI) and Waist Circumference

	BMI (kg · m^{-2})	Disease Risk[a] Relative to Normal Weight and Waist Circumference

		Men (≤102 cm) Women (≤88 cm)	Men (>102 cm) Women (>88 cm)
Underweight	<18.5	—	—
Normal	18.5–24.9	—	—
Overweight	25.0–29.9	Increased	High
Obesity, class			
I	30.0–34.9	High	Very high
II	35.0–39.9	Very high	Very high
III	≥40.0	Extremely high	Extremely high

Dashes (—) indicate that no additional risk at these levels of BMI was assigned. Increased waist circumference can also be a marker for increased risk, even in persons of normal weight.

[a]Disease risk for Type 2 diabetes, hypertension, and cardiovascular disease.

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Adapted from National Institutes of Health. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults [Internet]. Bethesda (MD): National Institutes of Health. Available from: https://www.ncbi.nlm.nih.gov/books/NBK2003/pdf/Bookshelf_NBK2003.pdf.

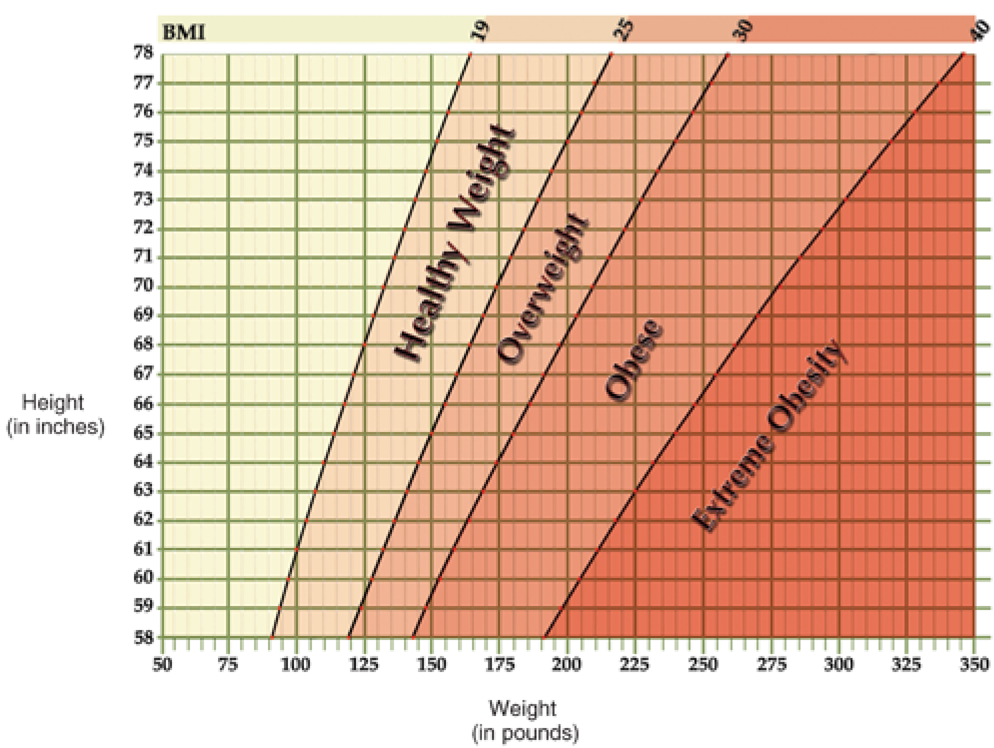


FIGURE 12.5. The risks of obesity. How is body fat measured? BMI is a measure of weight in relation to a person's height. For most people, BMI has a strong relationship to weight. For adults, BMI can also be found by using this table. To use the BMI table, first find the client's weight at the bottom of the graph. Go straight up from that point until the line matches the client's height. Then, identify the client's weight group. (Anatomical Chart Company. *Risks of Obesity Anatomical Chart*. Baltimore [MD]: Lippincott Williams & Wilkins; 2004. 1 p.)

Circumference Measurements

Circumference measurements, also known as girth measurements, are important for quantifying the distribution of body fat, the pattern of which is recognized as an important predictor of health. Android obesity, characterized by a high degree of fat distribution on the trunk, increases the risk of hypertension, metabolic syndrome, Type 2 diabetes, dyslipidemia, coronary heart disease, and premature death (3). Therefore, the measurement of waist and hip circumference and the calculation of the waist-to-hip ratio (WHR) offer a simple yet effective tool for ranking the disease risk of a client. Although the waist and hip are most commonly measured due to their relationship to disease risk, measuring the circumference of multiple body parts (*e.g.*, abdomen, arm, midthigh) can be a useful way to monitor and track regional changes in FM and FFM during the course of a fitness training program. Although %BF can be estimated using a variety of circumference measurements and translational equations, the standard error is fairly high at 2.5%–4.0% (12), making the use of true body composition analysis methods preferable when practical.

Measurement of circumferences should be made with a spring-loaded, inelastic tape measure, which should be positioned in a horizontal plane or perpendicular to the length of the body segment being measured. Tension on the tape should be firm but not severe enough to compress subcutaneous soft tissue, and measurements should be made directly on skin when possible. Duplicate measures should be taken at all sites in a rotational order, and an average of the two should be calculated and recorded if within 5 mm or one another (if not, do a third measurement). For measurement site location descriptions, refer to Box 12.3.

Box 12.3 Standardized Descriptions of Circumference Sites and Procedures

Abdomen: Horizontal measure taken at the height of the iliac crest, usually at the level of the umbilicus

Arm: Horizontal measure taken midway between the acromion and olecranon processes, with arms hanging freely at sides in a neutral position

Calf: Horizontal measure taken at the level of the maximal circumference between the knee and ankle, perpendicular to the long axis

Forearm: Measurement taken at the maximal circumference perpendicular to the long axis; arm hanging down with palm facing anteriorly

Hip: Horizontal measure taken at maximal circumference of the buttocks, above the gluteal fold

Midthigh: Subject should place one foot on a bench so that knee is flexed at 90°; measurement is taken midway between inguinal crease and proximal border of the patella, perpendicular to the long axis.

Waist: Measurement is taken at the narrowest part of the torso, between the umbilicus and xiphoid process.

Procedures

- All measurement should be taken with client standing.
- All measurements should be made with a flexible and inelastic tape measure.
- Place tape on skin (when possible) and excess pressure, causing compression of subcutaneous tissue.
- Take duplicate measures at each site and retest if not within 5 mm.
- Perform measurements in circuit fashion rather than consecutively.

Modified from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 10th ed. Philadelphia (PA): Wolters Kluwer; 2018. 480 p.

Waist Circumference

Some experts suggest that the waist circumference alone may be used as an indicator of health risk (3). For example, the health risk is elevated when the waist circumference is greater than 88 cm for women and 102 cm for men, particularly when combined with above normal BMI scores (as displayed in Table 12.3). Although there is some disagreement as to the optimal location to measure the waist circumference, a commonly accepted location is defined as the narrowest part of the torso, at a level between the umbilicus and the xiphoid process (3).

Hip Circumference

Hip circumference measurement, most often used during the calculation of WHR, is now considered, similar to waist circumference, as an independent predictor of health status. Hip girth has been found to be inversely related to cardiovascular disease, diabetes, and premature death (12). This measurement should be taken at the level of the largest circumference around the buttocks, above the gluteal fold. Refer to Figure 12.6 for a visual description of both waist and hip circumference measurement location.

FIGURE 12.6. Anatomical sites for measurement of waist (narrowest part of the torso) and hip circumference (level of maximal hip circumference).

Waist-to-Hip Ratio

The WHR is a comparison between the circumference of the waist and the circumference of the hip and is an important indicator of body fat distribution. WHR is calculated by dividing the circumference of the waist (cm) by the circumference of the hips (cm). Generally, the higher the ratio, the higher the risk of multiple chronic diseases. Disease risk reaches a degree of *very high* for young adults when WHR values exceed 0.95 for males and 0.86 for females. For older adults, ages 60 to 69 years, these very high risk values increase to 1.03 and 0.90, respectively (12).

- For example, if a male, age 52 years, is measured at a waist circumference of 103 cm and a hip circumference of 99 cm, WHR could be calculated as follows:
  - 103 cm (waist) / 99 cm (hip) = 1.04
  - WHR of 1.04 for a younger male would classify as *very high risk*.

Body Composition

Body composition analysis predicts the amount and relative proportions of FM and FFM in the human body and requires specialized equipment and varying degrees of technician skill to conduct. The result of this analysis is typically the prediction of %BF. As the initial direct method of body composition involved cadaver analysis, indirect and doubly indirect methods of assessing body composition were developed, albeit at the cost of a reduced accuracy of prediction (*e.g.*, a higher standard error of estimate [SEE]). Indirect methods predict body composition based on the measurement of another variable (12). For example, the hydrostatic weighing method predicts %BF based on the measurement of body density (BD). Doubly indirect methods of body composition analysis predict %BF based on a prior indirect measure. An example of a doubly indirect method is skinfold assessment. Skinfold assessment predicts %BF from an indirect measurement of BD, which is derived from a measurement of multiple skinfold thickness measurements. In the following text, several of the most common body composition assessment techniques are reviewed.

Skinfold Assessment

The skinfold technique of body composition analysis is based on the measurement of multiple skinfold thicknesses using a specialized caliper and is based on the theory that there is a predictable relationship between subcutaneous fat stores and total body fatness (5). This is a relatively simple and minimally invasive procedure that can be quite accurate depending on the skill of the technician and the quality of the skinfold caliper (*e.g.*, a Lange or Harpenden caliper) (12). If the technician is not properly trained, or does not adhere to the standardized instructions for skinfold measurement, significant error can be introduced into the assessment. Other factors that may contribute to measurement error include improper caliper calibration, inaccurate anatomical landmark identification, the measurement of extremely obese or extremely lean subjects (3), or the measurement of an individual with significant abdominal obesity (12). However, with proper training and equipment, adherence to defined procedures, and plenty of practice (*i.e.*, 50–100 clients [5]), the standard error associated with skinfold falls into a range of ±3%–4% (good to fairly good). For example, if body composition is determined to be 18%, then the actual range would be 14%–22%.

Use of skinfold measurement can also be very useful without determination of a %BF estimation. The sum of the skinfold measurements can be a useful tool to track changes in body fat distribution that may occur with training. Calculating the sum of skinfolds prior to and after training, or during routine follow-up testing, can provide the client with useful information on how the training program is impacting changes in body composition, particularly FM.

Prior to skinfold measurement, clients should be made aware of the potential discomfort promoted by the skinfold caliper and that measurements need to be made directly on the skin. In the event of the client being uncomfortable with either of these, it may be advisable to consider an alternative form of body composition assessment (if available) and/or offer to have a member of the same sex perform the assessment (12). Client preparation considerations for skinfold assessment include ensuring skin is dry and lotion-free and to avoid measuring skinfold immediately following exercise due to localized fluid shifts potentially increasing skinfold size (5).

Standardized descriptions as well as pictorial descriptions of skinfold sites are provided in Box 12.4 and Figure 12.7.

Box 12.4 Standardized Description of Skinfold Sites

Skinfold Site	
Abdominal	Vertical fold; 2 cm to the right side of the umbilicus
Triceps	Vertical fold; on the posterior midline of the upper arm, halfway between the acromion and olecranon processes, with the arm held freely to the side of the body
Biceps	Vertical fold; on the anterior aspect of the arm over the belly of the biceps muscle, 1 cm above the level used to mark the triceps site
Chest/pectoral	Diagonal fold; one-half the distance between the anterior axillary line and the nipple (men), or one-third of the distance between the anterior axillary line and the nipple (women)
Medial calf	Vertical fold; at the maximum circumference of the calf on the midline of its medial border
Midaxillary	Vertical fold; on the midaxillary line at the level of the xiphoid process of the sternum. An alternate method is a horizontal fold taken at the level of the xiphoid/sternal border on the midaxillary line.
Subscapular	Diagonal fold (45°); 1–2 cm below the inferior angle of the scapula
Suprailiac	Diagonal fold; in line with the natural angle of the iliac crest taken in the anterior axillary line immediately superior to the iliac crest
Thigh	Vertical fold; on the anterior midline of the thigh, midway between the proximal border of the patella and the inguinal crease (hip)

FIGURE 12.7. Anatomical sites for skinfold measurement.

Visit thePoint to watch videos 12.2 and 12.3, which demonstrate skinfold measurement and bioelectrical impedance analysis.

Skinfold Measurement Procedures

The following procedures help standardize skinfold measurement (3,5,12):

1. Take all skinfold measurements on the right side of the body with the subject standing upright while remaining relaxed.
2. Carefully locate (see Box 12.4 and Figure 12.7), measure, and mark the skinfold sites using a grease pencil (if available).
3. Typically, the skinfold caliper is held in the right hand of the technician, and the pinch is performed with the left hand.
4. The pinch is performed with the thumb and index finger; begin with these two fingers roughly 8 cm (3.15 in) apart and held 1 cm (0.39 in) above the site. Larger skinfolds (obese individuals) will require separating your fingers farther than 8 cm.
5. Firmly grasp a double fold of skin with the thumb and index finger, lifting up and away from the body while the subject is relaxed. The direction of each skinfold is described in Box 12.4. Be certain that you have not included muscle in the skinfold but only skin and subcutaneous fat.
6. With the caliper dial facing up (toward you), open the jaws of the caliper and place over the skinfold area perpendicular to the pinched area. The tips of the jaws should be slowly released to minimize discomfort and placed halfway between the crest and base of the fold (1 cm below the fingers).
7. Maintain the pinch while allowing the caliper to settle over 2–3 seconds (to allow for tissue compression). Measure the skinfold to the nearest 0.5 mm (if using the Lange caliper).
8. Once the reading has been made, open jaws of caliper prior to removal from the skin and then release the pinch. It is important to maintain the finger pinch for the duration of the measurement.

9. Measure each skinfold at least twice in a rotational rather than consecutive fashion. If the two measurements differ by more than 2 mm for one or more sites, perform a third measurement at those sites. The measurements for each site are then averaged.
10. For calculation of %BF, measurement averages are typically summed and input into a population-appropriate regression equation. For the purpose of this text, we suggest using the Jackson–Pollock 3-Site Skinfold Formula as discussed in the following text, although additional formulas can be found elsewhere (11). Percentile rankings for %BF for men and women can be found in Table 12.4.

Table 12.4 Fitness Categories for Body Composition (% Body Fat) for Men and Women by Age

		Age, yr (Men)					
%		**20–29**	**30–39**	**40–49**	**50–59**	**60–69**	**70–79**
99	Very lean[a]	4.2	7.3	9.5	11.1	12.0	13.6
95		6.4	10.3	13.0	14.9	16.1	15.5
90	Excellent	7.9	12.5	15.0	17.0	18.1	17.5
85		9.1	13.8	16.4	18.3	19.2	19.0
80		10.5	14.9	17.5	19.4	20.2	20.2
75	Good	11.5	15.9	18.5	20.2	21.0	21.1
70		12.6	16.8	19.3	21.0	21.7	21.6
65		13.8	17.7	20.1	21.7	22.4	22.3
60		14.8	18.4	20.8	22.3	23.0	22.9
55	Fair	15.8	19.2	21.4	23.0	23.6	23.6
50		16.7	20.0	22.1	23.6	24.2	24.1
45		17.5	20.7	22.8	24.2	24.9	24.5
40		18.6	21.6	23.5	24.9	25.6	25.2
35	Poor	19.8	22.4	24.2	25.6	26.4	25.7
30		20.7	23.2	24.9	26.3	27.0	26.3

25		22.1	24.1	25.7	27.1	27.9	27.1
20		23.3	25.1	26.6	28.1	28.8	28.0
15	Very poor	25.1	26.4	27.7	29.2	29.8	29.3
10		26.6	27.8	29.1	30.6	31.2	30.6
5		29.3	30.2	31.2	32.7	33.5	32.9
1		33.7	34.4	35.2	36.4	37.2	37.3
n **=**		1,938	10,457	16,032	9,976	3,097	571
Total ***n*** **= 42,071**							
		Age, yr (Women)					
%		**20–29**	**30–39**	**40–49**	**50–59**	**60–69**	**70–79**
99	Very lean[b]	11.4	11.0	11.7	13.8	13.8	13.7
95		14.1	13.8	15.2	16.9	17.7	16.4
90	Excellent	15.2	15.5	16.8	19.1	20.1	18.8
85		16.1	16.5	18.2	20.8	22.0	21.2
80		16.8	17.5	19.5	22.3	23.2	22.6
75	Good	17.7	18.3	20.5	23.5	24.5	23.7
70		18.6	19.2	21.6	24.7	25.5	24.5
65		19.2	20.1	22.6	25.7	26.6	25.4
60		20.0	21.0	23.6	26.6	27.5	26.3
55	Fair	20.7	22.0	24.6	27.4	28.3	27.1
50		21.8	22.9	25.5	28.3	29.2	27.8
45		22.6	23.7	26.4	29.2	30.1	28.6
40		23.5	24.8	27.4	30.0	30.8	30.0
35	Poor	24.4	25.8	28.3	30.7	31.5	30.9
30		25.7	26.9	29.5	31.7	32.5	31.6
25		26.9	28.1	30.7	32.8	33.3	32.6
20		28.6	29.6	31.9	33.8	34.4	33.6
15	Very poor	30.9	31.4	33.4	34.9	35.4	35.0
10		33.8	33.6	35.0	36.0	36.6	36.1
5		36.6	36.2	37.0	37.4	38.1	37.5

1	38.4	39.0	39.0	39.8	40.3	40.0
n **=**	1,342	4,376	6,392	4,496	1,576	325
Total *n* = 18,507						

Norms are based on Cooper Clinic patients.

[a]Very lean; no less than 3% body fat is recommended for men.

[b]Very lean; no less than 10%–13% body fat is recommended for women.

Adapted with permission from *Physical Fitness Assessments and Norms for Adults and Law Enforcement*. The Cooper Institute, Dallas, Texas. 2013.

Jackson and Pollock Three-Site Skinfold Formula for Percent Body Fat

Jackson and Pollock (17) have developed several skinfold formulas for the prediction of %BF or body composition (often referred to as the Jackson–Pollock formulas). Jackson and Pollock developed two three-site skinfold formulas in 1980 and 1985 as well as a seven-site skinfold formula (3). The 1980 formula provides %BF averages for the skinfold measurement for the chest, abdomen, and thigh for men and triceps, suprailiac, and thigh for women. The measurements from these sites can also be used in the nomogram provided in this text (Fig. 12.8). The sum of the means of the three skinfold site measures, along with the client's age, are plotted on the nomogram. Where the line dissects the "%BF" section of the nomogram represents the client's %BF.

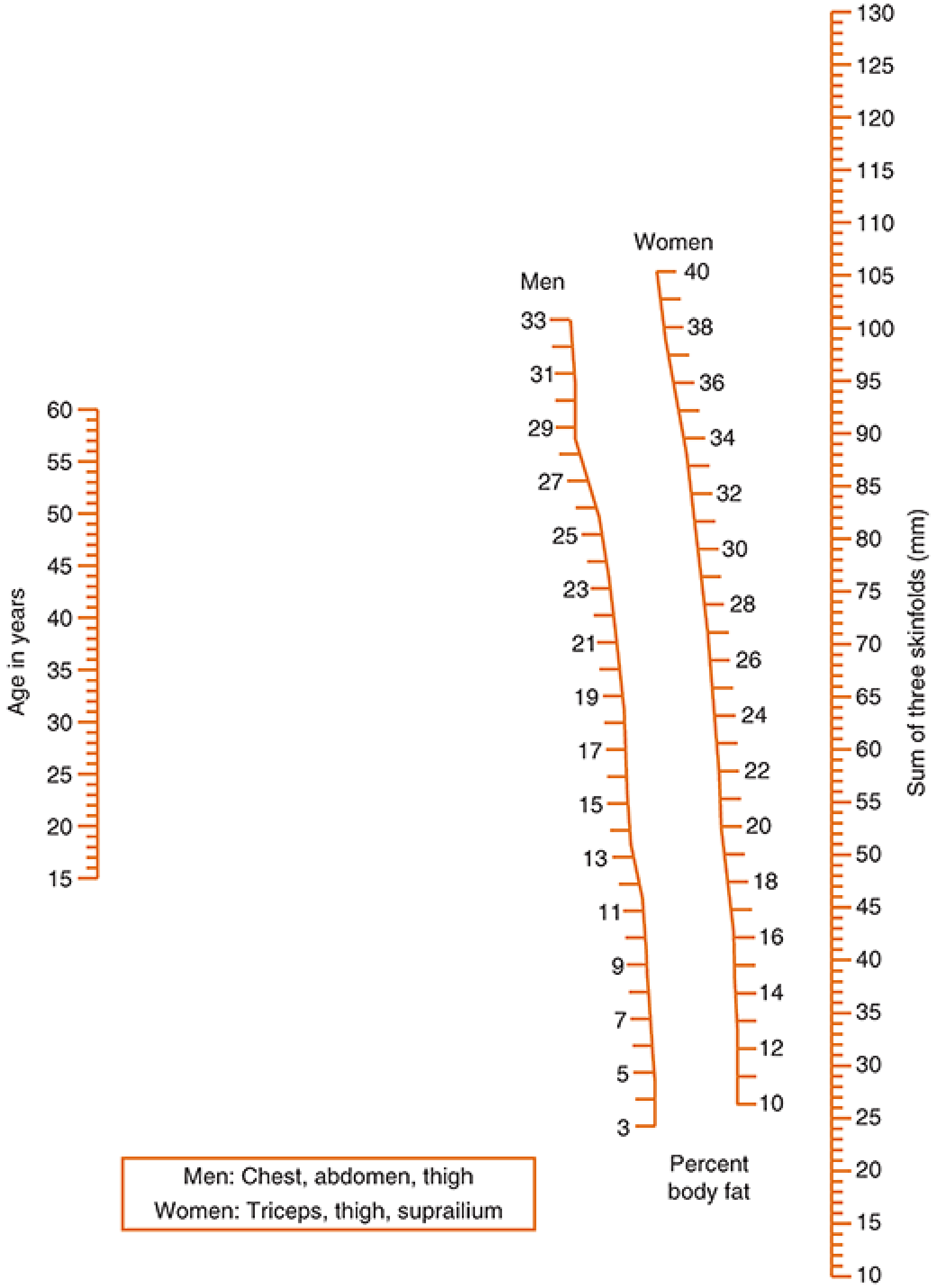


FIGURE 12.8. The Jackson–Pollock nomogram for the estimate of %BF. (Reprinted with permission from Baun WB, Baun MR, Raven PB. A nomogram for the estimate of percent body fat from generalized equations. *Res Q Exerc Sport*. 1981;52[3]:382. Reprinted by permission of the Society of Health and Physical Educators, www.shapeamerica.org)

Bioelectrical Impedance Analysis

BIA is a noninvasive and easy-to-administer method for assessing body composition. The basic premise behind the procedure is that the volume of FFM in the body will be proportional to the electrical conductivity of the body. A BIA device, as shown in Figure 12.9, is used to pass a small electrical current through the body (from ankle to wrist, from hand to hand, or from foot to foot, depending on the device used) and then measure the resistance to that current. Fat is a poor electrical conductor containing little water (14%–22%), whereas lean tissue contains mostly water (more than 90%) and electrolytes and is therefore a good electrical conductor. Thus, fat tissue provides impedance to electrical current.

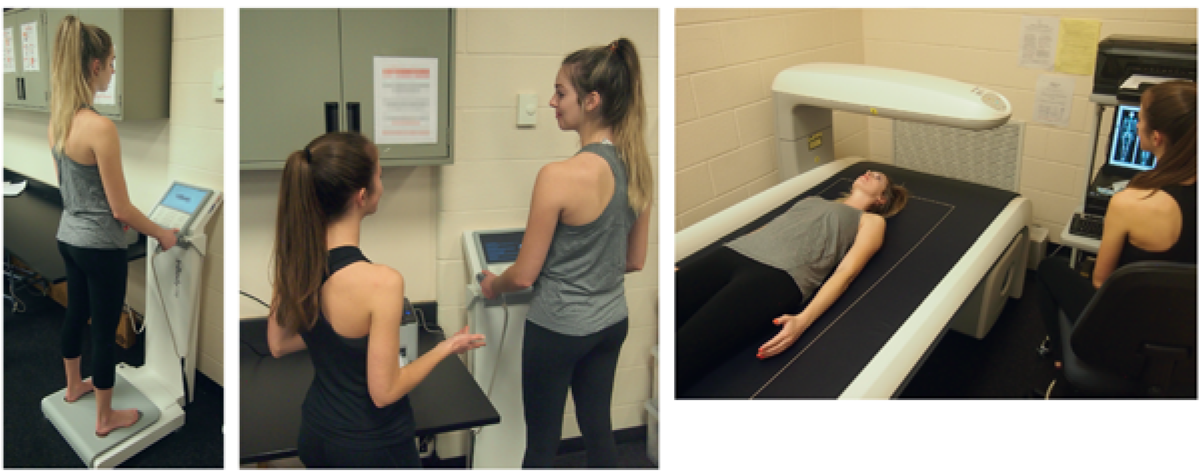


FIGURE 12.9. Other body composition assessment methods of note include BIA and DXA.

As a doubly indirect method of body composition analysis, BIA uses the impedance measurement to predict total body water (TBW), which is then used to predict %BF. Due to the degree of prediction, a substantial standard error exists, but under correct conditions (described in the following text) and with the use of a high quality device, the error falls within the acceptable range of ±3.5%. (Note: Error can vary significantly depending on the type of device used [5].)

In addition to the quality of the device promoting differing levels of SEE, the number of frequencies used during BIA can also influence accuracy. Most commonly used BIA devices operate using a single frequency and can be referred to as single-frequency BIA (SF-BIA) devices. This frequency is able to assess TBW using both intracellular and extracellular compartments but is unable to differentiate between the two — leading to a higher SEE (18). Bioimpedance spectroscopy is a more advanced form of BIA that takes measurements using 256 different frequencies and is also known as multifrequency BIA. This range of measurement variance allows for differentiation between intracellular and extracellular fluid compartments, building a more detailed portrait of body composition and thus promoting a greater level of accuracy compared to SF-BIA devices (18). For more information regarding this topic, see additional source (18).

Clients should be given the following instructions prior to BIA testing for improved accuracy (5):

- Do not eat or drink within 4 hours of the test.
- Do not exercise within 12 hours of the test.
- Urinate (or void) completely within 30 minutes of the test.
- Do not consume alcohol in the previous 48 hours before test.
- Avoid diuretics (including caffeine) prior to assessment unless prescribed by a physician.
- If in a menstrual cycle stage during which water is being retained, postpone test.
- Instructions may vary regarding client body position based on the type of device used, so be sure to consult owner's manual prior to use.

BIA offers an advantage over skinfold measurement in that there is no physical discomfort associated with the procedure. In addition, clients may feel less self-conscious with BIA, as minimal skin exposure is required, relative to that needed for skinfold measurement. However, BIA is highly sensitive to hydration status, offering a potential disadvantage. Indeed, the accuracy of BIA as an assessment method is thought to primarily be affected by hydration status (18).

Other Techniques

Hydrostatic Weighing

Once considered the gold standard for body composition analysis, hydrostatic weighing (also known as hydrodensitometry) is based on the Archimedes principle, which states that when a body is immersed in water, it is buoyed by a counterforce equal to the weight of the water displaced (3). Hydrostatic weighing is an indirect method of body composition analysis as %BF is predicted from a direct measure of BD and is based on the two-component model of body composition analysis. The two components, FFM and FM, react differently in water. FM is less dense than water (0.9007 $g \cdot cm^{-3}$ vs. 1.0 $g \cdot cm^{-3}$) and is therefore buoyant, whereas FFM is more dense than water (assumed to average 1.100 $g \cdot cm^{-3}$ vs. 1.0 $g \cdot cm^{-3}$) and will therefore sink (12). Procedures for hydrostatic weighing are outside of the scope of this text because it is a technique rarely used in a fitness setting. Hydrostatic weighing tanks are typically found in clinical/research laboratory-based settings. Therefore, although quite accurate at a standard error ranging from ≤1% to 3.7% (depending on whether residual volume of the lungs is measured or estimated), limitations such as lack of availability and the high degree of subject cooperation required for accurate measurement make hydrostatic weighing a less viable option for body composition analysis (5).

Ultrasound

The use of ultrasound devices is gaining popularity in both fitness and clinical settings as an accurate, versatile, portable, and moderately priced alternative for body composition analysis. It can be used for the assessment of skinfold thickness as well as the analysis of deeper adipose tissue deposits (5). Ultrasound would classify as a doubly indirect method, similar to the skinfold method because subcutaneous body fat measurements are used to predict BD, which is then used to predict %BF. Advantages of this technique are listed earlier, and disadvantages include reliability/quality of ultrasound equipment, dependence on technician skill, and current lack of standardization with this technique (12).

Dual-Energy X-ray Absorptiometry

DXA technology has traditionally been used medically for the measurement of bone mineral density (BMD) and by researchers to develop a body composition database (12). Although impractical in fitness settings due to high cost of the device and the requirement of specialized training, the commercial use of DXA is on the rise, with this assessment offered as a service in a growing number of clinical and/or medical private practices. DXA is based on the three-component model of body composition, composed of bone mineral stores, lean body mass, bone mineral density, and fat mass. It measures the attenuation of x-rays as they pass through the body to quantify the aforementioned components, each of which allows for a differing level of attenuation, or reduction in the strength, of the x-rays (5). Disadvantages to this method are a lack of commercial availability and the potential high cost of one assessment (likely > \$100). On the other hand, this technique is relatively quick, requires minimal subject effort and/or cooperation, and presents minimal discomfort, if any. Additionally, the ability to also provide BMD increases the value of this assessment, and the accuracy with which %BF can be predicted (±<2%) makes DXA now the gold standard for body composition analysis. A typical DXA device is shown in Figure 12.9.

Cardiorespiratory Fitness Assessment

CRF can be described as the ability to perform large muscle, dynamic, moderate- to high-intensity exercise for prolonged periods of time and reflects the functional capabilities of the cardiovascular, respiratory, and musculoskeletal systems. The demand placed on these systems during this type of exercise can be succinctly summarized by the Fick equation (12), which states,

$$\dot{V}O_{2max} = \dot{Q}_{max} \times (a{-}\bar{v}O_2 \text{ diff}_{max})$$

In other words, $\dot{V}O_{2max}$, or the maximal volume of oxygen consumed per unit time, is the product of the level of maximal cardiac output per minute ($\dot{Q}_{max}$) and the maximal arterial-venous oxygen difference (a-$\bar{v}O_2$ $diff_{max}$). Cardiac output, often described as the central component, reflects the contribution of the cardiorespiratory system, whereas the arterial-venous oxygen difference (the peripheral component) represents the ability of the musculoskeletal system to extract and use oxygen during energy production.

CRF is commonly expressed as $\dot{V}O_{2max}$, which in relative terms is expressed as milliliters of oxygen consumed per kilogram of body weight per minute ($mL \cdot kg^{-1} \cdot min^{-1}$). Absolute $\dot{V}O_{2max}$ is expressed in $L \cdot min^{-1}$, but when comparing CRF to norms or against other individuals, the relative expression of $\dot{V}O_{2max}$ in $mL \cdot kg^{-1} \cdot min^{-1}$ is used.

CRF is a synonym for several other commonly used terms (14), some of which include the following:

- Maximal aerobic capacity
- Functional capacity
- Physical work capacity
- Maximal oxygen uptake ($\dot{V}O_{2max}$) or maximal oxygen consumption or maximal oxygen intake
- Cardiovascular endurance, fitness, or capacity
- Cardiopulmonary endurance, fitness, or capacity

CRF can be measured or predicted by many methods. This chapter discusses the prediction of CRF using both field tests and laboratory tests. The Personal Trainer needs to decide which test is the most appropriate to determine CRF for a client. The measurement of CRF can be used in the following:

- Exercise prescription and programming
- Progress in, and motivation of, an individual in an exercise program (providing both feedback and motivation to keep a client interested in exercise)

- Although outside of the scope of a Personal Trainer, measurement of CRF may be useful in the prediction of medical conditions such as coronary artery disease and/or other health problems.

The true measurement of CRF, commonly known as maximal aerobic testing, involves maximal exertion during a graded exercise test with simultaneous collection of expired gases using open-circuit spirometry — the analysis of which is used to measure $\dot{V}O_{2max}$. Maximal aerobic testing is not always applicable or desirable in many settings (*e.g.*, corporate fitness or wellness programs) or with many populations (*e.g.*, deconditioned populations, clinical populations, and/or large groups of individuals), and the equipment used is quite expensive and therefore uncommon in fitness centers. Indeed, maximal aerobic testing is likely beyond the scope of practice for many Personal Trainers (14) and is therefore not covered any further in this text.

> CRF can be described as the ability to perform large muscle, dynamic, moderate- to high-intensity exercise for prolonged periods of time and reflects the functional capabilities of the cardiovascular, respiratory, and musculoskeletal systems during various types of exercise demands.

Submaximal aerobic testing protocols provide a suitable alternative and predict aerobic capacity typically based off of HR responses to one or multiple submaximal exercise stages (12). These typically require only basic equipment, making them more practical in fitness and wellness settings. In an effort to avoid maximal levels of exertion, many CRF testing protocols call for termination of the test if the client's HR exceeds 70% of the heart rate reserve (HRR) or 85% of age-predicted HR_{max} (12).

Accurate estimation of $\dot{V}O_{2max}$ using submaximal CRF protocols is dependent on the following assumptions, and every effort should be made to ensure these have been satisfied (12):

- A steady-state HR is obtained during each exercise stage.

- A linear relationship exists between HR and work rate.
- The difference between actual and predicted HR_{max} is minimal.
- Mechanical efficiency is the same for all individuals.
- The client is not taking any HR-altering medications (*e.g.*, β-blockers).
- HR response is not altered by high quantities of caffeine, illness, or high ambient temperatures.

As it is likely impossible to satisfy any portion or all of these assumptions, there is a strong possibility of prediction error with submaximal CRF testing (12), with the specific degree determined by the particular test chosen. Communication of pretest instructions can assist in minimizing this possible standard error.

Pretest Considerations

Standardization of pretesting conditions is an effective way to increase accuracy of prediction and/or measurement as well as increase client safety and comfort. Instructions should be relayed to clients prior to the day of testing, and a list of general instructions is as follows:

- Abstain from prior eating (4 h).
- Abstain from prior strenuous exercise (>24 h).
- Abstain from prior caffeine ingestion (>12–24 h).
- Abstain from prior nicotine use (>3 h).
- Abstain from prior alcohol use (>24 h).
- Medication considerations (If the client's medications affect resting or exercise HR, it will invalidate the test.)

Submaximal Cardiorespiratory Fitness Test Selection

There are several factors to consider when selecting an appropriate submaximal CRF test for a client or group of clients. CRF test options are typically based on a single mode of locomotion — walking/running, cycling, or stepping. The client should be consulted on the most familiar mode of locomotion and that mode should be chosen for the CRF test (3). For example, if a client participates in recreational cycling, then a cycling test would be an appropriate choice. On the other hand, if a client has not ridden a bike in 40 years, then choosing a walking-based protocol would be more appropriate. Additional considerations when selecting a submaximal CRF testing protocol include client's age and health status, equipment available, location of testing, need for data accuracy, and whether or not testing an individual or a group of individuals. When testing is set to occur "off-site" and/or with a group of individuals, it may be necessary to perform a field test.

Field Tests for Prediction of Cardiorespiratory Fitness

A field test generally requires the client to perform a task in a nonlaboratory or field setting, such as running 1.5 miles or walking 1 mile. Although considered submaximal, certain field tests may be inappropriate for safety reasons, and these tests are generally not used for clinical populations. For example, a sedentary individual at moderate to high risk for cardiovascular or musculoskeletal complications should not perform a running-based field test. Conditions that are more controlled, such as those that would exist within a laboratory setting, would be more appropriate for at-risk populations. Field tests, then, are possibly most appropriate for apparently healthy and active populations. Benefits of CRF field testing include usefulness with large groups, relative ease of administration, lack of expense and specialized equipment, as well as being less time consuming than lab-based CRF testing (5).

There are two common field test protocols that use a walk or run performance to predict CRF. These walk or run tests tend to be more accurate (*i.e.*, less error in prediction) than the step tests discussed next. The performance tests can be classified into two groups: walk/run tests or pure walk tests. In the walk/run test, the client can walk, run, or use a combination of both to complete the test. In the pure walking test, clients are strictly limited to walking (always having one foot on the ground at any given time) the entire test. Another classification for these tests is whether the test is performed over a set distance (*e.g.*, 1 mile or 1.6 km) or over a set time period (*e.g.*, 12 min). The first test discussed uses a 1.5-mile (2.4-km) distance and requires the client to complete the distance in the shortest time possible, either by running the whole distance, if possible, or by combining periods of running and walking to offset the fatigue of continuous running in a less fit individual. The second test uses a set 1-mile course and requires the subject to walk the entire distance.

The 1.5-Mile Test Procedures

1. This test is contraindicated for unconditioned beginners, individuals with symptoms of heart disease, and those with known heart disease or risk factors for heart disease. A client should be able to jog for 15 minutes continuously to complete this test and obtain a reasonable prediction of his or her aerobic capacity.
2. Ensure that the area for performing the test measures 1.5 miles in distance. A standard .25-mile track would be ideal (6 laps in lane 1 = 1.5 miles). For a metric 400-m track, this would be 6 laps (1.49 miles) plus approximately 46 ft to equal 1.5 miles.
3. Inform the client of the purpose of the test and the need to pace over the 1.5-mile distance but to cover the distance in the shortest time possible. Effective pacing and client motivation are key variables in the outcome of the test.
4. Instruct the client to start the test while starting a stopwatch. If possible, give the client feedback on time throughout the assessment to help with pacing.
5. An HR monitor may be useful to ensure the client is performing the test at a steady pace/steady HR.
6. Record the total time to complete the test and use the formula below to predict CRF as measured by $\dot{V}O_{2max}$ and recorded in $mL \cdot kg^{-1} \cdot min^{-1}$:

   - For men and women: $\dot{V}O_{2max}$ $(mL \cdot kg^{-1} \cdot min^{-1}) = 3.5 + 483 / time$, where time = time to complete 1.5 miles in nearest hundredth of a minute.

- For example, if the time to complete 1.5 miles was 14:20 (14 min and 20 s), then time used in the formula would be 14.33 minutes (20 / 60 = 0.33).
- $\dot{V}O_{2max}$ (mL · kg^{-1} · min^{-1}) = 3.5 + 483 / 14.33 = 37.2 mL · kg^{-1} · min^{-1}

Rockport 1-Mile Walk Test Procedures

This test may be useful for those who are unable to run because of a low fitness level and/or injury. The client should be able to walk briskly (and should get the exercise HR above 120 bpm) for 1 mile to complete this test.

The 1-mile walk test requires the client to walk as fast as possible around a measured 1-mile course. The client must not break into a run — walking can be defined as having one foot in contact with the ground at all times, whereas running involves an airborne phase. The client must also be taught to accurately measure the pulse.

Upon completion of the 1-mile walk, time to complete should be recorded and the client should count the recovery HR (or pulse) for 10 seconds and multiply by 6 to determine a 1-minute recovery HR (bpm) (19). In another version of the test, HR is measured in the final minute of the 1-mile walk (during the last quarter mile). The use of an HR monitor may give the client more accurate results than manual palpation of HR.

The formula to determine $\dot{V}O_{2max}$ (mL · kg^{-1} · min^{-1}) is sex specific (the constant 6.315 is added to the formula for men only). This formula was derived on apparently healthy individuals ranging in age from 30 to 69 years (20).

$$\dot{V}O_{2max}\ (\text{mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}) = 132.853 - (0.1692 \cdot \text{WT}) - (0.3877 \cdot \text{AGE}) + (6.315, \text{ for men only}) - (3.2649 \cdot \text{TIME}) - (0.1565 \cdot \text{HR})$$

where WT = weight in kilograms, AGE = age in years, TIME = time for 1 mile in nearest hundredth of a minute (*e.g.*, 14:42 = 14.7 [42 / 60 = 0.7]), and HR = recovery HR in bpm.

For example, a male, 30 years of age, with a weight of 180 lb (81 kg) completed the 1-mile run in 14:42 minutes and had a recovery HR of 140 bpm. Therefore, his estimated $\dot{V}O_{2max}$ would be as follows:

$$\dot{V}O_{2max}\ (mL \cdot kg^{-1} \cdot min^{-1}) = 132.853 - (0.1692 \times 81) - (0.3877 \times 30) + (6.315) - (3.2649 \times 14.7) - (0.1565 \times 140) = 43.9\ mL \cdot kg^{-1} \cdot min^{-1}$$

Step Tests

Although commonly performed in laboratory or fitness settings, step tests can be defined as field tests due to the relative lack of specialized equipment required, hence their ability to be performed anywhere, and the ability to test a group of individuals simultaneously (equipment permitting). Step tests have been around for more than 50 years, and there are quite a few of them. Equipment required for most step tests include a watch, a metronome, and one or more standardized steps or benches; and most use postexercise and recovery HR to assess CRF (5). Some tests provide an estimate of $\dot{V}O_{2max}$ ($mL \cdot kg^{-1} \cdot min^{-1}$), such as the Queens College Step Test, whereas others provide only a CRF ranking rather than an estimate. The major advantage of step tests is the aforementioned ability to test large groups of individuals simultaneously. Disadvantages include potential safety concerns for individuals who may have balance problems or difficulty with stepping due to existing musculoskeletal issues or excess body weight and that some do not provide estimates of $\dot{V}O_{2max}$ ($mL \cdot kg^{-1} \cdot min^{-1}$).

General procedures for step tests involve the client(s) stepping on a step or bench at a specified height at a specified pace set by a metronome. Once the specified time period for stepping has expired, recovery HR is determined and used to either rank CRF or estimate $\dot{V}O_{2max}$ ($mL \cdot kg^{-1} \cdot min^{-1}$). As a specific example of a step test, the Queens College Step Test is described in the following text:

1. The Queens College Step Test requires that the individual step up and down on a standardized step height of 16.25 in (41.28 cm) for 3 minutes.

Many gym bleachers have a riser height of 16.25 in.

2. Males step at a rate (cadence) of 24 steps per minute, whereas females step at a rate of 22 per minute for a total of 3 minutes of exercise. This cadence should be closely monitored and set with the use of an electronic metronome. A 24-step-per-minute cadence means that the complete cycle of step-up with one leg, step-up with the other, step-down with the first leg, and finally step-down with the last leg is performed 24 times in a minute (up one leg — up the other leg — down the first leg — down the second leg). Set the metronome at a cadence of four times the step rate, in this case 96 bpm for men, to coordinate each leg's movement with a beat of the metronome. The women's step rate would be 88 bpm. Thus, although it may be possible to test more than one client at a time, depending on equipment, it is problematic to test men and women together.
3. After 3 minutes of stepping are completed, the client stops and has his or her pulse taken (preferably at the radial site) while standing and within the first 5 seconds. A 15-second pulse count is then taken. Multiply this pulse count by 4 to determine HR in bpm. Thus, the recovery HR should occur between 5 and 20 seconds of immediate recovery from the end of the step test.
4. The client's $\dot{V}O_{2max}$ ($mL \cdot kg^{-1} \cdot min^{-1}$) is determined from the recovery HR using the sex-specific formulas as given in Table 12.5.

Table 12.5 Calculation of Maximal Oxygen Consumption as Determined from the Recovery Heart Rate

For Men	For Women
$\dot{V}O_{2max}$ ($mL \cdot kg^{-1} \cdot min^{-1}$) = 111.33 − (0.42 × HR)	$\dot{V}O_{2max}$ ($mL \cdot kg^{-1} \cdot min^{-1}$) = 65.81 − (0.1847 × HR)

HR, recovery heart rate (bpm).

Visit thePoint to watch video 12.4, which demonstrates the Queens College Step Test.

Submaximal Treadmill Cardiorespiratory Fitness Tests

Treadmill protocols have been developed that use both single and multiple stages and rely on the assumption that HR and workload have a linear relationship (5). HR, therefore, is a key variable to monitor during one of these tests, using either palpation, an HR monitor, or an ECG. Other variables monitored during treadmill CRF tests may include rating of perceived exertion (RPE) and BP.

In certain settings such as fitness facilities and wellness centers, the use of a treadmill to perform a submaximal CRF test with an individual client is an appropriate choice, particularly if the client is unaccustomed to cycling. Indeed, a major advantage of a walking- or jogging-based test is that these are typically familiar modes of exercise for clients, and familiarity can enhance test accuracy. A potential disadvantage is an increased risk of falling, so if a client presents with instability and/or balance issues, then a cycle-based test may be a more appropriate choice. Presented in the following text are two submaximal treadmill tests — one walking and one jogging. As previously mentioned, consider the current health status of the client when making a specific test selection. In addition to factors such as low fitness level and existing lower extremity musculoskeletal injury as contraindications for a jogging-based test, lack of experience with jogging would also make a walking-based test a more prudent choice.

Single-Stage Treadmill Walking Protocol

The single-stage treadmill walking protocol developed by Ebbeling et al. (21) is an effective way to predict CRF for apparently healthy/low-risk adults between the ages of 20 and 59 years old (12) and has produced high test–retest reliability and validity with a sample of middle-aged females (5).

HR response is monitored during the single stage and used in an equation to estimate $\dot{V}O_{2max}$ ($mL \cdot kg^{-1} \cdot min^{-1}$). Perform the following steps using the Ebbeling et al.'s (21) Single Stage Treadmill protocol to estimate a client's CRF level:

1. Determine client's age-predicted HR_{max}, 85% of age-predicted HR_{max}, and 50%–70% age-predicted HR_{max} range.
2. Client will warm up at a speed between 2.0 and 4.5 mph for 4 minutes, at a 0% incline, with the goal of elevating the HR into the previously calculated 50%–70% age-predicted HR_{max} range.
3. At the 3-minute-and-30-second mark, determine client HR using either palpation or an HR monitor. If the subject's HR has not elevated to within the 50%–70% age-predicted HR_{max} range, continue the warm-up for an additional minute at an appropriately adjusted speed.
4. Upon confirmation that the HR has elevated into the desired range, begin the test by increasing the treadmill incline to 5% and continue at the same speed for another 4 minutes.
5. Check HR and RPE at the end of each minute. If the subject reaches 85% of age-predicted HR_{max}, terminate the test.
6. At 3 minutes 30 seconds, record steady state HR. (Note: This HR will be used in the equation in the following text.)
7. Allow client to cool-down appropriately by walking for 1–3 minutes at 2.5 mph and 0% grade.
8. Plug the speed, age, gender, and HR recorded in step 6 earlier into the following equation to predict $\dot{V}O_{2max}$:

$$\dot{V}O_{2max}\ (mL \cdot kg^{-1} \cdot min^{-1}) = 15.1 + (21.8 \times \text{speed in mph}) - (0.327 \times HR) - (0.263 \times \text{speed} \times \text{age}) + (0.00504 \times HR \times \text{age}) + (5.48 \times \text{sex});\ \text{females} = 0,\ \text{males} = 1$$

Single-Stage Treadmill Jogging Protocol

A single-stage jogging protocol, developed by George et al. (22), can be used to estimate CRF for younger individuals (18–28 yr) who are experienced with jogging/running. Perform the following steps to estimate a client's CRF level:

1. Instruct client to select a comfortable jogging pace between 4.3 and 7.5 mph (with maximum running speeds capped at 6.5 mph for females and 7.5 mph for males).
2. Client will then run at chosen speed consistently for 3 minutes.
3. If HR exceeds 180 bpm, terminate the test.
4. Use the HR measurement obtained at the end of the 3-minute stage in the following equation:

$$\dot{V}O_{2max}\ (mL \cdot kg^{-1} \cdot min^{-1}) = 54.07 \cdot (0.1938 \times \text{weight in kg}) + (4.47 \times \text{speed in mph}) \cdot (0.1453 \times HR) + 7.062\ (\text{sex});\ \text{females} = 0,\ \text{males} = 1$$

Submaximal Cycling Cardiorespiratory Fitness Tests

Multiple submaximal cycling protocols have been developed and validated as a non–weight-bearing option for predicting CRF, and these rely on the assumption that HR and $\dot{V}O_2$ have a linear relationship with work rate (5). Advantages of cycling as a testing modality include the aforementioned fact that it is non–weight bearing and therefore may be appropriate for obese individuals or individuals with musculoskeletal issues aggravated by weight-bearing activity as well as individuals with balance and/or stability issues. Additional advantages include the fact that work rates can be easily adjusted in small increments and HR and BP can be more easily obtained while cycling. The major disadvantage of cycling as a testing modality is that it may be an unfamiliar mode of exercise for a given client, resulting in local muscular fatigue in the lower extremities and an underestimation of $\dot{V}O_{2max}$ (3).

When using an upright cycle ergometer for CRF testing, ensure that the cycle seat height is adjusted appropriately based on the client's height and leg length. Once the client is seated, the knee of the extended leg should be slightly flexed at approximately 5°–10°. Instruct the client to pedal lightly to ensure comfort while observing if there is any hip rocking present (there should be minimal to none). Readjust seat height if needed and note seat height for any future testing. Also, ensure that the client remains in an upright-seated posture with hands on the handlebars for the duration of a cycling test (5).

Commonly used sIn other wordsubmaximal cycling protocols are presented in the following text. (Note: Although the protocols designed in the following text were designed for use with mechanically braked cycle ergometers, such as the Monark cycle ergometer, these protocols can be performed on electronically braked cycle ergometers as well. It may be necessary, however, to convert workload in Watts to kg or kg · m · min^{-1}, or vice versa, in order to complete CRF prediction [1 W = 6.12 kg · m · min^{-1}].)

Åstrand–Rhyming Submaximal Cycling Protocol

Per Olaf Åstrand (a famous exercise physiologist from Sweden) along with his wife, Irma Rhyming, developed a simple protocol in the 1950s to be used for the prediction of CRF from laboratory submaximal cycle exercise results known as the Åstrand–Rhyming protocol. This protocol uses a single-stage approach for the prediction of CRF, which may be a simpler and more preferable protocol for use by a Personal Trainer. In summary, the client performs a 6-minute submaximal exercise bout on the cycle ergometer. Thus, this is typically a single-stage test. The client's HR response to this bout will determine his or her maximal aerobic capacity or CRF by plotting his or her HR response on a test-specific nomogram (see Fig. 12.8). More specifically, the test is performed as follows (5,12):

1. Instruct the client to start pedaling at a cadence of 50 rpm with no resistance.
2. Select and use a work rate based on the client's sex and fitness level using the following:
   Men, unconditioned: 300 or 600 kg · m · min^{-1} (50 or 100 W)

Men, conditioned: 600 or 900 kg · m · min^{-1} (100 or 140 W)
Women, unconditioned: 300 or 450 kg · m · min^{-1} (50 or 75 W)
Women, conditioned: 450 or 600 kg · m · min^{-1} (75 or 100 W)

3. Start the timer, reminding the client to keep the cadence at 50 rpm for the duration of the test to promote accuracy.
4. Measure and record HR at the end of each minute (ideally, HR should be within range of 125 and 170 bpm. If the difference between the minute 5 and minute 6 HRs exceeds 5–6 bpm, extend the test until a steady state is achieved (<5 bpm difference). Take the average of the last two steady state HRs and use for prediction.
5. If the HR is <125 bpm at the end of the test, increase the work rate by 300 kg · m · min^{-1} (50 W) and continue test for an additional 6 minutes, repeating procedure earlier.
6. Use the average of the acceptable minutes 5 and 6 HRs in the nomogram found in Figure 12.10, being sure to apply the age correction factor if applicable to the determined nomogram value.
7. Standard error associated with this protocol is ±10% for well-trained and ±15% for untrained individuals.

Age	Correction Factor
15	1.10
25	1.00
35	0.87
40	0.83
45	0.78
50	0.75
55	0.71
60	0.68
65	0.65

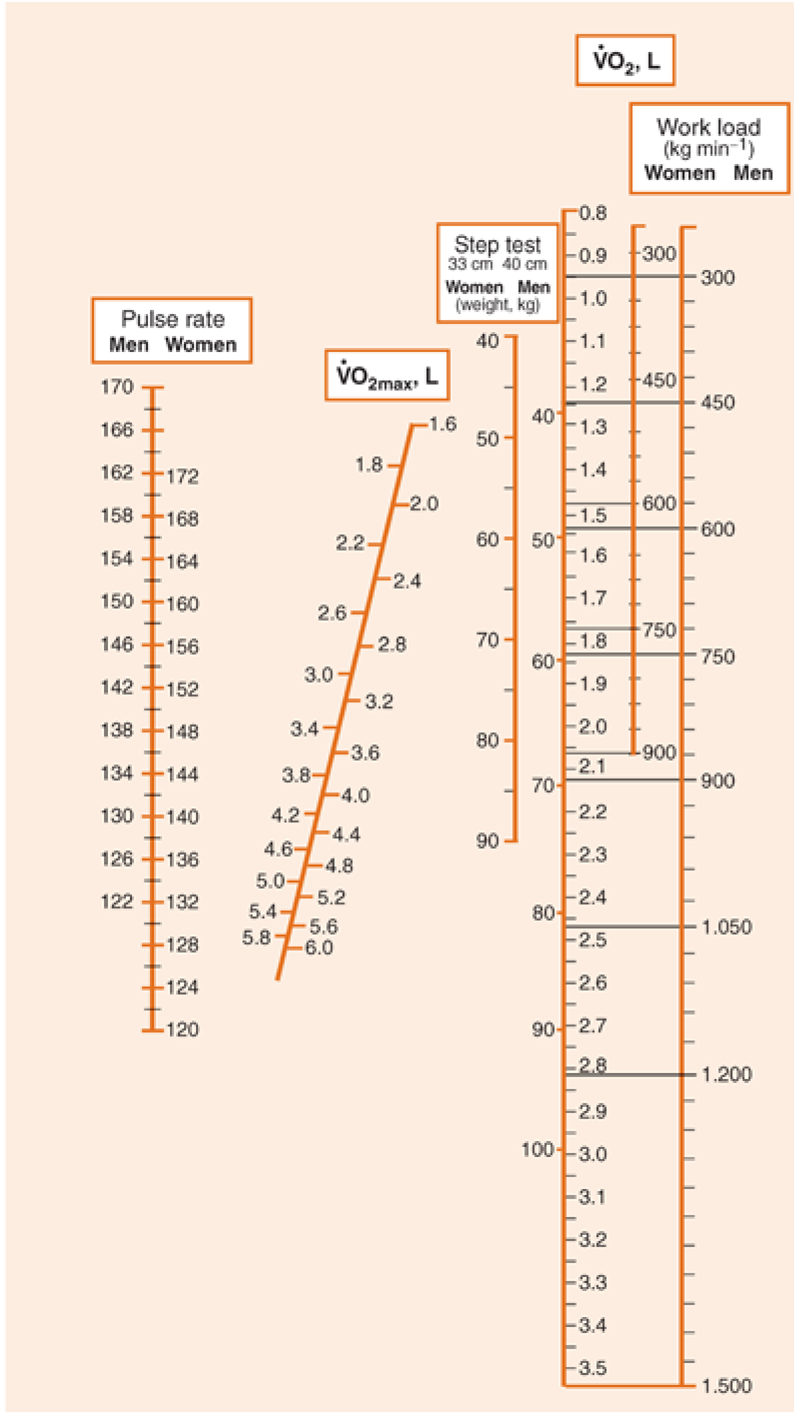


FIGURE 12.10. Åstrand–Rhyming submaximal cycle ergometer test nomogram and age-correction factors. (Used with permission from Åstrand PO, Rhyming I. A nomogram for calculation of aerobic capacity [physical fitness] from pulse rate during sub-maximal work. *J Appl Physiol*. 1954;7:218–21.)

Visit thePoint to watch video 12.5, which demonstrates the Åstrand–Rhyming protocol.

Additional Submaximal Cycling Protocols

The Fox Single-Stage Submaximal Cycling Protocol is a simple modification of the Fox Maximal Test Protocol (23) and requires the client to perform a single 5-minute cycling stage at a workload of 900 kg · m · min^{-1} or 150 W. Pedaling rate should be kept consistent at 60 rpm. Measure HR at the end of the fifth minute and input into the following equation in order to predict CRF:

$$\dot{V}O_{2max}\ (mL \cdot min^{-1}) = 6{,}300 - 19.26\ (HR)$$

Following this calculation, divide the value by the client's body mass in kilogram in order to determine $\dot{V}O_{2max}$ (mL · kg^{-1} · min^{-1}). For example, a male, 43 years of age, with a weight of 155 lb (70.5 kg) was measured at an HR of 125 following completion of the 5-minute cycling bout.

$$\dot{V}O_{2max}\ (mL \cdot min^{-1}) = 6{,}300 - 19.26\ (125) = 3{,}892.5\ mL \cdot min^{-1}$$

$$\dot{V}O_{2max}\ (mL \cdot kg^{-1} \cdot min^{-1}) = 3{,}892.5\ mL \cdot min^{-1} \div 70.5\ kg = 55.21\ mL \cdot kg^{-1} \cdot min^{-1}$$

The Fox Submaximal Cycling Protocol is associated with an SEE ±246 mL · min^{-1} and a prediction error of ±7.8% (5).

A second and more modern alternative is the submaximal cycling protocol developed by Swain et al. (24). The test relies on the relationship between HRR and $\dot{V}O_2$ reserve ($\dot{V}O_2R$) to predict $\dot{V}O_{2max}$ (mL · kg^{-1} · min^{-1}) and has been validated and found to be more accurate than other submaximal cycling protocols (24). Due to the length and relative complexity of this protocol, it will not be described here but can be referenced in other texts (5,24).

Norms for Cardiorespiratory Fitness ($\dot{V}O_{2max}$)

Table 12.6 shows the norms for $\dot{V}O_{2max}$ for men and women. These normative standards can be used to compare an individual's CRF level to a group of his or her peers (in terms of age and gender), provide a percentile rank and a descriptive adjective (*e.g.*, "excellent" or "fair") (12), and were developed from a collaborative testing of over 7,000 males and females between the ages of 20 and 79 years who were free of cardiovascular disease (25).

Table 12.6 Percentile Values for Maximal Aerobic Power ($mL \cdot kg^{-1} \cdot min^{-1}$) $\dot{V}O_{2max}$ ($mL\ O_2 \cdot kg^{-1} \cdot min^{-1}$)

		MEN				
		Age Group (yr)				
Percentile		**20–29 (*n* = 513)**	**30–39 (*n* = 963)**	**40–49 (*n* = 1,327)**	**50–59 (*n* = 1,078)**	**60–69 (*n* = 593)**
95	Superior	66.3	59.8	55.6	50.7	43.0
90	Excellent	61.8	56.5	52.1	45.6	40.3
85		59.3	54.2	49.3	43.2	38.2
80		57.1	51.6	46.7	41.2	36.1
75	Good	55.2	49.2	45.0	39.7	34.5
70		53.7	48.0	43.9	38.2	32.9
65		52.1	46.6	42.1	36.3	31.6
60		50.2	45.2	40.3	35.1	30.5
55	Fair	49.0	43.8	38.9	33.8	29.1
50		48.0	42.4	37.8	32.6	28.2
45		46.5	41.3	36.7	31.6	27.2
40		44.9	39.6	35.7	30.7	26.6

35	Poor	43.5	38.5	34.6	29.5	25.7
30		41.9	37.4	33.3	28.4	24.6
25		40.1	35.9	31.9	27.1	23.7
20		38.1	34.1	30.5	26.1	22.4
15	Very poor	35.4	32.7	29.0	24.4	21.2
10		32.1	30.2	26.8	22.8	19.8
5		29.0	27.2	24.2	20.9	17.4
			WOMEN			
		Age Group (yr)				
Percentile		**20–29 (*n* = 410)**	**30–39 (*n* = 608)**	**40–49 (*n* = 843)**	**50–59 (*n* = 805)**	**60–69 (*n* = 408)**
95	Superior	56.0	45.8	41.7	35.9	29.4
90	Excellent	51.3	41.4	38.4	32.0	27.0
85		48.3	39.3	36.0	30.2	25.6
80		46.5	37.5	34.0	28.6	24.6
75	Good	44.7	36.1	32.4	27.6	23.8
70		43.2	34.6	31.1	26.8	23.1
65		41.6	33.5	30.0	26.0	22.0
60		40.6	32.2	28.7	25.2	21.2
55	Fair	38.9	31.2	27.7	24.4	20.5
50		37.6	30.2	26.7	23.4	20.0
45		35.9	29.3	25.9	22.7	19.6
40		34.6	28.2	24.9	21.8	18.9
35	Poor	33.6	27.4	24.1	21.2	18.4
30		32.0	26.4	23.3	20.6	17.9
25		30.5	25.3	22.1	19.9	17.2
20		28.6	24.1	21.3	19.1	16.5
15	Very poor	26.2	22.5	20.0	18.3	15.6
10		23.9	20.9	18.8	17.3	14.6
5		21.7	19.0	17.0	16.0	13.4

Percentiles from cardiopulmonary exercise testing on a treadmill with measured $\dot{V}O_{2max}$ (mL $O_2 \cdot kg^{-1} \cdot min^{-1}$).

Data obtained from the Fitness Registry and the Importance of Exercise National Database (FRIEND) for men and women who were considered free from known cardiovascular disease.

Adapted with permission from Kaminsky LA, Imboden MT, Arena R, Myers J. Reference standards for cardiorespiratory fitness measured with cardiopulmonary exercise testing using cycle ergometry: data from the Fitness Registry and the Importance of Exercise National Database (FRIEND) Registry. *Mayo Clin Proc*. 2017;92(2):228–33.

Muscular Fitness Assessment

Muscular fitness testing is an important part of a client fitness assessment battery due to the importance of muscular fitness for performing ADL and leisure activities comfortably; the maintenance of an independent lifestyle as one ages (5); and its relative importance to weight management and reducing the risk of osteoporosis, sarcopenia, and glucose intolerance (3). Muscular fitness testing can also provide valuable information that can be used when designing an appropriate resistance training program for a client and can be used as a way to track progress over time (3).

Muscular fitness is typically divided into three separate categories — muscular power, muscular strength, and muscular endurance. Muscular power is most commonly assessed in athletic populations and less commonly with general/clinical populations. Vertical jump is typically used as an assessment of muscular power and can be easily included in a fitness assessment battery with the appropriate populations. For a description of vertical jump testing, additional sources should be consulted (1,5).

Muscular strength and muscular endurance, on the other hand, are regularly tested in fitness and wellness settings. Muscular strength is defined as the maximal amount of force that can be generated in a single contraction (5) and is typically tested using the 1-RM protocol. Muscular endurance is defined as the ability to exert submaximal levels of force for an extended duration or for multiple repetitions and is typically assessed using callisthenic-type exercises (3).

Prior to describing the protocols, it is important to discuss a few key points regarding the testing of muscular strength and muscular endurance. Just as there is no single test that can evaluate both muscular strength and muscular endurance simultaneously, there is no single muscular fitness test that can evaluate either total body strength or total body endurance. Muscular fitness testing is very specific to muscle groups and joints, ranges of motion, and velocities involved in a given movement as well as equipment used for that movement (3). Thus, it is common to include two or more muscular fitness tests when constructing a comprehensive fitness testing battery.

Standardization of muscular fitness testing can be difficult but is important for both safety and accuracy purposes to use the practices described in Box 12.5.

Box 12.5 Muscular Fitness Testing Standardization Procedures

- Familiarization and/or practice sessions are important to include prior to actual testing, particularly with novices, to minimize the learning effect.
- A general warm-up consisting of 5–10 min of light aerobic exercise, dynamic stretching, and practice reps completed with lighter loads should be completed prior to testing.
- Protocols should be strictly adhered to, specifically desired ranges of motion and movement velocities relevant to individual tests.
- One or multiple spotters should be used when necessary.
- Adherence to these practices can increase test score reliability and allow for more accurate tracking of physiological adaptation.

Muscular Strength Testing

The 1-RM indicates the maximum amount of weight that can be lifted for one complete repetition and is typically derived by trial and error using the procedure outlined in Box 12.6 (5). Although the 1-RM procedure can be performed with a variety of movements, the use of bench press exercise for upper body strength assessment and leg press exercise for lower body strength assessment are typically recommended (3). Because the 1-RM is a test involving maximal exertion, it may be inappropriate for certain populations, such as those with significant and relevant orthopedic limitation; youth and elderly populations; and those at a high risk or with diagnosed cardiovascular, pulmonary, or metabolic disease(s) (3). In these and potentially other cases, such as with a client who has never performed resistance training, a more submaximal approach may be prudent. As an alternative to the 1-RM strength test, a multiple repetition maximum test may be performed, with the value used to predict 1-RM. This procedure is described in Box 12.7.

Box 12.6 One Repetition Maximum Testing Procedures (12)

1. Demonstrate and explain all procedures for the intended movement using only the bar, providing as much detail as necessary based on the experience of the client.
2. Allow the client to practice the technique to allow for familiarization and the incorporation of any technique correction required.
3. The first warm-up trial involves the client performing 5–10 repetitions with a load that the client reports as “easy,” corresponding to 40%–60% of the estimated 1-RM load.
4. Client should next rest for 1 min, during which the performance of active flexibility movements using the full ROM are encouraged.
5. The second warm-up trial involves the client performing three to five repetitions at a load corresponding to 60%–80% of the estimated 1-RM load. The client will then rest for 2 min while performing the active recovery movements.
6. The third and final warm-up trial involves the client performing two to three repetitions with a load corresponding to 90%–95% of the estimated 1-RM. The client then rests for 2–4 min while performing active recovery movements.
7. The first 1-RM test attempt is made after adding 5–10 lb for upper body exercise or 10–20 lb for lower body exercise to the load used in the final warm-up trial. If the client succeeds in lifting the load once but fails on the second repetition, the test is completed. If the client either fails on the first attempt or is able to complete a second repetition, continue the test after another 2- to 4-min rest period.
8. If another trial is warranted, the test will continue at either the next higher or lower load increment (±2.5–5 lb or ±5–10 lb depending on exercise) until successfully completed, continuing to actively rest 2–4 min between trials.

9. Ideally, the test is completed within 3–5 testing sets/attempts.
10. Record the absolute 1-RM value as the highest load successfully lifted for one repetition. Relative strength can be calculated by dividing the absolute 1-RM value by the client's body mass, and this value can be compared to the established norms for upper body strength in Table 12.7 or lower body strength in Table 12.8.

Box 12.7 Multiple Repetition Maximum Testing Procedures (1,26,27)

1. The multirep max test can be used to predict 1-RM values using equations or tables with populations for whom the 1-RM test may be inappropriate for a variety of reasons. The multirep max can also be used as a measure of muscular strength on its own; for example, tracking performance and increase of a 5-RM over time (3).
2. The test performance is very similar to the 1-RM test procedure, including multiple warm-up trials, outlined in Box 12.6. The key differences are outlined in the following:
   - Rather than proceeding with a goal of determining the max load that can be moved for one successful repetition, typically, the goal is to determine the max load that can be lifted for 5–10 repetitions.
   - It is important that the exercise be performed to failure (3). For example, if a load is lifted successfully for five repetitions, and failure occurs prior to completion of the sixth repetition, then the load would be expressed as a 5-RM.
   - As the repetition number decreases, accuracy with 1-RM prediction improves. For example, prediction of 1-RM using a 5-RM would be more accurate compared to using a 10-RM.
3. Upon successful completion of the test, the load can be expressed as the client's X-RM. For example, if the client was able to successfully complete five repetitions with 185 lb, then the client would have a 5-RM of 185 lb.
4. This data can either be used on its own as an index of strength, used in a table to predict 1-RM (1), or input into one of a number of population-specific equations developed to predict 1-RM. For example, Brzycki (27) developed the following equation to predict 1-RM for males:
   - 1-RM = weight lifted (lb) / [1.0278 · (reps to fatigue × 0.0278)]

- For example, if a male client successfully performed five repetitions with a load of 185 lb:

Predicted 1-RM = 185 lb / [1.0278 · (5 × 0.0278)] = 208.15 lb

Muscular strength can be expressed as either an absolute value (load successfully lifted) or in relative terms. When comparing a client to a group of his or her peers, the relative expression of strength is recommended and can be calculated by dividing the 1-RM (or multiple RM [multirep max]) value by the client's body mass (5). Norms for the 1-RM bench press can be found in Table 12.7 and 1-RM leg press in Table 12.8.

Table 12.7 Fitness Categories for Upper Body Strength[a] for Men and Women by Age

Bench Press Weight Ratio = weight pushed in lb ÷ body weight in lb

		MEN					
		Age					
%		**<20**	**20–29**	**30–39**	**40–49**	**50–59**	**60+**
99	Superior	>1.76	>1.63	>1.35	>1.20	>1.05	>0.94
95		1.76	1.63	1.35	1.20	1.05	0.94
90	Excellent	1.46	1.48	1.24	1.10	0.97	0.89
85		1.38	1.37	1.17	1.04	0.93	0.84
80		1.34	1.32	1.12	1.00	0.90	0.82
75	Good	1.29	1.26	1.08	0.96	0.87	0.79
70		1.24	1.22	1.04	0.93	0.84	0.77
65		1.23	1.18	1.01	0.90	0.81	0.74
60		1.19	1.14	0.98	0.88	0.79	0.72
55	Fair	1.16	1.10	0.96	0.86	0.77	0.70
50		1.13	1.06	0.93	0.84	0.75	0.68
45		1.10	1.03	0.90	0.82	0.73	0.67

40		1.06	0.99	0.88	0.80	0.71	0.66
35	Poor	1.01	0.96	0.86	0.78	0.70	0.65
30		0.96	0.93	0.83	0.76	0.68	0.63
25		0.93	0.90	0.81	0.74	0.66	0.60
20		0.89	0.88	0.78	0.72	0.63	0.57
15	Very poor	0.86	0.84	0.75	0.69	0.60	0.56
10		0.81	0.80	0.71	0.65	0.57	0.53
5		0.76	0.72	0.65	0.59	0.53	0.49
1		<0.76	<0.72	<0.65	<0.59	<0.53	<0.49
N		60	425	1,909	2,090	1,279	343
Total *n* = 6,106							

WOMEN							
		Age					
%		**<20**	**20–29**	**30–39**	**40–49**	**50–59**	**60+**
99	Superior	>0.88	>1.01	>0.82	>0.77	>0.68	>0.72
95		0.88	1.01	0.82	0.77	0.68	0.72
90	Excellent	0.83	0.90	0.76	0.71	0.61	0.64
85		0.81	0.83	0.72	0.66	0.57	0.59
80		0.77	0.80	0.70	0.62	0.55	0.54
75	Good	0.76	0.77	0.65	0.60	0.53	0.53
70		0.74	0.74	0.63	0.57	0.52	0.51
65		0.70	0.72	0.62	0.55	0.50	0.48
60		0.65	0.70	0.60	0.54	0.48	0.47
55	Fair	0.64	0.68	0.58	0.53	0.47	0.46
50		0.63	0.65	0.57	0.52	0.46	0.45
45		0.60	0.63	0.55	0.51	0.45	0.44
40		0.58	0.59	0.53	0.50	0.44	0.43
35	Poor	0.57	0.58	0.52	0.48	0.43	0.41
30		0.56	0.56	0.51	0.47	0.42	0.40
25		0.55	0.53	0.49	0.45	0.41	0.39
20		0.53	0.51	0.47	0.43	0.39	0.38

15	Very poor	0.52	0.50	0.45	0.42	0.38	0.36
10		0.50	0.48	0.42	0.38	0.37	0.33
5		0.41	0.44	0.39	0.35	0.31	0.26
1		<0.41	<0.44	<0.39	<0.35	<0.31	<0.26
N		20	191	379	333	189	42
Total *n* = 1,154							

[a] 1-RM bench press, with bench press weight ratio = weight pushed in pounds per body weight in pounds. 1-RM was measured using a universal dynamic variable resistance machine.
Adapted with permission from The Cooper Institute. Physical fitness assessments and norms for adults and law enforcement [Internet]. Dallas (TX): The Cooper Institute. Available from: www.cooperinstitute.org.

Table 12.8 Fitness Categories for Leg Strength by Age and Sex[a]

Leg Press Weight Ratio = weight pushed in lb ÷ body weight in lb

MEN						
		Age (yr)				
Percentile		**20–29**	**30–39**	**40–49**	**50–59**	**60+**
90	Well above average	2.27	2.07	1.92	1.80	1.73
80	Above average	2.13	1.93	1.82	1.71	1.62
70		2.05	1.85	1.74	1.64	1.56
60	Average	1.97	1.77	1.68	1.58	1.49
50		1.91	1.71	1.62	1.52	1.43
40	Below average	1.83	1.65	1.57	1.46	1.38
30		1.74	1.59	1.51	1.39	1.30
20	Well below average	1.63	1.52	1.44	1.32	1.25
10		1.51	1.43	1.35	1.22	1.16
WOMEN						
Percentile		**Age (yr)**				

		20–29	30–39	40–49	50–59	60+
90	Well above average	1.82	1.61	1.48	1.37	1.32
80	Above average	1.68	1.47	1.37	1.25	1.18
70		1.58	1.39	1.29	1.17	1.13
60	Average	1.50	1.33	1.23	1.10	1.04
50		1.44	1.27	1.18	1.05	0.99
40	Below average	1.37	1.21	1.13	0.99	0.93
30		1.27	1.15	1.08	0.95	0.88
20	Well below average	1.22	1.09	1.02	0.88	0.85
10		1.14	1.00	0.94	0.78	0.72

Study population for the data set was predominantly white and college educated. A universal dynamic variable resistance machine was used to measure the 1-RM.

[a] 1-RM leg press with leg press weight ratio = weight pushed per body weight. 1-RM was measured using a universal dynamic variable resistance machine.

Adapted from Institute for Aerobics Research, Dallas, 1994.

Visit thePoint to watch videos 12.6 and 12.7, which demonstrate multiple repetition and 1-RM bench press testing procedures.

Muscular Endurance Testing

Muscular endurance testing typically involves callisthenic-type exercises performed to either muscular failure or failure to keep up with a prescribed cadence while maintaining proper form. Muscular endurance may also be evaluated using a set percentage of 1-RM. For example, determining how many repetitions can be successfully performed using 70% of an individual's 1-RM for any given exercise (5). Although normative data does not exist, it is suggested that an average completed repetition number with this load is 12–15 (5). As with muscular strength tests, muscular endurance testing is also joint and muscle group specific — there is no single test that can evaluate full-body muscular endurance. Thus, it is common to include multiple muscular endurance tests in a fitness assessment battery. Common areas of muscular endurance assessment are upper body, lower body, and the core/abdominal area.

Upper body muscular endurance is commonly evaluated using the push-up test. This procedure is described in Box 12.8. Norms for this test can be found in Table 12.9. If the push-up test is an inappropriate choice for a client, for instance, if the body mass cannot be moved by the individual for one reason or another, using the percentage of 1-RM method is a better alternative. Core/abdominal muscular endurance has traditionally been evaluated using the curl-up (crunch) test. However, recent evidence indicates that this test is at best ineffective, and at worst places, the client at an increased risk for low back injury (3). An alternative option for evaluating core/abdominal muscular endurance, known by some as core stability, is the Sahrmann Core Stability Test. Procedures for this test can be referenced elsewhere (5,28). The isometric plank exercise is another option, but as of yet, there is no normative data to use for comparison.

Box 12.8 Push-up Testing Procedures (3)

1. The push-up test is administered with male subjects starting in the standard "down" position (hands pointing forward and under the shoulder, back straight, head up, using the toes as the pivotal point) and female subjects in the modified "knee push-up" position (legs together, lower leg in contact with mat with ankles plantarflexed, back straight, hands shoulder-width apart, head up, using the knees as the pivotal point) (Fig. 12.11).
2. The subject must raise the body by straightening the elbows and return to the "down" position, until the chin touches the mat. The stomach should not touch the mat.
3. For both men and women, the subject's back must be straight at all times, and the subject must push up to a straight arm position.
4. The maximal number of push-ups performed consecutively without rest is counted as the score.
5. The test is stopped when the client strains forcibly or is unable to maintain the appropriate technique for two consecutive repetitions.

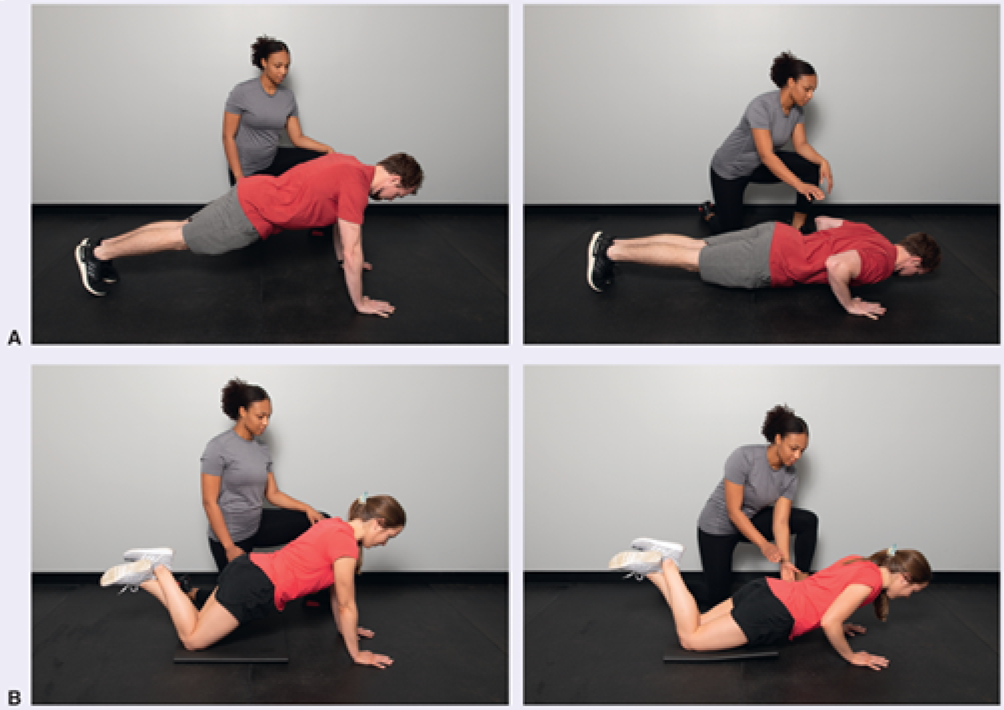


FIGURE 12.11. Proper push-up starting and ending positions for male and female clients.

Table 12.9 Fitness Categories by Age Groups and Sex for Push-ups

	Age (yr)									
Category	**20–29**		**30–39**		**40–49**		**50–59**		**60–69**	
Sex	**M**	**W**	**M**	**W**	**M**	**W**	**M**	**W**	**M**	**W**
Excellent	≥36	≥30	≥30	≥27	≥25	≥24	≥21	≥21	≥18	≥17
Very good	29–35	21–29	22–29	20–26	17–24	15–23	13–20	11–20	11–17	12–16
Good	22–28	15–20	17–21	13–19	13–16	11–14	10–12	7–10	8–10	5–11
Fair	17–21	10–14	12–16	8–12	10–12	5–10	7–9	2–6	5–7	2–4
Poor	≤16	≤9	≤11	≤7	≤9	≤4	≤6	≤1	≤4	≤1

M, men; W, women.

Reprinted with permission from the Canadian Society for Exercise Physiology. CSEP Physical Activity Training for Health® (CSEP-PATH®) Resource Manual, 2nd ed [Internet]. Ottawa (ON): Canadian Society for Exercise Physiology; [cited 2019]. Available from: https://store.csep.ca/collections/csep-path/products/csep-path_resource_manual_second_edition_english.

Flexibility and Functional Movement Assessments

Flexibility is an important component of physical fitness due to its importance for minimizing injury risk and its contribution toward the ability to perform ADL. For greater discussion on this topic, refer to Chapter 16. The assessment of flexibility has traditionally focused on some version of the sit-and-reach test, which was considered to be a good measure of hamstring and low back flexibility. It is now recognized to be a poor predictor of lower back pain, however, and is questionable as a measurement of hamstring flexibility (29,30). The sit-and-reach test is therefore, an indirect measurement of ROM. Multiple versions of the sit-and-reach have also been developed, which can lead to confusion with regards to interpretation. As a result, it is recommended that more direct measures of ROM (i.e., goniometer and inclinometer) be utilized for measurement of ROM. Box 12.9 provides general guidelines for ROM testing, and Table 12.10 provides ROM in degrees at select joints by age and sex.

Box 12.9 General Guidelines for Range of Motion Testing

Pretest: Each individual should participate in a general warm-up followed by static stretching prior to range of motion testing.

1. If using a goniometer, the axis of the goniometer should be placed at the center of the joint being evaluated. The fixed arm of the goniometer should be aligned with a bony landmark of the stationary body part, and the movable arm of the goniometer should be aligned with a bony landmark of the body segment that is going to be moving. For anatomical landmarks, refer to Soucie et al., (31). If using an inclinometer, is should be held on the distal end of the moveable body segment.
2. Record the range of motion in degrees.
3. Administer multiple trials; three are recommended.
4. Use the best score to compare reference values.

Multiple versions of the sit-and-reach (*e.g.*, Fig. 12.12) have been developed. As a result, it is recommended that more direct measures of ROM (i.e., goniometer and inclinometer) be utilized for measurement of ROM.

FIGURE 12.12. Client performing a sit-and-reach test.

Table 12.10 **Range of Motion in Degrees at Select Joints by Age and Sex**

Joint	Age (yr) 9–19 M	9–19 F	20–44 M	20–44 F	45–69 M	45–69 F
Hip extension	18 (17–20)	21 (19–22)	17 (16–19)	18 (17–19)	14 (13–15)	17 (16–18)
Hip flexion	135 (133–137)	135 (133–137)	130 (129–132)	134 (133–135)	127 (126–129	131 (129–132)
Knee flexion	142 (140–144)	142 (141–144)	138 (137–139)	142 (141–143)	133 (132–134)	138 (137–139)
Ankle dorsiflexion	16 (15–18)	17 (16–19)	13 (12–14)	14 (13–15)	12 (11–13)	12 (11–13)
Ankle plantarflexion	53 (51–55)	57 (55–60)	55 (53–56)	62 (61–64)	49 (48–51)	57 (55–58)
Shoulder flexion	171 (169–173)	172 (170–174)	169 (167–170)	172 (171–173)	164 (162–166)	168 (167–170)
Elbow flexion	148 (147–150)	150 (149–151)	145 (144–146)	150 (149–151)	144 (142–145)	148 (147–149)
Elbow pronation	80 (79–82)	81 (80–83)	77 (76–78)	82 (81–83)	78 (77–79)	81 (80–82)
Elbow supination	88 (86–90)	90 (88–92)	85 (84–86)	91 (89–92)	82 (81–84)	87 (86–88)

M, men; W, women. Data are means (95% confidence interval). Adapted with permission from (42).

Functional Movement Assessments

Practitioners and coaches in a variety of settings have begun using what have been termed *functional movement assessments* in an attempt to better assess and quantify individual and synergistic joint mobility and/or stability. Assessment data can be used to identify individuals who may be at risk for musculoskeletal injury with maintained or increased physical activity participation, for training program design purposes, and as a way to monitor improvements or regressions in movement quality (32). The most prevalent functional movement assessment, the FMS, was designed to predict potential musculoskeletal injury risk by identifying asymmetries or imbalances existing in fundamental movement patterns (32). The FMS consists of seven individual movement pattern assessments, each scored on a scale of 0–3, along with three clearing assessments. For a complete background and instructions for the FMS, refer to other sources (32–34). For a full chapter discussion on the subject, refer to Chapter 6 in the *ACSM's Resources for the Exercise Physiologist*, third edition. A brief description and instructions for the FMS and its movement pattern assessments/clearing assessments can be found in Box 12.10.

Box 12.10 Functional Movement Screen

1. **Deep Squat**

   The deep squat assessment is used to assess bilateral, symmetrical, and functional mobility of the hips, knees, and ankles. The use of a dowel rod held in the "overhead" position assists in determining bilateral, symmetrical mobility of the thoracic spine and shoulders.

   Instructions:

   Stand with feet shoulder-width apart and pointing straight ahead.

   - Grasp dowel rod with both hands and place rod on top of head. Adjust hand position so that both elbows are flexed at 90°.
   - Extend arms overhead.
   - Squat as low as possible while keeping the dowel rod aligned over the feet.
   - If the client is unable to achieve a score of 3 on this assessment, elevate the client's heels using a 2 × 6 board and repeat test.

   Scoring:

   3 = The following criteria must be met:

   - Upper torso and tibia should be parallel to one another, or torso should remain near vertical.
   - The femur should be below horizontal relative to the ground.
   - The feet should be straight ahead, with knees aligned over the feet, while keeping the heels on the ground.
   - The dowel rod should be aligned over the feet.

   2 = All of the previous criteria to score a 3 must be met but with heels elevated on a 2 × 6 board.

   1 = Client cannot perform the movement despite heel elevation.

   0 = Pain experienced during the movement

2. **Hurdle Step**

   The hurdle step is used to assess bilateral functional mobility and stability of the hips, knees, and ankles while attempting to replicate proper stride mechanics during a stepping movement.

Instructions:

- Hurdle height should be set at the height of the client's tibial tuberosity.
- The dowel rod should be placed across the shoulder blades as when performing a back squat. Feet should be hip-width apart with the toes directly under the hurdle.
- One foot is lifted up and over the hurdle. The heel should be tapped to the floor on the other side of the hurdle before returning to reset position without touching the hurdle.
- Test is repeated with opposite foot, and each side is scored independently.
- The final score for this assessment is the lower of the two raw scores (if different).

Scoring:

3 = All of the following must be met:

- Hips, knees, and ankles should remain aligned in the sagittal plane.
- Minimal to no movement is noted in the lumbar spine.
- The dowel rod should remain parallel to the hurdle/ground.

2 = Client performs the movement with some compensation.
1 = Client unable to perform the movement (loss of balance, contact between foot and hurdle).
0 = Pain experienced during movement

3. **Inline Lunge**

   The inline lunge assesses hip and ankle mobility and stability, quadriceps flexibility, and knee stability while promoting rotary stability and proper trunk alignment.

   Instructions:

   - Measure the height of the tibial tuberosity from the floor. Mark distance on floor using tape or a yardstick.

- The toes of the back foot should be placed at the back end of the marked distance. The heel of that foot should be flat on the floor and the foot pointed straight ahead.
- The heel of the front foot should be positioned at front end of marked distance.
- The dowel rod should be held behind the back, maintaining three points of contact — back of the head, upper back, and the buttocks. If the left leg is forward, then the right hand will be in the overhead position securing dowel rod at the cervical spine; with the left hand positioned behind the lower back, securing the dowel rod at the lumbar spine. When switching legs, switch hand position as well.
- While maintaining foot position, flex both knees, lowering back knee toward the front heel without touching the floor. Return to starting position and repeat two additional repetitions.
- Switch the feet and arm positions and repeat on opposite side.
- Score each side independently. The leg that is forward is the side that is scored.
- The final score for this assessment is the lower of the two raw scores (if different).

Scoring:

3 = The following criteria must be met:

- Front foot must remain flat on floor; heel cannot lift.
- Rear knee must come in contact with rear heel.
- Cannot lean upper body forward, left, or right

2 = Client performs movement with some compensation.

1 = Client unable to perform the movement; unable to maintain balance.

0 = Pain experienced during movement

4. **Shoulder Mobility**

   The shoulder mobility screen primarily assesses bilateral shoulder ROM and, additionally, scapular mobility and thoracic spine extension.

Instructions:

- Measure the distance between the base of the palm and the tip of the middle finger.
- Stand with feet together and arms hanging naturally.
- Make two fists — with fingers around the thumbs — and extend both arms directly out to the sides at shoulder level.
- In one smooth motion, place the right fist overhead and down toward the shoulder blades as low as possible while simultaneously taking the left fist down and up toward the shoulder blades as high as possible.
- Keep hands at position of initial placement; do not continue to move them closer together.
- Measure the distance between the two fists.
- Repeat assessment on opposite side, with left fist high and right fist low. The side that is high is the side being scored because each side is scored independently.
- The final score for this assessment is the lower of the two raw scores (if different).

Scoring: Score the movement and then perform the Shoulder Clearing Test as described in the following text.

3 = Fists are within 1 hand length of one another (as measured in step 1).

2 = Fists are within 1.5 hand lengths of one another.

1 = Fists are greater than 1.5 hand lengths from one another.

0 = Pain experienced during movement

Shoulder Clearing Test

- Stand with feet together and arms hanging naturally.
- Place the palm of one hand completely flat on the front of the opposite shoulder.
- While maintaining the position of the palm, raise the elbow as high as possible.

- Perform movement on both sides.
- If no pain is experienced, the client "passes" the clearing test. If pain is felt, the client fails the clearing test and would receive a "0" for the shoulder mobility test.

5. **Active Straight-Leg Raise**

   The active straight-leg raise assesses active hamstring flexibility and gastrocnemius–soleus flexibility as well as the ability to stabilize the pelvis while raising the lead leg while keeping active extension of the opposite leg.

   Instructions:

   - Client should lie flat on back with 2 × 6 board placed under knees. Arms should be placed at sides with palms facing upward.
   - Dowel rod should be positioned perpendicular to floor, lined up with a point midway between the client's anterior superior iliac spine and the knee joint.
   - Lift one leg while keeping the other leg in contact with board and keeping both legs as straight as possible.
   - Lower the leg and repeat on the other side, scoring each side independently.
   - The final score for this assessment is the lower of the two raw scores (if different).

   Scoring:

   3 = The following criteria must be met:

   - The leg is lifted high enough for the ankle to pass beyond the dowel rod.
   - Lifted leg remains straight with no flexion of the knee.
   - Other leg remains in contact with the board with no flexion of the knee.

   2 = The ankle is only lifted high enough to be above the knee.

   1 = The ankle is not lifted above the height of the knee.

   0 = Pain experienced during movement

6. **Trunk Stability Push-up**

The trunk stability push-up assesses the ability to maintain torso rigidity/stability and resist anterior/posterior movement.

Instructions:

- Lie prone on the floor, feet and legs together, toes pointing toward the floor, hands shoulder-width apart and either in line with the forehead (males) or the chin (females) (35). Point elbows out to the sides.
- Perform a push-up, focusing on maintaining a rigid torso and moving the entire body in unison into the up position.
- If unable to perform the movement, the following adjustments should be allowed:
  - Males: Lower hands to be in line with the chin and reattempt.
  - Females: Lower the hands to be in line with the clavicle and reattempt.

Scoring: Score the movement and then perform the Spinal Extension Clearing Test described in the following text:

3 = Able to perform the movement with no sag in the spine using the initially described hand position

2 = Able to perform the movement with no sag using the modified hand position

1 = Unable to perform the movement properly with modified hand position

0 = Pain experienced during movement

Spinal Extension Clearing Test

- Lie face down and place the hands next to the shoulders.
- Push upward until elbows are fully extended, lifting chest off the ground while keeping the lower body in contact with the ground.
- If pain is experienced during the movement, the client will receive a "0" for the trunk stability push-up assessment.

7. **Rotary Stability**

The rotary stability test assesses multiplane trunk stability and neuromuscular control during simultaneous upper and lower extremity movement.

Instructions:

- Assume the quadruped position, with hands and knees spaced approximately 6 in apart. The 2 × 6 board can be placed under the client to assist with spacing.
- Hands should be directly under the shoulders and knees directly under the hips. Feet should be in dorsiflexion position with toes pointed at floor.
- Simultaneously extend right arm and leg fully.
- Without touching the floor, touch elbow to knee.
- Return to extend position and then to the reset position.
- Repeat on the left side, scoring each side independently.

If unable to perform the movement, the following adjustments should be allowed:

- Perform the same movement using a diagonal extremity pattern (*i.e.*, arm and opposite leg).
- Score movements independently, with the upper extremity moving corresponding to the side scored.
- The final score for this assessment is the lower of the two raw scores (if different).

Scoring: Score the movement and then have the client perform the Spinal Flexion Clearing Test described in the following text:

3 = Able to perform the correct unilateral pattern

2 = Able to perform the correct diagonal pattern

1 = Unable to perform diagonal pattern

0 = Pain experienced during movement

Spinal Flexion Clearing Test

- Assume the quadruped position.
- Rock back and touch the buttocks to the heels and the chest to the thighs.
- If pain is experienced during the movement, the client will receive a “0” for the rotary stability assessment.

Adapted from American College of Sports Medicine. *ACSM's Exercise Testing and Prescription*. Philadelphia (PA): Wolters Kluwer; 2018. 592 p.

Other Functional Assessments

Although the assessments described in this chapter are appropriate for most apparently healthy individuals, there may be more suitable assessment alternatives for certain populations. The elderly (or senior) population, for example, is one for which specific assessments and testing batteries have been developed, with an emphasis on fitness components that have an impact on functional independence and the ability to perform ADL safely and without undue fatigue (36). As the percentage of those that classify as elderly in the population is growing, a Personal Trainer should be equipped to safely and effectively assess the overall fitness of this population.

One of the simplest and most commonly used of these functional assessments is the "timed get up and go" test, also known as the TUG (37). The TUG is described by Herman et al. (38) as a measure of lower extremity function, mobility, and fall risk and involves the client standing from a chair, walking a short distance, and then turning around and returning to the chair in a seated position. With regard specifically to fall risk, it has been suggested that individuals who take 14 seconds or longer to complete the TUG are at an increased risk for falling (39). For TUG performance details, see Box 12.11.

Box 12.11 Timed Get Up and Go

1. The test is timed with a stopwatch.
2. Beginning on the word "go," participants stand from a standard chair (seat height between 44 and 47 cm [17.3 and 18.5 in]).
3. Walk a 3-m distance (usually marked on the floor) at a comfortable pace.
4. Turn, walk back to chair, and sit down.
5. Participants may use walking aids; however, they may not use their arms to stand.
6. The test ends when the participant's back is positioned against the seatback after sitting.
7. The test is performed two times.

Herman T, Giladi N, Hausdorff JM. Properties of the 'timed up and go' test: more than meets the eye. *Gerontology*. 2011;57:203–10.

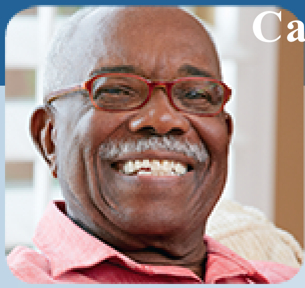
A second functional assessment for older adults, developed by Guralnik et al. (40), is the Short Physical Performance Battery (SPPB). This three-component assessment likewise evaluates the ability to rise from a chair, albeit repeatedly for five repetitions in this case, and walk a short distance but also adds a standing balance component using multiple foot positions. Specifically, the three components of the SPPB are the standing balance test (side-by-side, semitandem, and tandem foot positions), the (8-ft) walking test, and the repeated chair stand test (five repetitions performed as fast as possible). For more details on the SPPB regarding performance and established norms, refer to additional texts (40,41).

Lastly, possibly the most comprehensive functional assessment for older clients is the Fullerton SFT, developed by Rikli and Jones (36,42). The SFT evaluates multiple fitness components: muscular strength using a 30-second chair stand and 30-second arm curl (males 8 lb, females 5 lb), aerobic endurance using a 6-minute walk or 2-minute step test, flexibility using the chair sit-and-reach and back scratch tests, and agility/dynamic balance using the 8-ft up-and-go test (42). For normative data, as well as complete descriptions of each test in the SFT, see Rikli and Jones (42).

Contraindications to Mobility and Functional Assessment

Although important for assessing and improving movement and overall physical functionality, there may be instances when mobility, range of motion (ROM), and/or functional assessment are contraindicated. Examples include the periods of time following an acute bone, joint, or soft tissue injury or surgery, during which tissue may be inflamed, weakened, or generally disrupted. Other situations may include when a client is on medication for pain or taking muscle relaxants. Finally, if pain is experienced during a mobility, ROM, or functional assessment, the activity should be terminated (12).

Case Study 12.1



The Case of Willis: Willis is a 70-year-old male who has joined a local fitness facility. He measures at 5 ft 6 in and 177 lb. During an initial consultation, Willis reveals that he recently had a triple bypass procedure (roughly 6 months ago) and completed a cardiac rehabilitation program. He takes medication for hypertension (an angiotensin-converting enzyme inhibitor) but is currently not experiencing any symptoms and has maintained a pattern of regular physical activity since completion of the cardiac rehabilitation program. More specifically, he states that he walks about 3 miles, 5–6 days per week. When asked about his goals, Willis states that although he has lost a considerable amount of weight in the last year (~40 lb), he would like to lose "about 10 more." He mentions some musculoskeletal issues in passing — that his "knees are shot" and that at the end of most days, he has moderate discomfort in this lower back. However, he seems resigned to these problems being present because he is "getting old." He has seen a physician for both of these issues, but no diagnosis was made. In order to determine if Willis is cleared for physical activity, the ACSM preparticipation screening algorithm is used. As he is physically active and asymptomatic, he is cleared for moderate-intensity physical activity despite his disease diagnosis (11).

Prior to the performance of exercise testing and the development of a training program for Willis, a comprehensive needs analysis should be performed. The needs analysis is composed of three subanalyses — the movement analysis, the physiological analysis, and the injury analysis (1). Because Willis did not express any current or desired participation in specific sports, the movement analysis for this particular client would focus on movements that facilitate ADL. He has given some clues as to where he may be experiencing movement deficiency with his revelation of both knee and lower back pain. Willis may therefore require testing and training in multiple fundamental human movements — squatting/standing up from a chair (bilateral hip extension), stepping up and down (unilateral hip and knee extension/flexion), and lumbar spine stabilization.

The physiological analysis would likewise be performed while keeping the importance of ADL in mind but also with consideration of Willis's medical history. Due to his cardiovascular disease diagnosis, as well as the presence of hypertension, CRF is a high priority for Willis and should therefore be tested and targeted for improvement. Willis has no experience with resistance training, and due to his age, he has certainly experienced significant age-related loss of muscle mass. Muscular strength is important for the performance of ADL and its ability to reduce disease risk (12), so muscular strength would be a priority for Willis as well, in addition to muscular endurance. Due to Willis's age and health history, it would be wise to choose submaximal tests rather than maximal for both CRF and muscular strength (11).

Finally, the injury analysis would focus on current injuries held by the client as well as prevention of common injuries based on the individual's activity patterns, age, and health history. Willis has not communicated the presence of acute injury but rather has indicated that he experiences periodic discomfort in both right and left knees and in his lower back. Although these areas are not currently "injured," it would be prudent to avoid exercises during both testing and training that would exacerbate these issues. Shoulder injuries are common (2), and therefore, care should be taken while introducing resistance training exercises that use the shoulder joint during both testing and training, particularly with a novice resistance trainer.

In conclusion, by performing a needs analysis on Willis, information was gained that will promote the construction of a safe, appropriate, and individualized fitness testing battery for Willis. Needs analysis data can then be used with data gathered during the fitness testing battery to create an individualized and effective training program for Willis as he seeks to improve his health and overall quality of life.

QUESTIONS FOR CONSIDERATION

1. List all of the key pieces of information found in the client narrative that a Personal Trainer would need to be aware of prior to the testing/training of Willis.
2. Which is more appropriate for Willis — maximal or submaximal exercise testing? State why you came to this conclusion.
3. Choose a CRF test for Willis and discuss why this choice is appropriate.
4. Choose muscular fitness tests (muscular strength and muscular endurance) for Willis and discuss why the choices are appropriate.
5. Is the FMS appropriate for Willis? Why or why not?
6. Using the ACSM-recommended fitness testing sequence, write out a fitness testing battery for Willis.

SUMMARY

The results of a comprehensive fitness assessment battery are used to help a Personal Trainer understand the starting points for individual fitness clients in the different fitness categories. These results can be used, along with client goals, for training program planning purposes. Equally important as the initial assessment is regular and periodic reassessment. Adaptations to training can be quantified and documented — an important factor for the maintenance and bolstering of client motivation and dedication, as well as assessment of the training program itself. If reassessment shows a failure to improve on any given fitness component score, the training program should be reevaluated and adjusted appropriately in order to promote movement toward the desired outcome of the client.

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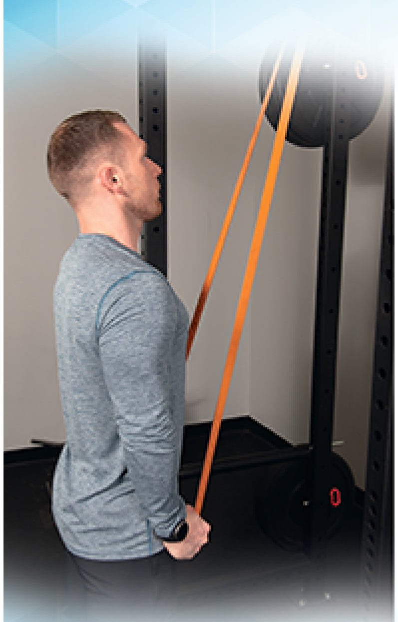
PART
V

Developing the Exercise Program

CHAPTER 13

Comprehensive Program Design



OBJECTIVES

Personal Trainers should be able to:

- Describe the physiological and psychological benefits of a comprehensive exercise program.
- Describe the components of a comprehensive exercise program.
- Consider advanced training options.
- Understand the anatomy of an exercise session.

INTRODUCTION

Personal Trainers have the opportunity to assist clients in creating exercise programs that not only help to prevent several hypokinetic diseases (*e.g.*, coronary heart disease, obesity, diabetes, low back pain) but also improve physical fitness and quality of life. As highlighted in this chapter, a comprehensive exercise program provides many physiological and psychological benefits. A well-rounded fitness plan follows a general format including a warm-up; the training stimulus, such as cardiorespiratory exercise and/or resistance exercise, a cool-down, and flexibility exercise; and, when indicated, neuromotor exercise training (Box 13.1) (1). For some clients, more advanced options with a greater focus on skill-related components of physical fitness may also be appropriate.

Box 13.1 Components of the Exercise Training Session (1,2)

- **Warm-up:** At least 5–10 min of low- to moderate-intensity cardiorespiratory and muscular endurance activities
- **Conditioning:** At least 20–60 min of aerobic, resistance, neuromotor, and/or sports activities. (Exercise bouts of 10 min are acceptable if the individual accumulates at least 20–60 min $\cdot$ d^{-1} of daily aerobic exercise.)
- **Cool-down:** At least 5–10 min of low- to moderate-intensity cardiorespiratory and muscular endurance activities
- **Flexibility:** At least 10 min of stretching exercises performed after the warm-up or cool-down phase

Reprinted from American College of Sports Medicine. American College of Sports Medicine position stand. Exercise and physical activity for older adults. *Med Sci Sports Exerc*. 2009;41(7):1510–30; Data from American College of Sports Medicine. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromuscular fitness in apparently healthy adults: guidance for prescribing exercise. *Med Sci Sports Exerc*. 2011;43(7):1334–59; and U.S. Department of Health and Human Services. 2018 Physical Activity Guidelines Advisory Committee Report [Internet]. Washington (DC): U.S. Department of Health and Human Services; [cited 1 Feb 2018]. Available from: https://health.gov/pageguidelines/second-edition/report/pdf/PAG_Advisory_Committee_Report.pdf.

In addition to health benefits of a fitness program, Personal Trainers should also be concerned with clients' sedentary behavior (*e.g.*, computer use, smartphone use, watching television). Sedentary behavior is associated with metabolic and cardiovascular risk factors promoting morbidity and mortality and reducing life expectancy and quality of life (1). Detrimental effects of sedentary activities are possible even among individuals who meet the *Physical Activity Guidelines*, and thus, including "physical activity breaks" or frequent short activity bouts on a daily basis to interrupt sedentary activities is recommended (3,4).

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Benefits of a Comprehensive Exercise Program

A comprehensive exercise program has many potential physiological as well as psychological benefits. This section provides Personal Trainers with insight into the range of physical and mental health benefits possible with a regular exercise program.

Physiological Benefits

Physiological changes as a result of a comprehensive exercise program provide many fitness and health benefits.

Improvement in Cardiovascular and Respiratory Function

Aerobic activities in which large muscle groups are used dynamically for extended periods of time place demand on the cardiovascular and respiratory systems in addition to the skeletal muscle system (5). By placing a stress on these systems, cardiorespiratory fitness can be improved. Increases in cardiorespiratory fitness are associated with a reduction in all-cause mortality. Conversely, low cardiorespiratory fitness is associated with increased risk of premature death, in particular cardiovascular disease mortality (5).

Reduction in Coronary Artery Disease Risk Factors

Prevention of risk factors (primordial prevention) and treatment of risk factors (primary prevention) are both important considerations considering the high prevalence of heart disease. Some primordial risk factors cannot be altered or prevented (*e.g.*, age, sex, or genetics), but others including physical inactivity can be addressed. Risk factors such as dyslipidemia, prediabetes, hypertension, and obesity are positively impacted with regular physical activity (3). Greater cardiorespiratory fitness in individuals with preexisting disease is associated with decreased risk of clinical events (1).

Decreased Morbidity and Mortality

Physical activity and exercise are known to prevent the development of several life-threatening diseases as well as premature death (6). Morbidity and mortality rates in a population can be directly affected by the quality and quantity of physical activity and exercise. Morbidity refers to the amount of disease in a given population, whereas mortality refers to the amount of death in a population. All-cause mortality is delayed with regular physical activity. Mortality is also delayed when individuals who were previously sedentary or insufficiently active increase their physical activity to meet the recommended levels of physical activity (1). The Centers for Disease Control and Prevention publishes a weekly report providing information on these rates in the United States, called the *Morbidity and Mortality Weekly Report*.

Physical activity and exercise are known to prevent the development of several life-threatening diseases as well as premature death.

Decreased Risk of Falls

According to the Centers for Disease Control and Prevention, each year, about 1 in 4 adults older than 65 years will experience a fall that leads to moderate or severe injury (7). Severe falls can cause injuries affecting mobility as well as brain trauma and can lead to other health conditions or disease. Falls may be linked to lack of muscular strength and endurance, balance, and coordination. Multicomponent physical activities (*i.e.*, aerobic, muscle strengthening, balance, gait, coordination, and functional training) can help reduce the risk of injury from falls and improve physical function. Moreover, recreational activities such as dancing, yoga, tai chi, gardening, or sports can also be considered multicomponent because they often incorporate multiple types of physical activity (2,3). Neuromotor exercise training (also called functional fitness training), which includes balance, coordination, gait, agility, and proprioceptive training, is a beneficial component of a comprehensive exercise program for older persons to reduce the risk of falls (1). Additionally, current research demonstrates the key role of resistance training in combating muscle strength and mass loss that is considered critical for several physiological indicators such as physical functioning, mobility, and independence, enhancing chronic disease management and life expectancy (8).

Increased Metabolic Rate

Metabolism is the rate at which bodily tissues break down and use energy consumed (calories). Unfortunately, metabolic rate declines steadily as a part of the aging process (2). If energy is not used, it is most often stored in fat cells. Typically, as individuals age, they become less and less physically active, losing muscle mass, thus contributing to this steady decline in metabolic rate (2). Older adults should do muscle-strengthening activities that involve all the major muscle groups at least 2 $d \cdot wk^{-1}$ performing two or three sets of 8–12 repetitions of each exercise in order to attenuate muscle loss or promote lean muscle gains, which can potentially maintain metabolic rate (3). More specifically, the effects of resistance training and especially the implementation of circuit training on energy expenditure is beneficial for weight control and cardiometabolic health in adults (9).

Improvement in Bone Health

Similarly with heart disease, bone health is affected by factors that cannot be modified (*e.g.*, age, sex, race, genetics) as well as those that can be changed (*e.g.*, diet, physical activity). Exercise training modalities for increasing bone mass or to slowing/preventing age-related bone loss require loading of the bone in a site-specific manner (10). Impact and weight-bearing activities (*e.g.*, plyometrics, jumping, resistance training) provide for a stress on the bone to promote positive adaptations in the bone (10).

Weight Loss and Reduced Obesity

Obesity is associated with several chronic diseases (*e.g.*, coronary heart disease, hypertension, stroke, Type 2 diabetes, dyslipidemia, some cancers) (5). Physical activity is recommended as part of an integrated weight management plan for prevention of excessive fat mass, for weight maintenance, to enhance weight loss strategies, and to reduce the risk of weight gain with age. In fact, evidence suggests a dose-response relationship between physical activity levels and the magnitude of weight loss. Although American College of Sports Medicine (ACSM) and the Physical Activity Guidelines for Americans recommend participation in at least 150 min $\cdot$ wk^{-1} of moderate-intensity activity for weight maintenance and reduction in chronic disease risk, 250–300 min $\cdot$ wk^{-1} of moderate-intensity activity may lead to greater weight loss (3,5).

Psychological

In addition to the many physiological benefits, regular exercisers may also experience a number of potential psychological benefits.

Decreased Anxiety and Depression

Depression is a common psychiatric disorder and a leading cause of disability that is marked by feelings of sadness and unhappiness along with being self-critical and having low self-esteem (11). In addition to impairing daily function and potentially creating difficulties in work and home life, depression is also associated with poor quality of life and health risks such as heart disease, diabetes, cancer, and osteoporosis (12). Exercise (both cardiovascular and resistance training) has been found to be helpful in treating mild to moderate depressive symptoms, to potentially reduce the risk of developing depression (13), and to work in conjunction with medication-based antidepressive therapy for those with diagnosed major depression (14).

Anxiety is an emotional state marked by excessive anticipatory worry, tension, and apprehensive expectation or fear and is considered a common psychiatric symptom. Anxiety is associated with poor health-related quality of life and increased risk for cardiovascular disease and is linked to all-cause mortality (15). Exercise has been linked to reduction in anxiety and is considered an effective, affordable, and convenient treatment option for individuals with anxiety while improving a variety of physical fitness components. Potential physiological explanations including regulation of the hypothalamic-pituitary-adrenal axis, increases in serotonergic and noradrenergic levels in the brain, and endogenous opioid release may play a key role (16).

Enhanced Feelings of Well-Being

Exercise provides enhancement of self-esteem, more restful sleep, and faster recovery from psychosocial stressors (17). Exercise also has the potential to enhance emotional well-being, to improve mood (18), and to enhance feelings of "energy" and quality of life (1).

> Exercise provides enhancement of self-esteem, more restful sleep, and faster recovery from psychosocial stressors.

Positive Effect on Stress

High stress is when the perceived demands appear to exceed the resources available to handle those demands (15). Stress is associated with a number of health risks, including weakening of the immune system, overeating, and adverse shifts in blood lipid levels (19). People with depression, those suffering from stress and hostility, have the same risk of heart attack as those who smoke or have high blood pressure. However, exercise and physical activity have potentially positive effects on stress. For example, exercise training has been shown to reduce depression, overall stress, as well as hostility by 50%–70% (17).

Better Cognitive Function (Older Adults)

Regular physical activity (both cardiovascular and resistance training) is known to play a pivotal role in the enhancement of cognitive function reducing the risk for dementia or cognitive decline in older adults through processes of neuroplasticity (20). Importantly, cardiovascular exercise has been widely studied as an efficient and easily accessible training modality for remediation aiming to improve cognition. Multicomponent exercise programs promoting cardiorespiratory and muscular fitness, balance, and flexibility have been suggested as an effective training option to influence cognitive function and to be a part of a comprehensive approach for the prevention, management, and treatment of dementia in older adults (21). Exercise can also impact tasks that require complex mental processing, in particular, executive-control tasks such as coordination, inhibition, scheduling, planning, and working memory (2).

Components of a Comprehensive Exercise Program

The optimal exercise program should address the health-related physical fitness components of cardiorespiratory fitness, muscular strength and endurance, flexibility, body composition, and neuromotor fitness (5). In addition, skill-related physical fitness components can also be added, and they include agility, coordination, balance, power, reaction time, and speed (5). Including activities to improve aerobic fitness, muscular fitness, and flexibility is recommended for everyone. Neuromotor exercise, which includes skill-related physical fitness components, is advocated for those at higher risk for falling, in particular, older individuals, although there are likely benefits for younger adults as well (5). Additionally, some clients have goals related to sport or competitive activities in which the skill-related components need to be addressed.

> The optimal exercise program should address the health-related physical fitness components of cardiorespiratory fitness, muscular strength and endurance, flexibility, body composition, and neuromotor fitness.

The FITT-VP principles of exercise prescription allow for complete design of the frequency (F), intensity (I), time (T) (or duration), and type (T) (or mode) of exercise plus the overall volume (V) or amount and progression (P) of the exercise (5). Within the FITT-VP framework, the Personal Trainer can develop individual exercise prescriptions (as discussed in more detail in the upcoming chapters in this part), which include cardiorespiratory and muscular fitness exercises as well as flexibility-promoting activities.

Cardiorespiratory Fitness

Cardiorespiratory endurance refers to the ability of the heart and blood vessels (circulatory system) and the lungs (respiratory system) to provide oxygen to the body during sustained physical activity (5). Another term commonly used is "aerobic" fitness because these activities require sufficient oxygen in order to be continued. Maximal oxygen consumption ($\dot{V}O_{2max}$) can be measured directly by analyzing expired gases or may be estimated from submaximal effort (see Chapter 12 for examples of submaximal exercise tests) or maximal effort. The higher the $\dot{V}O_{2max}$, the greater is the individual's aerobic capacity. Cardiorespiratory endurance training can be done in two different ways: continuously or in blocks (intervals), such as high-intensity interval training or HIIT. The first training option consists of rhythmic, aerobic-type endurance exercises. The latter is characterized by high-intensity efforts and recovery bouts performed intermittently (5). Both options demonstrate similar improvements in cardiorespiratory fitness, but interval training generally is more time-efficient compared to steady-state, continuous bouts of exercise.

Frequency

Although some activity is better than none, the recommended frequency for cardiovascular exercise is at least 3 $d \cdot wk^{-1}$ (5). When determining optimal frequency, intensity should be considered. As intensity levels increase, the number of days per week needed for health benefits decreases; the incidence of injury may also increase with vigorous intensity exercise done more than 5 $d \cdot wk^{-1}$ (5). In conclusion, a weekly combination of 3–5 $d \cdot wk^{-1}$ of moderate- and vigorous-intensity exercise options can be performed, which may be more suitable for most individuals (5).

> Although some activity is better than none, the recommended frequency for cardiovascular exercise is at least 3 $d \cdot wk^{-1}$.

Intensity

Exercise intensity can be quantified using various methods, including heart rate reserve (HRR), percentage of age-predicted maximal heart rate, oxygen uptake reserve ($\dot{V}O_2R$), and rating of perceived exertion. The intensity recommended for a given individual depends on the person's habitual activity and fitness level (5). For individuals who are sedentary and very deconditioned, the recommended intensity is very low (*i.e.*, 30%–39% HRR or $\dot{V}O_2R$) but progressively increases with higher activity and fitness levels (*i.e.*, for habitually active individuals with high fitness, 60%–89% HRR or $\dot{V}O_2R$) (7). See Table 15.2 in Chapter 15 for specific ranges for various intensity levels. Typically, interval training can be classified as either HIIT or sprint interval training (SIT). HIIT, characterized by "near-maximal" efforts, is often performed at an intensity close to that which elicits ≥80%–100% peak heart rate; SIT is characterized by an all-out, supramaximal effort equal to or greater than the pace that elicits ≥100% peak heart rate (5).

Time (or Duration)

Exercise duration is the amount of time the exercise is performed, typically expressed as minutes per day or minutes per week. General baseline targets for time spent exercising depend on the intensity of the exercise. Thus, the recommendations link duration and intensity (5):

- Moderate-intensity exercise is recommended 30–60 min · d^{-1} on at least 3 d · wk^{-1} for a total of at least 150 min · wk^{-1}, *or*
- Vigorous-intensity exercise is recommended 20–60 min · d^{-1} on at least 3 d · wk^{-1} for a total of at least 75 minutes, *or*
- A combination of moderate- and vigorous-intensity exercise at least 20–30 minutes on 3–5 d · wk^{-1}
- Interval training typically consists of alternating bouts of vigorous- to supramaximal-intensity exercise (20–240 s) followed by equal or longer bouts of light- to moderate-intensity exercise (60–360 s). However, for detrained individuals, a moderate-intensity interval training approach is recommended. For example, brisk walking periods are alternated with a reduced pace.

> General baseline targets for time spent exercising depend intensity of the exercise.

A dose-response relationship exists between physical activity and health outcomes. Thus, benefits may begin at low levels for sedentary individuals (*e.g.*, <20 min · d^{-1}), whereas extending the time or intensity may provide additional health benefits for those who are already regular exercisers (5). For example, one may gain even greater benefits with the following:

- Moderate-intensity exercise of 300 min · wk^{-1}, *or*
- Vigorous-intensity exercise of 150 min · wk^{-1}, *or*
- A combination of moderate- and vigorous-intensity exercise

Going above the baseline of 150 min · wk^{-1} of moderately intense exercise also is important to assist with weight loss or to help maintain weight loss. In these situations, the recommended duration of exercise is 50–60 min · d^{-1}, or 250–300 min · wk^{-1} (5). These recommendations provide a framework in which the Personal Trainer can develop a health-enhancing exercise program.

Type (or Mode)

Examples of continuous cardiovascular activities include walking, jogging, running, cycling, swimming, and using endurance-based machines (*e.g.*, stair climber, elliptical machines). Although most of these activities require low to moderate skills and can be used even by those with low fitness levels, others require considerable skill, fitness, and practice to master. Table 15.6 in Chapter 15 provides a classification system, which acknowledges the fitness and skill level required for optimal use of various aerobic exercises. Activities appropriate for everyone have minimal skill or fitness prerequisites (*e.g.*, walking). As fitness increases, more intense activities can be included (*e.g.*, jogging). Still, other activities have a major skill component (*e.g.*, swimming) that must be acquired before including in cardiovascular training or have a competitive nature (*e.g.*, team sports) that requires at least average physical fitness (5). On the other side, an interval training approach incorporates aerobic-based (*e.g.*, running, cycling, and rowing), resistance-based (*e.g.*, bodyweight exercises, plyometrics, traditional or adjunct resistance training equipment), or a hybrid of both aerobic- and resistance-based exercises depending on the goals of the training session and physical fitness level of the client (5).

Volume (Amount)

Exercise volume plays an important role for realizing health/fitness outcomes, particularly with respect to body composition and weight management. Exercise volume should be used to estimate the overall energy expenditure for an exercise prescription. Exercise volume is typically measured in metabolic equivalent (MET) · min · wk^{-1} and/or kcal · wk^{-1} (note that volume can also be tracked on a daily basis). Box 13.2 reflects the standard measures of exercise intensity (METs, MET-min, and kcal · min^{-1}) for different physical activities. These values can then be used to calculate volume of activity per week that is accumulated as part of the exercise program. The recommended volume that is consistently associated with lower rates of cardiovascular disease and premature mortality is greater than 500–1,000 MET · min · wk^{-1} (11). This is approximately equal to 1,000 kcal · wk^{-1} of moderate-intensity physical activity, ~150 min · wk^{-1} of moderate-intensity exercise, an intensity of 3–5.9 METs (for people weighing 68–91 kg or 150–200 lb), or 75 min · wk^{-1} of vigorous-intensity aerobic exercise, or an equivalent combination of moderate- and vigorous-intensity cardiovascular exercise per week to attain the volume of recommended physical activity. In deconditioned people, lower exercise volumes can have significant benefits, but even greater volumes may be needed for weight management.

Box 13.2 Calculation of METs, MET-min, and kcal · min^{-1} (2,3)

Metabolic equivalents (METs):

An index of energy expenditure. "[A MET is] the ratio of the rate of energy expended during an activity to the rate of energy expended at rest. . . . [One] MET is the rate of energy expenditure while sitting at rest . . . by convention, [1 MET is equal to] an oxygen uptake of 3.5 [mL · kg^{-1} · min^{-1}]" (21).

MET-min:

An index of energy expenditure that quantifies the total amount of physical activity performed in a standardized manner across individuals and types of activities (21). Calculated as the product of the number of METs associated with one or more physical activities and the number of minutes the activities were performed (*i.e.*, METs × min). It is usually standardized per week or per day as a measure of exercise volume.

Kilocalorie (kcal):

The energy needed to increase the temperature of 1 kg of water by 1° C. To convert METs to kcal · min^{-1}, it is necessary to know an individual's body weight. It is usually standardized as kilocalories per week or per day as a measure of exercise volume.

$$\text{kcal} \cdot \text{min}^{-1} = (\text{METs} \times 3.5\ \text{mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1} \times \text{body weight in kg}) \div 200$$

Example

Calculate weekly volume for a 70-kg male jogging (at ~7 METs) 3 days per week for 30 minutes.

$$7\ \text{METs} \times 30\ \text{min} \times 3\ \text{times per week} = 630\ \text{MET-min} \cdot \text{wk}^{-1}$$

or

$$(7\ \text{METs} \times 3.5\ \text{mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1} \times 70\ \text{kg}) \div 200 = 8.6\ \text{kcal} \cdot \text{min}^{-1}$$

$$8.6\ \text{kcal} \cdot \text{min}^{-1} \times 30\ \text{min} \times 3\ \text{times per week} = 774\ \text{kcal} \cdot \text{wk}^{-1}$$

Reprinted from American College of Sports Medicine. American College of Sports Medicine position stand. Exercise and physical activity for older adults. *Med Sci Sports Exerc*. 2009;41(7):1510–30; Data from American College of Sports Medicine. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromuscular fitness in apparently healthy adults: guidance for prescribing exercise. *Med Sci Sports Exerc*. 2011;43(7):1334–59; and U.S. Department of Health and Human Services. 2018 Physical Activity Guidelines Advisory Committee Report [Internet]. Washington (DC): U.S. Department of Health and Human Services; [cited 8 Feb 2018]. Available from: https://health.gov/sites/default/files/2019-09/PAG_Advisory_Committee_Report.pdf.

Progression Rate

Progression depends on an individual's health status, training response, fitness, and the exercise program goals. Progression allows for improvements in cardiorespiratory fitness while avoiding stagnation in training. The Personal Trainer may need to increase any or all of the FITT components to provide progression to the exercise program. Typically, only one variable is increased at a time. Initially, an increase in exercise time/duration per session of 5–10 minutes every 1–2 weeks over the first 4–6 weeks of an exercise training program is reasonable for the average adult. After about 1 month, the frequency, intensity, and time should be gradually increased over the next 4–8 months to meet the recommendations presented in *ACSM's Guidelines for Exercise Testing and Prescription* (5).

Progression depends on an individual's health status, training response, fitness, and the exercise program goals. Progression allows for improvements in cardiorespiratory fitness while avoiding stagnation in training.

A longer trajectory is recommended for those who are very deconditioned. Any progression should avoid making large increases in the FITT components to minimize risks of injury, muscular soreness, or overtraining.

Chapter 15 provides more detail on cardiorespiratory fitness training programs and incorporating the FITT-VP principle into a usable program for a client. A sample progression, including activity status and training focus, is provided in Table 13.1.

Table 13.1 Activity Status and Cardiovascular Training Focus

Activity Status	Cardiovascular Training Focus
Beginner: those who are inactive with no or minimal physical activity and thus are deconditioned	*No prior activity*: Focus is on light- to moderate-level activity for 20–30 min over the course of the day. Accumulating time in 10-min bouts is an option. Overall, the target is 60–150 min · wk^{-1}. *Minimal prior activity* (*i.e.*, once the previous target level is met): Focus is on light- to moderate-level activity for 30–60 min · d^{-1}. Accumulating time in 10-min bouts is an option. Overall, the target is 150–200 min · wk^{-1}.
Intermediate: those who are sporadically active but do not have an optimal exercise plan and thus are moderately deconditioned	*Fair to average fitness*: Focus is on moderate activity for 30–90 min · d^{-1}. Overall, the target is 200–300 min · wk^{-1}.
Established: those who are regularly engaging in moderate to vigorous exercise	*Regular exerciser* (moderate to vigorous): Focus is on moderate to vigorous activity for 30–90 min · d^{-1}. Overall, the target is 200–300 min · wk^{-1} of moderate-intensity activity or 100–150 min of vigorous-intensity activity or a combination of moderate- and vigorous-intensity activity.

Adapted with permission from Bushman B, editor. *ACSM's Complete Guide to Fitness & Health*. 2nd ed. Champaign (IL): Human Kinetics; 2017. 448 p.

Resistance Training

Resistance training is used to optimize muscular fitness including both muscular strength and muscular endurance. Muscular strength refers to the ability of a muscle or muscle group to exert force (*e.g.*, one repetition maximum [1-RM]). Muscular endurance refers to the ability of a muscle or muscle group to continue to perform without fatigue (*i.e.*, repeated contractions or to sustain a contraction).

To improve muscular fitness, the muscles must be exposed to an overload (stress beyond the typical activity). This is done via resistance training. Over time, as the muscles adapt to a given overload, the training stimulus must be increased to continue to have gains. This is referred to as progressive overload. Details on resistance training programs are found in Chapter 14, and a sample progression is found in Table 13.2. As with cardiorespiratory training programs, the FITT-VP principle can be applied to resistance training.

Table 13.2 Sample Resistance Training Progression

Stage[a]	Exercises[b]	No. of Sets	No. of Repetitions	No. Days per Week[c]
Beginner: Moving through this level typically takes about 2–3 mo, although remaining at this level until the client feels comfortable enough to advance is appropriate.	Do a total of six exercises. Select *one* exercise from each of the following areas: hips and legs, chest, back, shoulders, low back, and abdominals.	1–2	8–12 (10–15 for older adults)	2–3
Intermediate to established: Moving through the intermediate to established level typically takes 3–12 mo depending on the client's level of consistency.	Do a total of 10 exercises. Select *one* exercise from each of the following areas: hips and legs, quadriceps, hamstrings, chest, back, shoulders, biceps, triceps,	2	8–12 (10–15 for older adults)	2–3

	low back, and abdominals.			
More advanced: Some clients may have higher level goals in the area of muscular fitness and thus will include an expanded training program.	Do a total of 10 exercises. Select *two* exercises from each of these larger muscle group areas: hips and legs, quadriceps, hamstrings, chest, and back.	2–3	8–12	2–3
	Do a total of five exercises. Select *one* exercise from each of these smaller muscle group and trunk areas: shoulders, biceps, triceps, low back, and abdominals.	2	8–12	2–3

[a]The time spent at each stage will depend on the client's muscular fitness level. Transition slowly between the stages (*e.g.*, over time, a beginner can add additional exercises or increase the number of sets to move toward the intermediate level of resistance training).

[b]Different exercises can be performed on different days.

[c]Schedule training days so that at least 48 h separate training sessions that target the same muscle group.

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Frequency

The frequency of resistance training varies depending on the goals of the client. For general muscular fitness, resistance training the major muscle groups (chest, shoulders, back, abdomen, hips, and legs) 2–3 $d \cdot wk^{-1}$ is recommended (5). At least 48 hours should separate workouts targeting any given muscle group to allow time for adaptations to occur (1,5). Depending on client schedules, Personal Trainers may incorporate whole-body sessions in which all the major muscle groups are exercised in one session (repeating this sequence a couple times per week) or may train a few selected muscle groups (split program) each session (multiple sessions) (5). In the latter scenario, more frequent resistance training will occur, but individual muscle groups will still only be targeted two to three times per week. In summary, a wide variation in program design options can be applied by adopting periods of both low- ($1\ d \cdot wk^{-1}$), medium- ($2\ d \cdot wk^{-1}$) or high-frequency training ($>3\ d \cdot wk^{-1}$) throughout an individualized training plan.

Intensity

Intensity of resistance training is inversely related to the number of repetitions; with higher resistance, the number of repetitions will be fewer. Depending on the muscular fitness goal (*i.e.*, strength, muscular endurance, etc.), the recommended range for intensity and repetitions can vary greatly. To improve muscular fitness, typically 8–12 repetitions per set are completed, at an intensity of between 60% and 80% of the client's 1-RM (*i.e.*, the greatest amount of resistance overcome in a single repetition) (5). For older and very deconditioned individuals, a lower intensity (40%–50% of 1-RM) with 10–20 repetitions is recommended initially (1). To lower the chance of injury or extreme muscle soreness after exercise, the number of repetitions selected should allow for muscle fatigue at the end of the set but not failure (5).

> Intensity of resistance training is inversely related to the number of repetitions; with higher resistance, the number of repetitions will be fewer.

Time (or Duration)

The total time spent will vary with the program, in particular if a whole-body approach is used or if a split program targeting different muscles groups on separate days is applied. For adults, each muscle group should be trained with two to four sets with rest intervals of 2–3 minutes between sets (5). Four sets are more effective than two sets, but also realize that for novices, even a single set per exercise will improve muscular strength (5). When determining the number of sets, attention should be made to adherence and thus may be influenced by the individuals schedule, time availability, and level of commitment (5).

Type (or Mode)

Resistance training can be done using free weights, machines (stacked weights or pneumatic resistance), rubber bands/cords, body weight, and even alternative and nontraditional implements (kettle bells, medicine balls, battle ropes). For examples of different activities that can be used for the major body areas, see Table 13.3. In addition, Personal Trainers should include multijoint (*e.g.*, bench press, leg press) as well as potentially single-joint (*e.g.*, biceps curl, quadriceps extension) exercises (5). When selecting exercises, the Personal Trainer should ensure opposing muscle groups, agonists and antagonists, are included in order to prevent muscle imbalances. For example, including lower back extensions and abdominal crunches to strengthen both the lower back and the abdomen will provide for muscle balance.

Table 13.3 Examples of Resistance Training Exercises for Major Body Areas

Body Area	Exercises	
Hips and legs (gluteals, quadriceps, hamstrings)	Machine leg press Dumbbell squat	Ankle weight hip flexion and extension Band leg lunge
Legs (quadriceps)	Machine leg extension	Ankle weight knee extension
Legs (hamstrings)	Machine leg curl	Ankle weight knee flexion
Chest (pectoralis)	Machine chest press Band seated chest press	Dumbbell chest press Push-up and modified push-up
Back (latissimus dorsi)	Machine lat pull-down Dumbbell one-arm row	Machine seated row Band seated row
Shoulders (deltoid)	Machine overhead press	Dumbbell lateral raise

	Dumbbell or band upright row	
Arms (biceps)	Machine biceps curl	Dumbbell or band biceps curl
Arms (triceps)	Machine biceps press	Dumbbell lying triceps extension
Low back (erector spinae)	Machine back extension Prone plank	Kneeling hip extension
Abdominals	Curl-up Diagonal curl-up	Machine abdominal curl

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Volume

Muscular groups should be trained for a minimum of two to four sets. These may be the same exercise or from a combination of exercises affecting the same muscle group (1,5). For example, either four sets of bench presses or a combination of two sets of bench presses and two sets of dips may be used to train the pectoral muscles (5). For untrained individuals, lower volume per muscle group per session is needed, whereas for advanced trainees, a greater weekly volume is recommended to promoting hypertrophy and strength (5).

Progression

Progressive overload in resistance training is the gradual increase of stress placed on the body that can be done in many ways. One can increase the amount of resistance lifted, increase the number of repetitions, increase the number of sets done per muscle group, or increase the number of days per week the muscle groups are trained. However, if individuals seek to maintain a given level of muscular fitness, it is not necessary to continue to progressively increase the training stimulus. Muscular strength may be maintained by training muscle groups as little as 1 $d \cdot wk^{-1}$ as long as the training intensity or the resistance lifted is held constant (1,5).

Flexibility

Flexibility exercises have the potential to improve joint range of motion (ROM), physical function, postural stability, and balance (1). Although the Personal Trainer may not be able to point to benefits such as a reduction in cardiovascular disease risk, stretching is recommended as part of a comprehensive training program for adults (5).

Frequency

Stretching activities should be included a minimum of 2–3 days each week for most adults, although daily flexibility exercise is most effective (5).

Intensity

Describing the intensity of stretching to a client can be difficult because it is not a measurable entity like a treadmill speed. The Personal Trainer can use cues to help guide clients, such as moving within the ROM to point of mild tightness without discomfort (5). A stretch should not create discomfort; if so, the client should release slightly. A stretch should never be painful.

> A stretch should not create discomfort; if so, the client should release slightly. A stretch should never be painful.

Time (or Duration)

At least 10 minutes is recommended per session in order to allow all the major muscle–tendon groups to be targeted with at least four repetitions of each stretch (5).

Type (or Mode)

Flexibility can be improved using a wide variety of activities, including static stretching (active and passive), dynamic or slow movement stretching, and proprioceptive neuromuscular facilitation (5). Interestingly, when properly performed, even ballistic or "bouncing" stretches can be as effective as static stretches for increasing joint ROM in individuals engaging in activities that involve ballistic movements such as tennis or basketball (5).

Volume

Each flexibility exercise per joint should be held at the point of tightness for 10–30 seconds. Time/duration and repetitions of the flexibility exercises should be adjusted to accumulate a total of 60 seconds of stretching at each joint. Recommendations for using proprioceptive neuromuscular facilitation are to hold a 20%–75% maximum voluntary contraction for 3–6 seconds, followed by 10–30 seconds of assisted stretch. Performing flexibility exercises at least 2–3 d · wk^{-1} is recommended with daily flexibility exercise being most effective (1,5). Details on flexibility and various stretching program options are presented in Chapter 16.

Neuromotor Exercise

Neuromotor exercise involves motor skills including balance, coordination, agility, and proprioceptive training (1). Neuromotor-enhancing activities focus on the communication between feedback from the periphery (*e.g.*, arms and legs) and the interpretation by the central nervous system (*e.g.*, brain and spinal cord). As with any training, providing a challenge, or overload, will allow for improvements. This training is of particular importance for older adults who are at a higher fall risk or who have mobility impairments (5). In addition, all adults may gain benefits, especially if participation in recreation or occupational pursuits requires agility and balance (5).

Frequency

Neuromuscular exercise is recommended at least 2–3 d · wk^{-1} for 20–30 minutes of duration the previously mentioned populations (5). This recommendation is based on conventional use rather than evidence-based documentation of benefit as programs range from 1 to 7 d · wk^{-1}.

Intensity

The intensity of balance-related training can be manipulated by the Personal Training through three aspects:

1. Base of support (narrowing the base of support will increase the challenge)
2. Center of mass (displacing the center of mass increases difficulty)
3. Peripheral cues (visual, vestibular, and proprioceptive pathways)

Some examples of how these three domains can be manipulated are included in Table 13.4 (5).

Table 13.4 Factors Affecting Intensity of Balance Training (5)

Domain	Less Difficult	Moderate	More Difficult
Base of support	Feet apart (with or without assistive device)	Feet together Semitandem stand	Heel-to-toe stand One-legged stand
Center of mass	Leaning forward and backward Leaning side to side	Turning in a circle Shifting weight from side to side Stepping over an obstacle	Crossover walking Balancing on a large ball or rocker platform
Peripheral feedback	These are more difficult and are recommended only after particular activity was done successfully with peripheral feedback.	Closing the eyes (seated position) while leaning forward, backward, and side to side Standing on a foam pad while shifting weight or bringing feet close together	Closing eyes (standing position) while leaning in various directions or reducing base of support Standing on a foam pad in a heel-to-toe stance or one-legged stance

Data from American College of Sports Medicine. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. *Med Sci Sports Exerc*. 2009;41(3):687–708.

Time (or Duration)

The minimum effective dose of balance training has yet to be defined (1). Improvements have been noted with 20–30 minutes or more per day for a total of 60 $\text{min} \cdot \text{wk}^{-1}$ (5). When activities like tai chi are incorporated, typically durations are 45–60 minutes, but the minimum effective time for neuromotor exercise training is not known (5).

Type (or Mode)

Various activities (see Table 13.5 for example of a progressive balance program), as well as tai chi, Pilates, and yoga, can be used (5).

Table 13.5 Sample Progressive Balance Program

	Level 1	**Level 2**	**Level 3**	**Challenge**
Seated balance activities	Seated chair lean	Add arm movements: ■ Raise one arm at a time to the front and then to the sides. ■ Raise both arms to the front and then to the sides. Add leg movements: ■ Raise one knee at a time. ■ Raise one leg (straightened) at a time.	Combine arm and leg movements.	■ Sit on a pillow. ■ Sit on a stability ball. ■ Close one eye. ■ Close both eyes. ■ Turn head to the right and then to the left.
Standing balance activities	Upright stance (variations including wide stance, narrow stance, semitandem, and tandem)	In all four variations, add the following: ■ Forward and backward sway	Add arm movements to sway: ■ Raise one arm at a time to the front	■ Close one eye. ■ Close both eyes. ■ Turn head to the right and

		■ Lateral sway (side to side)	and then to the sides. ■ Raise both arms to the front and then to the sides.	then to the left. ■ Hold an item, such as a book.
Movement balance activities	Walk forward and backward.	■ Wide-stance walk ■ Narrow-stance walk ■ Walk on heels. ■ Walk on toes.	■ Tandem walk forward and backward. ■ Walk while carrying an item. ■ Walk with head turns.	■ Barefoot ■ One eye closed ■ Surface change (mat, sand, etc.) ■ Obstacles
	Walk side to side.	■ Sidestep on heels. ■ Sidestep on toes. ■ Turn in a circle.	■ Sidestep while carrying an item. ■ Sidestep with head turns. ■ Crossover walk: Cross one foot over the other foot.	

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Advanced Training Options

Personal Trainers may want to consider advanced training options for new clients with an extensive background in fitness training (such as athletes) or for long-term clients who have made great progress since starting their beginner comprehensive fitness programs. Advanced training options can increase the challenge of an exercise program by manipulating current exercises through the FITT-VP principle (see Tables 13.6–13.8 for examples of how the FITT components can be manipulated for beginner, intermediate, and established exercisers).

Table 13.6	Sample Beginner Adult Exercise Program[a]			
Week	**Aerobic**	**Resistance**	**Stretching[b]**	**Comments**
1–2	3 d · wk^{-1}; 10–20 min · d^{-1}; light intensity (level 3 or 4)	2 d · wk^{-1}; one set, 8–12 reps of six exercises[c]	2 d · wk^{-1}; 10 min of stretching activities	An easy beginning aerobic activity is walking at a comfortable pace. For inactive clients, target 10 min at a time for aerobic activity. Include some stretching activities (see Chapter 16) after the walk. For resistance training, see Table 13.3 for details on what activities to include.
3–4	3 d · wk^{-1}; 20–30 min · d^{-1}; light to moderate intensity (level 4 or 5)	2 d · wk^{-1}; one or two sets, 8–12 reps of six exercises[c]	2 d · wk^{-1}; 10 min of stretching activities	The focus for the client over the next couple of weeks will be getting comfortable with at least 20 min of aerobic exercise at least 3 d · wk^{-1}. Continue with the resistance training program.
5–7	3 or 4 d · wk^{-1}; 30–40 min · d^{-1}; moderate intensity (level 5)	2 d · wk^{-1}; two sets, 8–12 reps of six exercises[c]	2 d · wk^{-1}; 10 min of stretching activities	For the next 3 wk, the client's focus is on getting comfortable with up to 40 min of aerobic exercise at least 3 d · wk^{-1} (for each week, add 5–10 min per session). Continue with the resistance training program, completing two sets per exercise and adding more weight if the 12 reps for a given exercise now feel easy.
8–10	3 or 4 d · wk^{-1}; 35–50 min · d^{-1}; moderate intensity (level 5 or 6)	2 d · wk^{-1}; two sets, 8–12 reps of six exercises[c]	2 d · wk^{-1}; 10 min of stretching activities	Over the past couple of months, the client will develop a good aerobic fitness base. For some variety, other activities such as biking or swimming can be included (for more ideas, see Chapter 15). If the client likes

				walking, that is also an option. For your resistance training program, consider adding some variety and trying some other exercises (see Table 13.3 for ideas).

[a] All activity sessions should be preceded and followed by a 5- to 10-min warm-up and cool-down.

[b] Include stretching activities after aerobic exercise to improve flexibility. For specific stretches to target the major muscle groups, see Chapter 16.

[c] Resistance training is more fully outlined in Chapter 14. Beginners should select one exercise for each of the following body areas (see Table 13.3): hips and legs, chest, back, shoulders, low back, and abdominals.

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Table 13.7 Sample Intermediate-Level Adult Exercise Program[a]

Week	Aerobic	Resistance	Stretching[b]	Comments
1–2	3 or 4 d · wk^{-1}; 35–50 min · d^{-1}; moderate intensity (level 5 or 6)	2 d · wk^{-1}; one or two sets, 8–12 reps of 8–10 different exercises[c]	2 or 3 d · wk^{-1}; 10 min of stretching activities	Aerobic activity is included for a total of 150–200 min · wk^{-1} (moderate-intensity activity). For resistance training, include exercises for biceps and triceps (in addition to the body areas previously targeted) and add exercises for the quadriceps and hamstrings in the second week, so by the end of this stage, the client will include a total of 10 exercises (see Table 13.3).
3–5	3–5 d · wk^{-1}; 30–60 min · d^{-1}; moderate intensity (levels 5–7)	2 d · wk^{-1}; one or two sets, 8–12 reps of 10 different exercises[c]	2 or 3 d · wk^{-1}, 10 min of stretching activities	The focus for the next 3 wk is to increase the time spent in aerobic exercise or to increase the intensity (don't do both at the same time). If the client feels more comfortable with moderate-intensity activity, 200 min · wk^{-1}

				is appropriate. If the client is ready to increase intensity (*e.g.*, jogging rather than walking), cut back on the time to 20–30 min · d^{-1} (note that the target for vigorous-intensity activity is 75–100 min · wk^{-1}). A mix of moderate- and vigorous-intensity activity is also an option (see Chapter 15 for more details). Continue with the resistance training program.
6–10	3–5 d · wk^{-1}; 30–50 min · d^{-1}; moderate intensity (level 6)	2 d · wk^{-1}; two sets, 8–12 reps of 10 exercises[c]	2 or 3 d · wk^{-1}, 10 min of stretching activities	For the client's aerobic activity, either increase the time spent per day or increase the number of days per week. Ultimately, the weekly total should be 200–300 min of moderate-intensity activity or 100–150 min of vigorous-intensity activity (recall that 2 min of moderate activity equals 1 min of vigorous activity) or a combination of moderate and vigorous activity. For resistance training, consider trying some different exercises this week while still targeting the same muscle groups (see Table 13.3 for details).

[a]All activity sessions should be preceded and followed by a 5- to 10-min warm-up and cool-down.

[b]Include stretching activities after aerobic exercise to improve flexibility. Target all the muscle groups, holding each for 15–60 s. For specific stretches to target the major muscle groups, see Chapter 16.

[c]Resistance training is more fully outlined in Chapter 14. Select one exercise for each of the following body areas: hips and legs, chest, back, shoulders, low back, and abdominals. In the progression, the number of body areas targeted is increased by adding quadriceps and hamstrings as well as biceps and triceps. This provides 10 body areas to target. Examples of exercises for each body area are found in Table 13.3.
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Table 13.8 Sample Established Adult Exercise Program[a]

Week	Aerobic	Resistance	Stretching[b]	Comments
1–2	■ 5 d · wk^{-1} for moderate exercise, or ■ 3 d · wk^{-1} for vigorous exercise, or ■ 3–5 d · wk^{-1} for a mix of moderate and vigorous exercise	2 d · wk^{-1}; two sets, 8–12 reps of 10 different exercises[c]	2 or 3 d · wk^{-1}, minimum; 10 min of stretching activities	Target for aerobic activity is 200–300 min of moderate-intensity activity or 100–150 min of vigorous-intensity activity (recall that 2 min of moderate activity equals 1 min of vigorous activity) or a combination of moderate and vigorous activity. Resistance training exercise examples are found in Table 13.3.
3–4	2 or 3 d · wk^{-1} of moderate activity and 1 or 2 d of vigorous activity	2 d · wk^{-1}; two sets, 8–12 reps of 10 different exercises[c]	3 d · wk^{-1}, minimum; 10 min of stretching activities	For the next couple of weeks, try mixing up the activities. Suggest a new aerobic activity or change the intensity of an activity already part of the client's exercise program. Continue with the resistance training program.
5–6	■ 5 d · wk^{-1} for moderate exercise, or ■ 3 d · wk^{-1} for vigorous exercise, or ■ 3–5 d · wk^{-1} for moderate and vigorous exercise	2 d · wk^{-1}; two sets 8–12 reps of 10 exercises[c]	3 d · wk^{-1}, minimum; 10 min of stretching activities	Continue with the aerobic training program. For resistance training, consider trying some different exercises (see Table 13.3 and Chapter 14). If the client typically uses machines, suggest a couple of new exercises using dumbbells to provide the muscles with a new challenge. Be sure to watch for good form when the client tries new activities.
7–8	■ 5 d · wk^{-1} for moderate exercise, or	2 d · wk^{-1}; three sets, 8–10 reps of	3 d · wk^{-1}, minimum; 10 min of	Continue with the aerobic training program. For resistance training, consider doing three sets rather than two (this may require the

■ $3\ d \cdot wk^{-1}$ for vigorous exercise, or ■ $3–5\ d \cdot wk^{-1}$ for moderate and vigorous exercise	10 exercises[c]	stretching activities	client to cut back on reps to add the additional set).

[a]All activity sessions should be preceded and followed by a 5- to 10-min warm-up and cool-down.

[b]Include stretching activities after aerobic exercise to improve flexibility. For specific stretches to target the major muscle groups, see Chapter 16.

[c]Resistance training is more fully outlined in Chapter 14. Select one exercise for each of the following body areas: hips and legs, chest, back, shoulders, low back, abdominals, quadriceps, hamstrings, biceps, and triceps.

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> Advanced training options can increase the challenge of an exercise program by manipulating current exercises through the FITT-VP principle.

For some clients, development of the skill-related components of physical fitness is a training goal. The skill-related components of physical fitness include the following (5):

- Speed refers to the ability to perform a movement within a short about of time (*e.g.*, a 100-m sprinter moving quickly toward the finish line).
- Agility refers to the ability to change the position of the body in space with speed and accuracy (*e.g.*, cutting in a new direction to successfully execute a play in basketball).
- Coordination refers to the ability to use the senses, such as sight and hearing, together with body parts in performing tasks smoothly and accurately (*e.g.*, returning a serve in racquet sports).

- Balance refers to the maintenance of equilibrium while stationary or moving (*e.g.*, performing gymnastic moves on top of a balance beam).
- Power refers to the rate at which one can perform work (*e.g.*, a defensive back runs through the offensive line to sack the quarterback before the ball is thrown).
- Reaction time refers to the time elapsed between stimulation and the beginning of the response (*e.g.*, a soccer ball kicked toward a goal and the goalie's reaction to block it).

These skill-related components can be achieved simultaneously through several types of advanced training options such as HIIT, high-velocity weight training, Olympic weightlifting, plyometric training, balance training, sport- and nonsport-specific agility, and coordination drills (see Table 13.9 for examples of activities involving the skill-related components of fitness).

Table 13.9 Activities/Exercises Involving Skill-Related Components of Physical Fitness

Skill Component	Activity/Exercise Examples
Speed	Sprint drills Plyometric exercises (high-intensity jumps, bounds, and sprints) High-velocity resistance training Mixed martial arts (speed bag punching, sparring)
Power	Olympic weightlifting (clean and jerk, snatch) High-velocity resistance training Plyometric exercises (box jumps, push-up claps) Medicine ball exercises (ball slams, passing exercises)
Agility	Plyometric exercises (multidirectional jumps, bounds, and sprints) Sport-specific agility drills (shuttle drills, lateral shuffle drills)
Reaction time	Stimulus-response exercises (sprints initiated by whistle/start gun, quick response sport-specific ball handling) Mixed martial arts (blocking exercises, sparring)
Coordination	Multisensory integration exercises (sport-specific ball handling drills, racquet sports drills, batting exercises) Multimovement weightlifting (clean and snatch) Mixed martial arts (sparring)

	Yoga/Pilates
Balance	Stability exercises (traditional exercises performed on an uneven surface such as a foam pad or BOSU ball) Yoga/Pilates Static stretching

Power, Agility, and Speed

Personal Trainers can use several advanced training methods, such as plyometric exercises, to train their clients to improve power, agility, and speed. Plyometrics refer to exercises that link strength with speed of movement to produce power and were first known simply as "jump training." Plyometric exercises begin with a quick stretch of the muscle fibers (the eccentric phase) and then followed by a fast shortening of the same muscle fibers (the concentric phase) (1). This mode of training may improve a client's ability to increase speed of movement and power production as well as increase agility levels because plyometric exercises often change directions rapidly.

Another training method Personal Trainers can use to improve their clients' fitness levels is power resistance training. Muscular power production is used in various movements in sports, work, and daily living. Power can be increased through resistance training and by performing repetitions of lower loads at a high velocity (22). Some resistance training options Personal Trainers can use to develop more power in their clients are high-velocity resistance training and Olympic weight training. Both modes of resistance training yield increases in power production.

Reaction Time, Coordination, and Balance

Balance, coordination, and reaction time are not only needed for recreational purposes but also used in daily routines. There are many exercises and drills that Personal Trainers can use to condition their clients that require them to jump, run, slide, and bound in nontraditional movement patterns that will develop their coordination, reaction time, and balance skills. All three of these skills involve muscle activation along with sensory integration to perform exercise-related tasks in a more highly skilled way. Flexibility exercises have been shown to increase balance and reaction time (1).

Anatomy of an Exercise Session

The components of an exercise training session include the following: warm-up, conditioning exercise, cool-down, and stretching. Although the focus of exercise sessions can vary widely, this framework is appropriate for various conditioning stimuli.

Warm-Up

The warm-up is, at a minimum, 5–10 minutes of low to moderate activity intended to literally warm-up the muscles in preparation for the conditioning phase. This transitional phase provides opportunity for the body to adjust from resting status to the higher physiological, biomechanical, and bioenergetic demands of the conditioning phase (5). Warm-up activities include cardiovascular and muscular endurance activities.

Conditioning Phase

The conditioning phase is the main focus of the exercise session and may include one or more of the following: cardiorespiratory (aerobic) exercise, resistance training, neuromotor activities, and sport-specific activities. The conditioning phase will follow the FITT principles described previously in this chapter and as will be covered in greater detail in the upcoming chapters in this section.

Cool-Down

The cool-down involves similar cardiovascular and muscular endurance activities as found in the warm-up, but now, the transition is from the higher intensity of the conditioning phase back toward resting status. During this time of low- to moderate-intensity activity, the body will experience a decrease in heart rate and systolic blood pressure, and metabolic end products (*e.g.*, lactate) produced during more intense activity will be removed. Allowing for a gradual return toward baseline will help the client avoid postexercise hypotension (low blood pressure) and potential dizziness (due to blood pooling in the legs rather than flowing back to the heart and brain). The cool-down should be at least 5–10 minutes, longer for higher intensity conditioning phase sessions (5).

Stretching

The stretching phase is considered distinct from the warm-up and cool-down phases (5). For adults in a general fitness program and for athletes in sports in which flexibility is important, stretching after the warm-up is typically recommended (5). Stretching can also be included after the cool-down. For some sports (*e.g.*, those focused on muscular strength, power, and endurance), some research suggests stretching following the activity rather than following the warm-up (5). When properly performed, even ballistic or "bouncing" stretches can be as effective as static stretches for increasing joint ROM in individuals engaging in activities that involve ballistic movements such as tennis or basketball (5).

SUMMARY

A complete fitness program provides many physiological and psychological benefits. With an understanding of these benefits, a Personal Trainer can provide clients with the appropriate guidance regarding cardiorespiratory exercise, resistance training, and flexibility exercises as well as balance training or skill-related activities as needed to achieve individual client goals.

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CHAPTER 14

Resistance Training Programs

OBJECTIVES

Personal Trainers should be able to:

- Define resistance training principles.
- Review how and why resistance training should be performed.
- Design, evaluate, and implement resistance training programs.
- Evaluate clients' resistance training needs and progress.

INTRODUCTION

Resistance training, also known as strength training or weight training, is a standard part of a comprehensive Personal Training program. A resistance training program can affect almost every system in the body and is used in a wide variety of populations. The benefits of resistance training are numerous and include increases in strength, muscle mass, and bone density. Almost every population can benefit from resistance training, from children preparing for youth sports to individuals trying to counteract the effects of the aging process (1,2).

> A resistance training program can affect almost every system in the body and is used in a wide variety of populations, from children preparing for youth sports to individuals trying to counteract the effects of the aging process.

The History and Science behind Resistance Training

At the end of the Second World War, Captain Thomas DeLorme, MD, experimented with the use of progressive resistance exercise as a rehabilitation modality for injured soldiers (3). A few years later, DeLorme and A. L. Watkins published the first paper in a scientific journal on the topic of long-term resistance training (3). After the initial work by DeLorme and Watkins, the most influential personalities in resistance training were Mr. Bob Hoffman of York Barbell Club, who pioneered the interest in Olympic-style weightlifting and weight training with free weights through his publications and sales of barbells and dumbbells, and Mr. Joe Weider and his brother Ben, who promoted the bodybuilding industry.

The science of resistance training did not pick up again until two notable former weightlifters and future scientists, Dr. Patrick O'Shea from Oregon State University and Dr. Richard Berger from Temple University, fueled an explosion of scientific work in the 1960s and 1970s (4,5). Since then, published research on resistance training has grown exponentially with a gradual widening in research focus from enhancing athletic performance to also improving health and fitness (6). Although resistance training programs are critical for athletic and sports performance, they have now become a foundation of a variety of rehabilitation disciplines from orthopedic to cardiac to obesity management programs. Research on resistance training now appears in many medical and scientific journals such as the American College of Sports Medicine's (ACSM) *Medicine & Science in Sports & Exercise* and the National Strength and Conditioning Association's *Journal of Strength and Conditioning Research* (7,8). Thousands of scientific articles examining various aspects of resistance training with regard to designing optimal exercise prescriptions across the population spectrum are in print. However, in addition to these legitimate research articles, an abundance of resistance training mythology continues to be touted in popular books, magazines, and on the Internet. A demanding challenge has been placed on the Personal Trainer to sift through and carefully evaluate the scientific evidence from the marketing ploys. Resistance training programs and protocols should be guided by scientific evidence and not by dubious testimonials. Personal Trainers are advised to follow evidence-based practices to promote safety and effectiveness for clients.

General Resistance Training Principles

The terms *resistance exercise* and *resistance training* are often used interchangeably; however, there is an important distinction between the two terms. Resistance exercise refers to a single exercise session, whereas resistance training refers to the combination of many consecutive resistance exercise sessions over time. Thus, a resistance exercise protocol is an exercise prescription for a single session (most commonly called a "workout"), and a resistance training program is an overall plan guiding the specific exercise parameters chosen for each exercise protocol (or in other words, a series of planned "workouts" with a specific goal).

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Designing a resistance training program is a very individualized process, and the needs and goals of the client are paramount to the selection of program characteristics (Fig. 14.1) (9). However, be aware that although a client may be training to maximize muscle hypertrophy, the client will also develop some muscular strength and endurance. Thus, the program will be at the same time both specific and general. The general principles of any effective resistance training program are as follows:

- Specificity of training: Only the muscles that are trained will adapt and change in response to a given program. For this reason, resistance programs must target all muscles for which a training effect is desired.
- Specific Adaptations to Imposed Demands (SAID) principle: SAID indicates that the adaptation will be specific to the demands that the exercise places on the individual. For example, if a high number of repetitions are used, the muscles will increase their ability to perform a high number of repetitions (muscular endurance).
- Progressive overload: As the body adapts to a given stimulus, an increase in the stimulus is required for further adaptations and improvements. Thus, if the load or volume is not increased over time, progress will be limited.

- Variation in training: No one program should be used without changing the exercise stimulus over time. An example of increasing variety in training is periodized training.
- Periodization: The phasic manipulation of the training variables (volume, intensity, frequency, and rest intervals) as a means of optimizing desired physiological outcomes while concurrently reducing the incidence of overtraining. Periodization allows for optimal training and recovery time in a resistance training program.
- Prioritization of training: It is difficult to train for all aspects of muscular fitness. Thus, within a periodized training program, one needs to focus or prioritize the training goals for each training cycle. This technique is often used in athletics paralleling competitive season schedules.

FIGURE 14.1. Exercise prescription in resistance training is an individualized process that requires a series of steps from a needs analysis and goal setting to evaluations and making changes in the workouts over time.

Program Design Process

The key to a great program design is to identify the specific variables that need to be controlled to best predict and/or ensure the desired training outcomes. The most challenging aspect of resistance training exercise prescription is deciding which changes in program design will best meet an individual's training goals. Appropriate changes in the resistance training program are required over time. This means that sound decisions must take into consideration the needs of the sport or activity, the individual training response, and available testing data. Therefore, the resistance training exercise prescription is a continual process of planning, assessing, and changing.

Planning a resistance training exercise prescription allows one to quantify the exercise stimulus. Planning ranges from the initial development of a single exercise session to the variation of the training program over time. A successful Personal Trainer needs the ability to quantify a client's workout and evaluate progress made to ensure the program is safe and effective and will lead to optimal physical development of the client.

Training Potential

The gains made in any variable related to muscular performance will ultimately be linked to an individual's genetic potential. A deconditioned individual will likely achieve large initial gains because of the great adaptive potential available. As training proceeds, the rate of adaptation slows, as an individual approaches genetic limits. Over time, the physiological adaptation as measured from baseline will continue to increase albeit at a much slower rate. At this point in the training process, because gains are less noticeable, other goals for the resistance training program must be targeted to prevent the client from losing interest because of a lack of progress (9–12). Appreciation of the process by which adaptations occur over time is critical in developing an optimal program.

Initial Assessments

When working with a new client, Personal Trainers should always devote adequate time to evaluate the clients' prior resistance exercise experience and discuss their training goals carefully before beginning any exercise sessions. The initial assessment should include the following:

- A needs analysis focusing on learning about the client's personal goals and needs
- The intended time frame for achieving these goals
- Targeted areas or muscle groups
- Health issues (*e.g.*, cardiovascular disease, asthma, diabetes, osteoporosis, osteoarthritis, immune system disorders, neurological disorders), musculoskeletal limitations, recent surgeries, chronic injuries, sites of pain, and so on

Personal Trainers should try to understand the motivation underlying their clients' goals. In addition, Personal Trainers should assess the level of support their clients feel they have, available from family or friends (see Chapter 8 for additional discussion of social support). Finally, Personal Trainers should discuss any prior resistance training experience their clients have had in order to uncover potential challenges or barriers to training and develop appropriate strategies for motivation. Personal Trainers work with clients to develop strategies to overcome potential barriers to resistance training. These initial assessments will help Personal Trainers determine which muscle groups, energy systems, and muscle actions need to be trained and how these and the other acute program variables should be manipulated to meet the specific needs of the training program.

Before developing a resistance training program, Personal Trainers should take the time to conduct a baseline fitness assessment, consisting of anthropometric measurements (height, weight, circumferences, skinfolds, etc.), resting hemodynamics (heart rate, blood pressure), body composition, and tests of muscular strength and endurance (see Chapter 12 for more information on assessment). Determination of initial fitness is necessary to the development of an effective training program.

Muscular strength assessments include the one repetition maximum (1-RM) testing on a variety of exercises, especially those exercises that involve the major muscle groups such as bench press and squat, but only if tolerable to the client (13). The 1-RM test allows the Personal Trainer to determine loading values for a particular exercise. There are specific procedures that should be followed when conducting a 1-RM test to help ensure safety, reliability, and validity of the test (14). Although 1-RM is a measure of maximal strength, muscular power can be tested by using the medicine ball "put" for the upper body power assessment and the vertical jump test or standing long jump for the lower body muscular power assessment (14–17). Muscular endurance testing might include curl-ups, push-ups, or maximal amount of repetitions that can be performed at a given percentage of the 1-RM load (16,17).

Follow-up Assessments

It is exciting and motivating for clients to see improvements toward reaching their goals. To see these improvements, it is important that Personal Trainers keep records of their clients' progress. Individualized training logs are a useful tool for monitoring progress. These logs should record specific exercises, resistance or load, number of sets, and number of repetitions. Another possible measure to consider on the training log is a rating of perceived exertion (RPE) similar to what was discussed in Chapter 15. However, there is a resistance training–specific RPE, termed the *OMNI-Resistance Exercise Scale* (OMNI-RES) (18,19). Clients rank the last repetition of each set using a 0–10 scale (0 being extremely easy and 10 being extremely hard). This has been shown to be a valid and reliable tool that can be used to track and evaluate intensity of exercise (18,20), which can be used to track progress as well as for adjusting exercise prescription. The training log provides a record of the resistance and knowledge of performance of previous exercise sessions, which is necessary for assigning the appropriate resistance for successive sessions. Kept over time, these logs provide the Personal Trainer with a means to examine and evaluate program effectiveness or to identify areas of weakness.

Formal reassessment of a client's progress should occur periodically for encouragement but not so often that there has not been adequate time for noticeable changes to develop. For example, in individuals with little to no resistance training experience, significant gains in muscular strength can be seen in as little as a few training sessions, whereas those with extensive experience (greater than 2 y of consistent resistance training) alterations in muscular adaptation may be limited (21). As such, more frequent testing may be necessary for untrained individuals (such as once per month or every other month); however, for trained individuals, this might be best to test only once per year (22). These follow-up assessments should include the same measures as administered at the baseline assessment, including anthropometrics and tests of muscular strength, power, and endurance.

Based on these assessments, the concepts of progression, variation, and overload can be applied to the resistance training program to achieve optimal physiological adaptations and to accommodate changing fitness levels and goals of clients (9,23–25). These assessments give Personal Trainers a basis for modifying the short-term acute program variables, including choice of exercise, order of exercises, intensity, number of sets, set structure, rest periods, load or resistance, and repetition speed (23,26–29). Variation can be incorporated by altering joint angles and positioning, primary exercises versus assistance exercises, or multijoint exercises versus single-joint exercises to stress the muscles and joints specified by the client's needs analysis (26,30). Progressive overload can be accomplished by increasing the intensity and/or volume by increasing the resistance, number of sets, number of repetitions, or number of exercises or by decreasing or increasing the rest intervals (10–12,24,25,31,32).

Individualization

Each Personal Training client is unique and should be treated as such when it comes to their resistance training programming. Similar training programs provided to different clients will result in varied training responses. Therefore, skilled and effective Personal Trainers do not give standard programs to multiple clients. Exercises need to be modified to best suit the anatomical characteristics, needs, and abilities of each client. Additionally, the Personal Trainer must make modifications in the progression of the program based on the training response of the specific client. For example, different levels of chronological age and/or maturation may lead to differing effects of the same resistance training program (33). Adjustments to programs should focus on optimizing the individual's physiological adaptations.

Client Feedback

To design an effective resistance training program, the Personal Trainer needs to pay special attention to feedback from the client. Clients may request favorite exercises or muscle groups, or they may complain of pain or fatigue requiring program modifications. Personal Trainer must be alert to this feedback and encourage further feedback to ensure that the program and strategy meet the expectations of the client. This can be accomplished by asking the client for feedback, for example, "How do you think the workout went?" "Did you feel that you worked out hard enough? Too hard? Just right?" "What did you find went especially well or easier? What was particularly challenging?" These are examples of simplistic questions that are meant to help the Personal Trainer establish a repertoire/buy-in with the client. With time and practice, these questions can become more discerning, and the ongoing relationship with each client will allow for greater depth to ensure answers are truthful and fully transparent. With such information, appropriate programming adjustments can be made. In addition, always pay attention to physical signs of overuse or exhaustion, such as dizziness, light-headedness, complexion changes, profuse sweating, facial expressions, and muscular exhaustion. Clearly, working a client to the point of vomiting or passing out is not safe and will not leave a good impression with clients or any spectators who are present when medical attention arrives.

Of special concern for Personal Trainers is the careful and proper progression in the resistance training program, especially for beginners or those coming back from an injury lay off. Too much exercise, too heavy of exercise, and/or accentuated eccentric exercise can lead to an excessive amount of muscle tissue damage and breakdown. This can result in delayed-onset muscle soreness (DOMS) or in extreme cases rhabdomyolysis (34–37).

Rhabdomyolysis is a clinical pathology that is characterized by the rapid breakdown of muscle tissue resulting in high amounts of intramuscular proteins (*e.g.*, myoglobin, myosin protein) entering into the blood stream that are potentially harmful to kidneys and can cause kidney failure and sometimes death (37–39).

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The most common manifestation of muscle injury is DOMS. DOMS symptoms are a first sign that the individual has done too much too soon. DOMS is a condition of heightened postexercise soreness that presents in the initial 24–48 hours after the exercise session and may last upward of 5–7 days (34,35,40,41). Although some swelling, pain, and soreness are common and classical signs of muscle tissue adaptation following a workout, DOMS should *not* be considered a goal of the training program (*i.e.*, no pain no gain). If these symptoms are extreme, tissue damage may be more serious, and DOMS is likely to reduce training potential as well as having a deleterious effect on performance (40,41).

To reduce the instances of DOMS and prevent rhabdomyolysis, Personal Trainers carefully progress the client to heavier loads with prudent volume changes, thus allowing for adequate recovery from each workout. A simple Likert-type (Box 14.1) scale can be used to gauge the level of soreness for the client. Individuals having a score of 3 or more should have the resistance intensity and/or volume reduced dramatically and should increase the amount of rest allowed in a periodized training program. Although some muscle soreness is a normal result of muscular adaptation, extreme soreness is a sign of physiological overshoot.

Box 14.1 Likert-Type Chart to Determine Muscle Soreness

0	
1	Minor soreness
2	
3	Moderate soreness
4	
5	Extreme soreness
6	

Symptoms of rhabdomyolysis include severe muscle aches, weakness, and extremely dark reddish-brown urine. Kidney shock and acute renal failure can develop in up to 2 days after major tissue trauma. If rhabdomyolysis is suspected, seek medical help immediately.

Personal Trainers should always explain the muscle group(s) that the exercise is intended to target, and clients should be taught how to differentiate between muscle fatigue and soreness, and extreme soreness, pain, or injury. Clients must be told that new exercises often feel uncomfortable or awkward, but that if pain is felt in any joint or nonsynergistic or stabilizer muscle, that exercise should be discontinued. The exercises should be stopped immediately if the client complains of pain or the Personal Trainer suspects that the client is in pain. The last thing a Personal Trainer wants to do is induce or aggravate an injury.

Feedback from the client can also come from paying close attention to the technique of the client during an exercise. Deterioration in technique often results from fatigue, insufficient flexibility in the range of motion (ROM), too heavy of a load, or even low technical ability of the client. It should also be noted that technique depends on the individual exercise. That stated, proper exercise technique should always be a priority. When technique is compromised during an exercise, the exercise should be either stopped or modified to reestablish correct technique to avoid injury.

In summary, it is important to properly assess workouts and prevent extreme muscle injury from occurring. The resistance load and volume of training need to be carefully progressed and monitored to limit muscle tissue damage and develop a physiological toleration to heavier resistance and volumes of exercise stress. Emphasizing proper technique and paying attention to the basic principle of progression are important to an effective and safe exercise prescription.

Setting and Evaluating Goals

Optimal program design needs to be individualized for each client's goals. Personal Trainers encounter an assortment of clients with a plethora of goals, including weight loss; weight gain; building strength; building muscle; improving overall health; improving speed, agility, power, balance, and coordination; decreasing blood pressure or cholesterol level; managing diabetes and other chronic diseases; injury rehabilitation; or sport-specific training. Often, the desired goals of clients are unrealistic. When improvements do not meet expectations, motivation can be lost, frustration may set in, and nonadherence to the program can occur. Therefore, it is crucial that the Personal Trainer help the client understand what realistic and obtainable goals are, considering the time course, the individual's training history and status, fitness level, and genetic potential. The expectations of the client must be realistic and measurable (see Chapter 8), considering the physiological time course of neural and cellular adaptations. Goal setting and time frame, as well as the individual's age, physical maturity, training history, and psychological and physical tolerance, should also be considered. Progression toward the goals must be gradual to minimize the risk of injury.

Common program goals in resistance training are related to improvements in function, such as increased muscular strength, power, and local muscular endurance, or decreased body fat (Fig. 14.2). Other functional gains such as increased coordination, agility, balance, and speed are also common goals of a program. Factors such as balance may have implications for injury prevention by limiting falls in older individuals. Other goals may relate to physiological changes related to increased body mass through muscle hypertrophy, improved blood pressure, decreased body fat, and increased metabolic rate for caloric expenditure.

FIGURE 14.2. Setting goals and evaluating progress in a resistance training program are vital to realistic progress and gains.

For the most part, training goals or objectives should be measurable variables (*e.g.*, 1-RM strength, vertical jump height, and fat mass loss) so that one can objectively judge whether or not gains were made or goals were achieved. Examination and evaluation of a workout log is invaluable in assessing the effects of various resistance training programs. Formal strength tests to determine functional changes in strength can be done on a variety of equipment, including isokinetic dynamometers, free weights, and machines. Using the results of these objective tests can help in modifying the exercise program to reach previous training goals or to develop new goals.

Athletic performance and good health are not always the same thing. A person being a competitive athlete does not mean that he or she makes healthy choices or has a healthy lifestyle. Many elite athletes train in ways that far exceed what is recommended for good health (*e.g.*, lifting 7 $d \cdot wk^{-1}$ or running 140 miles in a week or training 4–6 $h \cdot d^{-1}$). In fact, they may actually do exercises that would be considered contraindicated for the average healthy person. Thus, goals in resistance training have to be put in the context of the desired outcome not only for each individual but also within what is healthy.

Athletic performance and good health are not always the same thing.

Maintenance of Training Goals

A concept called "capping" may need to be applied to various training situations in which small gains will require very large amounts of time to achieve, and yet, in the long run, these small gains are not necessary for success. Capping a training goal is a tough decision that comes only after an adequate period of training time and observation of what the realistic potential for further change is for a particular variable. This may be related to a performance goal (*e.g.*, bench press 1-RM strength) or some form of physical development (*e.g.*, calf size). At some point, one must make a value judgment on how to best spend training time. By not adding any further training time to develop a particular muscle characteristic (*e.g.*, strength, size, and power), one decides that the current gains are "good enough," and it is time to go into a maintenance training program. Thus, more training time is available to address other training goals. Ultimately, this decision may result in greater total development of the individual.

Decisions such as capping are part of the many types of clinical decisions that must be made when monitoring the progress of resistance training programs. Are the training goals realistic in relation to the sport or health enhancement for which the client is being trained? Is the attainment of a particular training goal vital to the program's success? These difficult questions need to be continually asked in the goal development phase of each training cycle for any program.

Unrealistic Goals

Too often, goals are open-ended and unrealistic. Careful attention must be paid to the magnitude of the performance goal and the amount of training time needed to achieve it. Although scientific studies may last up to 6 months, most real-life training programs are developed as a part of a lifestyle for an individual's sports career or whole life. Over time, clients' goals change, and thus, resistance training programs must also change to reflect these changing needs.

Goals may at times exceed the reality of genetic limitations. For example, some men desire near impossible and extreme muscle size (*e.g.*, 23-in biceps, 36-in thighs, 20-in neck, and 50-in chest) or strength (*e.g.*, 400-lb bench press), or in contrast, some women desire drastic decreases in body weight and limb size and/or shape. Genetic limits in anatomical structure or somatotype may make these changes unattainable (42,43). Ultimately, for both men and women, goals must be carefully and honestly examined to determine if the resistance training program can actually stimulate the changes desired.

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Big marketing of the newest high-tech fitness equipment and training programs can also create unrealistic training expectations in clients. Airbrushed pictures of movie actors and models advertising a specific program or product project body images that are desired but totally unobtainable. Most people make mistakes in goal development by wanting too much too soon, with too little effort expended. Making progress in a resistance training program requires a long-term commitment to a total training program. Thus, resistance training is one aspect of an overall healthy lifestyle that includes cardiovascular conditioning and proper nutrition.

Resistance Training Modalities

Many different training tools (*e.g.*, free weights, machines, and medicine balls) can be used in resistance training programs. Each tool fits into a category of training, which has certain inherent strengths and weaknesses. The modality chosen should depend on the accessibility of equipment, needs, goals, experiences, and limitations of the client.

Variable-Resistance Devices

Variable-resistance equipment operates through a lever arm, cam, or pulley arrangement. Its purpose is to alter the resistance throughout the exercise's ROM in an attempt to match the increases and decreases in strength (*i.e.*, strength curve). Proponents of variable-resistance machines believe that by increasing and decreasing the resistance to match the exercise's strength curve, the muscle is forced to contract maximally throughout the ROM, resulting in maximal gains in strength.

There are three major types of strength curves: ascending, descending, and bellshaped (Fig. 14.3). In an exercise with an ascending strength curve, it is possible to lift more weight if only the top one-half or one-fourth of a repetition is performed rather than if the complete ROM of a repetition is performed. For example, an exercise with an ascending strength curve is the squat exercise. If an exercise has a descending strength curve, it is possible to lift more weight if only the bottom half of a repetition is performed. Such an exercise is upright rowing. A bell-shaped curve is an exercise in which it is possible to lift more resistance, if only the middle portion of the ROM is performed and not the beginning or end portions of the ROM. Elbow flexion has a bell-shaped strength curve. Because there are three major types of strength curves, variable-resistance machines have to be able to vary the resistance in three major patterns to match the strength curves of all exercises (44). To date, this has not been accomplished. Additionally, because of variations in limb length (point of attachment of a muscle's tendon to the bones) and body size, it is hard to conceive of one mechanical arrangement that would match the strength curve of all individuals for a particular exercise (44–46).

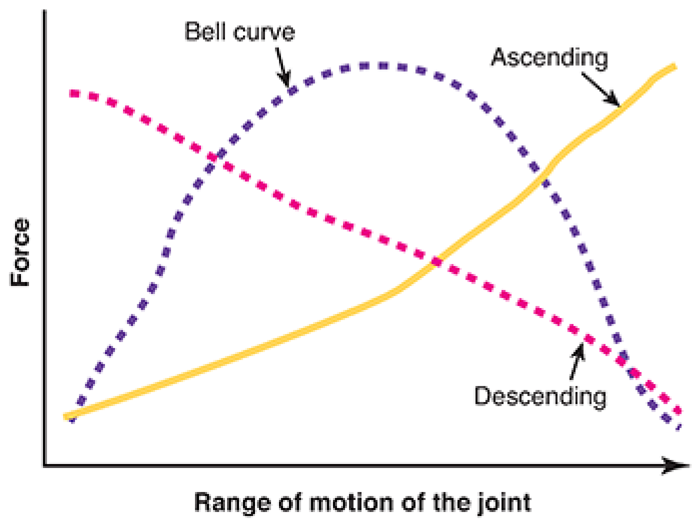


FIGURE 14.3. Three basic strength curves exist for every exercise, with hybrids of them for certain movements.

Biomechanical research indicates that certain types of cam-operated variable-resistance equipment do not match the strength curves of specific exercises such as the elbow curl, fly, knee extension, knee flexion, and pullover exercises (47–53). For example, one type of cam equipment was shown to match the strength curves of females fairly well (54), although not for all aspects of each exercise. For example, in women, the cam resulted in too much resistance near the end of the knee extension exercise and provided too much resistance during the first half and too little during the second half of elbow flexion and extension. The knee flexion machine matched the female's strength curve well throughout the ROM. This research indicates that not all machines are appropriate for all populations or for all exercises.

Elastic resistance bands have become popular within the fitness world because they are relatively easy to work with and less intimidating to clients. Although very effective as a training modality (55) if the resistance can be heavy enough (56), care must be taken when using elastic bands with certain types of exercises that do not match the ascending strength curve. A possible drawback to elastic bands is that the constantly increasing resistance offered as the band is stretched. In other words, elastic bands have a resistance pattern that only matches an ascending strength curve. At the beginning of a muscle flexion, the resistance is low, and at the end of the flexion, the resistance is very high. If the setup is not correct, only part of the muscle involved in the latter part of the flexion may be optimally stimulated. Thus, proper starting angle, band fit, and stretch are essential for optimal training outcome. Also, because of the physics of elastic bands, the resistance during the extension phase will be lower than that during the flexion phase, again reducing the training stimulus. In addition, elastic bands give minimal feedback to clients or trainers in that the resistance cannot be quantified.

Dynamic Constant External Resistance Devices

Isotonic is traditionally defined as a muscular contraction in which the muscle exerts a constant tension. The execution of free-weight exercises and exercises on various weight training machines, although usually considered isotonic, is not by nature isotonic. The force exerted by a muscle in the performance of such exercises is not constant but varies with the mechanical advantage of the joint involved in the movement and the length of the muscle at a particular point in the movement. A more workable definition of isotonic is a resistance training exercise in which the external resistance or weight does not change and both a lifting (concentric) phase and a lowering (eccentric) phase occur during each repetition. Thus, free-weight exercises and exercise machines that do not vary the resistance are isotonic in nature. Because there is confusion concerning the term *isotonic*, the term *dynamic constant external resistance training* has been adopted.

The types of devices used for dynamic constant external resistance include dumbbells, barbells, kettle bells, weight machines, sandbags, and medicine balls. These are generally devices that do not use pulleys or levers. The major disadvantage to this type of device is that it does not stimulate the neuromuscular systems involved maximally throughout the entire ROM. The changes in the musculoskeletal leverage occurring during a movement also change the force requirement and thus the exercise stimulus. However, these types of devices require recruitment of muscles, other than the primary movers of an exercise, to act as stabilizers. This increases the total amount of physiological work the body must do to perform the exercise as well as providing exercise stimuli to the stabilizing muscles that are very important in a real-world setting or for athletic performance. These types of modalities are referred to as "free form" exercises because they operate in multiple dimensions of space (frontal, sagittal, and transverse planes). Other benefits to most constant external resistance devices include little or no limitation in the ROM allowed and easy adaptation of the exercise to accommodate individual differences such as the clients' body size or physical capabilities. Equipment fit is also not a limiting factor for large and small body sizes and limb lengths.

Static Resistance Devices

Specialized static or isometric contraction devices, in which a person pulls or pushes against an immovable resistance, are not as commonly used in Personal Training. That state, pushing an overloaded barbell against the safety racks, or using a wall or partner for an isometric contraction, can be used for an individual to overcome a sticking point, and this form of resistance exercise is called "functional isometrics." Meaning that isometric training can be effective for superior joint angle specific strength (57). Isometrics or static resistance training refers to a muscular action in which no change in the length of the muscle takes place. This type of resistance training is normally performed against an immovable object such as a wall, barbell, or weight machine loaded beyond the maximal concentric strength of an individual.

Isometrics can also be performed by having a weak muscle group contract against a strong muscle group (*e.g.*, trying to bend the left elbow by contracting the left elbow flexors maximally while resisting the movement by pushing down on the left hand with the right hand with just enough force to prevent any movement at the left elbow). If the left elbow flexors are weaker than the right elbow extensors, the left elbow flexors would be performing an isometric action at 100% of a maximal voluntary contraction (MVC).

Increases in strength resulting from isometric training are related to the number of muscle actions performed, the duration of the muscle actions, whether the muscle action is maximal or submaximal, the angle at which the exercise is performed, and the frequency of training. Recommendations for muscular hypertrophy include isometric contractions at 70%–75% of MVC for 3–30 seconds per contraction with a total duration of 80–150 seconds per session. For maximal strength gains, isometric contractions should be performed at 80%–100% MVC for 1–5 seconds with a total contraction time of 30–90 seconds per session (57). Isometric exercises are thought to strengthen muscle fibers within 15° of the position being held isometrically, and therefore, clients should perform multiple positions with isometric contraction to ensure full ROM strengthening. Also, isometric training is good for individuals with joint disorders in which pain is elicited by motion (*i.e.*, rheumatoid arthritis).

Other Resistance Devices

Isokinetic devices allow one to maintain a maximum resistance throughout the whole ROM by controlling the speed of the movement. These devices use friction, compressed air, or pneumatics, which often allow for both the concentric and the eccentric component of a repetition, or hydraulics for the concentric component of a repetition. Isokinetic exercises, although popular in the rehabilitation setting, have never caught on as a typical modality used in a weight room. The initial excitement for this training modality was related to the ability to train at fast velocities similar to the high-speed movements seen in sport and real life. Isokinetic refers to a muscular action performed at constant angular limb velocity. Unlike other types of resistance training, there is no set resistance to meet; rather, the velocity of movement is controlled. The resistance offered by the isokinetic machine cannot be accelerated; any force applied against the equipment results in an equal reaction force. The reaction force mirrors the force applied to the equipment by the user throughout the range of movement of an exercise, making it theoretically possible for the muscle(s) to exert a continual, maximal force through the movement's full ROM.

Pneumatic resistance (compressed air) exercise has become relatively popular because it allows both the concentric and eccentric portions of a repetition and can be adjusted during a repetition or a set of exercises with handheld buttons. In addition, with no deceleration, it can be used effectively to train power with joint exercises not possible with conventional machines. Power is as important for older adults to maintain function as it is for athletes' performance. Because of the fixed nature of the configuration for most pneumatic machines, they are unable to address key factors such as balance and control in a multidimensional environment.

Hydraulics equipment has also become more popular with many fitness clubs promoting it as a safe and nonintimidating form of resistance exercise. Although this modality has no deceleration in its repetition range and has been used as a type of power training modality, it also has no eccentric component, which limits its efficiency as twice the number of repetitions may be required to get the same effect as a typical concentric–eccentric repetition (58,59). Training the eccentric phase is important to protect the body from injury and also to enhance the ability to recover from injury. Furthermore, concentric-only training appears to be less resistant to detraining (60,61).

Machines versus Free-Weight Exercises

A topic of great debate, especially in the health and fitness world, is the use of free weights versus machine resistance exercises. These different exercise modalities were discussed previously in the sections on constant external resistance and variable-resistance devices. The following is a comparison of the two modalities.

A topic of great debate, especially in the health and fitness world, is the use of free weights versus machine resistance exercises.

1. Machines are not always designed to fit the proportions of all individuals. Clients who are obese; who have special physical considerations or disabilities; and who are shorter, taller, or wider than the norm may not be able to fit comfortably in the machines. In contrast, free-weight exercises can easily be adapted to fit most clients' physical size or special requirements.
2. Machines use a fixed ROM; thus, the individual must conform to the movement limitations of the machine. Often, these movements do not mimic functional or athletic movements. Free weights allow full ROM, and the transfer to the real-world movements is greater than that for machines.
3. Most machines isolate a muscle or muscle group, thus negating the need for other muscles to act as assistant movers and stabilizers. Free-weight exercises almost always involve assisting and stabilizing muscles. On the other hand, if the goal is to isolate a specific muscle or muscle group, as in some rehabilitation settings or because of physical disabilities, machine exercises may be preferred.
4. Although it is never advisable to perform resistance exercise alone, machines do allow greater independence because the need for a spotter or helper is usually diminished once the client has learned the technique of the exercise. However, there is a misconception of extra safety that may lead to a lack of attention being paid to the exercise. Injuries are still possible when using machines, specifically when there is a breakdown in lifting form or improper seat height, lifting form, and/or joint alignment.

5. Machine exercises may be more useful than free-weight exercises in some special populations. One reason for this is that machines are often perceived to be less intimidating to a beginner. As the resistance training skill and experience level increases, free-weight exercise can gradually be introduced, if desired. However, it is important to inform clients of the benefits that free weights have compared with machines (*e.g.*, increased musculoskeletal loading that reduces the risk of developing osteoporosis, improved balance).
6. Certain free-weight exercises (*e.g.*, Olympic-style lifts) and hydraulic and pneumatic machines allow training of power because no joint deceleration occurs. (It should be noted that a certain amount of deceleration does occur during the lockout of the catch phases for various Olympic lift and free-weight movements.)
7. Rotational resistance accommodates certain body movements (*e.g.*, shoulder adduction) that would be difficult to work through a full ROM with free weights.

From the comparison earlier, it seems that variable-resistance devices (machines) in general are at a comparative disadvantage to constant resistance devices (free weights). However, machine exercises are still recommended for certain populations and can be very useful when used appropriately. In fact, a safe and optimally effective resistance training program involves a combination of both free-weight and machine exercises, taking into consideration many aspects of the client’s needs and the advantages of the different modalities. Both modalities can be used to add variation to the training program and are effective “tools” in a Personal Trainer’s “tool box.” To summarize, for the general population, a combination of free weights and variable-resistance machines are generally most effective. Machines and other variable-resistance devices are recommended as an adjunct to a free-weight training program in midlevel and advanced clients.

For the general population, a combination of free weights and variable-resistance machines are generally most effective.

The Needs Analysis

Before designing a training program, a needs analysis of the client should be performed to design the most effective program. Once the needs and goals of the client have been established, the Personal Trainer can address questions that will come up when designing the workout using the acute program variables.

A needs analysis for strength training involves answering some important initial questions that affect the program design components (13,62,63). The needs analysis requires that the following questions be considered:

1. What is the main goal of the resistance training program?
2. What muscle groups need to be trained?
3. What are the basic energy sources (*e.g.*, anaerobic, aerobic) that need to be trained?
4. What type of muscle action (*e.g.*, isometric, eccentric actions) should be used?
5. What are the primary sites of injury for the particular sport or prior injury history of the individual?

Resistance Training Goals

The first question to be asked of the client concerns the main goal for the resistance training program. A discussion with the client of what type of outcome (*i.e.*, general health, muscular strength, muscular endurance, muscular hypertrophy, and/or muscular power) he or she desires will help the Personal Trainer develop an appropriate program. Each of the aforementioned program goals will require a different program design to optimize the stated goals. Reviewing these with the client allows for discussion of realistic expectations and time commitments before continuing with more extensive program evaluation procedures.

Biomechanical Analysis to Determine Which Muscles Need to Be Trained

In determining the client's needs and goals, an examination of the muscles and the specific joint angles to be trained needs to be conducted. For any activity, including a sport, this involves a basic analysis of the movements performed and the most common sites of injury. With the proper equipment and a background in basic biomechanics, a more definitive approach to this question is possible. With the use of a slow-motion videotape, a Personal Trainer can better evaluate specific aspects of movements and can conduct a qualitative analysis of the muscles, angles, velocities, and forces involved. The decisions made at this stage help define one of the acute program variables — choice of exercise.

Specificity is a major tenet of resistance training and is based on the concept that the exercises and resistances used should result in training adaptations that will transfer to better performance in sport or daily activity. Resistance training is used because it is often difficult, if not impossible, to overload a sport skill or other physical movement without risk of injury or dramatically altering skill technique. Specificity assumes that muscles must be trained similarly to the sport or activity in terms of the following:

- The joint around which movement occurs
- The joint ROM
- The pattern of resistance throughout the ROM (ascending, descending, or bell-shaped)
- The pattern of limb velocity throughout the ROM
- The types of muscle contraction (*e.g.*, concentric, eccentric, or isometric)

Resistance training for any sport or activity of daily living should include full ROM exercises around all the major body joints. For example, for general fitness and muscular development, the major muscle groups of the hips and legs, chest, back, shoulders, low back, and abdominals should be the training focus. For those who are interested in enhancing sport performance, specific sport activity movements should be included in the workout to maximize the contribution of strength training to those movements. The best way to select appropriate exercises is to biomechanically analyze, in quantitative terms, the sport or physical activity (64). Unfortunately, such analyses of each sport or activity are not readily available to the Personal Trainer. Thus, the Personal Trainer must use biomechanical principles in a qualitative manner to intelligently select exercises. Ideally, this analysis should be followed up with appropriate resistance exercises in the weight room that train the specific muscles and joint angles involved.

> Biomechanical principles can be used in a qualitative manner to intelligently select exercises.

Transfer Specificity

Each resistance exercise used in a program will have various amounts of transfer to another activity, referred to as "transfer specificity." When training for improved health and well-being, transfer is related to its effects on specific clinical outcomes (*e.g.*, bone mineral density). However, training for enhancing sport performance requires equally specific exercises. Every training activity has a percentage of carryover to other activities, but no conditioning activity has perfect carryover. Although some activities have a higher percentage of carryover than others, because of similarities in neuromuscular recruitment patterns, energy systems, and biomechanical characteristics, only by practicing the exact task (*e.g.*, lifting groceries or shoveling snow) or sport (*e.g.*, running or basketball) itself is the training 100% transferred.

Unfortunately, most of the time, one cannot use the specific sport or activity as the training stimulus because it is not possible or safe to gain the needed "overload" on the neuromuscular system. Thus, this is why resistance training is used in the conditioning process. The optimal training program needs to maximize carryover to the sport or activity.

Determining the Energy Sources Used in the Activity

Performance of every sport or activity uses a percentage of all three energy sources. The energy sources (see Chapter 5) to be trained have a major impact on the program design. Resistance training usually stresses the anaerobic energy sources (adenosine triphosphate–creatine phosphate [ATP–CP] energy source and glycolytic energy source) more than aerobic metabolism (65). Individuals who have gained initial cardiovascular fitness will have difficulty improving maximal oxygen consumption values using conventional resistance training alone (66). However, resistance training can be used to improve endurance performance by improving running/cycling efficiency and economy (67). In addition, systematic reviews of the literature have reported that concurrent resistance and endurance training has a positive effect on endurance performance among well-trained runners and cyclists (67–69).

Selecting a Resistance Modality

Decisions regarding the use of isometric, dynamic concentric, dynamic eccentric, and isokinetic modalities of exercise are important in planning *any type* of resistance training program. Not all equipment uses concentric and eccentric muscle actions, and this can impact training effectiveness (*e.g.*, hydraulics) (70). Whether for sport, fitness, or rehabilitation, basic biomechanical analysis is used to decide which muscles to train and to identify the type of muscle action is involved in the activity. Most resistance training programs use several types of muscle actions.

Injury Prevention Exercises

Personal Trainers need to know the prior injury profile of their client and the common sites of potential injury from the sport or recreational activity performed or other daily activities. The prescription of resistance training exercises will be directed at enhancing the strength and function of tissue to better resist injury, enhance recovery if injured, and minimize the extent of damage related to an injury. The term *prehabilitation* (the opposite of rehabilitation) has become popular. Prehabilitation refers to preventing initial injury by training the joints and muscles that are most susceptible to injury in an activity (such as a rotator cuff program for throwing athletes). The prevention of reinjury is also an important goal of a resistance training program. Thus, understanding the sport's or activity's typical injury profile (*e.g.*, knees in downhill skiing, elbows and shoulders in baseball pitching, extended hours sitting or standing for work) and the individual's prior history of injury can help in properly designing a resistance training program.

Acute Program Variables

Developed more than 20 years ago, the paradigm of acute program variables allows one to define every workout (63). Every resistance exercise protocol or workout is derived from five acute program variables. The classical acute program variables are (a) choice of exercises, (b) order of exercises, (c) amount of resistance and number of repetitions, (d) number of sets, and (e) duration of rest periods between sets and exercises. In turn, the choices made for each of these variables define the exercise stimuli and ultimately, with repeated exposure, the training adaptations. Essentially, the choices made for the specific combination of acute program variables create an exercise stimulus "fingerprint" that is specific and unique to that workout protocol. Thus, by making specific choices for the acute program variables that are related to the needs and goals of the client, the Personal Trainer is able to create many different types of workouts (6).

The classical acute program variables are (a) choice of exercises, (b) order of exercises, (c) amount of resistance and number of repetitions, (d) number of sets, and (e) duration of rest periods between sets and exercises.

Choice of Exercises

The choice of exercise will be related to the biomechanical characteristics of the goals targeted for improvement. The number of possible joint angles and exercises is almost as limitless as the body's functional movements. As muscle tissue that is not activated will not benefit from resistance training, the exercises should be selected, so they stress the muscles, joints, and joint angles specified by the client's needs analysis. To aid the Personal Trainer in making the correct choices, exercises can be divided into several different categories based on their function and/or muscle involvement.

Exercises can be designated as primary exercises or assistance exercises. Primary exercises train the prime movers in a particular movement and are typically major muscle group exercises (*e.g.*, leg press, bench press, hang pulls). Assistance exercises are exercises that train predominantly a single muscle group (*e.g.*, triceps press, biceps curls) that aids (synergists or stabilizers) in the movement produced by the prime movers.

Exercises can be classified as multijoint or single-joint exercises. Multijoint exercises require the coordinated action of two or more muscle groups and joints. Power cleans, power snatches, dead lifts, and squats are good examples of whole-body multijoint exercises. The bench press, which involves movement of both the elbow and shoulder joints, is also a multijoint, multimuscle group exercise, although it involves only movement in the upper body. Some examples of other multijoint exercises are the lat pull-down, military press, and squat. Exercises that attempt to isolate a particular muscle group's movement of a single joint are known as single-joint and/or single-muscle group exercises. Biceps curls, knee extensions, and knee curls are examples of isolated single-joint, single-muscle group exercises. Many assistance exercises may be classified as single-muscle group or single-joint exercises.

The inclusion of both bilateral (both limbs) and unilateral (single limb) exercises in a program will ensure proper balance in the development of the body. Bilateral differences in muscle force production can be developed with one limb working harder on every repetition than the other, leading to an obvious force production deficit and imbalances between limbs. Unilateral exercises (*e.g.*, dumbbell biceps curl) play an important role in helping maintain equal strength in both limbs.

Multijoint exercises require neural coordination among muscles and thus promote coordinated multijoint and multimuscle group movements. Although multijoint exercises require a longer initial learning or neural phase than single-joint exercises (71), including multijoint exercises in a resistance training program is crucial, especially when whole-body strength movements are required for a particular activity. Multijoint exercises activate several different muscle groups at the same time and thus are time-efficient. Therefore, they can be especially useful for an individual or a team with a limited amount of time for each training session. Other benefits of multijoint exercises include enhanced hormonal response and greater metabolic demands. Be aware that many multijoint exercises, especially those with an explosive component, require advanced lifting techniques (*e.g.*, power cleans, power snatches). These exercises need additional coaching, practice, and skill development beyond the basic movement patterns. Almost all sports and functional activities in everyday life (*e.g.*, climbing stairs) depend on structural multijoint movements. Whole-body strength/power movements are the basis for success in most sports. Clearly, all running, jumping, or striking activities, as well sport-specific movements such as tackling in American football, a takedown in wrestling, or hitting a baseball, depend on whole-body strength/power movements. Thus, incorporating multijoint exercises in a resistance training program is important for all competitive or recreational athletes.

Order of Exercises

The order in which exercises are performed is an important acute program variable that affects the quality and focus of the workout. ACSM recommends that by exercising the larger muscle groups first, a superior training stimulus is presented to all of the muscles involved (9). Exercising the larger muscles first is thought to stimulate optimal neural, metabolic, endocrine, and circulatory responses, which may augment the training response to subsequent exercises later in the workout. This concept also applies to the sequencing of multijoint and single-joint exercises. The more complex multijoint technique-intensive exercises (*e.g.*, power cleans, squats) should be performed initially followed by the less complex single-joint exercises (*e.g.*, leg extension, biceps curls).

The rationale for this exercise sequencing recommendation is that the exercises performed in the beginning of the workout require the greatest amount of muscle mass and energy for optimal performance. This has been observed (72) during resistance exercise, where multiple-set performance was affected by order of exercise, meaning volume was greater when the exercise was placed at the beginning of a workout. These sequencing strategies focus on attaining a greater training effect for the large muscle group exercises. If multijoint exercises are performed early in the workout, more resistance can be used because of less fatigue in the smaller muscle groups that assist the prime movers during the multijoint exercises. Also, alternating upper and lower body exercises and/or pushing and pulling exercises allows more time for the assisting muscles to recover between exercises.

If multijoint exercises are performed early in the workout, more resistance can be used because of less fatigue in the smaller muscle groups that assist the prime movers during the multijoint exercises.

Because the order of exercise affects the outcome of a training program, it is important to have the exercise order correspond to the specific training goals. In general, the sequence of exercises for both multiple and single muscle group exercise sessions should be as follows:

1. Large muscle group before small muscle group exercises
2. Multijoint before single-joint exercises
3. Alternate push/pull exercises for total body sessions
4. Alternate upper/lower body exercises for total body sessions
5. Explosive/power type lifts (*e.g.*, Olympic lifts) and plyometric exercises before basic strength and single-joint exercises
6. Exercises for priority weak areas before exercises for strong areas
7. Most intense to least intense (particularly when performing several exercises consecutively for the same muscle group)

Resistance and Repetitions

The amount of resistance used for a specific exercise is one of the key variables in any resistance training program. The resistance is the major stimulus related to changes observed in measures of strength, hypertrophy, and local muscular endurance. When designing a resistance training program, the resistance for each exercise must be chosen carefully. The use of either RMs (the maximal load that can be lifted, the specified number of repetitions) or the absolute resistance, which allows only a specific number of repetitions to be performed, is the easiest method for determining resistance. Typically, a single training RM target (*e.g.*, 10-RM) or an RM target range (*e.g.*, 3–5 RM) is used. The absolute resistance is then adjusted to match the changes in strength over the training program. Every set is done until failure (*e.g.*, momentary muscular fatigue) to ensure that the resistance used corresponds to the prescribed number of repetitions. This is because performing 3–5 repetitions with a resistance that allows for only 3–5 repetitions produces very different results than performing 13–15 repetitions using a resistance that would allow for only 13–15 repetitions.

When designing a resistance training program, the resistance for each exercise must be chosen carefully.

Another method of determining resistances for an exercise involves using a percentage of the 1-RM (*e.g.*, 70% or 85% of the 1-RM). If the client's 1-RM for an exercise is 200 lb (90.7 kg), a 70% resistance would be 140 lb (63.5 kg). This method requires that the maximal strength in all exercises used in the training program must be evaluated regularly. In some exercises, percentage of 1-RM needs to be used, as going to failure or near-failure is not practical (*e.g.*, power cleans, Olympic-style lifts). Without regular 1-RM testing (*e.g.*, each week), the percentage of 1-RM actually used during training, especially at the beginning of a program, will decrease, and the training intensity will be reduced. From a practical perspective, the use of percentages of 1-RM as the resistance for many exercises may not be administratively effective because of the amount of testing time required. In addition, for beginners, the reliability of a 1-RM test can be poor. Instead, by using the RM target or RM target range, the Personal Trainer has the ability to alter the resistance in response to changes in the number of repetitions that can be performed at a given absolute resistance.

As is the case for any of the acute program variables, the loading intensity should depend on the goal and training status of the client. The intensity of the loading (as a percentage of 1-RM) has an effect on the number of repetitions that can be performed and vice versa. The number of repetitions that can be performed at a given intensity ultimately determines the effects of training on strength development (73). If a given absolute resistance allows a specific number of repetitions (defined as the RM), then any reductions in the number of repetitions without an increase in the resistance will cause a change in the training stimulus. In this case, the change in the stimulus will lead to a change in the motor units recruited to perform the exercise and thus the neuromuscular adaptations. Differences exist between free weights and machines for percentage of RM used. For example, in a squat exercise, one may be able to perform only 8–10 repetitions, whereas in the leg press, 15–20 repetitions are possible. Differences exist related to the amount of balance and control that is needed in the exercise and the size of the muscle groups. For example, free-weight exercises require more neural control and activation of assistance muscles; also as the muscle group gets smaller, the magnitude of the response to a given percentage of the 1-RM is reduced.

The neuromuscular adaptations to resistance training depend on the amount and modality of resistance used. These adaptations follow the SAID principle presented earlier in this chapter. Compared with lower resistances, heavier resistances will allow lower numbers of repetitions (9,58,73) but will lead to greater improvements in maximal strength (9,10). Thus, if maximal strength development is desired, heavier loads should be used. Alternately, if muscular endurance is the goal, a lower load should be used, which will in turn allow a greater number of repetitions (12–15 RM) to be conveyed (68,73). Alternately, adaptations specific to muscular hypertrophy necessitate a differential training style. Recent systematic reviews and meta-analysis as well as reviews of the literature recommend a range of anywhere from 6–20 repetitions to optimize exercise-induced hypertrophic adaptations (9,28). Training at lower intensities (as low as 30% of 1-RM) to volitional fatigue as well as training across a wide spectrum of loads (6–20 repetitions range) can be used to induce alterations in muscular size (28,74). (See Tables 14.1–14.3 for more information relative to the guidelines set for by ACSM with regard to intensity of training.)

Table 14.1 ACSM Recommendations for Muscular Strength (9,14)

Novice Individuals	
Volume	1–3 sets per exercise
Intensity	Can range between 40% and 85% 1-RM Mean training intensity of 60% 1-RM 8–12 reps

Rest period	2–3 min between sets for core lifts 1–2 min for assistance exercises
Frequency	1–3 d · wk^{-1}
Trained Individuals	
Volume	Multiple set programs with systematic variations in volume and intensity
Intensity	Cycling load of 80%–100% 1-RM Progressing to heavy loads 1–6 reps
Rest period	2–3 min between sets for core lifts 1–2 min for assistance exercises Extended rest periods may be necessary
Frequency	4–6 d · wk^{-1}

Data from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2022. 548 p; and American College of Sports Medicine. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. *Med Sci Sports Exerc*. 2009;41(3):687–708.

Table 14.2 ACSM Recommendations for Muscular Hypertrophy (9,14,76)

Novice Individuals	
Volume	1–3 sets per exercise
Intensity	Lower load training 30% 1-RM+ to volitional fatigue or 70%–80% 1-RM 6–20 reps
Rest period	1–2 min
Frequency	Novice: 2–3 d · wk^{-1} Intermediate: up to 4 d · wk^{-1} for split routines
Trained Individuals	
Volume	3–6 sets per exercise in a periodized manner
Intensity	Lower load training 30% 1-RM+ to volitional fatigue Up to 20 reps or

	70%–100% 1-RM be used 1–12 reps per set 6–12 reps for the majority
Rest period	2–3 min for heavy loading 1–2 min moderate to moderate–high intensity
Frequency	4–6 d · wk^{-1}

Data from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2022. 548 p; and American College of Sports Medicine. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. *Med Sci Sports Exerc*. 2009;41(3):687–708.

Table 14.3 ACSM Recommendations for Muscular Power (9,14)

Novice Individuals	
Volume	1–3 sets per exercise
Intensity	Light to moderate load — moved at maximal velocity 30%–60% of 1-RM for upper body exercises 0%–60% of 1-RM for lower body exercises 3–6 repetitions not to failure
Rest period	2–3 min between sets for primary exercises when intensity is high 1–2 min for assistance exercises or lower intensity exercises
Frequency	Novice: 2–3 d · wk^{-1} Intermediate: 3–4 d · wk^{-1}
Trained Individuals	
Volume	3–6 sets per exercise
Intensity	Heavy loading 85%–100% of 1-RM (necessary for increasing force) Light to moderate loading 30%–60% of 1-RM for upper body exercises 0%–60% of 1-RM for lower body exercises Performed at an explosive velocity 1–6 reps in a periodized manner
Rest period	2–3 min between sets for primary exercises when intensity is high 1–2 min for assistance exercises or lower intensity exercises
Frequency	

	4–5 d · wk^{-1}

Data from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2022. 548 p; and American College of Sports Medicine. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. *Med Sci Sports Exerc*. 2009;41(3):687–708.

Number of Days per Week of Training (Frequency)

Frequency of training (*i.e.*, number of days per week) is another program variable that needs to be determined when developing an optimal resistance exercise program. Factors such as desired outcome, training status, competition season (for athletes), and type of training session (full-body or split routine) are a few of the variables that should be considered when developing the frequency recommendations of a resistance training program.

When health-related benefits are the desired outcome for the program, ACSM has proposed that 2–3 d · wk^{-1} using a full-body resistance training program are sufficient. These recommendations are consistent with the *Physical Activity Guidelines for Americans*, second edition, which recommends 2 or more days per week of muscle strengthening activities. However, additional training days may be necessary for intermediate (4–5 d · wk^{-1}) and advanced trained individuals (4–6 d · wk^{-1}) for continued strength-related gains. These additional days may allow for greater volume of training, which appears to be a primary modulator in training adaptation. There are additional recommendations for frequency of training when hypertrophic, muscular endurance, power, or motor adaptations are the desired outcome (9). Tables 14.1–14.3 provide more information on the training frequency recommendations for differential program variables.

Number of Sets for Each Exercise

The number of sets does not have to be the same for all exercises in a workout program. For resistance-trained individuals, multiple-set programs have been found to be superior for strength, power, hypertrophy, and high-intensity endurance improvements (9,10,75). Additionally, recent meta-analytic research has shown a dose-response relationship between set number and muscular strength and hypertrophy (10,31,32). These findings have prompted support from ACSM for periodized multiple-set programs when long-term progression (not maintenance) is the goal (9). Both single- and multiple-set programs appear to be effective for increasing strength in untrained clients during short-term training periods (*i.e.*, 6–12 wk). However, multiple-set programs are superior for long-term progression. Single-set programs are effective for developing and maintaining a certain level of muscular strength and endurance. For some fitness enthusiasts, this level of muscular fitness may be adequate. Also, one-set programs sometimes result in greater compliance by those who are limited in their time for exercise and also need to perform cardiovascular exercise, flexibility exercise, and so on. Having a client do one set is better than no sets at all. However, no study has shown single-set training to be superior to multiple-set training in either trained or untrained individuals.

The number of sets is one of the critical variables in the exercise volume equation (*e.g.*, volume = sets × reps × resistance). The principle of variation in training or, more specifically, "periodized training" involves the number of sets and volume performed. Exercise volume is a vital concept in resistance training progression, especially for those who have already achieved a basic level of training or strength fitness. Some short-term studies (9,10) and most long-term studies (9,10) support the contention that the greater training stimulus associated with the higher volume from multiple sets is needed to create further improvement and progression in physical adaptation and performance. Meta-analytic research has shown that as experience in training increases, the need for greater volumes of training also increases (10,31,32). Use of a constant-volume program can lead to staleness and lack of adherence to training. Making variations in training volume (*i.e.*, both low- and high-volume exercise protocols) are critical during a long-term training program to continue to provide appropriate overload stimulus yet also to provide adequate rest and recovery periods. This concept is addressed later in this chapter under "Periodization of Exercise." See Tables 14.1–14.3 for more information on training recommendations from ACSM.

> The number of sets performed for each exercise is one variable in what is referred to as the volume of exercise equation (*e.g.*, sets × reps × resistance) calculation.

Duration of Rest Period between Sets and Exercises

The rest periods play an important role in dictating the metabolic stress of the workout and influence the amount of resistance that can be used during each set or exercise. A major reason for this is that the primary energy system used during resistance exercise, the ATP–CP system, needs to be replenished, and this process takes time (see Chapter 5). Therefore, the duration of the rest period significantly influences the metabolic, hormonal, and cardiovascular responses to a short-term bout of resistance exercise as well as the performance of subsequent sets (76,77). For advanced training emphasizing absolute strength, rest periods of at least 2–3 minutes (with the possibility of extended rest periods as long as 3–5 min) are recommended for primary, large muscle mass multijoint exercises (such as squat or dead lift), whereas shorter rest may be sufficient for assistant, smaller muscle mass single-joint exercises (9). That stated, it appears that robust strength gains can be achieved with rest intervals of less than 1 minute. For novice resistance trained individuals, rest periods of 1–2 minutes may suffice for large muscle mass multijoint exercises because the lower absolute resistance used at this training level seems to be less stressful to the neuromuscular system (29). Performance of maximal resistance exercises requires maximal energy substrate availability at the onset of the exercise and thus requires relatively long rest periods between sets and exercises.

> The duration of the rest period significantly influences the metabolic, hormonal, and cardiovascular responses to a short-term bout of resistance exercise as well as the performance of subsequent sets.

Based on an extensive review, a minimum of 3 minutes rest is recommended when training for muscular power (*e.g.*, plyometric jumps) due to the need to perform maximal effort movements (78). Similarly, when training for muscular strength, more than 2 minutes of rest is recommended between sets (29). Alternately, when training for muscular hypertrophy, shorter rest intervals of 30–60 seconds between sets is advocated. The shorter rest interval stimulates greater hormonal activity associated with a hypertrophic effect (78), but some research has noted similar hypertrophic adaptations with longer rest intervals (79).

Resistance training that stresses both the glycolytic and ATP–CP energy systems appears to be superior in enhancing muscle hypertrophy (*e.g.*, bodybuilding); thus, less rest between sets appears to be more effective in high levels of muscular definition. If the goal is to optimize both strength and muscle mass, both long rest with heavy loading and short rest with moderate loading types of workout protocols should be included. However, it should be kept in mind that short-rest resistance training programs can potentially cause greater psychological anxiety and fatigue because of the greater discomfort, muscle fatigue, and high metabolic demands of the program (80). Therefore, psychological ramifications of using short-rest workouts must be carefully considered and discussed with the client before the training program is designed. The increase in anxiety appears to be associated with the high metabolic demands found with short-rest exercise protocols (*i.e.*, 1 min or less). Despite the high psychological demands, the changes in mood states do not constitute abnormal psychological changes and may be a part of the normal arousal process before a demanding workout.

The key to determining optimal rest period lengths is to observe the client. Symptoms of loss of force production in the beginning of the workout and clinical symptoms of nausea, dizziness, and fainting are clear signs of the inability to tolerate the workout. When such symptoms occur, the workout should be stopped and longer rest periods used in subsequent workouts. With aging, rest periods need to be carefully heeded. Aging decreases the ability to tolerate changes in muscle and blood pH and underscores the need for gradual progression of cutting rest period lengths between sets and exercises (76). Typical rest periods are characterized as follows:

- Very short rest periods: 1 minute or shorter
- Short rest periods: 1–2 minutes
- Moderate rest periods: 2–3 minutes
- Long rest periods: 3–4 minutes
- Very long rest periods: 5 minutes or longer

The heavier the resistance, the more rest that should be allowed between sets and exercises. Also, more rest allows for a greater number of repetitions to be performed at a specific RM load (77,78,81). The gradual use of shorter rest periods stimulates improvements in the body's blood bicarbonate and intramuscular buffering systems (77,81). (See Tables 14.1–14.3 for the recommended rest period intervals set forth by ACSM.)

Variation of Acute Program Variables

As long as the demands placed on the neuromuscular system are similar, the acute program variables can be manipulated in various ways to develop different workouts for the single-exercise sessions used over time. The number of sets, number of repetitions, relative resistance used, and rest periods do not have to be the same for each exercise in a session. They can be varied either within an exercise or, more frequently, between different exercises in an exercise protocol. The use of light exercise levels can be used when it is necessary to rest higher threshold motor units (*i.e.*, motor neuron and associated muscle fibers). Motor recruitment follows a "size principle." Because not all motor units are recruited with each resistance loading or contraction of a muscle, different loadings can result in varying amounts and types of muscle tissue being used. Heavier loads with adequate volume recruit more muscle tissue than high repetitions of lower load levels (82). Understanding and using the size principle is vital for developing variation in resistance training and ultimately periodized training.

Muscle Actions

Muscles produce force while performing one of three different actions:

1. When sufficient force is produced to overcome the external load and shorten the muscle, the muscle action is termed a *concentric muscular action* or *contraction*.
2. When the muscle produces force but there is no change in the length of the muscle, the muscular action is termed an *isometric muscular action*.
3. When the production of force occurs while the muscle is lengthening (*i.e.*, resisting the movement), the muscular action is termed an *eccentric muscular action*.

In the past, the term *contraction* was used for each of the three muscle actions; however, only concentric muscle actions actually involve a classic muscle shortening or true contraction. Any exercise can include any combination of the three muscle actions; however, most exercises are performed using either isometric muscle action or both concentric and eccentric muscle actions. However, the most effective training programs appear to use concentric–eccentric repetitions (82). The skeletal muscle force–velocity relationship patterns encompass high- to low-speed eccentric muscle actions, maximal isometric muscle actions, and slow- to high-velocity concentric muscle actions, creating a descending hierarchy of force productions.

> The most effective training programs appear to use concentric–eccentric repetitions.

True Repetition and Range of Movement

Muscle actions involving movement of a joint are termed *dynamic*, and thus, exercises involving joint movements are called dynamic exercises. A full-range dynamic exercise usually contains both a concentric phase and an eccentric phase. The order of the phases depends on the choice of exercise.

A squat, for example, starts with the eccentric phase, whereas a pull-up normally starts with the concentric phase. It is important to perform the exercise so that the joints involved move through a full ROM. This is especially true for single-joint exercises. For example, in the arm curl, a full repetition should start with the elbow almost completely extended, progress until the elbow is maximally flexed, and finish with the elbow almost completely extended again. By using the whole ROM, the whole length of the muscle is stimulated, leading to adaptations throughout the whole muscle. However, ROM may need to be carefully monitored and perhaps restricted when working with clients who have orthopedic injuries or limitations or anatomical joint laxity such as in the knee, elbow, or shoulder.

Periodization of Exercise

Periodization is a concept that is applied in the design of workouts used in an exercise program (16,83). Periodization refers to systematic variation in acute program variables such as the prescribed volume and intensity during different phases of a resistance training program. A traditional linear periodization program contains four phases:

1. Hypertrophy phase, consisting of high volume and short rest periods
2. Strength/power phase, consisting of reduced volume but increased load and rest periods
3. Peaking phase, consisting of low volume but high load and longer rest periods
4. Recovery phase, consisting of low volume and load

> Periodization refers to systematic variation in acute program variables such as the prescribed volume and intensity during different phases of a resistance training program.

There is no set formula for how a program should be periodized because it depends on the specific goals and needs of the client (84). Table 14.4 presents an example of a traditional four-phase periodized training program aimed at producing maximal strength.

Table 14.4 Traditional American-Style Periodization Schedule

Goal	Hypertrophy	Maximal Strength/Power	Peak	Recovery
Repetitions	High	Moderate–low	Low	Moderate
Sets	High	Moderate	Low	Moderate
Rest	Short	Moderate	Long	Moderate
Load	Low	Moderate	Very high	Low
Volume	High–moderate	Moderate	Low	Low

Periodization acts as a way to systematically vary the workout over time. Incorporating periodization into the training program systematically varies the acute program variables, which exposes muscles to different stimuli, leading to greater muscular adaptation and performance. In addition, rest is encouraged at different points in the training program, which allows for appropriate recovery and the prevention of both short- and long-term overtraining. Another important benefit to periodization is that it can reduce the potential boredom found with repeating the same resistance exercise program over and over again, which may improve program adherence. Many different models for periodization have been developed. Thus, the model to be used should be selected on the basis of the needs and desires of the client.

The terms *micro*-, *meso*-, and *macrocycle* refer to the time course of the different phases of periodization. The macrocycle is the largest training cycle time frame. A common example of a macrocycle is a calendar year, and all phases are included in this cycle. A mesocycle refers to the next smaller group of training cycles that make up the macrocycle, usually four to six in a year. Finally, the microcycle is the smallest component, which usually ranges in time from 1 to 4 weeks and is typically dedicated to one type of workout variable in that phase (*e.g.*, high-volume, low-intensity power).

The use of periodized resistance training has been shown to be superior to constant training methods (85). Periodized training involves the planned variation in the intensity of exercises and in the volume of a workout. Typically, one periodizes large muscle group exercises. However, periodization schemes can be created for smaller muscle groups as well. Although opinions among trainers differ regarding the number and time course of the cycles that are most effective, a primary theory suggests that a greater variation in the training stimulus will produce greater overall adaptations in the body. This idea has led to different variations in the classic periodization model. In general, there are two basic types that have been developed for maximal strength development: linear and nonlinear periodized protocols.

Linear Periodization

Classic periodization methods use a progressive increase in the intensity with small variations in each 1- to 4-week microcycle. An example of a classic 16-week, four-cycle linear periodized program is presented in Table 14.5.

Table 14.5 An Example of a Classic Linear Periodized Program Using 4-Week Microcycles

Microcycle 1 (4 wk)	Microcycle 2 (4 wk)	Microcycle 3 (4 wk)	Microcycle 4 (4 wk)	Microcycle 5 (2 wk)
3–5 sets of 12–15 RM	4–5 sets of 8–10 RM	3–4 sets of 4–6 RM	3–5 sets of 1–3 RM	Active rest/recovery

Classic periodization methods use a progressive increase in the intensity with small variations in each 1- to 4-week microcycle.

Although there are some variations within each microcycle, the general trend for the 16-week program is a steady linear increase in the intensity of the training program. Microcycle 5 is a 2-week active rest period in which no lifting is done or only a very light, low-volume training is used prior to the next mesocycle. Because of the straight-line increase in the intensity of the program, it has been termed "linear" periodized training. Linear periodization originally evolved from training for single-peak performance events (*e.g.*, track and field, weightlifting). Thus, consecutive or linear buildup in the training intensity to the peak was used.

The volume of the training program in the classic periodization program will gradually decrease in concert with an increase in intensity. The volume–intensity trade-off can be lessened as an individual improves training status. In other words, advanced athletes can tolerate higher volumes of exercise during heavy and very heavy microcycles. A meta-analysis of the research has shown that progressing to an average of eight sets per muscle group is the optimal dose needed to stimulate muscular strength adaptations in muscular strength in advanced lifters as compared to an average of three sets per muscle group for beginners and four sets for intermediate lifters (10).

One must be very careful not to train with high volumes and heavy weights too quickly; monitor the stress of the workouts and the total conditioning program. Pushing too hard has the potential for creating a serious overtraining syndrome. Overtraining can compromise progress for weeks or even months. Although it takes a great deal of excessive work to produce this type of overtraining effect, highly motivated individuals can easily make these mistakes out of sheer desire to make gains and see rapid progress in their training.

The idea of high-volume exercise in the early microcycles is that it may promote the muscle hypertrophy needed to eventually enhance strength in the later phases of training. Thus, the later cycles of training are dependent on the early cycles of training. Programs that attempt to gain strength without developing the needed hypertrophy of muscle tissue are limited in their potential.

The increases in the intensity of the periodized program allows for development of the needed nervous system adaptations for enhanced motor unit recruitment. As the program progresses, the heavier weights require that higher threshold motor units become involved in the force production process. The subsequent increase in muscle protein from the early cycle training enhances force production from the motor units. Thus, it is clear to see how the different parts of the 16-week training program are integrated.

One mesocycle is the completion of all of the cycles in this 16-week program. A year training program (macrocycle) is made up of several mesocycles. Multiple and short mesocycles allow for delineating different trainable features of muscle. In theory, each mesocycle can progress the body's musculature upward toward one's genetic limitations. Thus, the theoretical basis for a linear method of periodization consists of developing the body with a sequential loading from light to heavy and from high volume to low volume, thereby addressing the goals of the program for that training cycle while providing active rest at the completion of the mesocycle. This is repeated again and again with each mesocycle, and progress is made in the training program over an entire macrocycle.

Reverse Linear Programs

A twist on traditional linear periodization is termed *reverse linear periodization*. As the name states, it is a technique that follows the tenants of linear periodization for volume and strength; however, it is in the reverse order. One study has shown that this type of periodization is beneficial when muscular endurance is the primary program outcome (86).

Nonlinear Periodized Programs

More recently, the concept of nonlinear periodized training programs (also called daily undulating periodization or DUP) has been developed to maintain variation in the training stimulus (86–89). Nonlinear periodized training enhances program implementation because it is flexible and can accommodate schedule, business, or competitive demands placed on the individual. The nonlinear program allows variation in the intensity and volume within each week over the course of the training program (*e.g.*, 12 wk). Active rest is then taken after the 12-week mesocycle. The change in the intensity and volume of training will vary within the cycle, which could be 7–14 days. An example of a nonlinear periodized training program over a 12-week mesocycle is shown in Table 14.6.

Table 14.6 An Example of a Nonlinear Periodized Training Protocol[a]

Monday	Wednesday	Friday	Monday
1 set 12–15 RM	3 sets of 8–10 RM	4 sets of 4–6 RM	Power day 6 sets of 3 at 30%–45% of 1-RM using power exercises (*e.g.*, hang pulls) or plyometrics

[a]This protocol uses a 4-d rotation with 1-d rest between workouts.

> The nonlinear program allows variation in the intensity and volume within each week over the course of the training program (*e.g.*, 12 wk).

Recent research has shown that nonlinear periodized training can have similar or greater beneficial effects on resistance training outcomes when compared with traditional linear periodization. Rhea and colleagues (86) showed the nonlinear periodization training elicited a greater percentage of strength gains as compared with linear training. Additionally, Prestes and colleagues (90) found that undulating periodization induces greater increases in maximal strength as compared with linear periodization. These studies suggest that daily variations in the undulation training had a superior effect on maximizing strength as compared with weekly or monthly variation.

One of the theorized reasons for the success of nonlinear periodization is that unlike linear programs, the different components of muscle size, strength, and power are trained with the goal of attempting to train different features of muscle within the same time frame (*e.g.*, hypertrophy and power and strength). Thus, an individual stimulates multiple physiological adaptations within the same 7- to 10-day period of the 12-week mesocycle.

Often, busy travel, school, or competition schedules conflict with time requirements of traditional training program. A DUP program is highly adaptable to variations in a client's schedule. This type of training model may enhance adherence as it may "fit" the client's schedule better than the traditional linear method. Additionally, constantly altering program variables keeps the program interesting and challenging for clients, thereby reducing the boredom of repeating the same program. Theoretically, a DUP program can be different with each and every training session. Because the workouts are not linear, the different workouts change with different training sessions. If the Monday workout is missed, the rotation is just changed. For example, if a client misses a workout scheduled for Monday, with DUP, that workout is performed on the next training day and the sequence is continued. In this way, no workout stimulus is missed in the training program. With a DUP-type program, any mesocycle will be completed when a certain number of workouts are completed (*e.g.*, 48) rather than counting the completion of a set number of weeks (86,88–90).

> With a DUP type program, any mesocycle will be completed when a certain number of workouts are completed (*e.g.*, 48) rather than counting the completion of a set number of weeks.

Unplanned/Flexible Nonlinear Periodized Programs

One of the new advances in periodization is called “unplanned nonlinear periodization.” The name is somewhat of a misnomer because an overall plan is developed for a 12-week mesocycle, but the actual day that a given workout will be performed is based on the readiness to train. Thus, it is also termed “flexible nonlinear periodization.” In unplanned or flexible nonlinear periodization, a workout plan is set for the mesocycle, but deciding what workout is to be done on what day is left to the Personal Trainer, who will base it on the client’s fatigue level, psychological state, or fitness, to use only the most optimal workout that can be performed on a given day. In this model, the training session category (*e.g.*, light, moderate, power, or heavy) is prescribed on the basis of the physiological ability or state of the client at the time of the session. Thus, if the client is very fatigued before a particular exercise session, some workouts would not be prescribed. For example, a power training or plyometrics training day or a high-volume, low-rest training day would not be a good choice because fatigue would reduce the workout quality. After a specific workout is completed, it is checked off in the major planning matrix for the 12-week mesocycle. Again, the goal for any mesocycle in this type of nonlinear periodization program is to complete each planned workout rather than “x” number of weeks.

In any periodization model, it is the primary exercises that are typically periodized, but one can also use a two-cycle periodization program to vary the small muscle group exercises. For example, in the “triceps push-down,” one could rotate between the moderate (8–10 RM) and the heavy (4–6 RM) cycle intensities. This would provide not only the hypertrophy needed for such isolated muscles of a joint but also the strength needed to support heavier workouts of the large muscle groups.

In summary, different approaches can be used to periodize a resistance training program. Programs can be linear, reverse linear, nonlinear “daily undulating,” or unplanned/flexible nonlinear schedules. Periodized programs are more effective than constant-intensity training programs for increasing strength. Effective periodization is accomplished by melding specific program goals (strength, hypertrophy, muscular endurance, or some combination) with appropriate variations in volume–intensity and frequency of training. The key to workout success is variation, and different periodization approaches can be used to accomplish this training need.

Effective periodization is accomplished by melding specific program goals (strength, hypertrophy, muscular endurance, or some combination) with appropriate variations in volume–intensity and frequency of training.

Progression from Beginner to Advanced

The level of fitness and resistance training experience of the client is perhaps the most important factor to be considered when designing a resistance training program. Resistance exercise can place a large stress on the body, and certain exercises require high levels of skill to avoid injury. Thus, exercise technique is the most important aspect of resistance training for beginners. At the beginning of the training program, correct technique should be significantly emphasized, and the resistance and volume should be kept low.

Resistance exercise can place a large stress on the body, and certain exercises require high levels of skill to avoid injury.

From a short-term performance-enhancement point of view, a single set per exercise may be enough for beginners to achieve the stimulus needed from an exercise. However, depending on the individual, multiple sets, even for beginners may be beneficial (9,10,32,75). Some studies have found that multiple sets even for beginners create larger improvements than single sets, whereas no study has found that single sets are superior (10,31). One reason for this is that more repetitions can lead to faster improvements in exercise technique, especially for multijoint exercises. The squat exercise is an example of an exercise that requires a great deal of technique to be performed correctly. Thus, only doing one set of a few squats does not allow the client many practice trials of this complex movement.

There is a dose-response relationship with progressive resistance training. As a person becomes accustomed to a given stimulus or dose of exercise, additional stress is needed to elicit the given response or increase in strength, muscular endurance, hypertrophy, power, or all four.

As the client progresses past the initial few months of training, multiple sets should be used for each exercise session. As the skill and experience level of the client improves, more technical exercises can be taught. Advanced resistance training can include highly technical exercises such as the clean or the snatch as well as advanced modalities such as plyometric exercises. The progression will differ among individuals, and the Personal Trainer must evaluate each client extensively and continuously before including more advanced exercises to ensure that the exercises match the client's skill and experience level.

Client Interactions

As a Personal Trainer working with clients, it is important to encourage and motivate them as well as to provide innovative, optimal, individualized resistance training programs. Clients hire Personal Trainers for a variety of reasons. Many clients hire Personal Trainers because they feel they need constant guidance. In addition, Personal Trainers provide them with a support system. Most importantly, clients desire to hire professionals with training and knowledge in conditioning science. They want a professional to help them perform exercises properly and who understands exercise prescription to allow them to achieve their personal goals and objectives. For some clients, it is an important part of their sports conditioning program. Ultimately, the Personal Trainer must form a special relationship with each and every client that is based on professionalism, trust, and openness (Fig. 14.4).

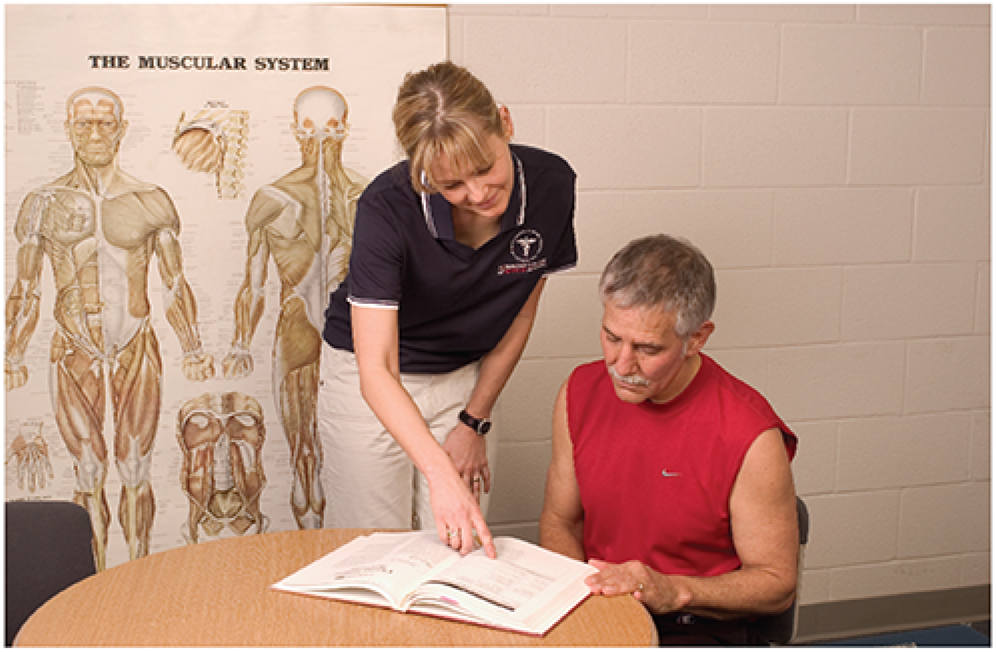


FIGURE 14.4. Having education and being a credible source of knowledge as a fitness expert is part of what Personal Trainers must provide to their clients. This takes continual study and preparation to stay current and up-to-date on basic topics and hot topics of the day.

Clients should feel that their Personal Trainer genuinely cares about them and is personally vested in helping them achieve their goals. Clients expect their Personal Trainer to be a source of knowledge and an educator. Clients expect their Personal Trainer to be able to explain things or answer the question "why?" Thus, clients appreciate having their Personal Trainer explain the reason they are doing a particular exercise or combination of sets and reps in their program. Personal Training has been found to be superior to unsupervised training, even for people who understand resistance training (91,92).

Personal Trainers should convey the specific benefits of resistance training, including increases in strength, muscle mass, and bone mass, particularly to clients who may be skeptical about why resistance training is important. Some uneducated clients may have false impressions of the outcomes from resistance training or on how to go about attaining optimal gains. Some men may do too much of one exercise (*e.g.*, biceps curls) trying to get huge, thereby creating muscular imbalance or women may hold back from performing any heavy loading because of the "fear of getting big muscles." These mistakes may at best diminish the gains that could be realized with resistance training and at worse result in serious overtraining or acute injury.

> Personal Trainers should convey the specific benefits of resistance training, including increases in strength, muscle mass, and bone mass, particularly to clients who may be skeptical about why resistance training is important.

Clients consider Personal Trainers experts and will often want to hear their opinion on fads facing the fitness industry. Often, clients' knowledge of resistance training comes from infomercials or magazine advertisements. Personal Trainers need to stay up-to-date with the scientific literature in order to provide accurate information and current research to their clients. Additionally, Personal Trainers should develop a network of experts who can act as resources for when clients ask questions that the Personal Trainer does not know the answer. It is always best to admit you do not know the answer than to convey potentially incorrect information. Furthermore, because Personal Trainers are required to obtain continuing education credits to maintain their certifications, staying current is critical to success.

Demonstration of Proper Lifting Technique

A key aspect in Personal Training is the ability to demonstrate a given lift or technique. Providing the client with a good visual representation of the lift will allow the client to then replicate the movement pattern. The Personal Trainer should demonstrate each lift with proper form with a verbal explanation of the lift or technique and then actually physically demonstrate proper form of the given lift.

Spotting in Resistance Exercise

Resistance training often requires that the Personal Trainer have physical contact with the client to ensure correct positioning, fit and setup of a machine, and proper technique in both machine and free-weight exercises. Personal Trainers should take time to explain to clients the spotting procedures in resistance training and the level of physical interaction required. Always ask your clients before physically touching them to ensure that they are comfortable with it. For example, when performing elbow extension exercises, it is sometimes helpful for the Personal Trainer to place his or her hands on the client's elbows as a reminder to keep the elbow from pointing outward. In these cases, explain to the client, "I am going to put my hands on your elbows to remind you to keep them from pointing outward. Is this okay with you?" In most cases, clients will have no problem with this physical contact, but it is always better to ask than to assume.

> Always ask your clients before physically touching them to ensure that they are comfortable with it.

Know Proper Spotting Technique

Good spotting technique is vital for a safe resistance training program. Personal Trainers must understand the movement technique of every exercise and how to position clients to get the proper anatomical positioning throughout the exercises. In addition, Personal Trainers need to know where to position themselves to spot appropriately for each exercise. The goal of correct spotting is to prevent injury. A lifter should always have an exercise spotted, and the Personal Trainer must mediate this process, alone or with additional help. A checklist for the Personal Trainer is the following:

1. Know proper exercise technique.
2. Know proper spotting technique.
3. Be sure you are strong enough to assist the lifter with the resistance being used or get help.
4. Know how many repetitions the lifter intends to do.

5. Be attentive to the lifter at all times.
6. Stop lifters if exercise technique is incorrect or they break form.
7. Know the plan of action if a serious injury occurs.

Resistance Exercises

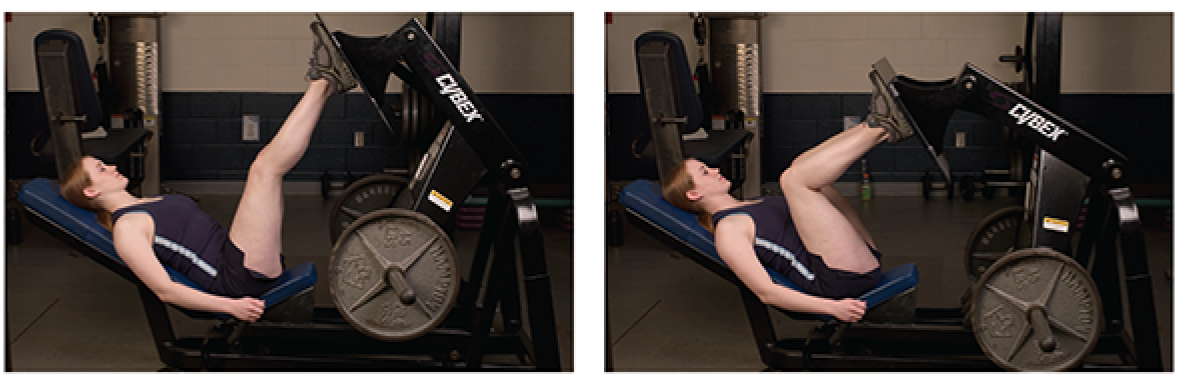
A large number of resistance exercises can be used in a program. It is beyond the scope of this chapter to go through each and every exercise. The reader is referred to a comprehensive list of more than 125 exercise descriptions of both machine and free-weight exercises along with spotting techniques by Kraemer and Fleck (93). Each program should be designed on the basis of the principles outlined in this chapter. Periodization is very important, and many Personal Trainers are now using nonlinear methods to keep the clients interested and the programs effective (93). Free weights and machines can be used for each exercise as well as bilateral and unilateral exercises. See Figure 14.5 for examples of 15 basic exercises: (A) squat, (B) supine leg press, (C) 45° leg press, (D) lunge, (E) leg extensions, (F) leg curls, (G) machine vertical bench press, (H) smith supine bench press, (I) free-weight supine bench press, (J) dumbbell bench press, (K) machine seated rows, (L) front lat pull-down, (M) dumbbell arm curls, (N) barbell arm curls, and (O) triceps push-down.

A

Start Finish

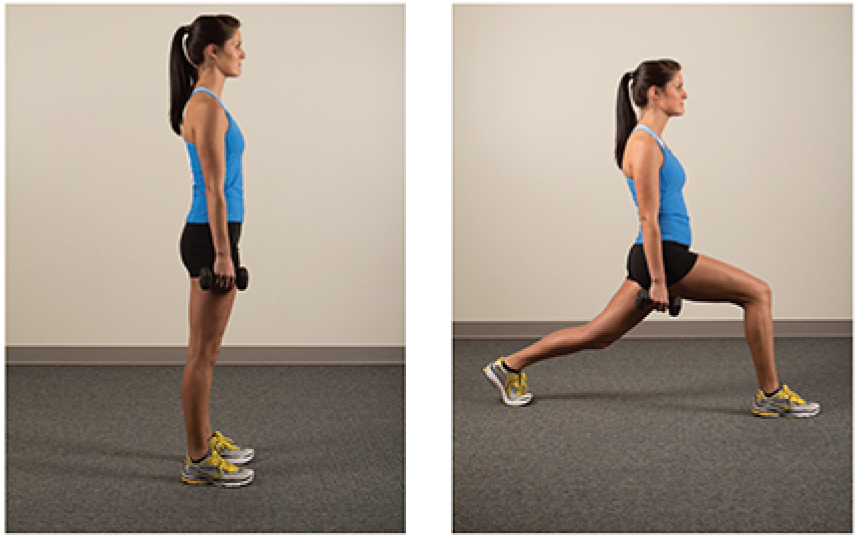
B

Start Finish



C

Start Finish

D 

Start Finish

E 

Start Finish Center of Rotation

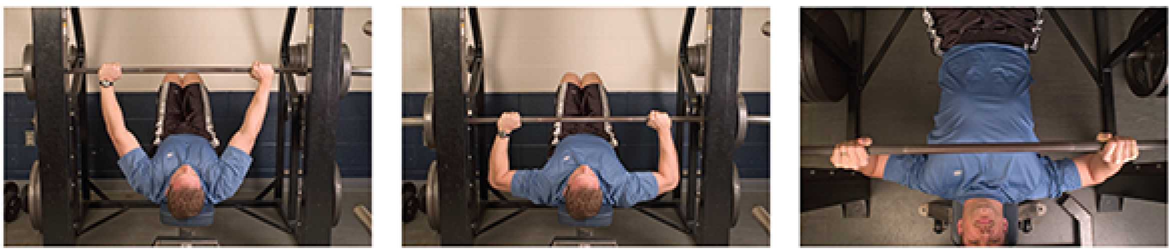
F 

Start Finish

G

Start Finish

H



Start Finish Bar Position Over Chest

I

Start Finish

J

Start Finish

K

Start Finish Arm Position

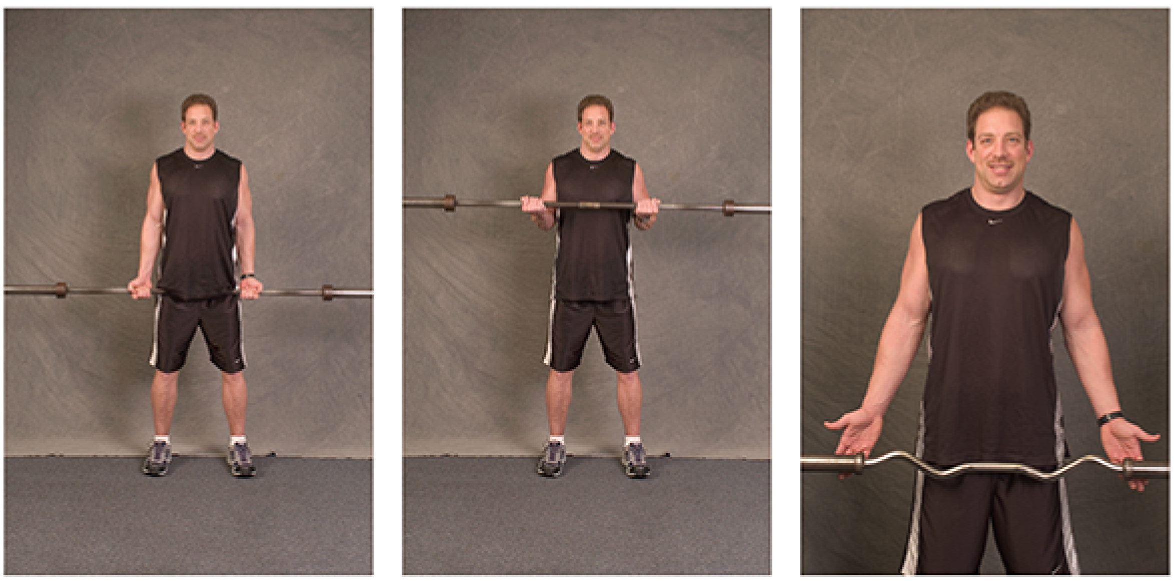
L

Start Finish

M

Start Finish

N



Start Finish E-Z Bar

O

FIGURE 14.5. **A.** Back squat (thighs and glutes). Place the barbell on the back of the shoulders and grasp the barbell at the sides, with feet shoulder-width apart and toes slightly out. Dismount bar from rack. Descend until thighs are parallel to the floor and then extend the knees and hips until legs are straight, returning you to the starting position. Repeat for the appropriate number of repetitions. Keep the head forward with the chin level, back straight, and feet flat on the floor; keep equal distribution of weight throughout forefoot and heel and either squat within the power rack or have spotter(s). **B.** Supine leg press (thighs). Lie flat on the sled with shoulders against the pad. Place the feet on the platform, making sure that they are securely on the base plate. Extend the hips and knees. Flex the hips and knees until the knees are just short of complete flexion and return to the starting position to complete the repetition. Keep the feet flat on the platform and do not lock the knees. A full ROM should be used; keep the knees in the same direction as the feet. **C.** The 45° leg press (thighs). Lie down on the machine with the back on the padded supports. Place the feet on the platform. Grasp the handles on the side and release the weight. Lower the weight by flexing the hips and knees until the hips are completely flexed and then extend the knees to complete the repetition. Make sure that the feet are flat on the platform and the knees track over the feet. **D.** Lunge (thighs, unilateral). Standing straight up with feet shoulder-width apart, stand holding the dumbbells at the sides. Lunge forward with one leg at a time, keeping the hips in the middle of the two legs, with the trailing knee just above the ground. Return to the standing position to complete the repetition and then repeat with the opposite leg. Keep the back straight and chin level with the ground. **E.** Leg extensions (thighs, bilateral or unilateral). Sit on the machine with the back straight against the back pad or seat and grasp the handles on the side of the machine. Place the legs under the padded lever, making sure that they are positioned just above the ankles. Most machines will allow adjusting the length of the lever. Lift the lever until the legs are almost straight and return to the starting position to complete the repetition. It is important not to “rip” the plates off the stack because this can add stress to the knees. This exercise can be done with a single leg (unilateral) or with both legs (bilateral). Make sure that the knees are aligned with the machine’s center

of rotation. **F.** Leg curls (hamstrings, bilateral or unilateral). Lying face down, grab the support handles in the front of the machine with the heels just beyond the edge of the lever pads. Lift the lever arm by flexing the knees until they are straight. Return to the starting position to complete the repetition. Keep the body on the bench and focus on moving only the legs. Many machines are angled so that the user is in a better position for the exercise movement to reduce stress on the lower back. Other forms of leg curls are standing and seated forms. This exercise can be done with a single leg (unilateral) or with both legs (bilateral). **G.** Vertical machine bench press (chest–triceps, bilateral). Sit on the seat, making sure that the line of the grips is just below the chest. The bar line should be an inch above the chest. Grasp the handles with an overhand grip and make sure that the feet are flat on the ground. Push the lever arm straight out until the elbows are straight. Return to the starting position to complete one repetition. **H.** Smith supine bench press (chest–triceps, bilateral). Lie flat on the bench with the upper chest under the bar, as shown in the bar position figure above. Place the feet flat on the floor unless the bench is too high, in which case put them flat on the bench. Keep the shoulders and hips on the bench at all times during the lift. Grasp the bar with elbows at 45° angles. Disengage the bar hooks from the smith machine. Lower the weight to the chest and then press the bar up until arms are extended to complete the repetition. When completed, rehook the bar to the machine. **I.** Free-weight supine bench press (chest–triceps, bilateral). Lie flat on the bench with the upper chest under the bar, as shown in the bar position figure above. Place the feet flat on the floor unless the bench is too high, in which case put them flat on the bench. Keep the shoulders and hips on the bench at all times during the lift. Grasp the bar with elbows at 45° angles. Lower the weight to the chest and then press the bar up until the arms are extended to complete the repetition. When completed, rerack the bar with a spotter's help. **J.** Dumbbell bench press (chest–upper arms–triceps, unilateral). Start in a seated position on the bench with a dumbbell in each hand resting on the lower thigh. Lift the weights to the shoulder and lie back on the bench or have the spotter give you the dumbbells once you are in a position. Position the dumbbells to the side of the upper chest. Press the dumbbells up until the arms are extended and then return to complete a repetition. When completed, return to the seated position with the dumbbells on your thighs or have the spotter take the dumbbells. If heavy weights are used, two spotters may be necessary. **K.** Machine seated rows (upper back, bilateral). Take a seated position with the chest against the pad. Grasp the lever vertical handles with a vertical or horizontal overhand grip. Pull the lever back until the elbows are in line with the upper body and return to complete the repetition. Check the seat height so that the chest is directly in front of the lever handles and check whether the client is pulling in a straight line parallel to the ground. The client can use an overhand grip as a variation to the movement, using the other horizontal handles. **L.** Front lat pull-down (upper back, bilateral). Use a locked grip (thumb around the bar) and grasp the cable bar with a wide grip. Sit with thighs under machine support. Proceed to pull down the bar to the upper chest. Return to the starting position to complete the repetition. **M.** Dumbbell arm curls (upper arm–biceps, unilateral). Take a seated position with two dumbbells held at the sides, with the palms facing in and the arms hanging straight down. Raise the dumbbells and rotate the forearm so that the palms face the shoulder. Lower to the original position to complete one repetition. One can also alternate one arm at a time. **N.** Barbell arm curls (upper arm–biceps, bilateral). In the standing position with the feet shoulder-width apart, grasp the straight barbell with an underhand grip and palms facing up. Raise the bar until the forearms are vertical and then lower the bar to the starting position to complete a repetition. One can also perform this exercise with an e-z bar with the palms facing inward. **O.** Triceps push-down (upper arm–triceps, bilateral). Stand in front of the lat pull station or high pulley station and take an overhand grasp on the bar with your elbows at the sides. Start at chest level and extend the arms down until straight and return to the starting position to complete the repetition. Position the hands above the bar prior to the push-down phase of the repetition. Other types of attachments also can be used (*e.g.*, rope, v-bar).

Visit thePoint to watch videos 14.1, 14.2, and 14.3, which demonstrate a body weight squat, lunges, and a dumbbell bench press.

SUMMARY

Development of a resistance training program is a systematic process in which science and art come together to allow the Personal Trainer to specifically address a client's needs for neuromuscular fitness. A sequence of events in the exercise prescription process consists of getting a client's medical clearance, Personal Training history, goal generation, a needs analysis, and a general preparation phase of initial training and testing before putting together workouts based on the acute program variables that will be used in a resistance training program. This program is then updated and revised with the same process over time. Education, client interactions, and motivation are vital components of successful resistance training programs that meet each client's goals and objectives.

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CHAPTER 15

Cardiorespiratory Training Programs

OBJECTIVES

Personal Trainers should be able to:

- Understand the current recommendations to improve cardiovascular fitness.
- Understand the physiological basis of the warm-up and cool-down.
- Apply the FITT-VP principles of exercise prescription to cardiovascular exercise training based on the client's preparticipation screening results, cardiovascular assessments, and goals.

INTRODUCTION

According to the most recent American College of Sports Medicine (ACSM) position stand (1), "The scientific evidence demonstrating the beneficial effects of exercise is indisputable, and the benefits of exercise far outweigh the risks in most adults." Regular cardiorespiratory, resistance, flexibility, and neuromotor exercise training is considered "essential for most adults" (1). This chapter focuses on one of the primary components of a balanced exercise program: cardiorespiratory training. The other major components, resistance and flexibility training, are described in Chapters 14 and 16, respectively.

History of Physical Activity Recommendations

In 1953, more than 55% of U.S. children failed to meet a minimum standard of muscular fitness and health compared with about 8% for European children (2). These troubling findings became a primary impetus for policy makers to focus on developing and improving fitness standards and recommendations. Expert panel meetings were held in the 1960s and 1970s to summarize all the research that was conducted by that time. Most of the research at this point was primarily focused on describing and comparing the benefits of different exercise training regimens in order to improve cardiovascular fitness. In 1973, an article by Michael Pollock (3) served as the basis of the first ACSM position statement entitled "Quantity and Quality of Exercise for Developing and Maintaining Fitness in Healthy Adults" (4). This statement provided the first guidelines for improving cardiorespiratory fitness (CRF), including performing moderate to vigorous cardiorespiratory exercise using large muscle groups 15–60 minutes for 3–5 $d \cdot wk^{-1}$.

As time continued and research expanded, it became apparent that significant health-related benefits could be achieved at lower levels of physical activity. In 1990, a distinction was made between physical activity recommendations for *health* and physical activity recommendations for *fitness*. Later recommendations by the Centers for Disease Control and Prevention (CDC) and the ACSM (5) were combined with the 1996 Surgeon General's guidelines (6) that clearly highlighted the health benefits of physical activity. These documents were based on evidence that significant health benefits could be achieved with the accumulation of at least 30 minutes of moderate-intensity physical activity on most days of the week (5). A unique characteristic of these CDC/ACSM recommendations is the option for "accumulating" physical activity across the day. The concept of accumulating activity was a large deviation from previous guidelines, which had recommended continuous exercise of at least 20 minutes in duration. In 1998, ACSM updated its position stand and included a more balanced approach by adding muscular fitness and flexibility components to the cardiorespiratory recommendations (7). These recommendations are supported by the current *2018 Physical Activity Guidelines for Americans*, second edition (8), which underscores the importance of physical activity in stating that "adults should move more and sit less throughout the day. Some physical activity is better than none. Adults who sit less and do any amount of moderate-to-vigorous physical activity gain some health benefits" (8, p. 8). The guidelines also recommend performing moderate- to vigorous-intensity exercise throughout the week and that additional health benefits can be gained by performing at least 300 minutes of moderate-intensity exercise.

> "Adults should move more and sit less throughout the day. Some physical activity is better than none. Adults who sit less and do any amount of moderate-to-vigorous physical activity gain some health benefits."

The recently updated *Physical Activity Guidelines for Americans*, second edition, published in 2018 (8) expanded on previous guidelines to include preschool-aged children, children and adolescents, adults, older adults, women during pregnancy and postpartum, adults with disabilities, and people with chronic medical conditions. This report emphasized that for activity to have substantial health benefits, adults need to accumulate at least 150 minutes (2 h and 30 min) per week of moderate-intensity physical activity (with additional benefits noted for more physical activity) or 75 minutes (1 h and 15 min) per week of vigorous-intensity physical activity (8). Personal Trainers should use the most recent ACSM position stand (1) and the current physical activity recommendations (9) to determine the most effective method to improve a client's CRF. The ACSM position stand includes over 400 references providing an extensive summary of the scientific evidence and most up-to-date recommendations for professionals concerning individualized exercise prescription (1). Table 15.1 provides an excerpt of the recommendations for cardiorespiratory exercise as presented in the 2011 ACSM Position Stand (1). This chapter is based on the most recent ACSM Position Stand and the *2018 Physical Activity Guidelines for Americans*, second edition.

Table 15.1 Evidence Statements and Summary of Recommendations for the Individualized Exercise Prescription of Cardiorespiratory Exercise

Component	Evidence-Based Recommendation	Evidence Category[a]
Frequency	$\geq$5 d · wk^{-1} of moderate exercise, $\geq$3 d · wk^{-1} of vigorous exercise, or a combination of moderate and vigorous exercise on $\geq$3–5 d · wk^{-1}	A
Intensity	Moderate- and/or vigorous-intensity exercise for most adults	A
	Light- to moderate-intensity exercise may be beneficial in deconditioned persons.	B
Time	30–60 min · d^{-1} (150 min · wk^{-1}) of purposeful moderate exercise, 20–60 min · d^{-1} (75 min · wk^{-1}) of vigorous exercise, or a combination of moderate and vigorous exercise per day for most adults	A
	<20 min · d^{-1} (<150 min · wk^{-1}) of exercise can be beneficial in previously sedentary persons	B
Type	Regular, purposeful exercise that involves major muscle groups and is continuous and rhythmic in nature	A
Volume	$\geq$500–1,000 MET · min · wk^{-1}	C
Pattern	One continuous session per day or in multiple $\geq$10-min sessions to accumulate the desired duration and volume of exercise per day	A
	<10 min per session may yield favorable adaptation in very deconditioned individuals	B
Progression	Gradual progression of exercise volume by adjusting exercise duration, frequency, and/or intensity until desired exercise goal (maintenance) is attained	B

[a]Table evidence categories: A, randomized controlled trials (rich body of data); B, randomized controlled trials (limited body of data); C, nonrandomized trials, observational studies; D, panel consensus judgment.

Adapted with permission from Garber CE, Blissmer B, Deschenes MR, et al. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. *Med Sci Sports Exerc*. 2011;43(7):1334–59.

General Training Principles

CRF refers to the ability of an individual to perform large muscle, rhythmic, repetitive, and continuous moderate- to vigorous-intensity exercise for an extended period of time. The goal is to increase heart rate (HR) and respiration in order to place an appropriate physiological stress on the cardiorespiratory system. The increase in stress is often referred to as “overload.” The term *overload* is commonly used when referring not only to resistance or strength training (*i.e.*, lifting a weight heavier than typically done in daily activity to stress the muscle, resulting in increases in strength and potential hypertrophy) but also applies to CRF. Overload of the cardiovascular and respiratory systems is required to create beneficial adaptations in CRF. CRF is a function of enhancing both the central oxygen delivery (*i.e.*, heart and circulatory) processes and the peripheral oxygen-uptake mechanisms of the working muscles. Enhancing the body’s ability to deliver and use oxygen for metabolic processes allows one to do more work. Typical measurements used to determine improvements in CRF include increases in maximal volume of oxygen consumed per unit time ($\dot{V}O_{2max}$) and decreases in HR or $\dot{V}O_2$ in response to a given submaximal workload.

> Overload of the cardiovascular and respiratory systems is required to create beneficial adaptations in CRF.

Major benefits of increased cardiorespiratory training and physical activity include the following (10):

- Overall decrease in morbidity and mortality
- Decreased risk of premature death from coronary artery disease
- Decrease in incidence of cardiovascular disease, stroke, Type 2 diabetes mellitus, metabolic syndrome, osteoporotic fractures, and gallbladder disease
- Lower risks of developing cancers of the bladder, colon, endometrium, esophagus, kidney, lung, and stomach
- Decreased risk of dementia (including Alzheimer disease), anxiety, and depression
- Increased likelihood of increased habitual activity levels that are also associated with health benefits

Additional benefits from regular physical activity and/or exercise are listed in Box 15.1 (10). Clearly, including CRF in an exercise program has many benefits and is instrumental in designing a balanced health-related program.

Box 15.1 Benefits of Regular Physical Activity/Exercise

Improvement in Cardiovascular and Respiratory Function

- Increased maximal oxygen uptake resulting from both central and peripheral adaptations
- Decreased minute ventilation at a given absolute submaximal intensity
- Decreased myocardial oxygen cost for a given absolute submaximal intensity
- Decreased heart rate and blood pressure at a given submaximal intensity
- Increased capillary density in skeletal muscle
- Increased exercise threshold for the accumulation of lactate in the blood
- Increased exercise threshold for the onset of disease signs or symptoms (*e.g.*, angina pectoris, ischemic ST-segment depression, claudication)

Reduction in Coronary Artery Disease Risk Factors

- Reduced resting systolic/diastolic pressures
- Increased serum high-density lipoprotein cholesterol and decreased serum triglycerides
- Reduced total body fat and reduced intraabdominal fat
- Reduced insulin needs and improved glucose tolerance
- Reduced blood platelet adhesiveness and aggregation

Decreased Morbidity and Mortality

- Primary prevention (*i.e.*, interventions to prevent the initial occurrence)
- Higher activity and/or fitness levels are associated with lower death rates from coronary artery disease
- Higher activity and/or fitness levels are associated with lower incidence rates for combined cardiovascular diseases, coronary artery disease, stroke, Type 2 diabetes, osteoporotic fractures, and gallbladder disease
- Lower risks of cancers of the bladder, breast, colon, endometrium, esophagus, kidney, lung and stomach
- Regular physical activity/exercise interventions act as secondary prevention (*i.e.*, interventions after a cardiac event help prevent another)
- Based on meta-analyses (pooled data across studies), cardiovascular and all-cause mortality are reduced in postmyocardial infarction patients who

participate in cardiac rehabilitation exercise training, especially as a component of multifactorial risk factor reduction

- Randomized controlled trials of cardiac rehabilitation exercise training involving postmyocardial infarction patients do not support a reduction in the rate of nonfatal reinfarction

Other Benefits

- Decreased anxiety and depression
- Decreased risk of dementia (including Alzheimer disease)
- Enhanced physical function and independent living in older persons
- Enhanced feelings of well-being
- Enhanced performance of work, recreational, and sport activities
- Reduced risk of falls and injuries from falls in older persons
- Prevention or mitigation of functional limitations in older adults
- Effective therapy for many chronic diseases in older adults

Reprinted from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2022. 480 p. Data from Chodzko-Zajko WJ, Proctor DN, Fiatarone Singh MA, et al. American College of Sports Medicine position stand. Exercise and physical activity for older adults. *Med Sci Sports Exerc*. 2009;41(7):1510–30. Data from U.S. Department of Health and Human Services. *Physical Activity and Health: A Report of the Surgeon General*. Atlanta (GA): U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion; 1996. 278 p.

The training guidelines presented in this chapter can be followed to bring about the appropriate overload for cardiorespiratory adaptations. However, the training methods used to overload the cardiorespiratory system can be quite varied. When the cardiorespiratory system is challenged (or overloaded) by endurance training (*i.e.*, exercise of a certain intensity for a certain period of time), then adaptation occurs. Over time, functional (*i.e.*, fitness or performance) changes or improvements follow. There is no single or best "one-size-fits-all" exercise program to apply universally. Determining how to stress the system appropriately for a given individual is one of the roles of a Personal Trainer. One must be aware that the presented guidelines are just that, guidelines. They give the Personal Trainer the *science* behind exercise prescription. A Personal Trainer must understand that each client comes with unique characteristics (*i.e.*, health risk factors, fitness levels, exercise goals, and personal preferences) that must be considered when designing a client’s optimal fitness program. This is where the *art* of exercise prescription comes into play.

Performing activities that increase HR and respiration are required to overload or challenge the cardiorespiratory system. Altering the mode or type of exercise brings about specific adaptations as well as more generalized CRF gains. The minimal amount of overload needed to bring about the desired adaptation is referred to as the “threshold” for change. If the training level exceeds the threshold, then characteristic physiological adaptations occur. However, exceeding the threshold that is required for physiological adaptations to occur can result in diminished performance. This diminished performance is often termed *overtraining syndrome*. Here, the chronic accumulation of too much training (*i.e.*, overreaching) leads to long-term diminished performance and can take weeks to overcome. Conversely, the *principle of diminishing returns* is a general training principle that can be used to describe the theoretical “genetic ceiling” that each individual has in regard to his or her ability to continually improve his or her fitness with training. As an individual reaches his or her genetic ceiling, the amount and rate of improvement that occurs slows and eventually plateaus. Conversely, if a client is injured or decreases his or her exercise below the threshold of change, the *principle of reversibility* will apply, where physiological effects and health benefits will decrease with the reduction in exercise. The Personal Trainer must carefully balance the FITT principles of exercise prescription:

- Frequency (F; number of days per week)
- Intensity (I; how hard the workout is for the client)
- Time (T; duration or minutes per workout)
- Type (T; mode or what kind of activity)

The Personal Trainer should also consider the volume (V; total amount of energy expenditure achieved per week) and progression (P; gradual increase in the overload) when designing exercise programs to ensure that one properly overloads the cardiorespiratory system without overwhelming the client beyond an appropriate amount of overload (1).

> The Personal Trainer must carefully balance frequency, intensity, duration, volume, and progression of the workouts to avoid overchallenging the client beyond an appropriate amount of overload.

Design of a Cardiorespiratory Training Session

A well-planned CRF session should include a warm-up, a conditioning phase, and a cool-down. The warm-up prepares the person for the conditioning phase, where a target intensity is to be achieved allowing for appropriate overload. The cool-down allows the person to transition back toward resting levels. Development of the structure of the entire exercise program sequence is presented in Chapter 13.

> A well-planned CRF session should include a warm-up, a conditioning phase, and a cool-down.

Warm-Up

A properly constructed exercise program will include a transition period from rest to the target exercise intensity. This transition period is called the warm-up. The duration, intensity, and type of exercises performed during the warm-up will vary depending on the individual and purpose of the warm-up. During the warm-up, the client should perform low-level activities similar to what will be done during the conditioning phase. For example, an appropriate warm-up for a brisk walking exercise program would include slow walking. The muscle groups used are similar in the two activities — slow walking being a low-intensity activity, which naturally leads to the brisk walking of the exercise program. The warm-up may also include gentle dynamic stretching activities, although stretching should not be done with cold muscles. The specific activities included in a warm-up will vary depending on the target activity to be included in the endurance phase. In general, the warm-up should include 5–10 minutes of low-intensity large muscle activity that progresses to an intensity at the lower end of the target exercise range for the endurance phase (10).

The intent of a warm-up is to prepare the muscles and cardiorespiratory system for the upcoming workout. It is a time of transition and should provide a gradual (rather than an abrupt) increase in HR, respiration, and body temperature. Taking sufficient time to prepare the body for physical activity increases the safety and enjoyment of the target exercise during the endurance phase. The benefits of completing a warm-up include the following (10):

- May reduce the susceptibility of injury to muscles or joints by increasing the extensibility of connective tissue
- May improve joint range of motion and function
- May improve muscle performance
- May help prevent ischemia (lack of oxygen) of the heart muscle, which may occur in clients with sudden strenuous exertion

Conditioning Phase

The warm-up allows a transition from rest to the conditioning phase, which is at a higher level of intensity. The object of the conditioning phase is to provide the appropriate overload to promote beneficial cardiorespiratory adaptations. Thus, the Personal Trainer must consider and balance the exercise prescription principles (FITT-VP). Each of these factors, as they pertain to cardiorespiratory endurance, is discussed in more detail later in this chapter.

Cool-Down

The cool-down is a transition from the higher intensity of the conditioning phase back toward resting levels. The cool-down reduces the risk of cardiovascular complications by allowing HR, blood pressure, and respiration rate to gradually decrease toward resting levels. By allowing a gradual progression toward resting rather than abruptly stopping exercise, the client will avoid an acute, excessive drop in blood pressure that could result in dizziness (this differs from the positive adaptation that exercise can provide to lower blood pressure chronically). A gradual decrease in intensity also helps remove metabolic end products (*e.g.*, lactate) from muscles used more intensely during the conditioning phase (10). Furthermore, 5–10 minutes of static stretching that incorporates all the major muscle groups should be incorporated following the aerobic cool-down. Stretching may help reduce the potential risks of muscle cramping.

> The cool-down reduces the risk of cardiovascular complications by allowing HR, blood pressure, and respiration rate to gradually decrease toward resting levels.

Approximately 10 minutes of diminishing intensity activities are appropriate for a typical cool-down (10). For exercise done at higher intensity during the conditioning phase, a longer cool-down may be warranted. However, for the client who uses brisk walking as an exercise mode for the endurance phase, an appropriate cool-down could be a bit shorter and could include slow walking for 5 minutes followed by 5 minutes of dynamic body stretches.

Exercise Prescription for Cardiorespiratory Fitness

Frequency

According to the ACSM guidelines (1,10), the optimal frequency of aerobic exercise appears to be 3–5 $d \cdot wk^{-1}$ for most adults, with the frequency varying with the intensity. The *2018 Physical Activity Guidelines for Americans* suggest that adults should accumulate 150 $min \cdot wk^{-1}$ of moderate-intensity exercise. In addition, these guidelines recommend that adults should do any amount of moderate to vigorous physical activity at least 3 $d \cdot wk^{-1}$. Although additional benefits may be achieved beyond 5 $d \cdot wk^{-1}$, improvements can be attenuated as the frequency increases such that a plateau in benefits is often seen with exercise done greater than 5 $d \cdot wk^{-1}$ (1,10). Additionally, training at high intensity or vigorous activity for greater than 5 $d \cdot wk^{-1}$ might increase the incidence of injury and is not recommended for most adults (10). Admittedly, individuals focused on competition or high-level performance will likely train 6 or more days a week for specific physiological adaptations. Clearly, different goals will require altering the exercise program and thus involve different associated risks.

There is an inverse relationship between the recommendations for frequency and intensity such that if the exercise intensity is held at the lower end of the target range, then the frequency can be increased and vice versa (10). Current evidence suggests that multiple combinations of frequency and duration can be used to meet current physical activity recommendations. For example, 5 $d \cdot wk^{-1}$ of moderate-intensity exercise for 30 minutes may not be any different than performing 3 $d \cdot wk^{-1}$ of moderate-intensity exercise for 50 minutes. In addition, performing aerobic exercise only once or twice a week at a moderate- to vigorous-intensity can still confer health benefits for a client (10).

Intensity

A client's initial level of fitness is one variable to consider when determining the appropriate exercise intensity needed to achieve the required overload. The *principle of initial values* suggests that intensity levels are necessarily higher in fit than in unfit individuals because the threshold for cardiorespiratory benefits is higher. The Personal Trainer must understand that the minimum intensity threshold for improvement varies based on initial fitness level, age, health status, physiological differences, genetics, habitual physical activity, and social and psychological factors (1,10). For individuals with lower fitness, intensity levels as low as 45% oxygen uptake reserve ($\dot{V}O_2R$) and heart rate reserve (HRR) may provide a sufficient challenge to increase $\dot{V}O_{2max}$. In contrast, highly trained athletes may train at 95%–100% $\dot{V}O_{2max}$. Moderately trained individuals may find that 70%–80% $\dot{V}O_{2max}$ provides a sufficient training stimulus (10). Recent evidence suggests (11,12) that performing vigorous-intensity exercise (>6 metabolic equivalents [METs], 60%–84% HRR) is more effective at increasing $\dot{V}O_{2max}$ than moderate-intensity (3.0–5.9 METs, 40%–59% HRR) exercise, but moderate- to vigorous-intensity exercise is best used to meet current physical activity recommendations. Intensity can be determined using various methods. Table 15.2 provides an overview of the intensity classifications for CRF (10). Details on these various methods will be outlined in this section.

Table 15.2 Methods of Estimating Intensity for Cardiorespiratory Endurance Exercise

Cardiorespiratory Endurance Exercise					
	Relative Intensity				Absolute Intensity
Intensity	**%HRR or %$\dot{V}O_2R$**	**%HR_{max}**	**%$\dot{V}O_{2max}$**	**Perceived Exertion (Rating on 6–20 RPE Scale)**	**METs**
Very light	<30	<57	<37	Very light (RPE <9)	<2.0
Light	30–39	57–63	37–45	Very light to fairly light (RPE 9–11)	2.0–2.9
Moderate	40–59	64–76	46–63	Fairly light to somewhat hard (RPE	3.0–5.9

				12–13)	
Vigorous	60–89	77–95	64–90	Somewhat hard to very hard (RPE 14–17)	6.0–8.7
Near maximal to maximal	≥90	≥96	≥91	≥Very hard (RPE ≥18)	≥8.8

Adapted from Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee IM, et al. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. *Med Sci Sports Exerc*. 2011;43(7):1334–59.

Traditionally, moderate- to vigorous-continuous aerobic exercise has been the focus for improving CRF and decreasing the risk of developing hypokinetic diseases (*i.e.*, diseases caused by lack of movement). Interval training, broadly defined as performing intermittent bouts of vigorous- to supramaximal-intensity bouts of exercise (20–240 s) separated by equal or longer bouts of light- to moderate-intensity exercise (60–340 s), has emerged as a method of exercise prescription. There are two main classifications of interval training: high-intensity interval training (HIIT) or sprint-interval training (13). It is of vital importance that the Personal Trainer ensures his or her client can safely perform exercises at this intensity based on his or her preparticipation evaluation as outlined in Chapter 11 of this book. Because HIIT training is so popular, the 2018 Physical Activity Guidelines Advisory Committee examined the available scientific evidence regarding the use of HIIT for cardiometabolic health benefits (14). The results indicate that HIIT can improve CRF in adults with varied weight and health status and improve insulin sensitivity and blood pressure to a greater extent in adults that were overweight or obese.

Interval training can be composed of aerobic-based, resistance-based, or a combination of the two. Ultimately, the type of programming chosen, the intensity of exercise, the exercise interval duration, recovery intervals, and total number of intervals performed will be based on the goals of the training session and the physical readiness of the client (15,16).

Methods of Estimating Intensity for Cardiorespiratory Endurance Exercise

There are many ways to determine exercise intensity. Table 15.2 shows the different methods commonly used to determine exercise intensity. Some methods require knowledge of measured $\dot{V}O_{2max}$, maximal heart rate (HR_{max}), and/or resting heart rate (HR_{rest}). Others rely on estimations of HR_{max} based on age. Personal Trainers must use the information available to determine the most appropriate exercise prescription, realizing the shortcomings of the various methods. A good Personal Trainer has the willingness and ability to modify the exercise program to provide the appropriate overload and prescription to the client.

Maximal Heart Rate and Heart Rate Reserve

Using HR in prescribing intensity can be helpful because it represents a client's physiological response, but it too has shortcomings. Accuracy can be compromised when estimations of HR_{max} are used or with the use of medications known to influence HR (*i.e.*, β-blockers, a medication that suppresses HR at rest and during exercise). Medication use can be identified from the initial health history and should be updated as needed when changes in medications occur. When a measured HR_{max}, obtained during a graded exercise test, is unavailable, the Personal Trainer commonly uses an age-predicted estimate (220 − age). Be aware that there is controversy over using this method to estimate HR_{max}. Most notably, it can underestimate or overestimate measured HR_{max} and has a variability of ± 10–12 bpm (*i.e.*, 1 *standard deviation*). Thus, a 20-year-old may not have an HR_{max} of 200 as predicted by this formula, but instead, his or her estimate could be as low as 188 or as high as 212. Some population-specific equations for estimating HR_{max} are available. These may be superior to the "220 − age" equation, at least in some individuals, although they are not currently recommended for universal application (10). Table 15.3 provides the commonly used equations for estimating HR_{max} for various populations. Although directly measured HR_{max} is preferred to estimated methods, when this is not feasible, an estimation using one of these methods is acceptable. When estimating HR_{max}, choose an equation that most represents the client population.

Table 15.3 Commonly Used Equations for Estimating Maximal Heart Rate

Author	Equation	Population
Astrand	$HR_{max} = 216.6 - (0.84 \times age)$	Men and women age 4–34 yr
Tanaka et al.	$HR_{max} = 208 - (0.7 \times age)$	Healthy men and women
Gellish et al.	$HR_{max} = 207 - (0.7 \times age)$	Men and women participants in an adult fitness program with broad range of age and fitness levels
Gulati et al.	$HR_{max} = 206 - (0.88 \times age)$	Asymptomatic middle-aged women referred for stress testing

Adapted from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2022. 548 p.

Often, a Personal Trainer will not have access to information on oxygen consumption from an exercise test. We do know that as exercise intensity increases, HR and oxygen consumption have a linear relationship. Therefore, in the absence of oxygen consumption information, HR can be used. Whether using measured or predicted HR_{max} to determine intensity, ACSM recommends a percentage of HR_{max} for moderate-intensity exercise between 64% and 76% and a vigorous intensity from 77% to 95% of HR_{max} (10). The following calculation can be used to determine the exercise target HR based on a percentage of HR_{max} for moderate intensity:

$$\text{Percentage of target HR (lower end of range)} = (HR_{max}) \times 0.64$$

$$\text{Percentage of target HR (lower end of range)} = (HR_{max}) \times 0.76$$

For example, a 20-year-old with an estimated HR_{max} of 200 (220 − 20 = 200 bpm), the range moderate-intensity rage will be 128–152 bpm. However, based on the client's goals, health history, and current fitness level, this intensity range may be too limiting for the exercise session. The Personal Trainer must therefore decide if increasing the intensity range to include vigorous exercise (77%–95% HR_{max}) is appropriate and beneficial (10). Therefore, for the 20-year-old, moderately active client, the target HR range could be 128–190 bpm. Conversely, if a client is very deconditioned or unfit, then a lower percentage should be used (light intensity 57%–63% HR_{max}). Ultimately, it is up to the Personal Trainer to decide at what intensity the client should exercise. When picking the initial exercise intensity, it is important not to overestimate the client's ability and start at too high of an intensity and subsequently have to reduce it for the client because this can negatively impact the client’s confidence. Often, it is more effective to start with a conservative intensity with the ability to increase it as needed.

Another HR method to determine intensity is HRR. HRR is a measure of *relative* intensity because this method uses information relative to the client’s peak or HR_{max} and HR_{rest}. As discussed in previous chapters, a lower HR_{rest} can be an indicator of greater CRF. HRR, often referred to as the Karvonen method or formula, is based on the difference between HR_{max} and HR_{rest}. Exercise intensity can be determined from HRR in a similar manner as $\dot{V}O_2R$. For moderate- to vigorous-intensity exercise the intensity range is 40%–89% HRR (10).

$$\text{Percentage of target HRR (lower end of moderate range)} = [(HR_{max} - HR_{rest}) \times 0.40] + HR_{rest}$$

$$\text{Percentage of target HRR (upper end of vigorous range)} = [(HR_{max} - HR_{rest}) \times 0.89] + HR_{rest}$$

For example, when using this method for a 20-year-old client who has an HR_{rest} of 75, the range will be 125–186 bpm. This range is too wide to be a useful intensity for exercise prescription. Thus, changes must be made based on the client’s fitness, goals, and health history. Additional examples are listed in Box 15.2.

Box 15.2 Example HR_{max} and HRR Calculations

Client name: Amy
Client demographics:
Age: 29 yr
Weight: 136 lb (61.8 kg)
Height: 5 ft 4 in (64 in; 1.63 m)
HR_{rest}: 62 bpm

$\dot{V}O_{2max}$ ($mL\ O_2 \cdot kg^{-1} \cdot min^{-1}$): 36.4 $mL\ O_2 \cdot kg^{-1} \cdot min^{-1}$ (fair category)

Amy is a healthy female adult who has been doing moderate-intensity cardiovascular exercise on her own for the last year and a half. She would like to continue exercise but at a vigorous intensity.

Step 1: Calculate her estimated HR_{max}.
Equation: 220 – age
220 – 29 = 191 bpm
Step 2: Determine appropriate HR_{max} and HRR intensities.
HR_{max} vigorous range: 77%–95%
HR_{max} intensity equation: HR_{max} × % intensity desired

191 × 0.77 = 147 bpm   191 × 0.95 = 181 bpm

HRR vigorous range: 60%–89%
HRR intensity equation: [(HR_{max} – HR_{rest}) × % intensity desired] + HR_{rest}

[(191 – 62) × 0.60] + 62	[(191 – 62) × 0.89] + 62
[129 × 0.60] + 62	[129 × 0.89] + 62
77 + 62 = 139 bpm	115 + 62 = 177 bpm

So, for Amy to exercise at a vigorous intensity, she should try to achieve an HR between 147 181 bpm (%HR_{max}) and 139 177 bpm (%HRR).

Selection of the intensity range must be made with the client's fitness, health status, and fitness goals in mind.

Rating of Perceived Exertion

Rating of perceived exertion (RPE) is used to subjectively rate overall feelings of exertion during exercise and can be helpful in guiding exercise intensity (10,17). Commonly used is the Borg 6–20 scale and the Borg Category Ratio 10 (CR10) scale (10). Table 15.4 lists and compares the two Borg RPE scales. The threshold level for cardiorespiratory benefits appears to be an RPE of 12–13, which represents moderate intensity. When using the Borg 6–20 scale, it is important for the Personal Trainer to explain how to use the scale and to "anchor" certain numbers on the scale so the client has a point of reference. When explaining how to use the scale, the Personal Trainer should remind the client that the number he or she is giving represent overall body fatigue and is not localized to a specific area of the body. When anchoring the scale numbers, a 9 represents "very light" activity and can equate to a healthy individual walking slowly at his or her own pace. A 13 represents an intensity that is "somewhat hard" and means that the exercise is hard, but he or she can still continue (17). When using RPE, the Personal Trainer should keep in mind the variability between individuals (*e.g.*, the RPE value will not necessarily correspond directly with a particular percentage of HR_{max} or percentage of HRR) and then make adjustments as needed (10).

Table 15.4 Borg Rating of Perceived Exertion Scale and Borg Category-Ratio 10 Scale

Number Rating	Level of Exertion	Number Rating	Level of Exertion
6	No exertion at all	0	Nothing at all
7	Extremely light	0.3	
8		0.5	Extremely week
9	Very light	1	Very weak
10		1.5	
11	Light	2	Weak
12		2.5	
13	Somewhat hard	3	Moderate
14		4	
15	Hard (heavy)	5	Strong
16		6	

17	Very hard	7	Very strong
18		8	
19	Extremely hard	9	
20	Maximal exertion	10	Extremely strong
		11	
		•	Absolute maximum

Adapted from Borg G. *Borg's Perceived Exertion and Pain Scales*. Champaign (IL): Human Kinetics; 1998. 104 p.

RPE is often recommended for determining exercise intensity in older adults and is helpful for individuals having difficulty assessing their HR or who are taking medications, which influence HR. Although older adults are encouraged to attain similar amounts of physical activity related to days per week and time per session as younger people (18), given the wide range of fitness levels in older adults, using a perceived exertion scale (*i.e.*, a moderate or 12–13 rating on the 6–20 scale or a 3–4 level rating of exertion on a CR10 scale) to gauge intensity is often preferable to standard activity descriptions. For example, for some older adults, moderate-intensity activity may be a slow walk, whereas for others, it may be a brisk walk or jog.

Talk Test

A very simple, yet effective, way to determine intensity is with the "talk test." The talk test is a reliable method to estimate exercise intensity and is associated with the transition from aerobic to anaerobic energy systems via lactate threshold, ventilatory threshold, and the respiratory compensation point (10). Simply put, how well a client is able to speak or carry on a conversation relates well to his or her relative intensity. Table 15.5 represents current exercise intensity ranges and their relationship with the talk test. In practice, the Personal Trainer should first estimate the client's moderate- to vigorous-intensity HR range using the HRR method. Next, have the client perform a 5- to 10-minute warm-up and then gradually increase the intensity to a walking or jogging speed. When the client reaches a steady-state HR at the new intensity, have them recite a standard phrase aloud (*e.g.*, the 31-word United States Pledge of Allegiance). After saying the phrase, have the client subjectively assess his or her level of speech difficulty based on Table 15.5 (19).

Table 15.5 Physical Activity Intensity and the Talk Test			
	Relative Intensity		
Intensity	**%HRR**	**RPE**	**Speech Difficulty**[a]
Very light	<20	<10	Speech is unaffected from rest.
Light	20–29	10–11	Comfortable speech is possible.
Moderate	40–59	12–13	Speech is possible with some difficulty.
Vigorous	60–89	14–16	Speech is limited to short phrases.
Maximal to near maximal	≥90	17–19	Speech is very difficult.

[a]Individual must speak aloud.

Adapted from Webster AL, Azanar-Laín S. Intensity of physical activity and the “talk test” — a brief review and practical application. *ACSMs Health Fit J*. 2008;12(3):13–7.

Time or Exercise Session Duration

Exercise duration and intensity are typically inversely related. As one increases, the other decreases. Thus, the intensity of the exercise must be considered when determining the duration. ACSM recommends 30 $\text{min} \cdot \text{d}^{-1}$ (150 $\text{min} \cdot \text{wk}^{-1}$) of moderate-intensity exercise, 20 $\text{min} \cdot \text{d}^{-1}$ (75 $\text{min} \cdot \text{wk}^{-1}$) of vigorous exercise, or a combination of both to improve CRF (10). This duration can be in one exercise session or could be accomplished intermittently through multiple exercise bouts. If fitness gains are a primary goal and the exercise is done intermittently, then each exercise bout should be ≥10 minutes for each bout. However, current evidence suggests that accumulating physical activity in bouts that are <10 minutes in duration are also associated with favorable health benefits, including a reduction in all-cause mortality (20). Sedentary individuals may need to begin with very short bouts (*i.e.*, 5–10 $\text{min} \cdot \text{d}^{-1}$) of low-intensity exercise. Time and intensity should then be gradually increased while always being mindful of the client’s fatigue level. The rate of progression will vary depending on the health status and age of the individual. Longer durations of exercise (≥30–60 $\text{min} \cdot \text{d}^{-1}$ or more; 250–300 $\text{min} \cdot \text{wk}^{-1}$) are recommended for weight control especially for those who are otherwise sedentary (7). This time frame does not include warm-up and cool-down, both of which should be completed in addition to the time spent at the target exercise program (21).

Exercise Type or Mode

The type of exercise selected should be based on the client's fitness, health, skill, and interests. During the initial consultation with a client, it is best to discuss what activities are most enjoyed as well as those that are accessible. Enjoyability and access may seem obvious but are important to consider when selecting an exercise mode for best possible adherence, particularly outside of the sessions with the Personal Trainer.

Typically, cardiorespiratory exercises are those that involve the use of large muscle groups in a repetitive, rhythmic fashion. Some activities are weight bearing, meaning that body weight is moved during the exercise (*e.g.*, walking, running). In other activities, body weight is not a factor because the body is supported (*e.g.*, cycling, swimming) and are referred to as non–weight-bearing exercises. Use of non–weight-bearing exercises may be useful in avoiding injuries of the lower limbs due to overuse or in populations where weight-bearing exercise can create potential issues (*i.e.*, obese clients). ACSM has classified a number of cardiorespiratory endurance activities into four groups (Table 15.6) (10). The groups do not necessarily represent the recommended or optimal progression of activity but rather present the Personal Trainer with a structure of the characteristics of different exercise modes that should be considered when selecting activities.

Table 15.6 Grouping of Cardiorespiratory Exercise and Activities

Exercise Group	Exercise Description	Recommended For	Examples
A	Endurance activities requiring minimal skill or physical fitness to perform	All adults	Walking, leisurely cycling, aqua-aerobics, slow dancing
B	Vigorous-intensity endurance activities requiring minimal skill	Adults (per the preparticipation screening guidelines; see Chapter 11) who are habitually physically active and/or at least average physical fitness	Jogging, running, rowing, aerobics, spinning, elliptical exercise, stepping exercise, fast dancing
C	Endurance activities requiring skill to perform	Adults with acquired skill and/or at least average physical fitness levels	Swimming, cross-country skiing, skating
D	Recreational sports	Adults with a regular exercise	Racquet sports, basketball,

	program and at least average physical fitness	soccer, downhill skiing, hiking

Adapted with permission from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2022. 548 p.

Group A includes endurance activities that require minimal skill or fitness to perform, such as walking. These activities easily accommodate individual fitness levels and thus are recommended for all adults. Group B activities are those that require minimal skill but, in contrast to Group A activities, are typically performed at a more vigorous intensity. Jogging and running are examples. These activities are appropriate for those who exercise regularly and who have at least an average level of fitness. Examples of Group C exercises are swimming and cross-country skiing. This group reflects activities that have a high relationship between skill and energy expenditure. For example, an experienced swimmer may be able to easily swim at a constant intensity, whereas a person with poor swimming skill would be very inefficient and would struggle to swim at an appropriate and constant intensity to achieve cardiorespiratory benefits.

Recreational sports such as basketball, soccer, tennis, and other racquet sports are classified as Group D activities. These activities are typically vigorous and intermittent. The nature of these activities does not lend themselves to constant, controlled intensity levels. This is even more true when competition is involved. As a result, Group D activities should be used with caution for clients with low fitness or who are at high risk or symptomatic for disease unless modifications to rules are implemented. Group D activities are generally recommended as ancillary activities that are added to a regular fitness program (10).

The Personal Trainer can use these activity groupings to guide his or her selection of an appropriate exercise mode for his or her client. As noted previously, Group A activities are appropriate to use with any client but are particularly appropriate for clients beginning an exercise program. Group B activities are recommended for most regular exercisers with at least an average fitness level. Group C activities may be included but will require discussion with the client regarding his or her skill levels for the activities in question. Group D activities may best be included as additional activity after a fairly good level of fitness is achieved. The Personal Trainer and the client must maintain open lines of communication regarding the selection of exercise modes. In some situations, individuals will be satisfied with continuing with various Group A activities. Other clients may have goals to move to Group B, have the skills or desire to learn new skills to include Group C activities, or enjoy the variety and challenge of Group D activities.

The Personal Trainer should also always instruct clients about proper posture and body alignment during cardiorespiratory training. Having a client perform these exercises in a proper biomechanical position is just as important with cardiorespiratory exercise as when clients are performing resistance training exercises, as discussed in Chapter 14. Typical concerns with treadmill exercise include leaning forward, uneven or unnatural gait, and excessive gripping on the handrails. Proper upright posture, body alignment, and normal gait with the use of handrails only for balance should be encouraged. Similarly, with stair steppers or other cross-training machines, upright posture should be maintained rather than allowing forward head protrusion, rounded shoulders, or poor alignment. The biggest challenge with cycle ergometry is determination of appropriate seat height. Seat height should be adjusted to allow for 5°–10° of knee flexion at the bottom of the pedal stroke. Figures 15.1–15.4 show examples of proper exercise postures.

FIGURE 15.1. Personal Trainers should instruct clients to adjust seat heights to maintain a 5°–10° bend in the knee before reaching full extension to reduce compression on the joint structure. Full extension of knee while pedaling on the stationary bike is not recommended.

FIGURE 15.2. Stair climber activity.

FIGURE 15.3. Walking activity.

FIGURE 15.4. Rowing activity.

The Personal Trainer should also always instruct clients about proper posture and body alignment during cardiorespiratory training.

Volume (Quantity)

Exercise volume is the product of FITT of exercise. Exercise volume is used to estimate the gross energy expenditure of an individual's exercise program. Determining exercise volume is important in realizing health/fitness outcomes, particularly with respect to body composition and weight management. Exercise volume is typically expressed in kcal · day^{-1}, kcal · wk^{-1}, or MET-min · wk^{-1}. Box 15.3 provides definitions and calculations for MET, MET-min, and kcal · min^{-1}. These then can be used to calculate volume in MET-min · wk^{-1} and kcal · wk^{-1} to evaluate whether the exercise program is at the appropriate overload volume. In addition, volume can be approximated based on steps per day (10). Pedometers and other wearable technology have increased the accuracy of tracking physical activity. The Personal Trainer should be aware that the often-stated goal of 10,000 steps · d^{-1} is an appropriate target but that a daily step count of 7,000–8,000 steps · d^{-1}, with at least 3,000 steps · d^{-1} at a brisk pace, will meet the threshold for health benefits (12).

Box 15.3 Calculation of MET, MET-min, and kcal · min^{-1}

A shortcoming of caloric expenditure estimates includes the influence of coordination and skill. An experienced swimmer, for example, will expend less energy to swim the same pace as someone with an inefficient stroke patterns. Even though they are at the same pace and theoretically doing a similar amount of work, the inexperienced swimmer will expend more calories than those expended by the experienced swimmer. Thus, the Personal Trainer needs to understand that interindividual differences limit the precision of this estimation.

ACSM recommends expending 150–400 kcal in physical activity each day (10). Sedentary individuals need to begin on the lower end of the range and progress upward. Expenditures of approximately 1,000 kcal · wk^{-1} are associated with decreases in the risk of all-cause mortality (10) and values of ≥500–1,000 MET-min · wk^{-1} are consistently associated with lower rates of cardiovascular disease and premature mortality (10). Therefore, a recommended exercise volume for decreasing risk of premature mortality is an exercise volume of ≥500–1,000 MET-min · wk^{-1}.

> Selection of frequency, intensity, and duration determines the calories expended during the activity.

The following equation can be used to approximate the number of calories expended per minute of a given activity (10):

$$\text{Calories per min} = (\text{MET} \times 3.5 \times \text{body weight in kilograms}) / 200$$

The attraction of using this approach is it includes both time and intensity of the prescribed exercise mode. For example, if a client runs on the treadmill at 0% grade at 7 mph for 45 min, the Personal Trainer can "summarize" the caloric expenditure of the workout by using this formula and the MET level for 7 mph, which is 11.7 MET. If the client weighs 150 lb (68.2 kg), then the number of calories expended for the total workout can be determined as follows:

$$(11.7 \times 3.5 \times 68.2) / 200 = 14 \text{ kcal} \cdot \text{min}^{-1}$$

$$14 \text{ kcal} \cdot \text{min}^{-1} \times 45 \text{ min} = 630 \text{ kcal for the workout}$$

ACSM recommends a minimum goal of ≥500–1,000 MET-min · wk^{-1} (10). To determine if a person who walks 3 mph (about 3.3 METs) for 30 min on 5 d of the week is getting a sufficient volume of exercise, use the following calculation:

$$30 \text{ min at this intensity} = 3.3 \text{ MET} \times 30 \text{ min} = 99 \text{ MET-min} \cdot \text{d}^{-1}$$
$$\text{Volume for 5 d of activity} = 99 \times 5 = 495 \text{ MET-min} \cdot \text{wk}^{-1}$$

Thus, this person is just under the recommended volume. The Personal Trainer should encourage that this person increase time, intensity, or frequency to meet the guidelines. Weekly volume for someone exercising at a higher intensity, for example, jogging 5 mph for 20 min 3 d · wk^{-1} would be

$$5 \text{ mph} = 8.6 \text{ MET}$$
$$20 \text{ min at this intensity} = 8.6 \times 20 = 172 \text{ MET-min} \cdot \text{d}^{-1}$$
$$\text{Volume for the 3 d of activity} = 172 \times 3 = 516 \text{ MET-min} \cdot \text{wk}^{-1}$$

Thus, this person is within the recommended weekly volume range. Calculating MET-min · wk^{-1} is especially useful when individuals combine activities of different intensity levels (*e.g.*, walking and jogging in the same week). For example, the MET-min · wk^{-1} for a person walking 2 d · wk^{-1} at 3 mph for 30 min and jogging at 5 mph for 2 d · wk^{-1} for 20 min would be determined as follows:

$$3 \text{ mph} = 3.3 \text{ MET and } 5 \text{ mph} = 8.6 \text{ MET}$$
$$30 \text{ min at 3 mph} = 3.3 \text{ MET} \times 30 \text{ min} = 99 \text{ MET-min} \cdot \text{d}^{-1}$$
$$\text{Volume for 2 d of activity} = 99 \times 2 = 198 \text{ MET-min} \cdot \text{wk}^{-1}$$
$$20 \text{ min at 5 mph} = 8.6 \times 20 = 172 \text{ MET-min} \cdot \text{d}^{-1}$$
$$\text{Volume for 2 d of activity} = 172 \times 2 = 344 \text{ MET-min} \cdot \text{wk}^{-1}$$
$$\text{Total volume for 4 d} = 198 + 344 = 542 \text{ MET-min} \cdot \text{wk}^{-1}$$

For a more extensive list of MET values, please see the updated *2011 Compendium of Physical Activities* (12) or http://sites.google.com/site/compendiumofphysicalactivities/home. Note that the MET values in various tables may differ slightly as these are approximations.

Progression

Progression, as a component of the exercise prescription, ensures that the overload is not applied in a manner that exceeds the cardiorespiratory system's ability to adapt. Any or all of the FITT components may be increased to continually overload and challenge the cardiorespiratory system. However, the Personal Trainer should not increase all of the components at the same time but rather adjust them individually to help the client attain his or her CRF goals. When and how much to increase each component will depend on the client's initial fitness level, his or her progress, health status, and goals. Often, the duration of the exercise bout is increased first, with an increase ranging from 5 to 10 minutes for a couple of weeks before intensity is increased. Frequency may be increased from 3 to 5 $d \cdot wk^{-1}$ depending on the exercise responses and goals of the client. The volume of exercise is therefore gradually progressed during the course of the exercise prescription until the client's goals are reached. The intensity, duration, and frequency of the conditioning phase are gradually increased, which results in a gradual progression of the volume of exercise performed. As noted previously, if there is a decrease in the overload such as an injury, travel, or unexpected work obligations, the system will regress, and fitness gains will be lost. Therefore, the Personal Trainer must work with the client to anticipate periods of decreased physical activity and plan for a safe "reentry" back into the exercise program. To avoid an overuse injury, clients should refrain from "jumping back" into the same level of activity after more than a few days off.

The intensity, duration, and frequency of the conditioning phase are gradually increased, which results in a gradual progression of the volume of exercise performed.

Sample Cardiorespiratory Endurance Training Programs

Tables 15.7 and 15.8 include examples of cardiorespiratory endurance programs for various types of activities (*e.g.*, walking/jogging program and a typical mix of activities, which may be available at a health club). For each, an overall scheme of a 6-month training progression is shown for an apparently healthy client. Use of the terms *beginner*, *intermediate*, and *established* to describe the fitness level of the client is somewhat subjective. For some individuals, even the beginner stage may present too much of a challenge. If so, starting out with only 5–10 minutes of exercise may be more appropriate. The progression should not be overly aggressive. Do not focus on achieving target goals quickly but rather to gradually increase the overall workload to establish compliance and promote adherence. Progression should be individualized on the basis of the client's initial fitness level, health status, age, and individual goals.

Table 15.7 Sample Walking and Jogging Program

Status	Time Point	Warm-Up	Workout[a]	Cool-Down
Beginner	First week	Slow, easy walking pace for a couple of minutes	Walk at a pace that gives a light level of exertion (level 3 or 4) for 10 min at least twice a day for a total of 20 min each day (3 d · wk^{-1}). Your weekly total should be 60 min.	Slow, easy walking pace for a couple of minutes
	Progression, part 1	Slow, easy walking pace for 5 min	Each week add 15 min to your weekly total until you reach 120 min of activity (*e.g.*, 30 min 4 d · wk^{-1}). Stay at this duration and increase your intensity over the next couple of weeks from light (level 3 or 4) to moderate (level 5 or 6). Once you are comfortable with this time and intensity for a couple of weeks, continue to add 10–15 min · wk^{-1} until you reach 150 min.	Slow, easy walking pace for 5 min
	Progression, part 2	Easy walking pace for 5–10 min	Walk at a pace that gives a moderate level of exertion (level 5 or 6); continue to add 10–15 min each week to progress from 150 min · wk^{-1} to a total of 200 min.	Easy walking pace for 5–10 min
	Final week	Easy walking pace for 5–10 min	Walk at a pace that gives a moderate level of exertion (level 5 or 6) for 30–60 min (3–5 d · wk^{-1}). Your weekly total should be 200 min.	Easy walking pace for 5–10 min

Intermediate	Initial week	Easy walking pace for 5–10 min	Walk at a pace that feels moderate (level 5 or 6) for 30–60 min (3–5 d · wk^{-1}). Your weekly total should be 200 min.	Easy walking pace for 5–10 min
	Progression	Easy walking pace for 5–10 min	Continue to increase exercise duration by 10–15 min · wk^{-1} to approach 300 min of moderate activity accumulated on a weekly basis. Another option is to introduce a more vigorous activity, such as jogging, realizing that the time needed will be less (typically 2 min of moderate activity equals 1 min of vigorous activity).	Easy walking pace for 5–10 min
	Final week	Easy walking pace for 5–10 min	Walk at a pace that feels moderate (level 5 or 6) for 45–90 min (3–5 d · wk^{-1}). Your weekly total should be 300 min (moderate intensity). OR Combine moderate and vigorous walking on alternate days. Your weekly total should be equivalent amounts of moderate and vigorous activity (*e.g.*, 200 min of moderate plus 50 min of vigorous).	Easy walking pace for 5–10 min
Established	Continue/maintain	Easy walking pace for 5–10 min	Walk at a pace that feels moderate (level 5 or 6). Your weekly total should be a minimum of 300 min (moderate intensity). OR Jog (at level 7 or 8). Your weekly total should be a minimum of 150 min (vigorous intensity). OR Combine moderate and vigorous walking on alternate days. Your weekly total should be equivalent amounts of moderate and vigorous activity (*e.g.*, 200 min of moderate plus 50 min of vigorous).	Easy walking pace for 5–10 min

[a]Level of exertion is on a scale of 0–10 (sitting at rest is 0 and your highest effort level is 10).

Adapted with permission from American College of Sports Medicine. *ACSM's Complete Guide to Fitness & Health*. Champaign (IL): Human Kinetics; 2011. 408 p.

Table 15.8 Sample Cross-Training Program at a Health Club

Status	Time Point	Warm-Up	Workout[a]	Cool-Down

Beginner	First week	Slow, easy walking pace for a couple of minutes	Pick one activity each day at a light level of exertion (level 3 or 4) for 10 min at least twice a day for a total of 20 min each day (3 $d \cdot wk^{-1}$). Select from walking on the treadmill or stationary biking. Your weekly total should be 60 min.	Slow, easy walking pace for a couple of minutes
	Progression, part 1	Slow, easy walking pace for 5 min	Each week add 15 min to your weekly total until you reach 120 min of activity (*e.g.*, 30 min 4 $d \cdot wk^{-1}$). Potential activities include treadmill walking, stationary biking, and using a stair climber. Stay at this duration and increase your intensity over the next couple of weeks from light (level 3 or 4) to moderate (level 5 or 6). Once you are comfortable with this time and intensity for a couple of weeks, continue to add 10–15 $min \cdot wk^{-1}$ until you reach 150 min.	Slow, easy walking pace for 5 min
	Progression, part 2	Easy walking pace for 5–10 min	Exercise at an intensity that gives a moderate level of exertion (level 5 or 6); continue to add 10–15 min each week to progress from 150 $min \cdot wk^{-1}$ to a total of 200 min.	Easy walking pace for 5–10 min
	Final week	Easy walking pace for 5–10 min	Exercise at an intensity that gives a moderate level of exertion (level 5 or 6) for 30–60 min (3–5 $d \cdot wk^{-1}$). Activities may include treadmill walking; stationary biking; or using a stair climber, elliptical trainer, rowing machine, or Nordic ski machine. Your weekly total should be 200 min.	Easy walking pace for 5–10 min
Intermediate	Initial week	Easy walking pace for 5–10 min	Exercise at a level that feels moderate (level 5 or 6) for 30–60 min (3–5 $d \cdot wk^{-1}$) using a treadmill, stationary bike, stair climber, elliptical trainer, or Nordic ski machine. Your weekly total should be 200 min.	Easy walking pace for 5–10 min
	Progression	Easy walking pace for 5–10 min	Continue to increase exercise duration by 10–15 $min \cdot wk^{-1}$ to approach 300 min of moderate activity accumulated on a weekly basis. Another option is to introduce more vigorous activity a couple of days per week, such as jogging on the treadmill, taking a spinning class, or taking a step aerobics class, realizing that the time needed will be less (typically, 2 min of moderate activity equals 1 min of vigorous activity).	Easy walking pace for 5–10 min
	Final week	Easy	Exercise at a level that feels moderate (level	Easy

		walking pace for 5–10 min	5 or 6) for 45–90 min (3–5 d · wk^{-1}). Your weekly total should be 300 min (moderate intensity). OR Combine moderate and vigorous walking on alternate days. Your weekly total should be equivalent amounts of moderate and vigorous activity (*e.g.*, 200 min of moderate plus 50 min of vigorous).	walking pace for 5–10 min
Established	Continue/maintain	Easy walking pace for 5–10 min	Exercise at an intensity that feels moderate (level 5 or 6). Your weekly total should be a minimum of 300 min (moderate intensity). OR Exercise at a higher intensity (level 7 or 8). Your weekly total should be a minimum of 150 min (vigorous intensity). OR Combine moderate and vigorous walking on alternate days. Your weekly total should be equivalent amounts of moderate and vigorous activity (*e.g.*, 200 min of moderate plus 50 min of vigorous).	Easy walking pace for 5–10 min

[a]Level of exertion is on a scale of 0–10 (sitting at rest is 0, and your highest effort level is 10).

Adapted with permission from American College of Sports Medicine. *ACSM's Complete Guide to Fitness and Health*. Champaign (IL): Human Kinetics; 2011. 408 p.

For each stage, a range rather than a single number is included for frequency, intensity, and duration. The role of a Personal Trainer is to assist the client with the appropriate balance based on individual responses. Frequency of exercise progresses gradually over the 6-month period outlined from 3 d · wk^{-1} up to a target of 3–5 d · wk^{-1}. Intensity increases from relatively low to a target of 70%–85% HRR. By slowly increasing the intensity, the client is able to adapt to the higher levels of exercise without becoming discouraged or experiencing retrogression (*i.e.*, a reversal of gains due to excessive overload). The duration of the exercise session also increases in small steps to allow for appropriate adaptations. Finally, the Personal Trainer can consider changing the mode of exercise to provide more variety in the program.

Progression should be individualized on the basis of the client's initial fitness level, health status, age, and individual goals.

Recall that the activities are classified by group. Walking is a Group A activity and is appropriate for anyone. The progression found in Table 15.7 could also be used with swimming or other aquatic exercises, which are Group C activities and require skill to maintain an appropriate intensity for a sufficient period of time. For each activity, the sequence in time, intensity, and frequency as well as progression of the different types of activities should be noted. When designing a program, occasionally including new modes of exercise can provide much-appreciated variety but should be introduced gradually so that appropriate adjustments can be made (*i.e.*, appropriate overload). Most importantly, remember that the overall training program must match the goals of the client.

Weight Loss

Many clients are interested in losing weight and often consult Personal Trainers. The ACSM position stand "Appropriate Physical Activity Intervention Strategies for Weight Loss and Prevention of Weight Regain for Adults" (11) indicates that increasing activity levels above the baseline of 150 $\text{min} \cdot \text{wk}^{-1}$ of moderately intense exercise is important to assist with weight loss or to help maintain weight loss. In these situations, the recommended duration of exercise is at least 30–60 $\text{min} \cdot \text{d}^{-1}$ (this can be divided into multiple shorter exercise sessions), or 250–300 $\text{min} \cdot \text{wk}^{-1}$ (11). More information about exercise and weight loss is provided in Chapter 20.

Implementing Cardiorespiratory Endurance Training Programs

Implementation of effective cardiorespiratory training programs requires the Personal Trainer to have knowledge of the current scientific basis of exercise (*e.g.*, exercise prescription guidelines). This chapter has reviewed current guidelines (1,10) regarding the FITT-VP components of cardiorespiratory exercise prescription (*i.e.*, frequency, intensity, time, type, volume, and progression). These guidelines provide a framework to structure the exercise program and give the Personal Trainer the ability to showcase the *art* of exercise prescription. The Personal Trainer must evaluate each client individually for health status and disease risks (see Chapter 11) and conduct individual fitness assessments (see Chapter 12), which are used to determine an appropriate initial level of exercise. Think of an artist painting a sunset. The artist uses a palate of colors to create the exact sunset he or she has envisioned. The color palate equates to the information gained from fitness assessments and health screening. To create a realistic sunset, the artist uses different techniques (brushes, mixing colors, brush stroke, and brush pressure) to create his or her painting. The Personal Trainer does the same thing by changing the FITT components to create the best exercise program he or she can for the client.

Implementation of effective cardiorespiratory training programs requires the Personal Trainer to have knowledge of the current scientific basis of exercise (*e.g.*, exercise prescription guidelines).

SUMMARY

Cardiorespiratory training is an essential component of a client's overall exercise program. Other important components include resistance and flexibility training, which are detailed in Chapters 14 and 16, respectively. Each cardiorespiratory training session includes three basic parts: warm-up, conditioning phase, and cool-down. A CRF program or prescription requires the FITT-VP components: frequency, intensity, time/duration, type, volume, and progression. The Personal Trainer must balance the FITT-VP components with the client's characteristics (*e.g.*, health status, initial fitness), life situations (*e.g.*, work schedule, availability of exercise time), goals (*e.g.*, general fitness, weight loss, competition), and preferences.

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CHAPTER 16

Guidelines for Designing Flexibility Programs

OBJECTIVES

Personal Trainers should be able to:

- Describe the factors influencing flexibility.
- Understand the benefits and risks of flexibility training.
- Determine how to evaluate flexibility.
- Understand various methods of stretching.
- Be aware of precautions for individuals with health concerns.
- Understand the relationships between stretching and performance.
- Develop a flexibility program based on the FITT-VP principles.

INTRODUCTION

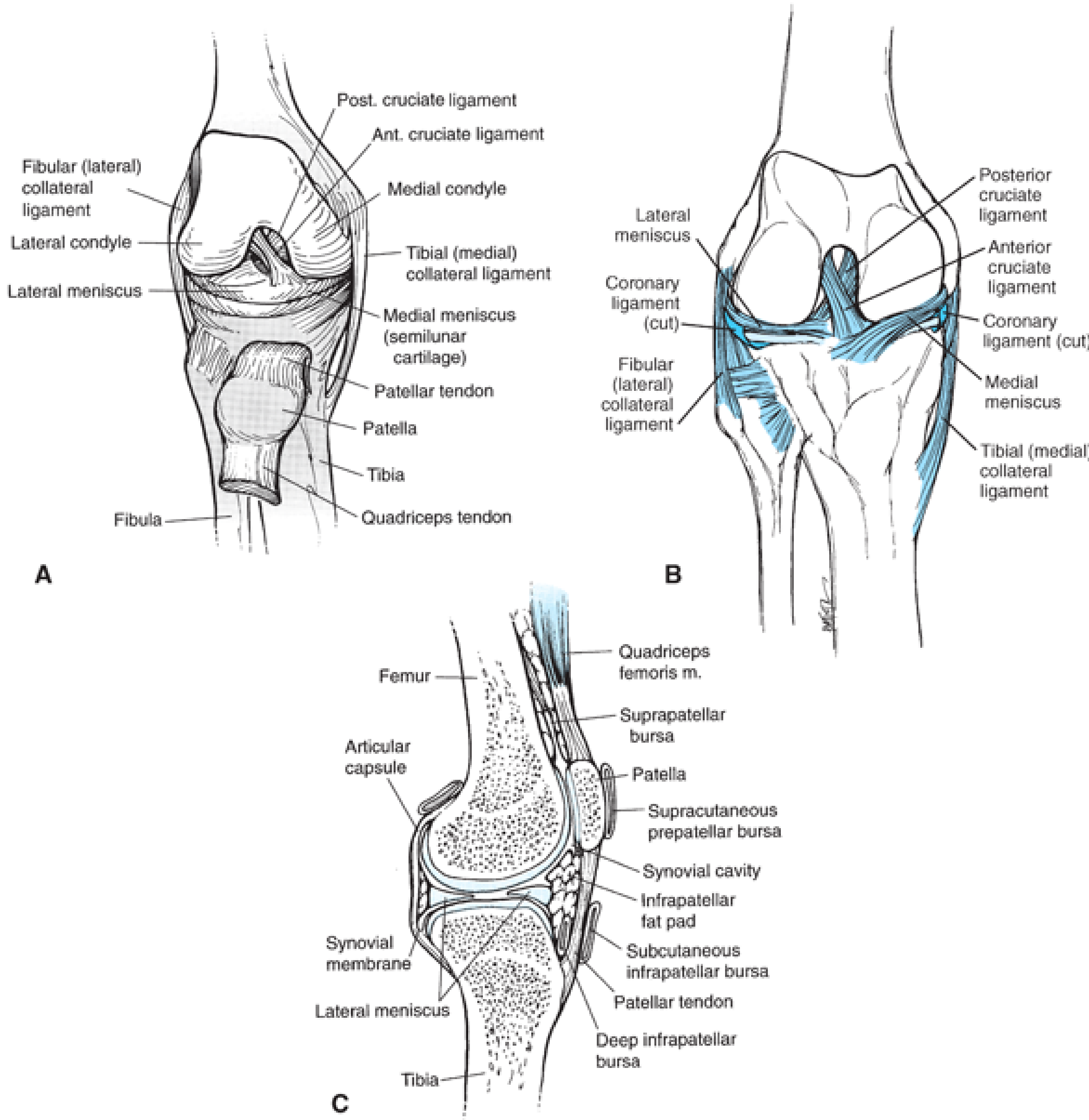
Flexibility refers to the degree to which a joint moves throughout a normal, pain-free range of motion (ROM). As most physical activities and sports consist of numerous multijoint movements, it is essential that musculoskeletal function not be compromised by inadequate flexibility. Stretching is the method used most commonly to increase joint ROM. The American College of Sports Medicine's (ACSM's) current position stand on exercises to develop and maintain fitness and flexibility in adults recommends the inclusion of general stretching exercises emphasizing the major skeletal muscle groups at least 2–3 d · wk^{-1} (1). Flexibility is classified as a health-related dimension of fitness (2), meaning that flexibility contributes to an overall improved quality of life in athletes and the general public.

The purpose of this chapter is to present flexibility as an essential component of health-related fitness and to provide Personal Trainers with a basic understanding of how to properly incorporate flexibility training into the exercise programs of apparently healthy individuals.

Determinants of Flexibility

Hamill et al. (3) suggest that several factors influence an individual's level of flexibility. These factors include joint structure, health of the soft tissue around the joint, length of antagonist muscles, and temperature of the tissues being stretched in addition to the viscoelastic ("rubber band–like") properties of the tissues surrounding the joint. For this reason, it is important that the Personal Trainer know which of these factors may be a hindrance to movement and develop training programs that address these restrictions.

Figure 16.1 depicts a typical human knee joint. To better understand the importance of the properties of the tissues surrounding this joint, study the anterior view (*panel A*) and the lateral view of (*panel C*) Figure 16.1. Notice that the knee is padded with fat and is secured into place by ligaments. These tissues influence knee ROM both at the joint itself and elsewhere in the lower extremity. For example, tightness of the ligaments as illustrated in Figure 16.1 or excessive fat surrounding the thigh could inhibit knee ROM during flexion. In fact, one belief about bodybuilders is that they are “muscle bound” and possess a more limited joint ROM as a result of the additional bulk. This may be true to a certain extent because possessing a large amount of skeletal muscle around a joint can certainly limit ROM. Thus, if the training demands of an athlete or the natural (healthy) body composition of a client predispose them toward greater muscle bulk rather than flexibility, there may be a trade-off such that a more limited joint ROM may be appropriate. However, regardless of the training goal, it is still a worthwhile endeavor to attain and maintain a healthy level of flexibility to mitigate the risk of potential injury associated with limited joint ROM (4).



Ligament	Insertion	Action
Anterior cruciate	Anterior intercondylar area of tibia to medial surface of lateral condyle	Prevents anterior tibial displacement; resists extension, internal rotation, flexion
Arcuate	Lateral condyle of femur to head of fibula	Reinforces back of capsule
Coronary	Meniscus to tibia	Holds menisci to tibia
Medial collateral	Medial epicondyle of femur to medial condyle of tibia and medial meniscus	Resists valgus forces; taunt in extension; resists internal, external rotation
Lateral collateral	Lateral epicondyle of femur to head of fibula	Resists varus forces; taut in extension
Patellar	Inferior patella to tibial tuberosity	Transfers force from quadriceps to tibia
Posterior cruciate	Posterior spine of tibia to inner condyle of femur	Resists posterior tibial movement; resists flexion and rotation
Posterior oblique	Expansion of semimembranosus muscle	Supports posterior, medial capsule
Transverse	Medial meniscus to lateral meniscus in front	Connects menisci to each other

FIGURE 16.1. Typical joint anatomy: anterior **(A)**, posterior **(B)**, and lateral **(C)**. (Reprinted with permission from Hamill J, Knutzen KM. *Biomechanical Basis of Human Movement*. 3rd ed. Philadelphia [PA]: Lippincott Williams & Wilkins; 2009. p. 212.)

As can be seen from Figure 16.1, contraction of the quadriceps femoris muscles will produce leg extension if the knee is bent at the start of the movement. However, tight quadriceps femoris muscles (perhaps as a result of soreness, poor recovery, or excessive conditioning) can restrict full leg extension and limit joint flexibility. Notice too from Figure 16.1 that the joint is restricted by the very architecture of the bones themselves. Leg extension is limited by what are termed "bony blocks," which consist of the ends of the femur and tibia resisting hyperextension during full leg extension. It is also possible that injury, disease, and poor soft tissue integrity can contribute to hypermobility or excessive ROM in a joint. The possibility of hypermobility can also be imagined when studying Figure 16.1.

> It is also possible that injury, disease, and poor soft tissue integrity can contribute to hypermobility or excessive ROM in a joint.

Clearly, joints have inherent structural properties that determine ROM. Not surprisingly, these properties differ by joint and among individuals, which often explains the large variability in joint ROM values observed in certain instances such as during testing and athletic performance. Although the anatomical structure of the joint clearly influences ROM, there are other influences such as age, sex, and physical activity history that also play a role in determining ROM.

Age

With increasing age, the ability to move through a full ROM typically becomes compromised due to an overall loss of flexibility of approximately 25%–30% by age 70 years (5–8). This reduction in flexibility observed in older adults has been linked to disability and reduced functional ability (9). The decreases in flexibility that one may experience will depend on the joint itself. Brown and Miller (10) reported a 30% loss in hamstring flexibility from the age of 20–29 years to older than 70 years, whereas Germain and Blair (8) observed a 15% loss in shoulder flexion from the age of 20–30 years to older than 70 years. Therefore, it is important that flexibility, including any changes over time, is assessed and addressed at each joint.

Loss of ROM within a joint may have several causes. With age, changes occur in the framework of the connective tissue collagen fibers as demonstrated by increased rigidity of the tissue. This increased rigidity is attributed to tighter cross-linkage within and between collagen fibers, which makes the joint more resistant to movement (11,12). There is also a general reduction of elastin as well as a deterioration of the cartilage, ligaments, tendons, synovial fluid, and muscles with age, which may decrease joint ROM (9,13,14). However, physiological changes are not the only suspect in the age-related loss of flexibility. Decreased physical activity appears to accelerate the age-related loss of ROM (14,15). Fortunately, this means some loss in flexibility may be preventable with regular, whole-body flexibility exercises.

Sex

Numerous studies suggest that females are more flexible than males due to a different pattern of skeletal architecture and connective tissue morphology as well as hormonal differences (16,17). This difference in ROM between sexes may result from differences in joint and bone structures (18). For example, females typically have broader and shallower hips compared to males, which allows for the possibility of a greater ROM in the pelvic region (18). Females may also have greater potential for flexibility during trunk flexion after puberty because of a comparatively lower center of gravity and shorter leg length (19).

Physical Activity History

In addition to one's anatomy, an individual's history of physical activity can impact his or her joint ROM. Studies have shown that individuals who are physically active are more likely to have a greater ROM than a sedentary individual (8,20,21). Cornu et al. (21) demonstrated that volleyball players exhibited greater flexibility in wrist extension than sedentary individuals. In another sport-related study, Jaeger et al. (22) found that elite field hockey players had significantly greater hip ROM than sedentary individuals. Studies have not been limited to sport activity, though. In a study by Voorrips et al. (23) that examined different habitual physical activity of older women, it was found that the more active older women had significantly greater flexibility in the hip and spine than moderately active and sedentary older women.

Benefits and Risks of Flexibility Training

As with other forms of physical training, flexibility training has both benefits and risks. These benefits and risks are frequently described from the anecdotal and personal experiences of coaches, clinicians, and exercise leaders rather than from sound research or understanding of the science of human anatomy, physiology, and biomechanics. The following sections provide the Personal Trainer with a short review of the scientific evidence supporting the benefits and risks associated with flexibility training.

> The existing science on flexibility training often presents fitness professionals with more questions than answers regarding the benefits and risks of stretching.

Benefits

Improved Range of Motion in Selected Joints

Flexibility training has been shown to improve an individual's joint ROM (23–25). In a long-term study on the effects of flexibility training on shoulder and hip ROM by Misner et al. (25), it was found that the flexibility program used produced significant increases in shoulder extension (5.7%), shoulder transverse extension (10.4%), hip flexion (13.3%), and hip rotation (6.3%). A minor improvement (5.5%) was also observed in shoulder flexion. Improvements in flexibility could be seen in a relatively short time period. Kerrigan et al. (26) recorded improved ROM values in both static and dynamic hip extension when participants followed the program twice daily for 10 weeks. Kuukkanen and Mälkiä (24) also found improvements in spinal ROM and greater hamstring flexibility after subjects followed a 3-month program.

Improved Performance for Activities of Daily Living

The extent to which individuals can live independently depends on their ability to perform basic daily tasks such as self-care and essential household chores. These tasks are formally termed "activities of daily living" (ADL). Balancing ability and postural control are critical aspects of performing ADL (27). Consequently, the ability to perform ADL has been highly correlated with joint mobility (28). In other words, ADL are easier to perform when an individual possesses an adequate ROM within the working joints. In addition, flexibility training can significantly aid balance and postural stability, particularly when combined with resistance exercise (15,29). Indeed, when performed correctly, flexibility training can improve ADL functioning both directly through enhancing ROM and indirectly through its effect on postural control (30–32).

Risks

Joint Hypermobility

Hypermobility syndrome is known as "congenital laxity" of ligaments and joints. This condition is characterized by extreme ROM accompanied by mild- to moderate-intensity pain (33). Although it is suggested that certain individuals or athletes (*e.g.*, gymnasts) may possess extraordinary joint ROM, there is insufficient scientific evidence to link hypermobility to flexibility training. Regardless, the Personal Trainer should be aware that too much flexibility may be as detrimental as too little. Individuals with both hyper- and hypomobility may be at increased risk of injury. For this reason, the prudent professional should aim for assisting his or her clients in achieving "optimal" flexibility rather than continually striving to achieve greater ROM.

Effects of Stretching on Strength, Power, Speed, and Agility

A recent review article by Behm et al. (4) suggests that static stretching may result in an acute decrease in force production (*e.g.*, muscular strength/power). Nelson et al. (34) found that muscular strength and endurance performance decreased after short-term static stretching among a group of college students enrolled in physical education courses. Similarly, Fowles et al. (35) discovered that voluntary strength and muscular activation was negatively affected after prolonged stretching and muscle force was reduced up to 1 hour poststretching. Bacurau et al. (36) observed a reduction in one repetition maximum leg press strength following a bout of static stretching when compared to ballistic stretching. Furthermore, Miyahara et al. (37) observed a 6.9% and 7.1% decrease in strength following both static and proprioceptive neuromuscular facilitation (PNF) stretching, respectively, although PNF stretching increased ROM approximately 8% more than static stretching. These findings suggest that static stretching might be detrimental to subsequent activities that require high force production (36). Overall, in the systematic review by Behm et al. (4), strength, power, and speed was negatively influenced by static stretching, suggesting that other stretching methods (*i.e.*, dynamic stretching) should be prioritized prior to activities requiring maximal strength and power production.

Strength may not be the only performance variables affected by different stretching protocols. Several literature reviews have reported the effects of different stretching methods (*i.e.*, dynamic, ballistic, static, and PNF) on power-speed-agility performance (4,38,39). Research provides support for the assertion static stretching may impair power (4,40–42), speed (40,43,44), and agility (45,46) performance when compared to other stretching modalities. Research also suggests that dynamic stretching may not be detrimental and/or lead to improvements in lower body power production (41–43), jumping (44,47), sprinting (43,47,48), and agility (45,46) performance compared to other stretching methods (*i.e.*, PNF and static stretching [SS]) (49). Additionally, dynamic stretches performed at a faster velocity throughout a similar, sport-specific movement pattern have been linked to improved strength and power performance (42,49). In fact, in activities such as gymnastics that require large ROM movements, it is necessary to perform preparticipation activity to achieve the required ROM for the performance (50). It is important to note that incorporating different stretching protocols (*i.e.*, static, dynamic, PNF) in a warm-up accompanying other movements may not necessarily impact performance (38). Thus, although these studies suggest that maximal strength or performance may be compromised following an acute stretching bout, it is possible that if preperformance stretching is accompanied by other warm-up movements, performance is not negatively impacted (38,51,52). In fact, research by Blazevich et al. (52) found that individuals were more confident about how their performance following a warm-up that included both static and dynamic stretching protocols. Therefore, based on the current literature, it is recommended that engaging in one, specific stretching protocol (*i.e.*, static stretching) to elicit improvements in ROM for a long duration should be completed following activity (38). However, when different stretching methods (*i.e.*, static, dynamic, or ballistic) are performed for a short duration (*i.e.*, ≤60 s) and included in a full dynamic warm-up prior to activity, subsequent performance may not be significantly affected (51–53).

Ineffective for Preventing Injury

Flexibility training is often promoted as a means of reducing injury risk. However, the research does not show a consistent link between performing regular flexibility training and a reduction in musculotendinous injuries (1,50,54,55). Reviews published regarding injury prevention and flexibility have generally been unable to conclude whether or not stretching before or after exercise contributed to injury prevention among competitive or recreational athletes (55). McHugh and Cosgrave (50) suggested that there is some evidence that preparticipation stretching may reduce the incidence of muscle strains but that it does not prevent overuse injuries. Finally, Witvrouw et al. (54) concluded that the type of sport activity in which an individual participates is critical when determining the value of flexibility training to reduce injury. They found that the more explosive the skills involved in an activity, the more likely stretching may be needed to decrease injury.

> The more explosive the skills involved in an activity, the more likely stretching may be needed to decrease injury.

Temporary Effects

Interestingly, the duration of time that increased flexibility lasts after stretching may not be as long as what Personal Trainers may think. Increased flexibility following acute stretching is extremely short-lived. Depino et al. (56) recruited 30 male subjects and found that the improvements in knee ROM following static stretching of the hamstrings lasted less than 3 minutes. These authors further suggest that athletes who statically stretch and then wait longer than 3 minutes before activity can expect to lose any ROM gained as a result of the preceding bout of stretching. Spernoga et al. (57) similarly found that ROM improvements in the hamstring following PNF stretching lasted only 6 minutes after the stretching protocol ended. However, although the acute effects appear to diminish quickly, a consistent stretching program over 12 weeks has been found to result in significant improvements in flexibility of the hip flexors (58), indicating the effectiveness of ACSM flexibility training recommendations at long-term improvements of flexibility.

Evaluating Flexibility

Assessment of clients' ROM is an essential component of developing their exercise program. Goniometry assessment provides the fitness professional with several important pieces of information. These include the following:

- Initial ROM prior to the start of the exercise program
- Baseline measurements from which plans can be made for future exercise goals
- Immediate ROM feedback
- Identification of muscular imbalances

> Assessment of clients' ROM is an essential component of developing their exercise program.

Chapter 12 provides a more comprehensive discussion on evaluating flexibility.

Types of Stretching

Several methods exist to improve flexibility and increase joint ROM, and nearly all of them involve some form of stretching (examples of most of the types of stretching are presented in Figs. 16.2–16.40). Stretches can be performed by the clients (active stretching) themselves or with the help of the Personal Trainer (passive stretching). Although passive stretching can be very helpful for improving flexibility, it should only be performed by a Personal Trainer with adequate knowledge and experience to prevent injury to the client. There are generally three types of stretching that can be performed using active or passive techniques to improve flexibility: static, dynamic, and PNF. Table 16.1 provides an overview of various types of stretching and their appropriate use.

There are generally three types of stretching that can be performed using active or passive techniques to improve flexibility: static, dynamic, and proprioceptive neural facilitation or PNF.

A B

FIGURE 16.2. Forward flexion and extension. **A.** Facing forward, move head forward to tuck chin into chest and hold. Then, move slowly from this flexion position to extension. **B.** Extension should involve looking up to ceiling until a 45° angle is reached and hold. Avoid dropping head back onto the upper back.

FIGURE 16.3. Chest stretch: Shoulders should be relaxed, not elevated. Move extended arms to the back and keep arms at or a little below shoulder height. A good cue for this stretch is "open arms wide."

FIGURE 16.4. Arm across the chest: Facing forward, extend the right arm and draw across the chest. Arm should be as straight as possible, with gentle tension developed on the right shoulder. Grasp right elbow with the left hand. Apply gentle pressure with the left hand to increase tension on the right shoulder and repeat with the other arm/other side.

A B

FIGURE 16.5. Chest stretch (progression). **A.** Place the palms of the hand on the back of the head and bring elbows back. **B.** Place extended arm against an open doorway and lean forward, feeling gentle tension develop across the chest.

FIGURE 16.6. Elbow behind the head: Facing forward, bring left arm up, bend from the elbow, and drop the hand behind the head. Try to reach right shoulder with left hand. Repeat with other arm/other side. Bring right hand to left shoulder and gently pull left elbow rightward to increase tension on left arm (triceps brachii).

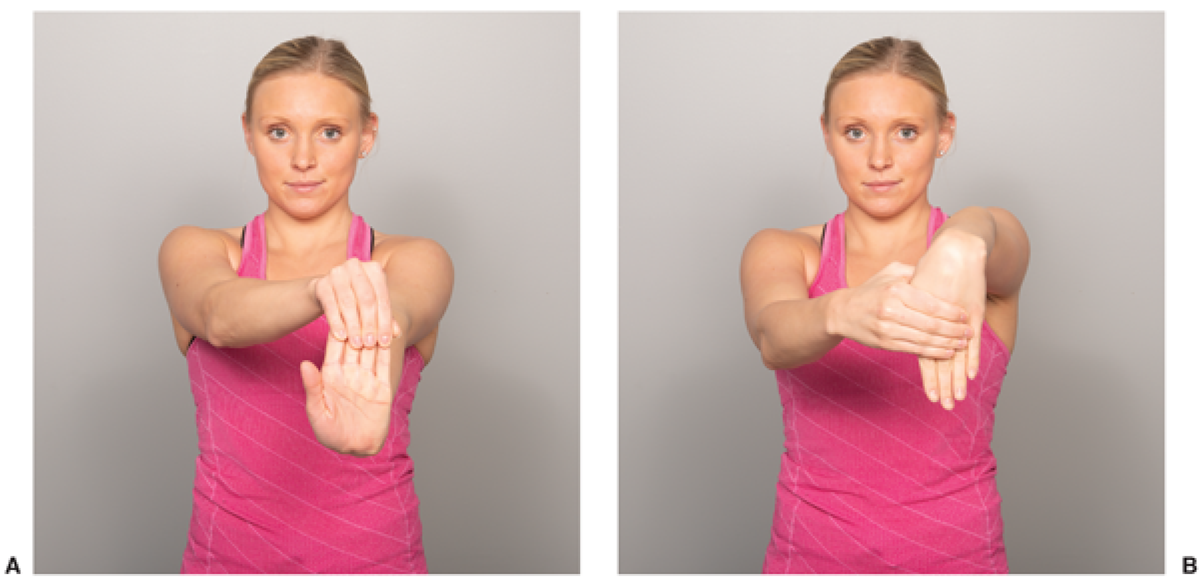


FIGURE 16.7. Palm up/palm down. **A.** This exercise can be performed while standing or seated. Extend right arm perpendicular to the body. Extend wrist, so the palm faces away from the body. Gently pull right hand (fingertips) toward body until tension develops in the forearm flexors. Repeat with other arm/other side. **B.** This exercise can be performed while standing or seated. Extend right arm

perpendicular to the body. Flex wrist, so the palm faces the body. Gently pull right hand with left hand until tension develops in the forearm extension.

FIGURE 16.8. Arm hug: Cross the arms around the body, elbows pointing forward. Let the upper body round.

A

B

FIGURE 16.9. **A.** Kneeling cat: Kneel in quadruped position. Draw in abdominals and contract the gluteals, round throughout the entire spine. **B.** Kneeling cow: From kneeling cat, lift the head, contract the hip flexors and arch the back. Keep the abdominals drawn in towards the spine.

Visit thePoint to watch video 16.1, which demonstrates the kneeling cat.

FIGURE 16.10. Pillar/overhead reach: Facing forward, stand erect and extend arms above head, keeping shoulders in neutral position. Place hands together and use the palms to press upward. Stretch can also involve the trunk muscles (torso) by moving in frontal plane to one side of the body and back. Hold when tension is developed in the torso on the side opposite reach.

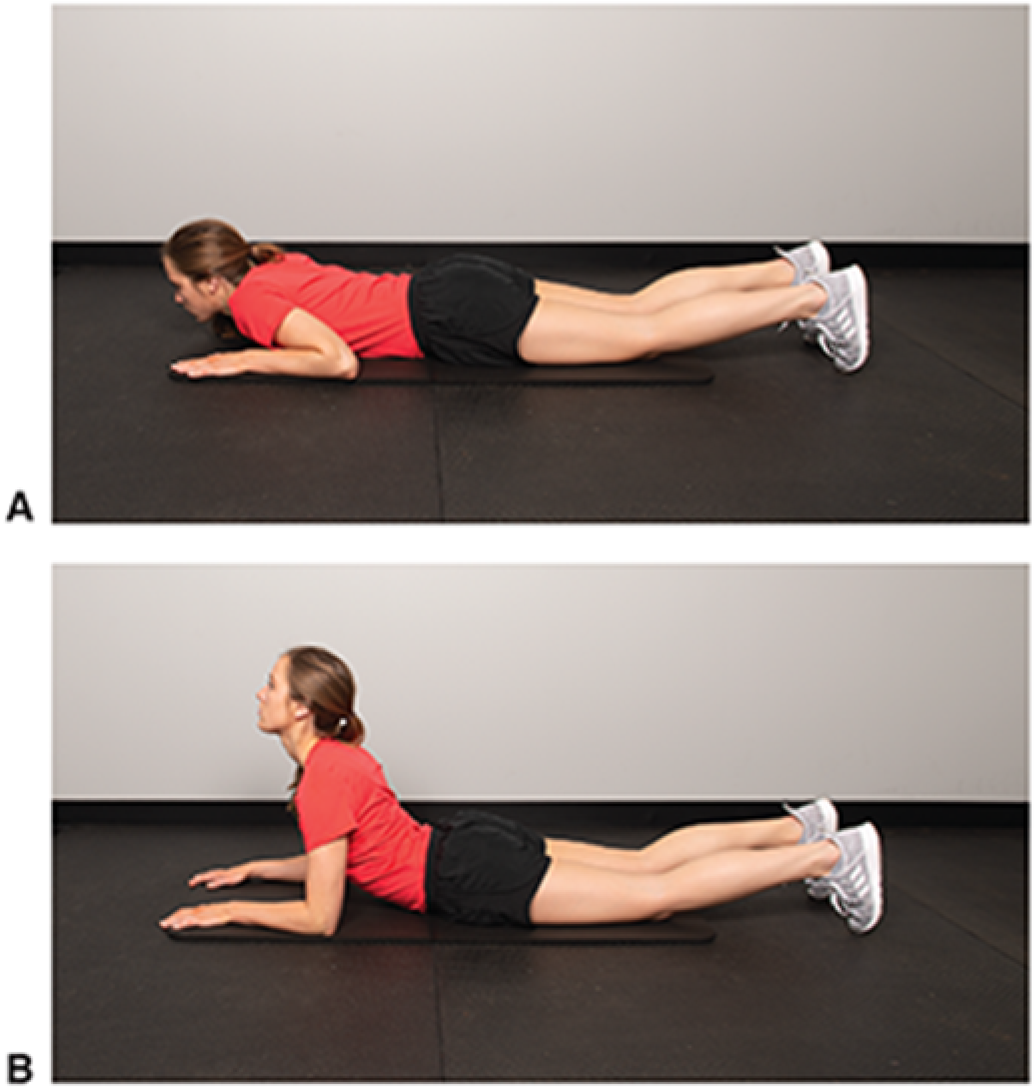


FIGURE 16.11. Modified cobra. **A.** Lie prone on the floor with the head resting on the forearms and the legs extended. Place the elbows directly under the shoulders with the hands facing forward. **B.** Press into the forearms and raise the upper body, keeping the hips on the floor.


A

B

FIGURE 16.12. Supine rotational stretch. **A.** Lie face up on the floor. Bend knees so that the feet are flat on the floor. Then, extend arms across the floor to stabilize upper body with movement. **B.** Slowly move both legs with the knees bent to the left side of the body. Maintain upper back against the floor and the abdomen oriented toward the ceiling. Repeat by moving the legs to the right side.

Visit thePoint to watch video 16.2, which demonstrates the modified cobra.

FIGURE 16.13. Seated hip rotator stretch level I: Sit upright on a sturdy, nonmovable chair. Cross right ankle onto bent left knee. Gently press down on right knee until tension develops in the outer portion of the right thigh. Repeat with the opposite side.

FIGURE 16.14. Seated hip rotator stretch level II: Sit upright on the floor, with left leg extended and right knee bent. Place the right foot over the left leg. Hug the knee toward the chest. Repeat on other side.

FIGURE 16.15. Supine hip rotator stretch (progression from seated): Lie face up on floor with knees bent, so feet are flat on the floor. Cross right ankle onto bent left knee. Lift left foot off the floor. Wrap hands around the left leg and draw into the body. Focus on opening up the right knee until tension develops in the outer portion of the right thigh. Repeat on the opposite side.

FIGURE 16.16. Kneeling hip flexors stretch: Kneel on knees with upper body lifted. Plant the left foot on the floor until a 90° angle is reached with both the front and back legs. Shift the weight forward while keeping the upper body lifted.

FIGURE 16.17. Standing hip flexor stretch: Stand erect and keep hands on the hips. Step forward with left foot into a lunge position; right heel may be elevated to facilitate this movement. Shift the hips forward. Maintain this position, feeling tension develop in hips, quadriceps, and buttocks. Repeat with the opposite side.

FIGURE 16.18. Prone quadriceps stretch: Lie prone on the floor with legs extended and draw right heel back toward the gluteals.

FIGURE 16.19. Side-lying quadriceps stretch (progression): Lie on floor with left side of the body; the trunk should be perpendicular to the floor. Bend right knee, keeping knees and hips stacked. Reach with the right hand across the front of the right foot. Gently pull thigh back slightly using the right arm. Allow the left arm to stabilize the torso. Repeat with the left thigh by positioning the body with the right side against the floor.

FIGURE 16.20. Standing quadriceps stretch (progression): While in a standing position (a chair may be used to hold onto for support), bend the right knee toward the gluteals. Grasp the right ankle with the right hand and gently pull thigh back slightly using the right arm.

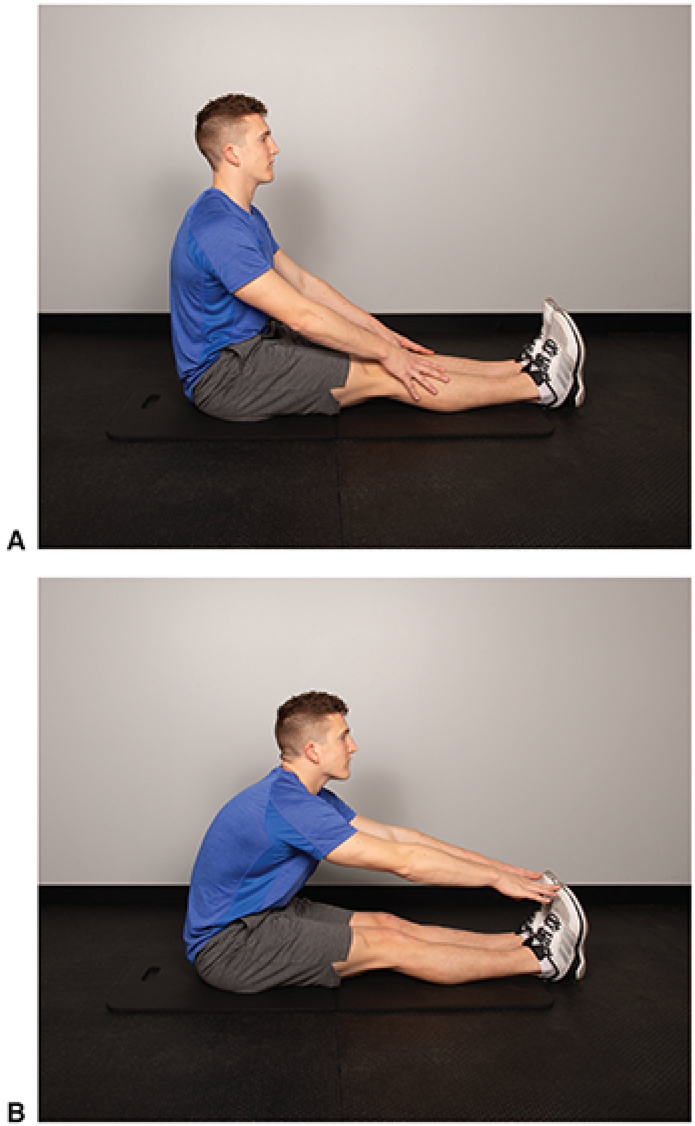


FIGURE 16.21. Seated hamstring stretch. **A.** Sit upright on the floor with both legs extended and hands resting on the quadriceps. **B.** Slowly walk the hands forward toward the feet, keeping the chest lifted.

FIGURE 16.22. Standing hamstring stretch (progression): Standing upright, bring the right foot slightly ahead of the left foot. Slowly draw the hips back while slightly bending the left knee and extending the right knee. Bring the toes of the right foot off the floor and toward the body, hold, and then return to the starting position. Repeat with the opposite leg.

FIGURE 16.23. Supine knees to chest: Lie supine on the floor and hug the knees to the chest. This can be done with one leg or two legs.

FIGURE 16.24. Child's pose: Kneel in a quadruped position and sit back onto heels with arms extended.

FIGURE 16.25. Butterfly stretch: Sit upright on the floor with the soles of the feet together. Draw the knees to the floor and lean forward from the hips.

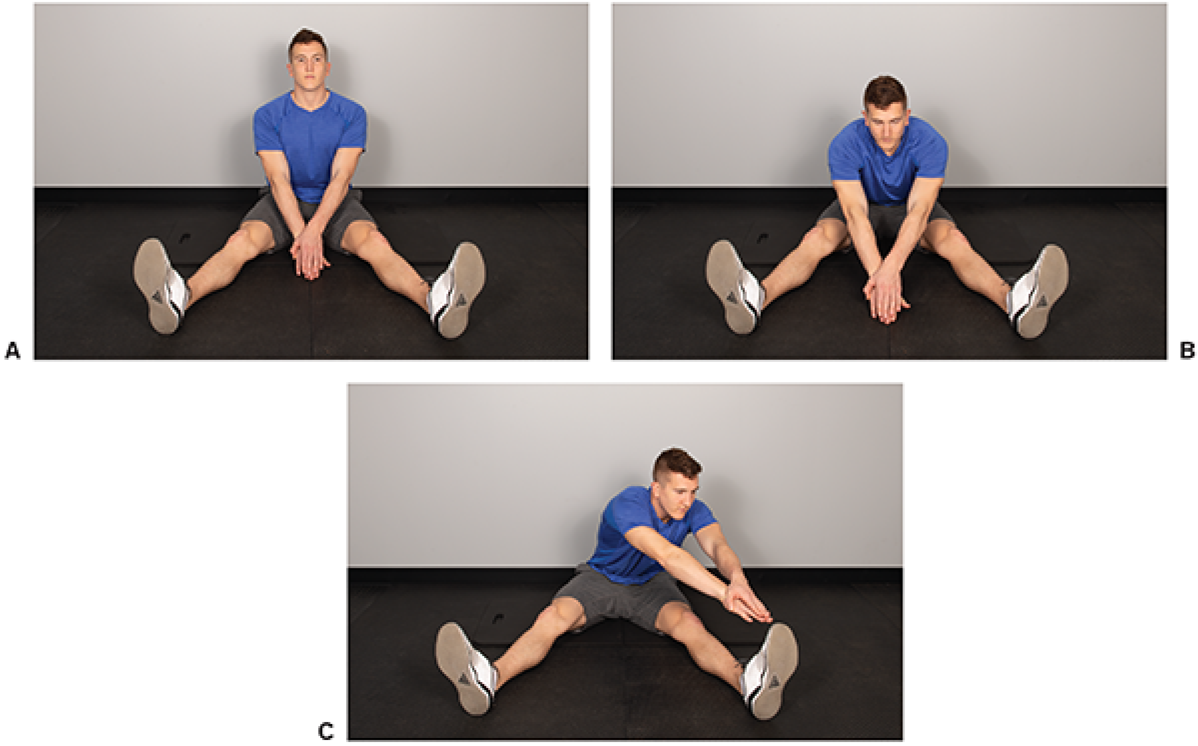


FIGURE 16.26. Straddle: Sit upright on floor with both legs extended **(A)**. Slowly spread legs apart so that feet are as far from each other as possible and gently reach toward center **(B)** or alternate reach from right to left **(C)**.

FIGURE 16.27. Seated calf stretch: Sit upright with both legs extended. Turn the toes toward the ceiling and draw the tops of the toes toward the upper body.

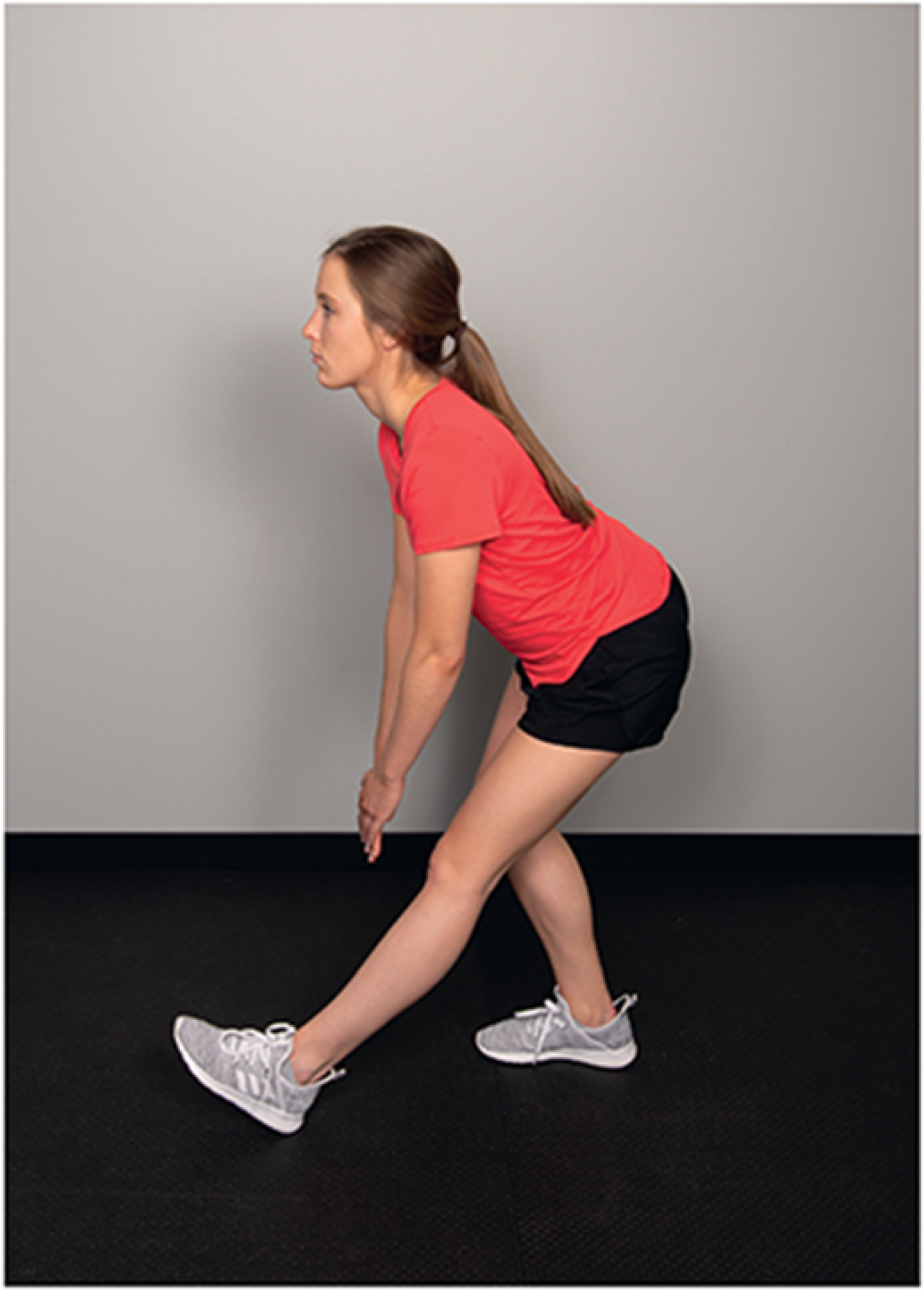


FIGURE 16.28. Standing calf stretch: Place body weight on the left leg, with the right leg forward and heel on the ground. Grasp banister or handrail for support if necessary. Bring the toes of the right foot toward the body and sit back slightly onto the left leg. Feel the stretch develop in the right calf and slowly return to the starting position and repeat with the opposite side.

FIGURE 16.29. Dynamic arm circles: Stand with feet shoulder-width apart and knees slightly bent. Raise both arms to the side at shoulder height, with palms facing down, and make small circles with the arms extended, gradually increasing the size of the circles.

Visit thePoint to watch video 16.3, which demonstrates dynamic arm circles.

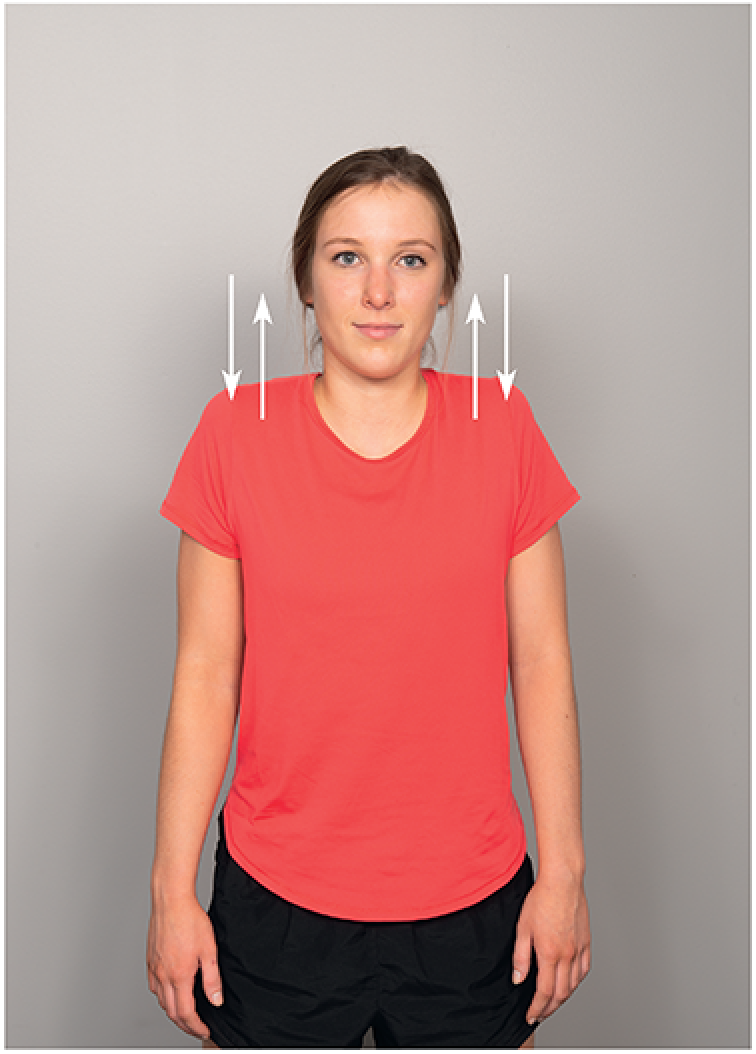


FIGURE 16.30. Shoulder shrugs: Lift both shoulders toward the ears and then lower away from the ears.

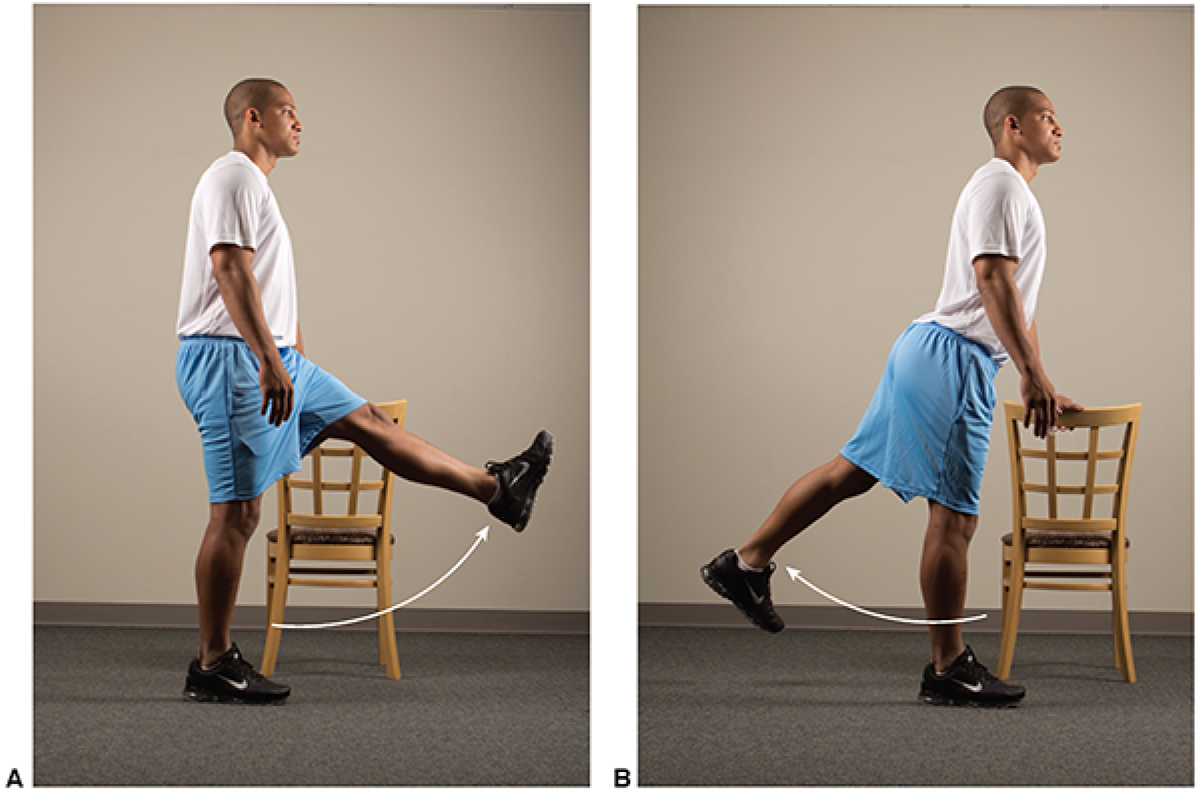


FIGURE 16.31. Pendulum leg swings (front to back): Place a hand on the back of a chair for balance. Lift the left leg and swing the leg forward (in front of the body) and backward (behind the body). Begin with small swings and progress to larger swings. Switch to the opposite leg.

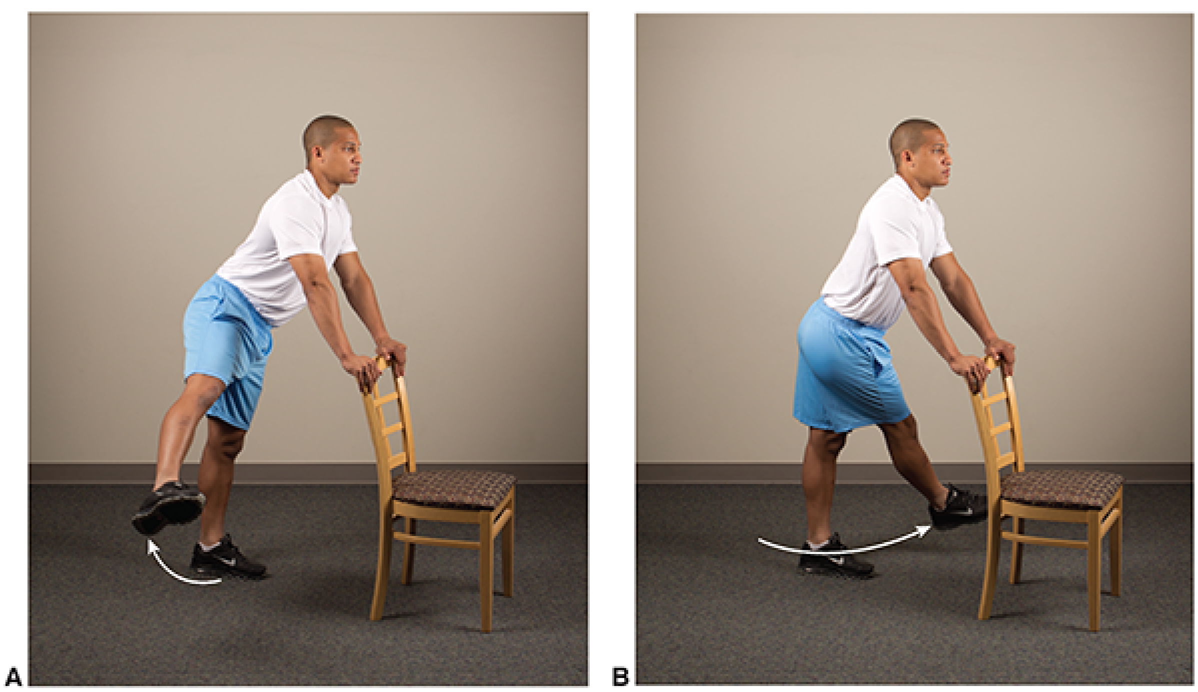


FIGURE 16.32. Pendulum leg swings (side to side): Place both hands on the back of a chair for balance. Swing the right leg out to the right and back across the body to the left. Begin with small swings and progress to larger swings. Switch to the opposite leg.

Visit thePoint to watch video 16.4, which demonstrates front to back and side-to-side leg swings.

FIGURE 16.33. Dynamic external hip rotation: Stand upright with feet shoulder-width apart. Raise the left foot in front of the body and allow the knee to rotate outward. Tap the inside of the left heel with the right hand. Switch and raise the right foot and rotate knee outward. Tap the inside of the right heel with the left hand. Alternate tapping each foot and progress to walking forward while alternating feet.

FIGURE 16.34. Dynamic internal hip rotation: Stand upright with feet shoulder-width apart. Raise the right foot toward the side of the body and tap the outside of the right heel with the right hand, allowing the knee to rotate inward. Switch and tap the outside of the left heel with the left hand. Alternate tapping each foot and progress to walking forward while alternating feet tapping.

Visit thePoint to watch video 16.5, which demonstrates dynamic internal and external hip rotation.

FIGURE 16.35. Side shuffle: Stand with feet shoulder-width apart and knees slightly bent. Take one step to the right with the right foot and then bring the left foot in to meet the right foot. Begin with small steps, progress to larger steps, and then progress to a shuffle. Switch to the opposite direction.

FIGURE 16.36. Butt kicks: Begin marching in place. Pull the heel in closer toward the buttocks with each step and progress to moving forward (walking or jogging) while kicking the buttocks.

FIGURE 16.37. High knees: Begin marching in place. Raise the knees higher and higher with each step and progress to moving forward (walking or jogging) with high knees (keep posture upright).

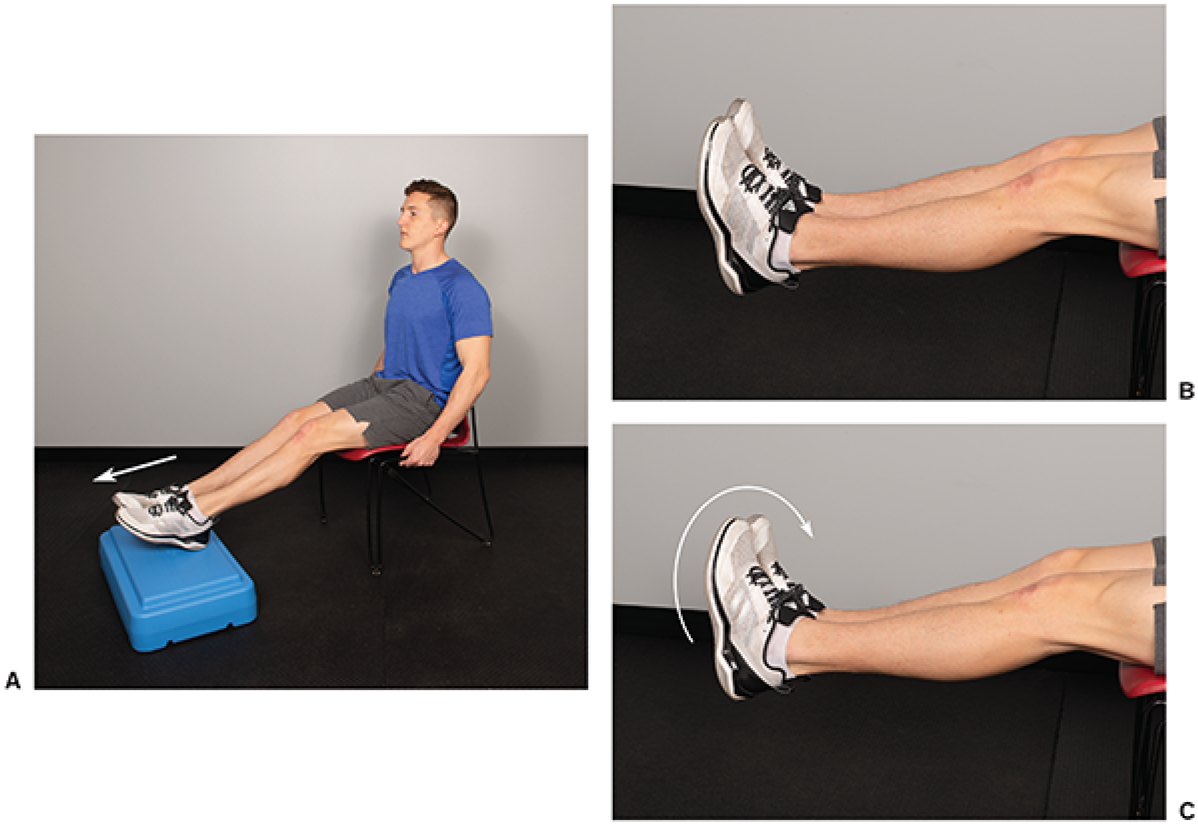


FIGURE 16.38. **A–C.** Dynamic foot ROM: Sit upright in a chair with both legs extended together. Pull toes toward the body and then point toes away from the body and pull toes toward the body. Rotate feet clockwise and counterclockwise. This stretching can be done one foot at a time.

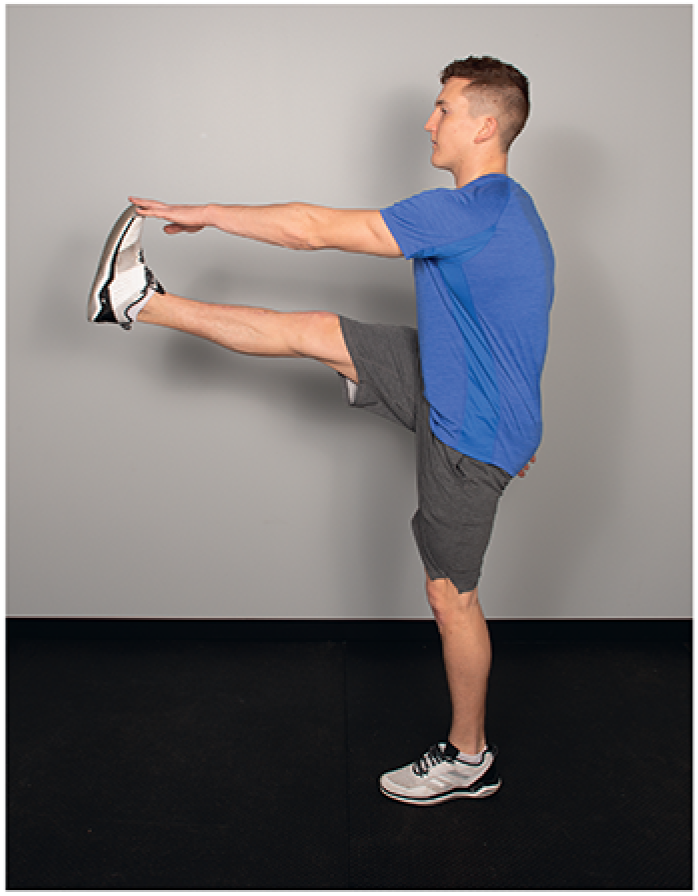


FIGURE 16.39. Soldier walk: Simultaneously rotate the right arm forward and raise the left leg (straight). Reach the right hand toward the left lower leg and toes and switch to the opposite side. Alternate to the opposite side. Progress to walking while alternating sides (keep posture upright).

Visit thePoint to watch video 16.6, which demonstrates the soldier walk.

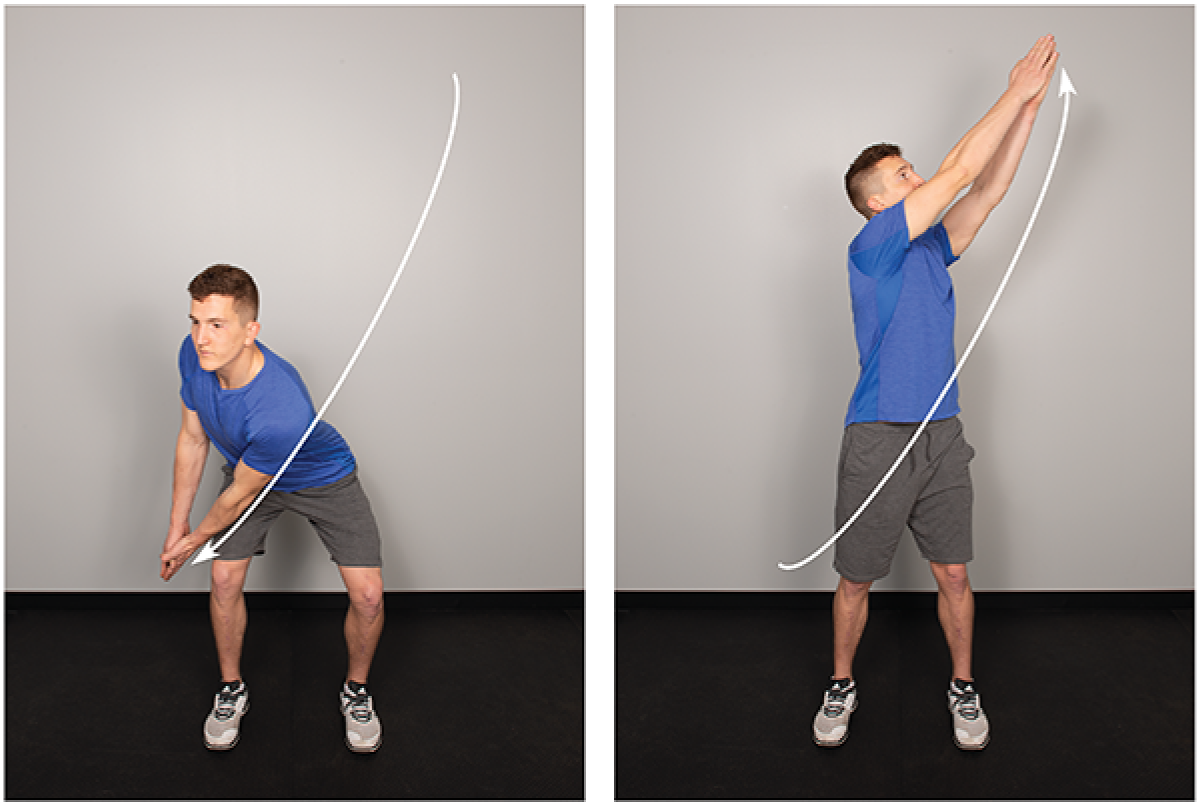


FIGURE 16.40. Wood chop: Stand with feet wider than shoulder width. Reach both arms down toward the outside of the left foot while bending the knees slightly. Move the arms diagonally across the body and end reaching above the right shoulder. Switch to the opposite side.

Visit thePoint to watch video 16.7, which demonstrates the wood chop.

Table 16.1 Overview of Stretching Technique and Appropriate Use

Technique	Definition	Exercise Design	Appropriate Use
Static stretching	This is the most common method used to improve flexibility. Static stretching consists of slowly moving to minor	All major muscle groups should be targeted at least 2–3 d · wk^{-1}. Hold each static stretch for 10–30 s, 30–60 s for older	Appropriate for use following a thorough warm-up (a thorough warm-up consists of 5–10 min of light to moderate multijoint,

	discomfort and then holding that stretch.	adults. ACSM recommends stretches be repeated 2–4 times to accumulate a total of 60 s for each flexibility exercise.	large muscle group movements) or during the cool-down period
Dynamic stretching	Dynamic stretching involves moving parts of your body through a full ROM while gradually increasing the reach and/or speed of movement in a controlled manner. These exercises are very rhythmic in nature. Dynamic stretching is often incorporated in the “active” phase of the group exercise warm-up due to its similarity to the movements or patterns that will be used during the conditioning period.	Begin gradually with a small ROM progressing to larger ROM, repeating each activity 5–12 times.	Appropriate for use during the warm-up or as part of the cool-down
PNF	PNF stretching involves both the stretching and contraction of the targeted muscle group. Although there are several ways to employ PNF, the most common technique is termed *contract-relax*. Following the preliminary passive stretch, the muscle is isometrically contracted for 6 s, relaxed for 2–3 s, and then passively moved into the final stretch,	All major muscle groups should be targeted at least 2–3 $d \cdot wk^{-1}$. A 3- to 6-s muscle contraction at 20%–75% maximum intensity is followed by 10–30 s of assisted stretching. A total of 60 s of stretching time should be achieved per targeted muscle group.	Appropriate for use following a thorough warm-up or during the cool-down period; appropriate for certified fitness professionals to use with clients if properly educated on the technique

	which is held for 10–30 s. This method is most effective with the use of a trainer to assist the client through the stretch.		
Passive stretching	The client is not actively involved in this type of stretching. The client assumes a position and then either holds it with some other part of the body (*i.e.*, arm) or with the assistance of a partner or some other apparatus (*i.e.*, stretching strap). The goal is to slowly move the client into the stretch in order to prevent a forceful action and possible injury.	Exercise design would follow the static stretching protocol.	Appropriate for use following a thorough warm-up or during the cool-down period; appropriate for certified fitness professionals to use with clients if properly educated on the technique
Ballistic stretching	This approach involves a bouncing or jerky type movement to reach the muscle's ROM limits. This bouncing motion may produce a powerful stretch reflex that counteracts the muscle lengthening and could possibly lead to tissue injury. Although ballistic stretch is not common practice for the general population, its use in training and rehabilitation of athletes who utilize explosive movements	Exercise design would be determined by activity-specific needs on an individual basis.	Not appropriate for the general population; may be suitable for athletes involved in ballistic sport skills

regularly may have a
justifiable role.

Static

Static stretching is undoubtedly the most commonly used method to improve flexibility. Static stretching can be performed actively or passively and consists of moving slowly into position and then holding the position for a few seconds at peak tension. For example, to actively stretch the sternocleidomastoid (neck) muscles, the client would perform a lateral flexion of the neck as depicted in Figure 16.41. This position would be held at peak tension for 10–30 seconds before returning the head upright. Static stretches can be modified too, as depicted in Figure 16.41, so that the client can better hold at peak tension or truly achieve peak tension via self-assistance and support. Similarly, a Personal Trainer can also assist in moving into the correct position and holding stretches at peak tension—thus achieving a passive, static stretch for the client. However, this should be done with significant care and communication between the client and Personal Trainer, so as not to overextend the joints, particularly in sensitive areas such as the head and neck.

FIGURE 16.41. Progression of a static stretch. **A.** Facing forward, tilt head to the left, moving only in the frontal plane. Hold and then return to the starting position. **B.** Repeat with the other side. A good cue for this exercise is "right ear to right shoulder." **C.** Reach with one arm in opposite direction from head tilt. With or without a partner, pull from top of head toward the direction of stretch, applying gentle pressure only.

Despite the popularity of static stretching, little agreement has been reached among experts with respect to how long the static stretch should be held at peak tension. The ACSM suggests a hold range of 10–30 seconds (59). Data from Nelson and Bandy (60) supports this recommendation when they concluded that static stretches of 30 seconds, 3 $d \cdot wk^{-1}$, for 6 weeks, significantly improved hamstring flexibility in high school–aged males versus unstretched controls. Interestingly, Sainz de Baranda and Ayala (58) reported that no particular single duration (15, 30, or 45 s) of static stretching was better with regard to its effect on ROM. Thus, the Personal Trainer should advise his or her clients to hold static stretches for 10–30 seconds. ACSM recommends stretches be repeated two to four times to accumulate a total of 60 seconds for each flexibility exercise (*e.g.*, if each stretch is held for 15 s, each would be repeated four times) (59). Box 16.1 provides an example of static flexibility stretches and training.

Box 16.1 Sample Static Flexibility Training Program

Client: A 40-yr-old woman who has been medically cleared to begin a consistent exercise program

Height = 168 cm (5 ft 6 in)

Weight = 68 kg (150 lb)

No history of orthopedic problems; mild chronic back pain

Objective: Improve flexibility as measured by goniometry

Session: 15-min warm-up using a NordicTrack CX 1055 elliptical trainer (average heart rate: 108 bpm)

Body Region	Exercise	Comments
Neck	Lateral flexion	Begin as an active stretch; move head slowly to prevent dizziness.
Shoulders	Arms across chest	Avoid bending the elbow as the arm is brought across the chest.
Chest	Chest stretch	Maintain relaxed shoulders.
Arms	Elbow extension	
Back	Kneeling cat	Discontinue stretch if it produces immediate back pain.
Torso	Modified cobra	Discontinue stretch if it produces immediate back pain.
Hips	Seated hip rotator, level I	Progress to level II exercise when level I was performed for 30 s without pain.
Thigh (anterior)	Prone quadriceps	Maintain upright posture and natural spinal curves.
Thigh (posterior)	Seated hamstring	Maintain upright posture and natural spinal curves.
Calves	Standing calf stretch	Maintain upright posture and natural spinal curves.

Trainer's Notes: Be sure to follow the FITT-VP guidelines for flexibility training suggested in this chapter, keeping in mind that they can be adapted to the individual needs of the client. If one or more of the recommended parameters do not seem to be effective, adapt as needed. This program can and should be progressed as the client achieves greater low back ROM.

Remeasure with the goniometer every 4–6 wk. By following the stretches listed in this chapter, this client will be able to progress from these basic stretches to more complex ones. The order of exercises performed during a session is not important.

Dynamic

Dynamic stretching is a form of stretching that incorporates movement along with muscle tension development. Dynamic stretches should be performed only as active stretches. In the broadest sense, dynamic stretches are built into every mode of exercise and physical activity. Dynamic stretching has been characterized as being very similar to a sport- or function-specific warm-up (61). The goal is to move the specific joint in a controlled manner within a normal ROM in order to minimize the risk of injury. It is important to progressively introduce dynamic stretches into the stretching program, particularly if the client is not accustomed to this type of stretching. Dynamic stretches should begin gradually with a small ROM progressing to larger ROM, repeating each activity 5–12 times (62,63). An example of this is arm circles; begin with small, slow circles and gradually progress into larger and faster circles until a full ROM is reached for the shoulder joint. It is difficult to depict examples of dynamic stretching on paper. Consider the movements of a boxer in the ring prior to a fight. Jabs he makes with the upper extremities and quick turns of the torso all serve as good examples of dynamic stretch. Tae Bo movements and stereotypical medicine ball exercises provide further examples of dynamic stretching. Ideally, dynamic stretches incorporate movements that are specific to sport movements of interest, but excellent dynamic stretches can also be developed on the basis of the flexibility needs of the medically cleared population at large. Box 16.2 provides an example of dynamic flexibility stretches and training.

Box 16.2 Sample Dynamic Range of Motion Training Program

Client: A 25-yr-old male, medically cleared to begin consistent exercise program

Height = 191 cm (6 ft 3 in)

Weight = 95 kg (215 lb)

No history of injury or orthopedic problems

Objective: Improve sports performance and prevent injury through increasing joint ROM and warming up prior to conditioning phase of activity

Session: 5-min warm-up using a treadmill (average heart rate, 110 bpm)

Body Region	Exercise	Comments
Shoulders	Arm circles	Start with small circles and progress to a larger ROM.
	Shoulder shrugs	
Hips and buttocks	Pendulum leg swings (front/back, side/side)	Begin with small swings and progress to larger swings.
	Hip internal/external rotation	Progress to walking forward while alternating feet.
	Side shuffle	This exercise can start in a stationary position and then progress to a walk or light jog.
Quadriceps	Butt kicks	This exercise can start in a stationary position and then progress to a walk or light jog.
Hamstrings	High knees	Progress to walking while alternating sides.
Ankles	Dynamic foot ROM	
Full body	Soldier walk	
	Wood chop	

Trainer's Notes: Full-body dynamic ROM exercises should be performed after the completion of exercises of individual muscle groups. Many dynamic ROM exercises can be progressed by adding forward or lateral movement in the phases of walking, jogging, and then running (*e.g.*, butt kicks and high knees). Progressions should be given to clients only when they have demonstrated control of movement in a stationary position.

Sometimes, dynamic stretching is confused with another form of movement termed "ballistic stretching." Ballistic stretching refers to the use of the momentum of the moving body segment to produce a bouncing movement at the end of the ROM that is done to obtain a peak muscle tension or stretch (64). For example, a ballistic stretch procedure would consist of a client reaching his or her maximal ROM and continuing to perform a "bouncing" movement at the muscle's maximal length (64,65). For example, a client seated upright on the floor could extend his or her arms forward in an effort to reach the toes. By moving slowly into that position and holding for a few seconds at peak tension, the client would be performing an active static stretch. However, if in an attempt to touch the toes, the client pushed forward repeatedly with short, successive, bouncing flexions at the hip, he or she would be performing a ballistic stretch. Ballistic stretching is controversial. It has often been considered a "contraindicated" movement, but in fact, when properly performed, ballistic stretching may be done safely in adults, particularly in individuals who perform ballistic movements such as those found in basketball. Ballistic stretching can be equally effective as static stretching in increasing joint ROM (1). Box 16.3 provides a discussion on the controversy regarding the use of ballistic stretching.

Box 16.3 Ballistic Stretching — Understanding the Controversy

Some flexibility experts fail to distinguish dynamic stretching from another form of movement termed *ballistic stretching*. Unfortunately, this misunderstanding has resulted in a great deal of confusion by fitness professionals, so much, so Personal Trainers often discourage clients from performing dynamic stretches. Almost all physical movements impose some type of dynamic stretch on the soft tissues that bring about these movements. In contrast, ballistic stretching refers to the bouncing or jerky stretching action or movement that is done to obtain a peak muscle tension. For example, a client seated upright on the floor could extend his or her arms forward in an effort to reach the toes. By moving slowly into that position and holding for a few seconds at peak tension, the client would be performing an active static stretch. However, if in an attempt to touch the toes, the client pushed forward repeatedly with short, successive, bouncing flexions at the hip, he or she would be performing a ballistic stretch.

The claim is often made that ballistic stretching is unsafe or at least ineffective for improving flexibility. It is thought that each successive "bounce" movement in ballistic stretching may impose too rapid a stretch on muscles while they are in the process of contracting making them susceptible to muscle injury. In fact, Smith et al. (66) found that similar bouts of static and ballistic stretching induced increases in delayed-onset muscle soreness (DOMS) in 20 male subjects unaccustomed to such exercise. Importantly, though, these researchers concluded that the static stretching actually induced significantly more DOMS than did ballistic stretching. In terms of performance, Kokkonen et al. (67) concluded that acute ballistic muscle stretching inhibited maximal strength performance, but Unick et al. (68) found no statistically significant difference in vertical jump performance as a result of static or ballistic stretching among actively trained women.

No attempt is being made here to settle the controversy surrounding ballistic stretching. Personal Trainers should recognize that both dynamic and ballistic stretching movements are normal components of sport activity and may have legitimate roles in the training and rehabilitation of athletes.

Proprioceptive Neuromuscular Facilitation

PNF involves both active and passive techniques designed to improve joint ROM. Several muscle groups can be trained when PNF techniques are properly used. This form of stretching requires an experienced Personal Trainer and a cooperative client. PNF stretching should be performed only by competent and trained practitioners because overstretching is possible if the technique is not fully understood. PNF techniques involve two dual process methods where an (a) isometric contraction is followed by a static stretch in the same muscle/tendon group (known as the contract-relax) and (b) an additional contraction of the agonist muscle group during the stretch, known as the contract-relax-agonist-contract method (69). PNF stretching is commonly believed to elicit a relaxation response from the neuromuscular system altering the stretch tolerance, allowing the musculature to continue to stretch (70). This response can occur in the prime mover (agonist), synergist, and antagonist muscles across a particular joint. With a stretch-induced reduction in muscle tone, joint ROM increases during subsequent stretches and eventually during physical activity. However, a review by Chalmers (71) refutes this rationale and points to studies that suggest that PNF improves ROM mainly because of changes in the ability to tolerate stretching and/or changes in the viscoelastic properties of the stretched muscle. Although the mechanism for ROM change following PNF stretching is unknown (70), it is clear that PNF techniques have long been shown to increase joint ROM. PNF stretching has been shown to improve ROM, however, due to the intensity of this stretching method, there are some risks associated with this type of stretching. Overstretching may result in injury or reduction in athletic performance. Because of this, the athlete or trained professional should not elicit any pain while doing PNF stretching. If the athlete or client experiences any pain above the feeling of the stretch, then the stretch should be stopped immediately.

Visit thePoint to watch video 16.8, which demonstrates PNF stretching.

PNF stretching should be performed only by competent and trained practitioners because overstretching is possible if the technique is not fully understood.

Rationale for Flexibility Training

Despite the importance of full, pain-free joint ROM for sport and physical activity, the justification for certain flexibility training techniques is controversial. Moreover, little scientific evidence exists to support either continuing or discontinuing even the most common stretching habits designed for injury prevention among competitive or recreational athletes (55). Not surprisingly, the Personal Trainer is bound to be confused with respect to the inclusion or omission of flexibility exercises in the overall conditioning of clients.

One approach to this problem involves conducting a thorough fitness assessment of the client to determine the extent to which inflexibility limits sport and/or general physical performance. Should ROM deficiencies be evident in the client, then the Personal Trainer is justified in prescribing the basic stretching techniques described in this chapter. These stretches (static, dynamic, and PNF) are most commonly known to improve flexibility. It is reasonable to employ these techniques and continue to monitor the flexibility needs of the client. Although at least one early study (72) found significant improvements in flexibility with all three methods, Personal Trainers are encouraged to select an approach that best suits the needs, limitations, and abilities of the client while continuing to monitor joint ROM and its ultimate impact on sport and physical activity performance.

Designing a Flexibility Training Program

There are three preliminary training guidelines unique to the design of flexibility programs. These involve warm-up, breathing, and posture.

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Warm-Up

Although stretches can be performed at the start, in the middle, and/or at the finish of the workout, it is common to precede stretching with a brief, aerobic exercise warm-up. An active warm-up reduces the resistance to stretch (73). It has been established that increasing the temperature of a muscle increases the elastic properties or the ability to stretch (12,74,75). Warm muscle tissue responds less stiffly than cold muscle tissue. Little evidence suggests that the exercise warm-up should be altered to accommodate flexibility training exclusively. Typical warm-up exercises include stationary cycling, treadmill walking/running, or rowing. It is often recommended that stretching be done at the end of the workout after the muscles are warm.

Breathing

Proper breathing techniques are often helpful in relaxing the client and allowing movement into position more comfortably. Flexibility training is no time to perform a Valsalva maneuver (air expiration against a closed glottis).

Purposeful and controlled breathing that accompanies relaxing exercise may help reduce stress levels and decrease voluntary muscle tension. Remind exercisers to exhale slowly as they move toward the endpoint of a stretch and inhale as they return to the starting position.

Posture

In the design of a flexibility training program, Personal Trainers should understand the proper positioning of the stretch to target the appropriate muscle group. Focus on maintaining proper body alignment during the execution of the exercises. For example, consider the stretch depicted in Figure 16.20. Posture can be greatly improved by using the “free hand” (the hand *not* grasping the ankle) to hold a railing or the back of a chair to maintain balance. The Personal Trainer should emphasize that one should avoid pressing the elevated foot to the gluteals (*i.e.*, hyperflexion at the knee) or leaning into the stretch for additional force development. Some reminders for correct postural alignment are listed in the following text:

- Maintain neutral position of the spine (characterized by having a slight inward curve at the cervical and lumbar spines and a slight outward curve of the thoracic spine).
- Shoulders should remain back and away from the ears.
- Hips should be in a neutral and level position (see Figs. 16.22 and 16.28 for examples of proper hip placement).

Precautions for Individuals with Health Concerns

There is little reason to avoid flexibility training in the apparently healthy individual. However, there are several common health conditions that require special attention and may present challenges to the Personal Trainer in regard to flexibility training. Four of these conditions are arthritis, muscular imbalance, osteoporosis, and hip fracture/replacement. Although Chapter 20 provides specific guidelines about exercise programming for these special populations, this section presents information to consider when designing flexibility training programs for individuals who may have these conditions.

> There is little reason to avoid flexibility training in the apparently healthy individual.

Arthritis

Over 50 million Americans suffer from arthritis or other joint pain and inflammation, with a higher prevalence found in women compared to men. Arthritis is believed to limit physical activity in both normal weight and obese adults (76). Arthritis is defined as an inflammation of a joint resulting in damage to the joint structure. There are more than 100 different types of arthritis, with the two most common types being osteoarthritis and rheumatoid arthritis (68). Osteoarthritis is a chronic degenerative condition that develops over time and is believed to result from either abnormal or excessive wear on “normal” cartilage or normal wear on “abnormal” cartilage. Rheumatoid arthritis is classified as an autoimmune disease in which the body attacks and destroys the joint surface. In either case, individuals with arthritis tend to limit movement because of pain and stiffness, which may result in an increased loss of flexibility and joint motion. Fortunately, flexibility and joint range can be improved in an individual with arthritis through training (77). In addition, training may assist in pain reduction, fatigue, and inflammation (59). Consider the following guidelines when flexibility training an individual with arthritis (59,68):

- Avoid strenuous exercises during acute flare-ups and periods of inflammation. However, it is appropriate to gently move joints through their full ROM during these periods.
- Encourage individuals with arthritis to stretch during the time of day when pain is typically least severe and/or in conjunction with peak activity of pain medications.

- If the client experiences greater joint pain following a training session, the session may have been too intense and may need to be modified.
- Avoid overworking individuals who have taken anti-inflammatory medications (*e.g.*, aspirin, ibuprofen, and naproxen sodium); these drugs can temporarily lessen musculoskeletal pain and make it possible for a client to do too much.
- Discuss with clients the importance of wearing shoes that have good shock absorption and stability.
- Functional activities such as sit-to-stand, step-ups, and stair climbing are good exercises that assist in ADL.

Muscular Imbalance

Many people have muscular imbalances of the body, which may create postural alignment issues and injury. Repetitive movements, poor posture, and weak or tight muscles can cause these muscular imbalances. Consider a baseball or tennis player who consistently trains and plays with joint dominance. When the body experiences an imbalance in muscular forces on opposite sides of a joint, ROM of that joint may be affected (18). The obvious goal to correct the muscular imbalance would be to strengthen the weak muscles and stretch the shorter muscle if ROM is compromised.

Osteoporosis

Osteoporosis is a disease in which bone mineral density (BMD) is reduced, bone microarchitecture deteriorates, and the bone becomes fragile and very susceptible to fracture. The prevalence of osteoporosis in all adults aged 50 years or older is approximately 11.0%, whereas prevalence of low bone mass in all adults aged 50 years or older is approximately 44.5% (78). In women 50 years and older, the prevalence for osteoporosis and low bone mass are 16.5% and 52.6%, respectively (78). In men, the estimates are 5.1% and 35.6% for osteoporosis and low bone mass, respectively (78). Both men and women lose bone steadily after about age 35 years; however, at menopause, women often have an accelerated loss of bone due to hormone changes. The most common sites for bone loss include spine, hips, and wrists. Flexibility exercises for those with osteopenia (low bone mass) or diagnosed osteoporosis should be designed to minimize the chance for fracture. When possible, it may be helpful to have the client use a chair or handrail for support when needed. Examples of exercises to avoid include those that involve twisting, bending, or compression of the spine or those that stress the wrists or hips. Specifically avoid the following:

- Bending forward (*e.g.*, forward fold pose)
- Supine spinal rotation or twists
- Plough pose
- Back extension (*e.g.*, cobra pose)

Hip Fracture or Replacement

For individuals who have recently had a hip fracture or hip replacement, it is recommended to avoid flexibility exercises that involve excessive

- Internal rotation of the hip (turning the foot inward)
- Hip adduction (crossing the legs beyond the midline)
- Hip flexion (thigh more than parallel to floor)

Flexibility Program Development

The ACSM recognizes that joint ROM is important and can be improved by engaging in flexibility training (1). Flexibility programs should follow the same FITT-VP principles (*i.e.*, frequency, intensity, type, time, volume, and progression) of exercise prescription as resistance training (see Chapter 14) or cardiorespiratory endurance (see Chapter 15). In this section, the ACSM FITT-VP guidelines are outlined. Unless otherwise indicated, the guidelines apply to all three of the stretching examples presented in Figures 16.2–16.40. Also as noted previously, flexibility exercises are most effective when the muscles are warm; thus, low- to moderate-intensity warm-up activities should be done preceding all stretching.

Frequency

It is currently recommended that stretches be performed at least 2–3 $d \cdot wk^{-1}$, but stretching exercises are most effective when performed daily, including two to four stretch repetitions per muscle group. There does not appear to be added benefit to stretching multiple times per day as found in a study by Bandy et al. (79), which found no increased in hamstring flexibility in 93 female and male subjects when the frequency of stretching was increased from one to three times per day. Little research exists to refute the practice of stretching daily whether followed by other physical activity or not.

Intensity

Intensity is commonly thought to be an important variable for successful stretching leading to improvements in flexibility (80). Moving into position of tightness or mild discomfort before holding a stretch is the current recommendation on static flexibility training intensity. This subjective feeling of discomfort will vary from client to client. Individual effort can be standardized in the laboratory using maximal voluntary isometric contractions. Feland and Marin (81) found that a submaximal form of PNF produced comparable gains in hamstring flexibility to those produced by maximal voluntary isometric contractions in 72 male subjects aged 18–27 years. These authors concluded that PNF stretching using submaximal contractions might reduce injury risk associated with PNF stretching. Because most Personal Trainers will not have access to isokinetic equipment, it is recommended that fitness professionals employ a Borg Rating of Perceived Exertion scale (82) and suggest that clients position themselves for (static) stretching at an intensity that corresponds to a 13–15 (*somewhat hard* to *hard*) range.

Time

Current recommendations involve stretch hold times of 10–30 seconds for active static stretches. Times of 10–30 seconds are also recommended for

PNF techniques when preceded by a 3- to 6-second active contraction. However, with older adults, an increase to 30–60 seconds for the stretch hold time is recommended. There seems to be little additional flexibility benefit to static stretch hold times that exceed 30 seconds in the younger adult (83).

Type

It is recommended that a general stretching routine be used to best improve flexibility. This means that stretches should involve the major muscle and tendon groups of the body. Some of the more commonly performed static stretches and dynamic stretches are presented in this chapter. For an example of how these parameters can be incorporated into a flexibility training program, see Box 16.2. Because PNF techniques require advanced skill and experience, only Personal Trainers who have advanced training and practice should attempt employing these stretches. For more information about PNF techniques, readers are referred to Houglum (20).

Volume

A total of 60 seconds of flexibility exercises per joint is recommended. This goal may be accomplished by repeating each exercise two to four times (*e.g.*, two 30-s stretches or three 20-s stretches or four 15-s stretches) of the same joint.

Progression

Recommendations for optimal progression are unknown. However, it is essential for continual stretching to maintain a "normal" level of flexibility. It is recommended to stretch before or after activity. Stretching along with dynamic movement should be performed prior to activity, and static stretching should be completed following activity. Flexibility exercises may acutely reduce power and strength, so it is recommended that flexibility exercises be performed after any exercise or sport where strength and power are important for performance.

SUMMARY

The purpose of this chapter is to present flexibility as an essential ingredient of health-related fitness and to provide Personal Trainers with a basic understanding of how to properly incorporate flexibility training into the exercise programs of healthy individuals. Although the science of flexibility training may seem confusing and at times conflicting, Personal Trainers are urged to continue to keep pace with the changes in the scientific literature as it develops.

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CHAPTER 17

Personal Training Session Components

OBJECTIVES

Personal Trainer should be able to:

- Understand how to organize training sessions.
- Apply basic customer service skills as they are applied in a fitness facility and during a Personal Training session.
- Understand communication skills necessary to promote client adherence and motivation.
- Use goal-setting techniques and client accountability to promote adherence.
- Understand criteria for an optimal Personal Training session.
- Develop a checklist for professional behavior.

INTRODUCTION

Developing a Personal Training session takes planning and critical thinking for short- and long-term goals. This requires the trainer to be aware not only of what will take place in a single session but also of what will take place in subsequent sessions in the future. Ensuring a well-organized session while taking notes of what was successful (or unsuccessful) during that time is crucial for the prosperity for the Personal Trainer and client. We address in detail how to plan for prosperous training session in this chapter as well as address the needs and typical activities of Personal Trainers.

In most facilities, Personal Trainers will encounter a diverse clientele, including older adults, middle-aged professionals, and adolescents. Furthermore, Personal Trainers assist clients who may be unfit, have injuries and disabilities, and lack sincere motivation to be active outside of training sessions. Nonetheless, a skilled Personal Trainer is able to communicate effectively with all types of people, provide motivation, and move clients toward their goals through implementation of individualized exercise programs.

Optimal Client Care and Customer Service

Before sequencing and motivational information is presented, a discussion of optimal customer service is in order. This is because effective customer service is the primary responsibility of every Personal Trainer.

Personal Trainers should keep in mind that every person they come in contact with throughout their workday, who is not on staff, is considered a "customer." This includes all training clients, facility members, and guests (prospective clients). This section presents basic customer service skills that every Personal Trainer should strive to perfect.

Personal Trainers should keep in mind that every person they come in contact with throughout their workday, who is not on staff, is considered a "customer."

Client Safety

Personal Trainers are responsible for client safety. For example, all Personal Trainers should understand mechanisms of injury for the major joints of the body. Knees, shoulders, and spines are more likely to get hurt in certain positions and during certain moves, so a competent Personal Trainer will avoid these positions and moves whenever possible (for additional information, see Chapters 3 and 4 as well as the activity-specific Chapters 14, 15, and 16). In addition, it is extremely important that Personal Trainers provide individualized exercises and training programs for each client. A hallmark of a skilled Personal Trainer is the ability to provide a personalized approach; in other words, no one client's program should look exactly the same as any other client's program. Knowledgeable Personal Trainers need to know hundreds, if not thousands, of exercises, progressions, and modifications. In this way, the Personal Trainer is always able to provide the right exercise at the right time for the right client. For example, not every client has the ability to complete a barbell-loaded back squat. If a client is unable to maintain proper exercise form, such as tracking knees with toes, keeping heels on the ground, or maintaining proper spinal alignment, the Personal Trainer must consider ways to modify this exercise. Using a different, simpler exercise that targets the same muscle groups is ideal for progressing to a back squat (*i.e.*, leg press, sit-to-stand, etc.). If pain occurs during the exercise, the Personal Trainer should cease implementation of exercises that require similar joint actions and potentially direct the client to the appropriate health professional. A primary duty of a Personal Trainer is to listen to and observe the client in order to find the safest, most effective exercise or variation at that point in time.

It is imperative that the Personal Trainer know the client's physical limitations as established from the medical history and fitness assessment prior to designing a program. However, the reality is that a client's needs can change from day to day, making it critical to modify and adjust the program or a specific exercise on the spot.

Providing an Exercise Program Road Map

Using information obtained from the client and an understanding of appropriate goal setting based on assessment results, the Personal Trainer should provide a general overview of a well-thought-out training program. Because most training sessions are purchased in packages, it is beneficial to develop a schedule (week by week) of what is expected from the client and what the client can expect from the Personal Trainer during their time together. Although this schedule will be more of a guide than a hard timeline, it is beneficial to provide a road map for success.

Plan Each Workout

Prior to each session, the Personal Trainer should review the client's exercise program road map, short- and long-term goals, any health issues or injuries, and the details of the last few sessions. In this way, the Personal Trainer can plan the most appropriate workout for each client, always keeping in mind the recommendations specified by current American College of Sports Medicine (ACSM) guidelines (1). How will overload be created? Changing the frequency, intensity, duration, and type of exercise are all proven strategies. Rest time, speed of movement, balance, core challenge, coordination, agility, and more can all be manipulated by changing the specific exercise, equipment used, sequencing of exercises, and order/format the program is executed. However, the Personal Trainer should always be ready to alter and adapt the plan, depending on the client's needs and current status. Checking with a client regarding his or her physical and mental readiness to begin the exercise session is crucial.

Use Proper Charting

Proper charting is a "must-have" — both from a customer service perspective as well as an ethical, safety, and liability standpoint. Documenting all activities and events will help the Personal Trainer provide optimal service while limiting liability risk. All workout specifics should be recorded, such as weight/repetitions/sets used, training heart rate (HR) and/or rating of perceived exertion (RPE), and blood pressure (BP) responses or changes (if BP cuff is available). Furthermore, the Personal Trainer should highlight any signs and/or symptoms that may have occurred during a session, including any pain with exercise and actions to address this pain/symptom. Relevant subjective comments made by the client should also be noted. The Personal Trainer should chart ideas and goals for the next workout. If another staff member will be training that client next, any exercise accommodation or program should be carefully detailed in order to prevent confusion. The purpose of keeping good notes is to

- Keep track of exercise programs to verify effectiveness following intermediate and summative assessments.
- Share program information if more than one Personal Trainer will be working with a client.
- Reinforce long- and short-term objectives.
- Keep track of the client's workout over time so that progression can be appropriately applied.
- Provide evidence of professionalism in the event of a lawsuit.

A Personal Trainer should be sure to update the fitness program chart as soon as any change in medical or structural condition (*e.g.*, musculoskeletal injury) presents itself. In addition, the Personal Trainer should take the appropriate steps, speak to the client regarding those conditions that affect the program, and ask the client's permission to contact his or her physician if warranted.

Be Attentive

Attentiveness begins the moment the client walks onto the exercise floor and finishes with the Personal Trainer saying goodbye to the client. Attention to every detail within the workout is important. Pertinent details include the following:

- Monitor all signs and symptoms of cardiovascular disease.
- Provide water and a towel, if appropriate.
- Modify or progress exercises based on the client's ability/feedback.
- Make certain the client trains within the desired target training zone.
- Ensure proper breathing, alignment, and technique during all exercises.
- Adhere to fitness program–specific recommendations.
- Listen to the client and ask for feedback.

> Attention to every detail within the workout is important.

Maintain Professional Conduct in the Training Facility

A Personal Trainer who is training a client must focus on that client alone (Fig. 17.1). Watching TV monitors, chatting with staff or other members, looking at oneself in the mirror, and talking or texting on a cell phone all show disrespect for the client. Aside from the safety factor, if a client perceives that his or her Personal Trainer is disinterested and uncaring, the quality of the workout will be compromised. Body language is important; a Personal Trainer should always face the client and, whenever possible, physically be on the same level. For example, if the client is lying supine on the floor performing abdominal crunches, the Personal Trainer should also be nearby on the floor, either in a sitting or in a kneeling position. Standing above a supine client and talking down to him or her may be intimidating and is impersonal. Finally, Personal Trainers should maintain professionalism even during potentially challenging work environments (*e.g.*, competition for clients among other Personal Trainers).

FIGURE 17.1. Proper body language is critical to success in the Personal Trainer.

Maintain a Professional Appearance

The Personal Trainer's appearance must be neat and professional. Personal Trainers who are not required to wear a uniform might consider developing their own to create a consistently professional image. Like effective branding does for any product on the shelf, a consistently professional appearance will speak volumes about a Personal Trainer. First impressions are important, and it is up to the Personal Trainer to portray a professional appearance that will produce the desired impression for every client and prospective client.

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Work on Self-Improvement

Personal Trainers should set short- and long-term career goals for themselves and make a concerted effort to reach those goals. Reading related literature; attending clinics, workshops, and conferences; and sharing information with other Personal Trainers will enhance knowledge, skills, and abilities. Networking with other trainers and allied exercise and health care professionals, such as dietitians, physical therapists, and exercise physiologists, allows Personal Trainers to refer when necessary, increases likelihood of receiving clients through referral, and helps promote the profession from within. It is highly recommended that Personal Trainers work to attain a college degree in a fitness- or health-related field; this may be critical if and when state licensure is mandated, although the potential degree requirements are not known. Additionally, acquiring certifications in specialty areas, such as martial arts, yoga, Pilates, older adults, pregnancy, and diabetes, will increase a Personal Trainer's knowledge and enhance his or her ability to attract a wide variety of clients (for more information on ACSM specialty certifications, see Chapter 1).

Help Keep the Facility Clean

During nontraining time, check the facility to make sure that all is in order, the weights are put back, and the facility looks presentable. Personal Trainers should make periodic checks of the changing rooms and locker room facilities, going out of their way to make sure the areas are inviting and comfortable to clients.

Personal Training Session Criteria for Appropriate Sequencing

Session Components

A Personal Trainer must include appropriate workout components in the Personal Training session (Table 17.1). A typical hour spent with a client should include some or all of the following components (note these components are not listed in a specific order):

- Greeting
- Appropriate warm-up
- Cardiorespiratory aerobic or anaerobic interval work
- Cool-down phase
- Muscular strength/endurance component: traditional exercises and functional exercises
- Core work for stability
- Condition-specific exercises (*e.g.*, orthopedic protocols, pregnancy protocol)
- Neuromotor training (promotion of balance, agility, and coordination)
- Flexibility component
- Goal setting and farewell
- Charting

Table 17.1 Personal Training Session Evaluation Criteria/Checklist

Greeting	■ Personal Trainer's appearance is neat and professional. ■ Provide appropriate greeting and reception. ■ Pick up client on time. ■ Display good client rapport. ■ Ask how the client feels and on what he or she would like to focus.
Warm-up phase	■ Use appropriate cardiorespiratory equipment. ■ Consider any musculoskeletal or metabolic limitations. *Relevant to goals and/or structure of workout* ■ A minimum of 5 min in length ■ Appropriate intensity (*i.e.*, at low end of training zone)
Cardiorespiratory phase	Monitor and document intensity responses (HR, RPE). Follow ACSM guidelines. ■ Monitor HR, RPE, TT, and/or breathlessness at the various stages of the workout. ■ Use RPE for any *hypertensive clients* on medication that affects HR. RPE is to be monitored throughout workout with *pregnant clients*. Perceptual signs/signals (such as ataxia [unsteadiness of gait] or other

	physical signs of fatigue) should be monitored in conjunction with HR, BP, and RPE, and exercise is modified accordingly. This is especially important in clients who have a tendency to work hard and underestimate their RPE.
Cool-down phase	■ A slow decrease in exercise intensity occurs at the end of the CV bout, any hard bout of exercise, or at any point within the workout, prior to final flexibility and abdominal work. ■ The postexercise cool-down activity should be 5–10 min in length; it is dependent on the exercise intensity, exercising time, and client-specific conditions (*e.g.*, provide hypertensive client and less fit clients a longer cool-down period to allow for HR and BP to return toward preexercise levels without blood pooling or orthostatic hypotensive responses).
Muscular strength and endurance component	Follow ACSM guidelines. *Exercise selection takes the following into account:* ■ Client's goals (long term and short term) ■ Overall training program and program components ■ Client's skill and fitness levels ■ Any musculoskeletal or metabolic conditions and subsequent health care provider recommendations ■ Any day-to-day considerations (*i.e.*, client is tired, sore, had recent illness, inconsistent attendance, hasn't trained in over 1 mo) ■ Availability of equipment and other activities occurring within fitness center ■ The client's need for foundational training, traditional resistance exercise, and/or functional training ■ Previous exercise sessions *Spotting and cueing:* ■ Always ask permission before hands-on spotting. ■ The hands-on interaction is based on the client, the exercises used, the appropriate feedback needed, and their overall program. ■ Properly monitor the range of motion on resistance training exercises; give feedback on speed of movement; ensure client safety. ■ Free weights: Appropriate spotting occurs *at all times* with all clients. Personal Trainer is in a position to assist the clients with the weights if they are not able to maintain good form or are unable to complete the activity. Personal Trainer positions his or her body in such a way that the client is comfortable, safe, and experiences an improved workout. ■ Teaching cues are safe, accurate, and appropriate for the client. Provide a variety of cues: alignment, safety, educational, and motivational. Use a positive style of cueing. ■ Incorporate a "setup" phase, when needed, to help the client achieve proper alignment and technique. *Equipment use:* ■ Use a variety of equipment during the workout. ■ Return all equipment and maintain them in a neat, orderly condition.

Core work for stability	■ Focus on appropriate core stability exercises for the neck, scapulae, spine, and pelvis.
Condition-specific protocols	■ Do not exceed scope of practice and follow the licensed health care provider's recommendations. ■ Know what *not* to do as well as what to do. ■ Seek medical clearance for all pregnant women.
Neuromotor training	■ Include exercises for balance, agility, and enhanced proprioception.
Flexibility component	■ Occurs after client is thoroughly warmed up ■ Static stretches are held for 30–60 s, proprioceptive neuromuscular facilitation stretches can be held for 6–7 s. ■ Include stretches for the major muscle groups, any specific areas highlighted within the fitness assessment, or muscle groups emphasized during the workout. ■ Incorporate relaxation and/or stress-management techniques, if appropriate.
Goal setting and farewell	■ Help client set a short-term goal and/or give "homework" at end of session, if appropriate. ■ Thank client for a good workout. ■ Farewell should be friendly, positive, and affirmative.
Charting	*The client's session should include specific information regarding* ■ New exercises/machines used, how the client felt and performed the exercises ■ Client's subjective comments ■ Any particular changes in the client's fitness level as noted on a specific machine (*e.g.*, "ran 0.3 m farther than usual today;" "wasn't able to complete usual distance due to hard workout") ■ Relevant observations made by Personal Trainer ■ Any pain or discomfort that occurred during the session ■ Any notes for the next workout
Innovation and problem-solving skills	*Ability to improvise and modify any aspect of client's workout based on* ■ Other activities occurring within the fitness center ■ Specific injuries, limitations, or complaints of pain/discomfort ■ Equipment availability

Adapted from American College of Sports Medicine. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. *Med Sci Sports Exerc*. 2009;41(3):687–708.

Continuity and Planning

The "flow" of the Personal Training session should proceed in a continuous, uninterrupted manner. Making efficient use of floor space and choice of exercise modality when the training floor is crowded is also important. It is up to the Personal Trainer to be creative and make alternative choices of exercises when necessary, particularly if the preferred equipment is already in use by other members of the facility. Additionally, prior to the session, the Personal Trainer should prepare the client's program for the day, set up equipment if possible, review the client's short- and long-term goals, any health issues or injuries, and the details of the last few sessions.

Greeting and Punctuality

The Personal Trainer should greet the client in an appropriate manner. A friendly, professional greeting with a handshake and a smile goes a long way to setting the tone and building rapport with the client. Rapport is developed over time through empathetic listening, being trustworthy, and establishing repeated positive interactions with a client (for more information on listening and communication, see Chapter 9). Personal Trainers should make every effort to improve communication skills; ability to listen and communicate well is essential for the development of client rapport and motivation. Inappropriate language (*i.e.*, demeaning comments; racial, ethnic, or sexist epithets; or "locker-room talk") has no place in a Personal Training session and can damage rapport. The relationship between a Personal Trainer and a client is a professional one, and thus, personal conversation should generally be kept to a minimum. A Personal Trainer should focus completely on the client's needs from the moment of greeting the client to the farewell at the end of the session. At the beginning of the session, an inquiry should be made about the client's status and include any of the following: how he or she feels, any aches or pains, how the client felt after the last session, and what the client would like to work on that day.

In addition, the Personal Trainer should always start the session on time. Starting a session late is unprofessional and indicates to the client that the Personal Trainer does not value the client's time.

Warm-Up Phase

The Personal Trainer must help the client select an appropriate warm-up modality that

- Considers any musculoskeletal or metabolic limitations
- Is relevant to the goals and/or structure of the workout
- Is a minimum of 5 minutes in length
- Is an appropriate intensity (*i.e.*, low intensity, increasing toward the low end of training zone)
- Includes monitoring of RPE and/or HR

In many cases, when a client is experienced and has worked with the Personal Trainer for an extended period of time, the client arrives early and completes a preplanned warm-up prior to the actual training session. Similarly to the workout phase, the warm-up should rely on feedback from the client to ensure its effectiveness and follow principles of progressive overload.

Cardiorespiratory Phase

The Personal Trainer is responsible for helping design an appropriate cardiorespiratory and/or anaerobic interval program for each client; ACSM guidelines for the development of cardiorespiratory fitness should be followed (1). The Personal Trainer should also monitor HR, respiration, or RPE throughout the various stages of the entire workout.

The client's HR may be monitored by palpating the pulse, either at the radial or carotid arteries, or by using an HR monitor (for information on measuring HR, see Chapter 12). If the Personal Trainer chooses to use HR to monitor exercise intensity, he or she should be well aware of its potential inaccuracy. For example, do not assume that one maximal HR formula fits all clients. Also, several extraneous factors, such as heat, humidity, illness, cigarette smoking, and stress, may affect HR. While using HR to monitor exercise intensity, the Personal Trainer should also monitor the client for ataxia (unsteadiness of gait) or other physical signs of fatigue or stress (1).

RPE is frequently recommended as another way to assess exercise intensity (1). The Borg 6–20 RPE scale (see Table 15.4) or a simple 0–10 scale may be used (see Chapter 15). With new clients, it is helpful to have an actual RPE chart visible while explaining proper intensity, but eventually, most clients can understand and apply the RPE scale effectively without a visible chart. For more information on monitoring exercise intensity, see Chapter 15.

Ventilatory symptomatology is a recommended way to assess exercise intensity when a client's HR response is not a reliable means (*i.e.*, client's taking medications, such as β-blockers) or to more closely relate to ventilatory thresholds for apparently healthy clients and athletes (2). Popularly referred to as a talk test (TT), this requires a client to determine if he or she can talk "comfortably" during cardiorespiratory exercise. It is useful to familiarize a client with this procedure during a pretest using "The Pledge of Allegiance", or something similar, as the paragraph he or she is reciting to determine if he or she is comfortable talking or not.

In practice, many Personal Trainers design cardiorespiratory programs for their clients but eventually encourage clients to perform this part of the workout on their own. In this way, for many clients, the actual session is reserved for the more various and complicated muscle-conditioning exercises. If the Personal Trainer is not actually supervising the cardiorespiratory workout, the Personal Trainer should nevertheless always ask the client about his or her adherence to the workout and about program variables such as duration, frequency, intensity, and mode.

Cool-Down Phase after Cardiorespiratory Exercise

The cool-down portion of the workout should be 5–10 minutes in length, depending on the intensity and duration of the workout and client-specific conditions (*i.e.*, less-fit clients should be allowed a longer cool-down period to allow HR and BP to decrease). Ideally, HR and/or RPE should be monitored during the cool-down.

Muscular Strength/Endurance Component

Many clients seek a Personal Trainer's advice because they are unsure of what exercises to do in the resistance training area; they want a program that generates results. Additionally, they often want a Personal Trainer to help make certain they are exercising correctly with safe and effective form and technique. Therefore, in addition to following ACSM guidelines for resistance training, Personal Trainers should be familiar with a large variety of exercises and know how to properly teach, spot, and cue each exercise in such a way that clients understand and follow through with correct performance.

Exercise Selection and Programming

The Personal Trainer must take several factors into account when deciding which exercises to give a client. These factors include the following:

- Client's goals and attitude
- Client's fitness and skill level
- Any musculoskeletal issues or injuries
- Any recommendations from the client's health care providers
- Considerations on the particular training day (*e.g.*, client is tired, sore, has been ill, has not trained regularly, has not trained in over a month)
- Availability of equipment and other activities occurring within the fitness center

A skilled Personal Trainer should know a large number of traditional exercises for each muscle group, including single-joint and multijoint exercises using machines as well as free weights and other equipment. It may be useful to organize the vast number of possible exercises along a continuum from easiest to hardest (Fig. 17.2); such a continuum provides a practical way to think about exercise selection (3).

FIGURE 17.2. Exercise session continuum. (Adapted from Ratamess N. *ACSM's Foundations of Strength Training and Conditioning*. Philadelphia [PA]: Lippincott Williams and Wilkins; 2012. 319 p.)

To be even more specific, the left, easy, or foundational side can provide a starting point for new clients. At the beginning of a program, it is wise to select basic exercises that promote core stability and mobility, thus helping to create a strong and safe foundation for harder and more complex exercises. Examples might include supine abdominal hollowing, supine heel slides, quadrupeds (bird dogs), hip hinging, and scapular depression and retraction exercises. These foundational exercises help prepare the client for more challenging work and can be used to educate him or her about safety, proper alignment, and injury prevention. As a client progresses, exercises may be selected from the traditional weight room repertoire and include the use of variable resistance machines, cable column setups, and free weights. Progression often moves from single-joint exercises to multijoint exercises and from open kinetic chain to closed kinetic chain movements.

Eventually, many clients may progress to less traditional exercises — now often labeled under the heading of functional training — such as woodchoppers; reverse woodchoppers; lunges with a pickup; and other moves that incorporate balance, core, and coordination challenges. Compared with traditional weight training, these moves often use a lighter weight held farther from the trunk and help to improve biomechanical efficiency and neuromuscular control (4). On the far-right side of the exercise continuum are sport-specific moves that prepare an athlete for performance (see Chapter 18 for more specifics on advanced program options). Because functional exercises and, especially, sport-specific moves require a high degree of fitness, skill, balance, coordination, and core stability, Personal Trainers should not select these exercises until the client is able to perform them safely and correctly. In fact, many clients have no desire to progress all the way to the sport-specific/performance end of the continuum. It's important to realize that many people want to exercise for health, fitness, and wellness benefits and that this does not necessarily include sports performance or aggressive, very difficult moves or routines. The Personal Trainer should emphasize the muscle groups and movements that are specific to the client's individual goals and objectives. Finally, the Personal Trainer should attempt to select exercises according to the initial or follow-up fitness evaluations and interviews.

Spotting: Hands-On Interaction

The Personal Trainer should provide appropriate spotting during all aspects of the exercise session. Legally, it is a Personal Trainer's job to ensure client safety. The Personal Trainer should monitor ranges of motion and prevent the client from moving into extreme and unsafe positions, such as extreme shoulder horizontal abduction in a supine dumbbell fly. As a general rule, when a client lifts a heavy weight, the Personal Trainer needs to spot the weight for safety (keeping hands on or near the weight). If the client is a novice, or is performing an exercise for the first time, or is lifting a light weight, the Personal Trainer may need to spot specific joints or actions instead of the weight. For example, if a client is performing a squat for the first time (in which case the weight would be either light or nonexistent), the Personal Trainer may need to kneel and spot the client's knees, helping the client to find and feel the correct knee position while moving. During core, balance, and agility work, the Personal Trainer should assist the client and help ensure proper alignment and technique. Personal Trainers should properly position themselves to prevent the client from falling and should provide adequate support for the client during balance-training drills. Furthermore, Personal Trainers should also position themselves in a way that does not impede the client's movement and maintains comfortable spatial interaction between both the client and Personal Trainer. During stretching, the Personal Trainer may spot the client as needed to help ensure proper form and alignment.

The hands-on interaction that occurs during the workout should be based on the client, exercises used, appropriate feedback needed, and overall program. Always consider the client's safety, alignment, and comfort level with touch. Because not all clients are comfortable with hands-on techniques, the Personal Trainer must always ask permission before touching.

> The Personal Trainer must always ask permission before touching the client.

Do not touch a client if he or she says no, or seems uncomfortable in any way, and stay away from gender-specific areas of the body. Additionally, the Personal Trainers should be aware of their body position. It is usually best to be on the same level as the client. For example, if the client is on the floor performing supine abdominal work, the Personal Trainer should not be standing over them shouting down commands. Instead, kneel or sit near the client in order to facilitate hands-on spotting if necessary, increase client comfort, and maintain an appropriate speech volume.

A good technique for teaching clients proper form is to have a "setup" phase prior to the performance of each exercise. During the setup, the Personal Trainer carefully ensures that the client is focused and properly aligned and the core is stabilized. Only then does the client actually begin to move and perform the exercise.

Cueing

Proper cueing during a client's session is critical. It is the Personal Trainer's job to help the client perform each segment of the workout, and each exercise, correctly. This can be accomplished with skillful spotting and cueing. There are many different types of cues, including educational, safety, alignment, and motivational cues. In addition, cues may be delivered visually, orally, and through touch (tactile cues). The Personal Trainer needs to be adept at exercise demonstration as well as visual cueing. Another useful cueing technique is the right/wrong method. This method can be very effective for clients who are having difficulty with proper positioning. For example, if a client is having trouble maintaining a neutral pelvis, the Personal Trainer may demonstrate a misaligned pelvis versus a neutral pelvis. In other words, show the client the incorrect position and then the correct position. Many clients find this type of teaching technique very helpful. Remember to phrase all cues positively, as in "Make sure to always keep a slight bend in your knees" instead of "Don't lock your knees." Constant use of the word "don't" sounds negative and pejorative. In general, it's best to avoid monotonous counting; clients already know how to count! Instead, the Personal Trainer should make certain he or she is providing detailed information and cues that will ensure the safety and efficacy of each exercise.

Equipment Use

The Personal Trainer may use a variety of equipment during the workout. Any equipment used during the workout must be returned to a neat, orderly condition during the course of the workout to maintain safety and not interfere with any other workouts that are occurring within the same time frame. Personal Trainers have many equipment and exercise options, and as a client progresses and becomes more skilled, variety may become more and more important. Machines, free weights, cable columns, stability balls, BOSU balance trainers, TRX Suspension Trainers, kettle bells, medicine balls, foam rollers, and elastic tubing and bands are all common in many facilities. Personal Trainers should be familiar with safety precautions, proper progressions/modifications, and a wide variety of exercises on all types of equipment. Once the Personal Trainer has a satisfactory understanding of the equipment, then he or she can select the most appropriate exercise for each client depending on the client's level of fitness, skill, goals, musculoskeletal and/or metabolic issues, exercises performed in the previous session, and equipment availability.

The Personal Trainer may use a variety of equipment during the workout.

Core Work for Stability

All clients, both novice and experienced, need to be able to maintain neck, scapular, spinal, and pelvic stability in order to perform exercises with good alignment and to minimize the risk of injury. The Personal Trainer should therefore make time in the session to focus on core exercises such as abdominal hollowing, pelvic tilts, and scapular depression and retraction; these may be performed supine or standing against a wall. Scapular awareness can also be promoted in the prone “prop” position (up on the elbows) because gravity pulls the torso downward and the scapulae tend to elevate. Many clients find it challenging to maintain the prone prop position for even 30–60 seconds while keeping the scapulae depressed. The quadruped/all fours/bird-dog position is another excellent way to teach core stability of the neck, scapulae, spine, and pelvis; many movement variations exist, such as holding the opposite arm and leg parallel to the floor or slowly lifting arm and leg up and down without moving the core. The plank, and all its variations, is yet another way to challenge core stability and, depending on the variation (*e.g.*, a side plank), can be quite advanced.

Condition-Specific Protocols

Most Personal Trainers will occasionally work with clients with special conditions; these conditions can include pregnancy as well as a large number of musculoskeletal issues such as low back pain, tennis elbow, rotator cuff tendonitis, hip bursitis, lateral knee pain, and more. Although a Personal Trainer must never exceed his or her scope of practice and should always refer a client with active musculoskeletal pain to the appropriate medical practitioner, the reality is that many clients want to stay active and will continue working with their trainer, even with an injury. If the Personal Trainer agrees to continue training a client with a history of musculoskeletal pain, it is incumbent on the Personal Trainer to adhere to the recommendations of the client's licensed health care provider. In other words, the Personal Trainer must know what not to do as well as what to do. For example, a client who has finished a regimen of physical therapy sessions for tennis elbow may have a specific exercise protocol that he or she need to continue postrehabilitation (provided by the physical therapist), which may then be incorporated into the Personal Training session. Likewise, when training pregnant women, it is recommended that a woman past her first trimester of pregnancy avoid exercising in the supine position, particularly if she is symptomatic. The Personal Trainer should make certain to include alternate abdominal exercises that are not in the supine position and should also seek a medical clearance for all pregnant women (1,5). Such condition-specific protocols will need to be sequenced into the Personal Training session.

> The Personal Trainer must follow the recommendations of the client's licensed health care provider.

Neuromotor Training

Neuromotor training includes training for balance, coordination, gait, agility, and enhanced proprioception. Neuromotor training is recommended as part of a comprehensive exercise program, particularly for older adults who are at an increased risk of falling (1,6). Younger and middle-aged adults involved in physical activities that involve agility, balance, and other motor skills may also benefit, although research in this area is still limited (1). Balance exercises may be either static (such as standing on one leg while incorporating upper body movements) or dynamic. A dynamic balance exercise involves transferring body weight from one foot to the other; for example, pretending to walk along a “tightrope,” or a line on the floor, with one foot directly in front of the other can be challenging for some clients. Personal Trainers should make an effort to include both types of balance exercises in the exercise session whenever possible.

Flexibility Component

A flexibility component can be included anytime the muscles have been warmed up. Flexibility exercises can be included at the end of the Personal Training session. The Personal Trainer should teach his or her client a basic stretching routine that addresses all active muscles and all joints with a decreased range of motion. Muscles that have been vigorously challenged or repetitively used during the workout should be stretched. This final segment can also be a good time to incorporate relaxation techniques such as deep breathing, progressive muscle relaxation, and positive imagery. Many clients are unfamiliar with stress management “quick fixes” and will be grateful for any tips and strategies from the Personal Trainer. Details on stretching and developing flexibility are found in Chapter 16.

Goal Setting and Farewell

Goal setting is critical for success (Fig. 17.3). The Personal Trainer can ask his or her client to set a short-term goal at the end of each session. The goal should ideally be relatively easy to attain, positive, and doable for the client. Some sample short-term goals include the following: “Take a 10-minute walk after lunch every day for the next 3 days,” “Go for a 1-hour walk in the park on Saturday with the kids,” and “Stand up and pace during every phone call on Friday.” Another suggestion is for the Personal Trainer to assign “homework” for the client. Examples of homework include the following: “Every night at dinner, sit on the edge of the chair and maintain a perfectly neutral spine for 60 seconds,” “Twice a day, stand against a wall and make certain the spine and neck are in neutral,” “While making coffee every morning, stand on one foot and balance for 20 seconds,” and so on. Goals should always be set by the client, whereas “homework” may be assigned by the Personal Trainer. In either case, let clients know that they will be asked about the goal or the homework at the next session. Small steps help promote long-term behavior change. Upon completion of the session, thank the client for a good workout. Always end the session with a positive and affirmative farewell, with plans for the next meeting.

FIGURE 17.3. Personal Trainer reviewing goal setting with a client.

Charting

Proper charting was discussed earlier in the chapter. The Personal Trainer needs to allow enough time after the session to record all workout details, client goals, and ideas for the next session.

Education and Motivation

Client Education

Most clients have a specific area of concern. In order to make the session more meaningful, Personal Trainers can gear the workout to address these concerns. Some clients, for example, want to "tone up" their hips and thighs. The Personal Trainer can take this opportunity to educate the client about the meaning of "toning up" and include information about muscle-specific exercises such as hip extensions and hip abduction and adduction movements. The effectiveness of multi-muscle exercises such as squats and lunges should be discussed. Additionally, the Personal Trainer might educate the client about the importance of increasing lean body mass while also promoting cardiorespiratory exercise as a way to burn large numbers of calories and reduce excessive body fat.

The Personal Trainer should talk to each client about how the routine he or she has designed relates to the client's goals and training objectives. When prudent, appropriate postrehabilitation protocols should be implemented and explained as to how they will be integrated into the client's program to improve or prevent further injury.

Another important area for client education is proper breathing technique. The client should never hold his or her breath during any contraction. This increases intrathoracic pressure and as a result increases BP, which may or may not be dangerous for a specific client but is certainly unnecessary. As a general rule, the client should inhale before starting the lift, exhale when performing the concentric contraction, and inhale during the eccentric phase.

Many clients hire trainers primarily for guidance in the weight room. However, the Personal Trainer should educate the client about all the components of fitness and should also provide a suitable program for cardiorespiratory conditioning. Typically, many clients will perform their cardiorespiratory workout before or after the actual supervised session. This will depend on the client's overall physical condition, daily schedule, and specific training goals and objectives. The Personal Trainer should make sure that clients understand how to operate their preferred aerobic equipment and that they can either take their own HR or gauge RPE effectively, before they exercise without supervision. It is important to ask clients what additional activities they are performing outside of the facility. This will assist the Personal Trainer in designing training sessions and can provide additional opportunities for education. The Personal Trainer should teach each client the physiological basis of the RPE scale and explain how this will assist in monitoring exercise intensity and how it will make the sessions more efficient (Fig. 17.4).

FIGURE 17.4. Personal Trainer explaining the use of the RPE chart to a client.

In light of the current obesity epidemic, Personal Trainers need to provide most clients with strategies for increasing their physical activity throughout the day, and the risks of constant sitting should be discussed. Help clients with tips for incorporating more nonexercise movement into their day. Encourage them to stand more and sit less, to take movement breaks during TV commercials, and to be “inefficient” when doing household chores — making more trips than necessary in order to burn more calories and keep the body active.

Another important area for client education involves low back care and the maintenance of proper posture throughout the day. Personal Trainers can help reduce the incidence of back pain by teaching clients how to adjust their chairs and sit correctly, how to bend and lift, and how to find ideal spinal alignment in activities of daily living.

Client Motivation

The ideal Personal Trainer is also a great motivator. What does this mean? A great motivator makes each workout as interesting and as varied as possible. Most clients are motivated by a trainer who is also a good role model, someone who practices what he or she preaches. Personal Trainers who are enthusiastic and passionate about fitness and wellness can be inspiring. Good motivators are genuine, empathetic, and caring and let clients know that they believe in the clients' ability to succeed at their goals. Many novice exercisers hire a Personal Trainer because they need extrinsic motivation. Extrinsic motivation is the type of motivation that comes from the outside; for example, a client who adheres to a program because he or she wants to win a reward, such as a free 6-month club membership, is extrinsically motivated. A client may be motivated to keep exercising because of positive feedback from the Personal Trainer — another example of extrinsic motivation, where the concern may be more about the outcome instead of the process.

However, people are more likely to adopt healthy lifestyles and fitness regimens for the long run if they are intrinsically motivated (7). Intrinsic motivation comes from within. Clients with intrinsic motivation continue to exercise simply because they enjoy it and they feel better when they do; exercise becomes its own reward. Personal Trainers can help clients become more intrinsically motivated by bringing attention to feelings of well-being after an exercise session and by helping clients discover the benefits of exercise for themselves. Exercise sessions should be productive yet fun and enjoyable.

A motivating Personal Trainer also helps clients achieve feelings of self-efficacy. Self-efficacy has been defined as the confidence a person has that they can perform a given task well (8). In the fitness setting, this means that a client eventually knows what to do and is comfortable doing it. A client with self-efficacy, for example, is able to walk into the cardiorespiratory training room and/or the weight room and feel a sense of mastery in terms of some or all of the equipment. Such a client knows how to adjust the machines for his or her own use and understands how to perform the chosen exercises properly. An important task of the Personal Trainer is to enable clients to have this type of mastery and competence in the exercise environment. Most clients find that having a sense of self-efficacy with regard to fitness and wellness is very motivating and helps ensure long-lasting adherence. Chapters 7, 8, and 9 can assist you in developing your client's self-efficacy regarding exercise.

> The Personal Trainer should help promote the client's self-efficacy, or sense of mastery and competence, in the exercise environment.

SUMMARY

The Personal Trainer must first and foremost ensure client safety and care while he or she strives to deliver the highest level of customer service. This includes focusing on proper exercise form, appropriate planning and charting the client's program and progress, being attentive to the client, and always behaving professionally. All components of a training session should be administered sequentially and closely observed, from warm-up through to the cool-down, and standard exercise guidelines should be followed. Personal Trainers should acknowledge that they are role models, educators, and motivators of clients and therefore continue to challenge themselves in these areas.

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CHAPTER 18

Advanced Program Options

OBJECTIVES

Personal Trainers should be able to:

- Identify the roles and proficiencies of Personal Trainers whose clients consist mostly of competitive athletes and/or those with advanced training goals.
- Discuss how to maximize performance by improving one or more health- and skill-related fitness components.
- Identify American College of Sports Medicine recommendations for advanced resistance training.
- Identify various advanced resistance training techniques used to maximize muscle strength, hypertrophy, power, and endurance and how they may be used in a training program.
- Understand recommendations for plyometric, speed, agility, and anaerobic conditioning program design.

INTRODUCTION

The Personal Training profession has evolved rapidly, and practitioners accommodate numerous segments of the population. Not only have Personal Trainers rendered services to previously sedentary, novice, and moderately trained individuals but also a growing number of athletes and highly fit individuals have hired Personal Trainers in order to maximize performance. Although sports teams at the university and professional level typically have a full-time strength and conditioning coach on staff, some athletes at the elite and professional levels prefer to hire a Personal Trainer for individualized training. It is not unusual for athletes to work with their strength coaches during in-season and preseason training and to hire a Personal Trainer for off-season training. For example, athletes commonly attend off-season speed and agility training camps, and many college football players attend strength and conditioning camps prior to combine testing in preparation for the National Football League draft. As the Personal Training profession increases involvement of clientele with advanced fitness levels, the roles and proficiencies of the Personal Trainer will expand. Box 18.1 presents examples of educational foundations and proficiencies important to a Personal Trainer. The scope of this chapter is to provide Personal Trainers with advanced training recommendations particularly suited to more highly fit individuals.

Box 18.1 Professional Educational Foundations and Proficiencies of a Personal Trainer

Anatomy, physiology, and kinesiology
Bioenergetics
Exercise/sports biomechanics
Sports nutrition
Supplements and ergogenic aids
Overtraining and detraining
Periodization and recovery
Weight loss/body fat reduction
CPR administration and first aid
Injury prevention
Weight and implement training
Aerobic endurance training
Plyometric, speed, and agility training
Balance and functional training
Strength, power, and ballistic training
Flexibility training
Muscle endurance and hypertrophy training
Sport-specific demands and conditioning
Advanced program design
Skills assessment

CPR, cardiopulmonary resuscitation.

> Not only have Personal Trainers rendered services to previously sedentary, novice, and moderately trained individuals but also a growing number of athletes and highly fit individuals have hired Personal Trainers in order to maximize performance.

The motivation, coaching, instruction, and direct supervision provided by the Personal Trainer are instrumental for athletes and highly fit individuals. Not only does supervised training result in fewer injuries and better technique but also performance abilities may be enhanced. Personal Training poses several advantages to the athlete/client targeting further progression.

Research has shown supervision results in greater strength gains (1,2) and the self-selection of greater training loads (2). Although athletes are supervised to a large extent by the coaching staff, coaches must often monitor several athletes simultaneously. Personal Trainers offer the advantage of one-on-one instruction for an entire workout.

Advanced Training Status

Personal Trainers who work in the general health and fitness domain train clients primarily to improve health and overall fitness, whereas advanced clients train rigorously with the aim of improving (or maximizing) one or more fitness components. The *needs analysis* for advanced clientele reveals areas of focus for the training program to maximize performance as well as for injury prevention (3–5). Fitness components may be categorized as health related or skill related. Health-related components of fitness include muscle strength and endurance, cardiorespiratory endurance, flexibility, and body composition. Skill-related components of fitness include power, speed, agility, balance, reaction time, and coordination. Both of these component categories are critical to improving performance. Although athletic success is related to skill level, conditioning traits can differentiate athletes of different caliber (6). Elite athletes possess greater strength, power, speed, and jumping ability compared with athletes of lesser rank (6). For example, National Collegiate Athletic Association (NCAA) Division I football players have greater maximal strength, vertical jump height, fat-free mass, lower percentage of body fat, and faster 40-yard dash times than NCAA Division II players (7). Thus, health- and skill-related components of fitness appear to contribute to athletic success and are of value to anyone with advanced training goals.

Advanced training status is determined by fitness level and training experience. Individuals who are classified as advanced typically have demonstrated a substantial level of adaptation, which occurs at different rates depending on the training program. Training advanced to elite clients can pose a challenge to Personal Trainers. Some of the largest rates of fitness improvements take place in untrained individuals where the window of adaptation is high, whereas trained individuals may show a slower rate of progression (8). Therefore, the Personal Trainer must be creative and must design advanced training programs based on the scientific principles of progressive overload, variation, and specificity (discussed in Chapters 13 and 14). This chapter provides an introduction to a number of advanced training options; additional instruction and experience in implementing the various techniques should be gained prior to Personal Training any clients.

Advanced Program Design

Advanced training programs consist of systematic manipulation of the acute program variables. The manipulation of these variables becomes more critical because of the smaller window of adaptation shown in advanced or elite athletes. The level of variation needs to be greater than that seen in beginning and intermediate programs. A basic program may improve several components of fitness simultaneously in an untrained or moderately trained individual. However, this same program may only improve one or two fitness components in a trained individual. Advanced training is characterized by greater specificity and requires periodization in the program (see Chapter 14) (3,5,9). Training cycles are common, and each cycle may target a few components of fitness. Exercise selection is based on training and program goals along with enhanced motor coordination, where movement complexity increases over time. Advanced training also requires the optimal integration of training modalities. A strength/power athlete may simultaneously perform resistance, speed, agility, and plyometric training in a preseason training phase, and an endurance athlete may simultaneously perform aerobic endurance, interval, and some resistance training (RT). Although training basics have been discussed in previous chapters, this chapter focuses on the applied concepts of advanced program design of resistance, plyometric, speed, and agility training.

Resistance Training

The American College of Sports Medicine (ACSM) has been instrumental in providing Personal Trainers with guidelines and recommendations for RT. Early position stands focused mostly on untrained populations. However, in 2002 the ACSM first published RT guidelines targeting progression from novice to advanced training status for those individuals striving to increase muscle strength, power, endurance, and hypertrophy (8). In 2009, the ACSM extended these guidelines by publishing an evidenced-based position stand (10). The basic elements of ACSM RT guidelines were discussed in Chapter 14. ACSM recommendations for advanced RT are presented in Table 18.1. The Personal Trainer can use these recommendations when prescribing the client exercise selection, sequence, intensity, volume, muscle actions, rest intervals, frequency, and lifting velocity. There are many effective progression structures for multiple-set programs. These may include constant load/repetition (keeping load and repetition number the same for each set), heavy to light (decreasing weight each set while maintaining or increasing repetition number), light to heavy (increasing weight each set while maintaining or decreasing repetition number), and undulating (integrated) systems (5,11). Thus, it is up to the personal preference of the Personal Trainer and client as to which one or combination of systems will be used.

Table 18.1 American College of Sports Medicine Recommendations for Advanced Resistance Training (8,10)

	Muscle Strength	Hypertrophy	Muscle Endurance	Power
Muscle action	CON, ECC, and ISOM	CON, ECC, and ISOM	CON, ECC, and ISOM	CON, ECC, and ISOM
Intensity and repetitions	Cyclical rotation of loads of 80%–100% of 1-RM	A loading range of 70%–100% of 1-RM used for 1–12 repetitions	Various loading strategies (10–25 repetitions or more) in	Moderately heavy loading (75%–85% of 1-RM) for 1–3

		per set in periodized manner such that the majority of training is devoted to 6–12 RM and less training devoted to 1–6 RM loading.	periodized manner	repetitions per set in a periodized manner for ↑ force, light to moderate loading (30%–60% of 1-RM for upper body exercises, 0%–60% of 1-RM for lower body exercises) for 3–6 repetitions per set in a periodized manner for ↑ RFD; performed explosively
No. of sets per exercise	Multiple sets (3–6)	Multiple sets (3–6)	Multiple sets (3–6)	Multiple sets (3–6)
Exercises	Unilateral and bilateral single- and multiple-joint exercises should be included with emphasis on multiple-joint exercises. Emphasis should be placed on free-weight exercises with machine exercises used to compliment program needs.	Unilateral and bilateral single- and multiple-joint free-weight and machine exercises	Unilateral and bilateral multiple- and single-joint free-weights and machine exercises	Unilateral and bilateral multiple-joint free-weight exercises
Exercise order	Large muscle group exercises before small muscle group exercises, multiple-joint exercises before	Large muscle group exercises before small muscle group exercises, multiple-joint exercises before	Various sequencing combinations	Similar to strength training

	single-joint exercises, higher intensity exercises before lower intensity exercises, or rotation of upper and lower body or opposing exercises	single-joint exercises, higher intensity exercises before lower intensity exercises, or rotation of upper and lower body or opposing exercises		
Rest intervals	At least 3–4 min for structural exercises using heavier loads. For assistance exercises, a shorter rest period length of 2–3 min may suffice.	Correspond to goals of each exercise: 2–3 min may be used with heavy loading for structural exercises, and 1–2 min may be used for other exercises of moderate to moderately high intensity.	Short rest periods, for example, 1–2 min for high-repetition sets (15–20 repetitions or more), <1 min for moderate (10–15 repetitions) sets. For circuit training, rest periods should correspond to time needed to get from one exercise to another.	At least 2–3 min for structural exercises when intensity is high; shorter rest interval (1–2 min) for assistance exercises
Repetition velocity	A continuum of velocities from unintentionally slow to fast CON velocities; should correspond to the intensity	Slow, moderate, and fast repetition velocities depending on the load, repetition number, and goals of the exercise	Intentionally slow with moderate repetition number (10–15); moderate to faster with large number of repetitions (15–25 or more)	Fast
Frequency	4–6 $d \cdot wk^{-1}$	4–6 $d \cdot wk^{-1}$	4–6 $d \cdot wk^{-1}$	4–5 $d \cdot wk^{-1}$

↑, increased; RFD, rate of force development.

The Personal Trainer can use ACSM recommendations for advanced RT when prescribing the client exercise selection, sequence, intensity, volume, muscle actions, rest intervals, frequency, and lifting velocity.

Key elements of advanced RT involve the planning of training and potential use of advanced techniques. Advanced RT involves periodization of the acute program variables, primarily the volume, intensity, and exercise selection. Training phases target different fitness components and the volume and intensity, especially for the critical structural exercises, should be prescribed accordingly. The Personal Trainer may assess the client's RT progress periodically via one repetition maximum (1-RM) testing (see Chapter 12) or multiple repetition maximum (RM) testing. Multiple RM testing involves lifting a weight multiple times and then doing some mathematical calculations to estimate 1-RM (see ACSM [5] for a list of commonly used equations). Common exercises assessed include the bench press, squat, deadlift, and power clean, although any exercise can be assessed depending on program priorities. Multiple RMs can be assessed and used for testing high-intensity muscle endurance or can be used to predict 1-RM strength (5,12). Periodic strength testing (~3 mo or more) not only can be used to measure progress but also is instrumental for determining training loads for some structural exercises that are prescribed based on a percentage of 1-RM. In addition, advanced RT techniques provide additional overload and can assist advanced clients in overcoming training plateaus (5). Although intermediate clients can benefit from their use, they are best reserved for advanced trainees.

Advanced Resistance Training Techniques

Advanced RT techniques are based on program variables and exercise range of motion (ROM). Techniques discussed in this chapter include eccentric (ECC) emphasis training, functional isometrics (ISOM), partial repetitions, variable resistance, forced repetitions, breakdown sets, combining exercises, discontinuous sets, quality training, and spectrum repetition/contrast loading combinations.

> Techniques discussed in this chapter include ECC emphasis training, functional ISOM, partial repetitions, variable resistance, forced repetitions, breakdown sets, combining exercises, discontinuous sets, quality training, and spectrum repetition/contrast loading combinations.

Eccentric Emphasis Training

ECC emphasis training targets the ECC phase of movement. Tempo ECC training uses a slow cadence (>3–4 s) during the ECC phase with heavy to supramaximal loading in the presence of capable spotters or a power rack with the pins set at appropriate height for safety. The concentric (CON) phase is performed with assistance from spotters. Alternately, variations include performing a bilateral exercise with a moderate weight (CON phase) and then performing the ECC phase with only one limb and/or using a machine with multiple loading capacities that enable greater ECC loading. Repetitions during traditional sets can be enhanced with additional force applied during the ECC phase via the Personal Trainer or weight releasers that are removed from the bar (*e.g.*, during bench press or squat) just prior to the start of the CON phase (13). ECC emphasis training should be used with caution (no more than 4- to 6-wk training cycles, one or two times per year) to reduce muscle damage and the risk of overtraining and/or injury. To perform ECC emphasis training in a less focused manner so it can be spread throughout the training year, for example, in a workout, the client may perform three or four sets of the bench press and then perform one or two additional sets of heavy negatives for two or three repetitions (5). This is a technique used in advanced strength and hypertrophy training (3).

Functional Isometrics

Functional ISOM involve lifting a barbell in a power rack a few inches until it is pressed or pulled against the rack's pins (3). The client continues to push/pull maximally for ~2–6 seconds with a high rate of force development. The rack's pins are set in two places (when not beginning from the floor): at the starting position and at the targeted area of the ROM. Because skeletal muscles produce more force during ISOM actions, the rationale is to target specific areas of the ROM to increase dynamic strength to a greater extent. Although there is no strong evidence for improvements in overall dynamic strength with an ISOM training program, there is a body of evidence that indicates that static strength increases from ISOM training are joint-angle specific (3). However, functional ISOM can be performed in multiple areas of the ROM but are most effective when performed near the sticking region (or weak point) of the exercise (5,11). For example, the client may set the pins slightly above the parallel position for the barbell squat and perform three to five sets of three to five repetitions with a moderate load. Some commonly targeted exercises are the bench press, deadlift, squat, and clean pull, and this type of training can be easily integrated into an RT program.

Partial Repetitions

Partial repetitions are performed in a limited ROM with the intent to enhance ROM-specific strength and potentially full exercise ROM strength. Most often, the repetitions are performed in either the area of maximal strength or near the sticking point. Partial repetitions can be used in different ways. Some clients may use them for hypertrophy and muscle endurance enhancement by extending sets beyond exhaustion when a full ROM repetition can no longer be performed unassisted. Some athletes (mostly bodybuilders) have integrated partial repetitions into dynamic sets with full ROM repetitions. Often, partial repetitions are performed in the area of maximal strength with heavy to supramaximal loading. Strength expression varies throughout the ROM, yielding differently shaped curves depending on the biomechanical characteristics of the movement (see Fig. 14.3). For an exercise like the bench press, maximal force is produced near the lockout phase. Supramaximal loads may be lifted in this ROM (14). Strength athletes such as power lifters may benefit from including partial ROM lifts into strength peaking mesocycles. Often, one to three sets of partial repetitions are performed following completion of the full ROM exercise. For example, the client may perform four sets of traditional squats followed by one to three sets of partial squats. A power rack is recommended because the pins prevent bar movement below the inferior segment of the lift.

Variable Resistance Training

Variable resistance training (VRT) is performed by altering the loading throughout the ROM. Common ways for clients to perform VRT are through specific machines, elastic bands, or by altering free-weight exercises via bands and/or chains. The latter is more often seen in advanced RT of strength and power athletes. Variable resistance machines modify loading via cams that vary in length and change the mechanics based on the various types of strength curves. Bands and chains can be added to barbells to create free-weight VRT (5). Bands and chains come in different sizes and provide a variety of resistance levels, and exercises such as the bench press and squat are commonly used. Chains are applied to both ends of the bar while it is in the racked position with much of the chain links suspended in the air. Upon liftoff, the client supports the majority of chain weight. As the bar descends, more chain links are supported by the floor, thereby reducing the load. Upon ascent of the bar, progressively more loading is encountered as the chain links are lifted from the floor. Loading depends on the weight and size (5–7 ft) of the chain and the distance of the bar from the floor. Chains oscillate, which increases the stabilization requirement. A similar effect is gained through elastic bands attached to the floor (or rack) and bar (with less oscillation). The farther the band is stretched, the more resistance applied to the bar.

Forced Repetitions

Forced repetitions are those completed with the assistance of a spotter or via self-spotting (for exercises like the leg press or unilateral arm exercises) beyond one's normal capacity. The rationale is to extend a set beyond failure with hopes of providing greater increases in muscle strength, endurance, and hypertrophy (3,5). The Personal Trainer should apply minimal assistance allowing up to approximately one to four repetitions. Forced repetitions can be used exclusively as a set with heavy to supramaximal loading or can be used to extend a set when failure has occurred. As a result, forced repetitions elicit higher levels of fatigue than traditional repetitions. Although forced repetitions are used in novice and intermediate RT, they are best used for advanced training because they provide a potent neuromuscular stimulus and need to be used with caution.

Contrast Loading

Contrast loading involves inclusion of low, moderate, and high repetitions (with concomitant changes in loading) within a session. Heavy weights are usually lifted first followed by light/moderate weights, or are alternated. For example, a client may perform six sets of an exercise. The first two sets may be performed with heavy weights for five repetitions, the next two sets may be performed with moderate weights for 10 repetitions, and the last two sets may be performed with light weights for 20 repetitions. Multiple fitness components are stressed. The goal is to recruit as many muscle fibers as possible with heavy weights and then stimulate circulatory/metabolic growth factors with low to moderate weight and high repetitions (5). This technique is used mostly by bodybuilders to increase muscle hypertrophy.

Breakdown Sets

Breakdown (or descending) sets involve a rapid reduction in weight with minimal rest thereby allowing the client to extend a set by performing additional repetitions. The rationale is when failure occurs, there is still potential to perform more repetitions beyond fatigue with less weight. Single or multiple breakdowns may be used and are most effective when a spotter or the Personal Trainer is present to remove weights or change pins on machine weight stacks quickly (11). Breakdown sets are traditionally used to enhance muscle hypertrophy and endurance. However, breakdown sets can be used to target muscle strength if a heavy weight is lifted for a few repetitions, and then 5%–10% of the load is reduced, allowing one to two additional repetitions are performed until the targeted number of repetitions are completed.

Combining Exercises

Combining exercises involves performing two or more exercises consecutively or simultaneously with minimal rest and are primarily used for increasing muscular endurance and hypertrophy, especially if the client is attempting to minimize workout duration. Muscle strength can increase, but it is a secondary goal as the weight lifted for each exercise is less than what would typically be used if the exercise was performed alone (and dependent on the weakest of the exercises). The metabolic demands of a workout can be greater when combination exercises are used due to the longer duration of each set and the potential for greater workout continuity (5). For example, multiple exercises can be combined to form a single exercise (combination lifts). This is common when using Olympic lifts (*e.g.*, a clean from the floor, a front squat, and a push press to finish for a series of repetitions) and traditional exercises. Combination exercises such as the lunge with rotation, dumbbell squat with shoulder press, and the burpee with push-up, to name a few, have become popular in recent years especially when included in metabolic circuit programs that have increased in popularity. It is important for the Personal Trainer to select a weight that can be tolerated for the weakest of the exercises in sequence when nonbody weight exercises are performed.

Another strategy is to perform all repetitions for one exercise followed by consecutive performance of one or more exercises with minimal rest in between exercises. Because the client is performing exercises in succession, weights can be selected that match each exercise. These include (a) supersets (consecutive performance of two exercises either for the same or different muscle groups), (b) tri-sets (consecutive performance of three exercises), and giant sets (consecutive performance of four or more exercises separate from circuit training). Often, bodybuilders use supersets, tri-sets, and giant sets of exercises that stress similar muscle groups. Some strength athletes use supersets to increase muscle strength but do so using exercises that stress opposing or unrelated muscle groups in order to allow adequate recovery with use of heavier weights.

Quality Training

Quality training involves reducing rest interval lengths within specific loading/volume parameters as training progresses. Although mostly used to increase muscle endurance and hypertrophy, recent evidence shows it can be used for strength increases (15). For example, a client currently training the squat for four sets of 10 repetitions with a particular load with 2.5 minutes in between sets may gradually reduce rest intervals by 10–20 seconds on a weekly or biweekly basis until a targeted value (*e.g.*, 1.5 min) is reached and performance is maintained. Subsequently, the client may add weight, increase rest interval length, and begin the process once again.

Discontinuous Sets

Sets that include rest intervals in between repetitions are discontinuous sets. The goal is to increase the quality of effort for each repetition by maximizing acute force and power output. Peak force and velocity decrease because a continuous set is prolonged. Including an intra-set rest interval may limit fatigue and increase repetition quality. Inserting a rest interval in between repetitions (inter-repetition) results in more repetitions performed and higher force/power output (16). One variation, *rest-pause training*, allows more repetitions to be performed with maximal or near-maximal weights. For example, a client may target five repetitions with a 3-RM load. The client performs three repetitions without assistance, racks the weight, and rests for 10–15 seconds. The client then proceeds to perform one additional repetition with the same load, rests for 10–20 seconds, and performs one additional repetition totaling five altogether. The length of the rest interval, volume, and resistance can be altered depending on the goals of the set. A variation used by some elite power lifters is the *dynamic method*. The way this method has been commonly used is by having the individual perform 8–10 sets of a structural exercise for two or three explosive repetitions with moderate loading (~60% of 1-RM) with 45 seconds to 1 minute rest in between sets. Although the repetitions are performed consecutively, the large set number coupled with substantial rest illustrates a variation of rest-pause training. The use of multiple repetitions is advantageous for those lifters who attain peak force or power on the second or third repetition rather than the first. A variation used successfully by Olympic weightlifters is *cluster training*. Typically, 10–45 seconds rest intervals are used in between repetitions of the Olympic lifts and variations to maximize bar velocity and power. Cluster sets can be structured in different ways. The load can be kept constant for all repetitions, or can be increased, decreased, or undulated.

Motion-Specific Training

Motion-specific training, also known as functional training, involves the use of exercises that train specific movements. Motion-specific training involves adding resistance to movements, many of which stress the entire body or core musculature to a large extent. The intent is to improve athletic performance, balance, and coordination and to provide a link between strength gained through traditional RT and motion-specific strength. Exercises consist of multiplanar movements sometimes performed in unstable environments with various pieces of equipment such as bands, medicine balls, dumbbells, stability balls, kettle bells, ropes, TRX (for suspension training), and other devices. Exercises performed in unstable environments often require that the client use less loading. The goal is to increase primarily core (stabilizer) muscle strength and not the prime movers per se (although there could be a secondary strength-building effect). For example, a client will be able to use heavier dumbbells when performing the bench press on a flat bench (*e.g.*, stable environment) versus a stability ball (*e.g.*, unstable environment). The flat bench press will have a better strength-building effect for upper body musculature, whereas the stability ball bench press will have a stronger core component. Thus, unstable motion-specific training is best used when integrated into traditional RT programs. The combination can be used to optimize performance.

A staple of motion-specific training is the use of body weight exercises. Exercises such as body weight squats, lunges, push-ups, pull-ups, dips, reverse dips, sit-ups, crunches, leg raises, burpees, and hyperextensions all require the client to overcome one's body weight. In the absence of adding external weight, body weight exercises can be made more difficult by changing grip/stance width, leverage (moment arm of resistance), or cadence or by using unilateral versus bilateral contractions (one rather than two arms or legs). Basic knowledge of biomechanics is critical for the Personal Trainer to make exercises easier or more difficult in the absence of adding external resistance (5). Increasing the moment arm of resistance, size of the base support, amount of weight supported by musculature, and the center of gravity (COG) can change exercise difficulty dramatically (see Chapter 4 for more information on biomechanics). The push-up is a good example. It can be made easier by performing it on the knees (*modified push-up*) or more difficult by staggering hand spacing or by performing it with one leg in motion while suspended in the air (a *Spiderman push-up*). Performing a back extension or sit-up is more difficult with the hands overhead than crossed at chest level. Difficulty is increased by adding a rotation or unilateral (vs. central) loading. Some body weight exercises are extremely difficult and performed mostly by advanced clients. Exercises such as one-arm push-ups, single-leg squats, and single-arm pull-ups are difficult for many. An exercise such as the pull-up press requires a great deal of strength. The client presses the body outward from the top pull-up position (with a wide pronated grip). Athletes such as gymnasts who train against body weight possess high levels of muscle strength and power.

Basic knowledge of biomechanics is critical for the Personal Trainer to make exercises easier or more difficult in the absence of adding external resistance.

Body weight training is aided by devices, which allow body weight to be manipulated. For example, the TRX Suspension Trainer consists of two straps with adjustable handles and foot attachments that can be suspended or anchored from the ceiling, a door, beams, or a power rack (Fig. 18.1). It is based on a pendulum system where manipulation of the client's body position (distance from anchor, body angle relative to floor, height of the starting position and COG, and size of base support) dictates the percentage of body weight that needs to be overcome. For example, the more upright the body (feet back), the easier the exercise is (less weight to support) for some upper body exercises. The closer to the ground (feet closer to anchor), the more difficult the exercise is because a larger percentage of body weight must be overcome. Advanced clients benefit greatly from body weight training as does a beginner.

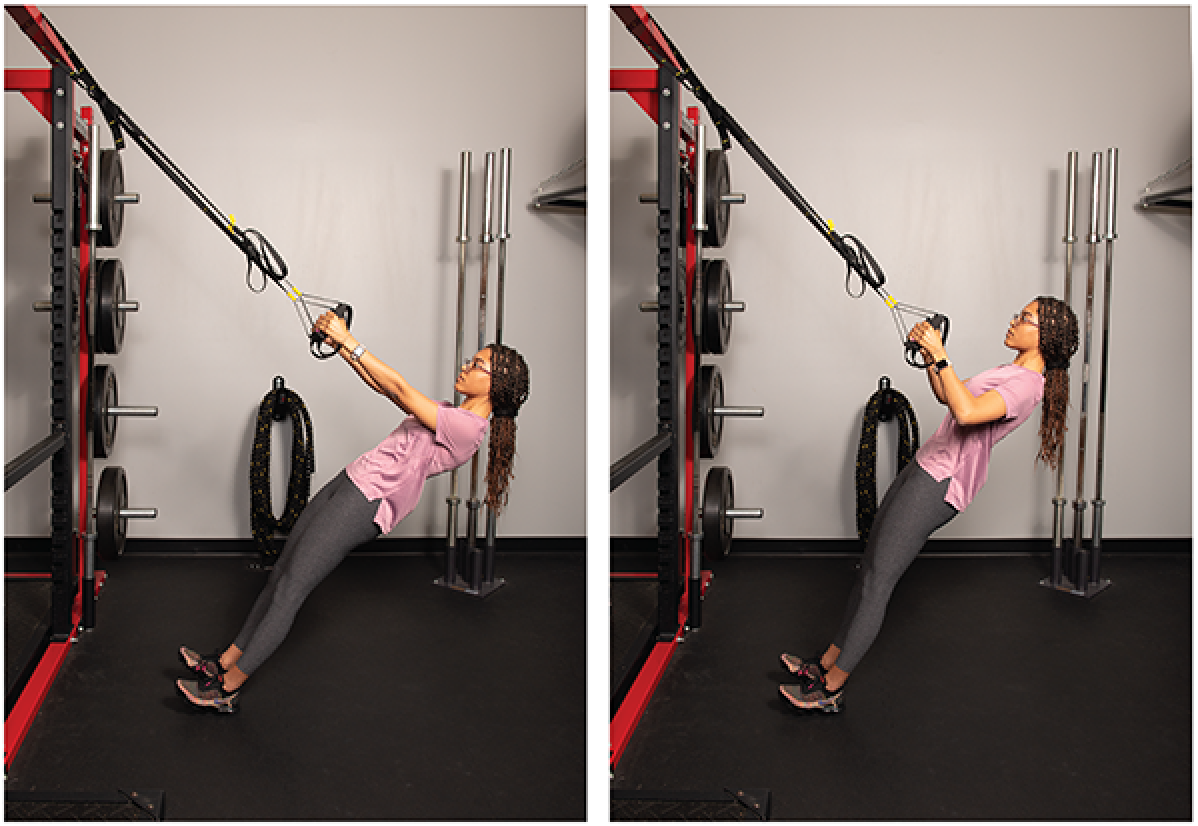

FIGURE 18.1. TRX inverted row.

Strength Implements

By definition, RT entails any method or form of exercise requiring the client to exert a force against a resistance. The source of the resistance may vary greatly. Although most advanced RT programs target free weights and machines, the use of other sources of resistance including body weight, medicine balls, movement-specific devices, bands/cables, and strength implements has increased in popularity among advanced trainees. Implements provide a different stress to the client than free weights because many implements provide unbalanced resistance and the gripping may be more difficult. Some exercises with implements cannot be replicated similarly with free weights. Table 18.2 presents some popular implements used in advanced strength and conditioning programs (see ACSM [5] for additional information).

Table 18.2 Examples of Strength Implements Used in Resistance Training

Implement	Characteristics
KB	Weights with superior handle location; enhance grip strength due to thicker handles and leverage changes as KB moves; handle allows KB to swing freely; grasped off of COG due to position of handle
Sleds	Resist linear movements; provide strong stimulus to all major muscle groups, ↑ metabolic challenge; can be loaded with weights for pushing or pulling (with a harness); some sleds have multiple handles, which allow pushing from low and high body positions; automobiles and trucks have been used in a similar manner.
Kegs	Fluid (or sand)-filled drums; great balance requirement as fluid moves when kegs are lifted; require strong grip to hold in stable positions during lifting
Log bars	Have a midrange grip support for lifting with a semipronated forearm position; some are filled with water to add resistance and balance requirements; vary in length based on strength level
Farmer's walk bars	Allows grasping of heavy weights and walk/run for a specified distance; great for grip strength/endurance training and total-body strength and conditioning
Thick bars	Bars with large diameters (2, 2¾, 3 in); used for grip strength training (17)
Super yoke	Device ~6 ft in length with a bar that is placed on rear shoulders supported by two beams that are loaded with weights; lifter must control yoke from swaying so ↑ balance requirement.
Sledge hammers	Used for striking drills on tires; can be made more difficult by grasping the hammer closer to end of handle or more explosive by grasping the hammer closer to the head for speed and power
Tires	From trucks and heavy equipment for flipping; involves triple extension of hips, knees, and ankles for total-body strength, power, and conditioning
Stones	Lifted from the ground to various heights for total-body strength, power, and endurance; adjustable stands may be used for loading stones
Sandbags	Bags of sand for lifting; some have handles making it easier to grasp and expands exercise selection; provides unbalanced resistance
Heavy bags	Punching bags used for exercises in addition to striking; can be thrown or lifted in multiple directions
Battling ropes	Ropes of various length and width used for various exercises during metabolic training
Chains	Added to BBs to provide variable resistance for multiple-joint exercises with ascending strength curves; oscillate during motion which increases stability requirement; can be used solely as a source of resistance

↑, increased; KB, kettle bell; BB, barbell.

Adapted with permission from 2018 Physical Activity Guidelines Advisory Committee. *2018 Physical Activity Guidelines Advisory Committee Scientific Report*. Washington (DC): U.S. Department of Health and Human Services; 2018. 779 p; American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2022. 548 p.

Olympic Lifts

The Olympic lifts (snatch, clean, and jerk) and several variations are total-body resistance exercises that recruit most major muscle groups. They are the most complex resistance exercises to perform and are considered the most effective exercises for increasing total-body power (3). Because of the complexity of these lifts, Personal Trainers should have advanced training and instruction before using with clients. Repetitions are performed with fast movements of the lower body and trunk (as the arms serve as guides and assist the client in preparation for catching the bar) and the kinetics closely resemble jumping and several motor skills comprising many anaerobic sports. The *clean and jerk* is a two-staged exercise where the lifter moves the bar from the floor to shoulder level and then to an overhead position. Although the clean and jerk is part of competition in the sport of weightlifting, the power clean is more commonly used with athletes in other sports and with more advanced clientele who wish to progress further in their training for strength and power (Fig. 18.2). The power clean is performed with less weight than the clean, so movement velocity is higher, and the jerk stage of the movement is not performed. This exercise results in larger amounts of weight lifted compared with the *snatch*, which involves lifting the weight directly from the floor to an overhead position (Fig. 18.3). The snatch is considered more complex because the bar must be lifted a greater distance directly from the floor. Variations (*e.g.*, overhead squat, hang clean/snatch, Romanian deadlift, high pull) are related exercises that enhance specific performance aspects of the complete lift and are used for strength and power enhancement because several require fast force production and teach proper kinesthetic awareness needed to apply maximal force to the ground. Often, these exercises are taught in progressions starting with the clean and later the snatch because they are similar in movement during some phases. Olympic lifts should be performed on a wooden platform with bumper plates. However, some facilities may not have platforms, so modifications can be made to create adequate space, and the use of a matted surface may suffice. It is important to teach the client how to properly drop the weights when learning the Olympic lifts. Poor technique in these movements can do more harm to the client if the movements are continued erroneously, so it is safer to drop the bar in a controlled manner. Lastly, the Olympic lifts are ideally performed using a *hook grip*. The hook grip involves wrapping the thumb around the bar and then wrapping the first three fingers around the thumb and bar for added support. A strong grip is necessary, and this configuration allows for greater support during fast pulling movements. Although effective for grip support, the hook grip is uncomfortable and may take some time for the client to adjust to the technique.

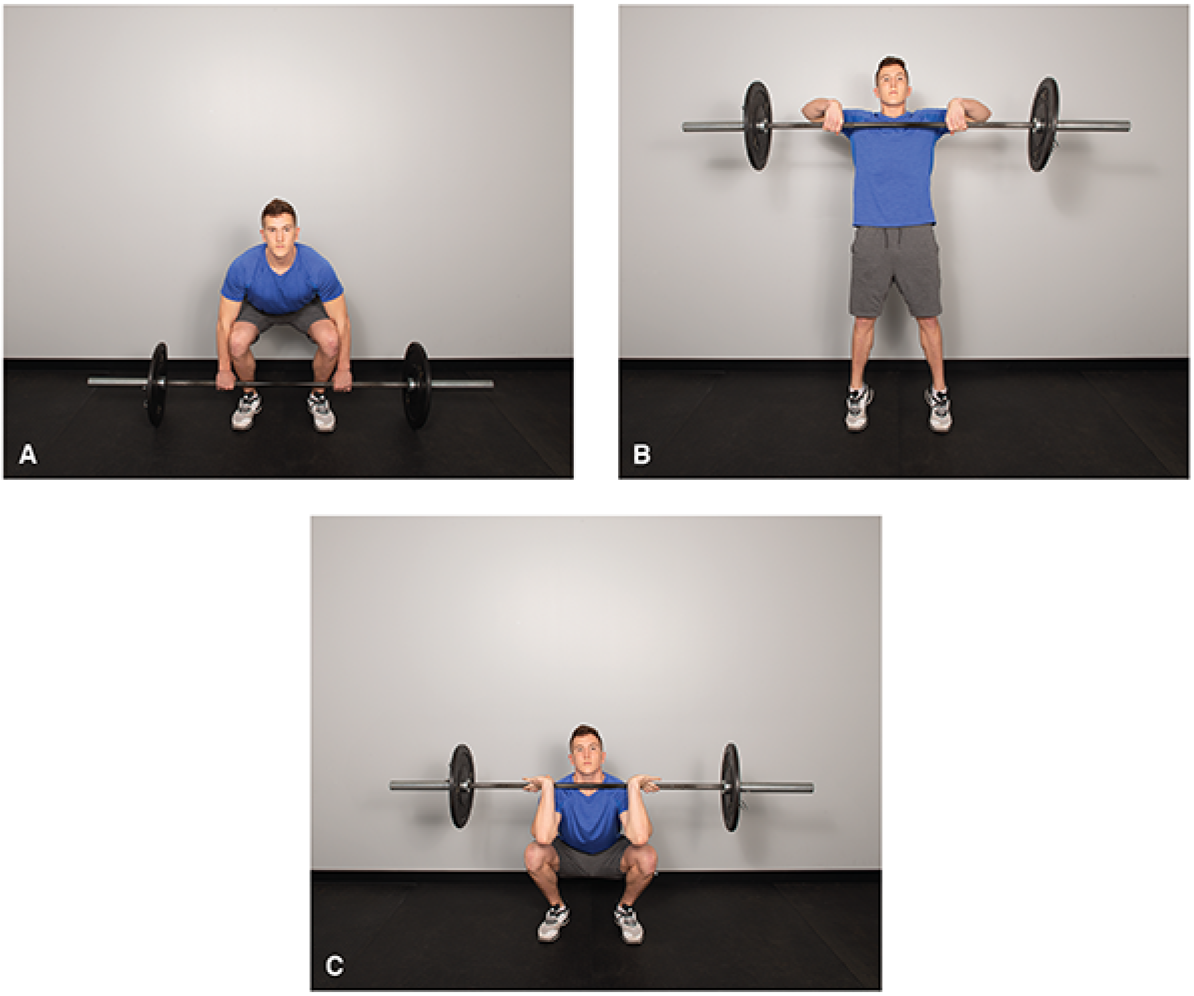

FIGURE 18.2. The power clean. **A.** The starting position. **B.** The second pull phase. **C.** The final position after catch when the client descends with the bar into the full front squat position.

FIGURE 18.3. The snatch. **A.** The starting position. **B.** The second pull phase. **C.** The catch position where the client descends into the full overhead squat position.

Because of the complexity of these lifts, Personal Trainers should have advanced training and instruction before using with clients.

Technical Aspects of Performing the Olympic Lifts

The Olympic lifts are technically challenging resistance exercises. Discussion of proper technique is best summarized by dissecting the lifts into phases. Because the clean and snatch have some similarities, they will be discussed together and their differences will be highlighted. The phases include the starting position, the first pull (barbell is pulled from the floor), a transition phase prior to the second pull, the second pull, the catch, and the finish. Boxes 18.2 and 18.3 discuss technical aspects of each of the phases of the clean and jerk and snatch exercises.

Box 18.2 Technical Aspects of Performing the Clean and Snatch

Phase	Correct Performance
Starting position	■ Feet are placed at hip width, toes pointed slightly outward, and bar is located on the floor near the shins. ■ Hips and trunk are flexed to an angle of 25°–50° with the ground, with the hips positioned close to or slightly above the knees. ■ Trunk is more upright and hips are higher during the clean because of the narrower grip width compared with the snatch. ■ Shoulders are positioned directly over or slightly in front of bar with the COG over the middle of the foot. ■ Low back is kept flat by hyperextending the lumbar spine and retracting the shoulder girdle. ■ Head is straight or slightly upward and arms grasp bar with elbows extended out and wrists flexed. ■ Wide grip width is used for snatch and shoulder width grip is used for clean. ■ Snatch grip width may be determined by having the individual stand and abduct one arm laterally (to where it is parallel to the ground) while making a fist and measuring the length of the opposite shoulder to the fist (the length represents the snatch width) — the bar should be ~4–6 in above the head during the overhead squat.
First pull	■ Bar is pulled toward the body (4–12 cm for the snatch; 3–10 cm for the clean) and is lifted off of ground to ~31% of height for the clean and ~35% for the snatch. ■ Mostly knee extension and plantarflexion with little change in trunk angle and COG shift toward heels

	(knee angle slightly greater for snatch than clean). ■ Elbows remain extended, shoulders move in front of bar, and trunk angle may slightly increase by end of phase. ■ Phase lasts ~0.50 s — bar is lifted ~1.5 $m \cdot s^{-1}$ for snatch and ~1.2 $m \cdot s^{-1}$ for clean.
Transition	■ Adjustment phase characterized by unweighting ■ Knee flexion (double knee bend) with an increase in trunk extension ■ Bar reaches lower third of thigh for clean and middle of thigh for snatch. ■ Postural realignment (vertical torso) occurs allowing a second pull to maximize force and power.
Second pull	■ Bar is pulled upward and slightly away from body by extension of hips, knees, and ankles. ■ Elbows remain extended throughout. ■ Force applied to bar decreases at top as lifter prepares to pull under the bar for the catch. ■ Most explosive phase takes ~0.1–0.25 s with snatch requiring more time than clean. ■ Bar velocities for snatch are ~10%–20% higher than the clean. ■ Optimal bar trajectory (S-shaped pattern): (a) bar is pulled toward body during first pull, (b) bar is pulled slightly away from body during second pull, and (c) bar moves closer to body in preparation for catch.
Catch	■ Involves optimal positioning to catch the bar after second pull while bar is rising ■ Lifter pulls bar to max height (68%–78% of height for snatch, 55%–65% of height for clean) and descends underneath simultaneously.

- For the snatch: Feet move out into a squatting position (wider than hip width).
- Arms pull body under bar while feet are moving.
- Elbows are wide, trunk is upright, wrists turnover, and bar rotates.
- Throughout descent lifter applies force to bar to support weight in full squat position.
- Lifter flexes shoulders, pushes head forward, and extends hips into an overhead squat finish.
- For the clean: Feet move out into squat position.
- Lifter pulls body down forcefully and receives bar at shoulder position.
- During foot landing, wrists rotate around bar, elbows push forward and upward creating a shelf to catch weight.
- Bar is caught on shoulders and chest — loading forces lifter down into a deeper front squat position.
- Upper arms are parallel to ground, knees are over feet, and lifter completes lift with a front squat.

Box 18.3 Technical Aspects of Performing the Jerk

Phase	Correct Performance
Starting position	■ Movement is initiated from the front squat position. ■ Hips and shoulders are aligned over the rear segment of the middle of the foot. ■ Feet are hip width with toes slightly pointed outward, head slightly back, and upper arms nearly parallel to floor, with elbows in front of the bar.
Descent	■ A countermovement is performed before the upward explosive thrust. ■ Knees flex and ankles dorsiflex in a vertical manner with COG shifting slightly forward. ■ Duration is ~0.20–0.25 s.
Braking	■ Transition between the end of final third of countermovement and beginning of thrust takes ~0.12 s. ■ With descent, horizontal bar displacement should be minimal (<2–4 cm).
Thrust	■ Explosive extension of hips, knees, and ankles drives the bar vertically upward with bar velocities of 1.2–1.8 $m \cdot s^{-1}$. ■ Final part of movement is brought about by forceful pushing of bar by arms to help with driving under the bar.
Split	■ Most common position, although some prefer the squat when driving under the bar. ■ One hip flexes (front) and other extends (back) to form a stable base; the back leg lands before the front leg as feet leave the ground (taking ~0.20–0.28 s).

	■ Back leg is nearly straight (~2-ft length from hip) and front knee flexes to >90° with shin perpendicular to floor (1-ft length in front of hip). ■ Bar is positioned slightly behind lifter's head in line with shoulders and hips, head is forward, and back is hyperextended.
Finish	■ Weight is transferred to rear foot as front leg pushes backward.

Performance of the Olympic lifts can be augmented by inclusion of several skill transfer exercises and variations. Some multiple-joint basic strength exercises enhance one or more phases of the Olympic lifts. For example, the deadlift, back squat, behind-the-neck press, and good morning are exercises that strengthen large muscles (*e.g.*, ankle, knee, and hip extensors, shoulder and elbow extensors) involved in the Olympic lifts, emphasize proper body position, and improve kinetics in a manner that may transfer to Olympic lift performance. Exercises such as the front squat, overhead squat, and Romanian deadlift offer similar benefits and teach the client proper kinesthetic awareness and balance. Teaching the second pull during the clean and snatch may involve performing the high pull exercise (wide grip for snatch, shoulder width grip for clean) from above the knee, below the knee, and from the floor. This allows the client to perform the pull rapidly from various levels without having to adjust body position for the catch. Some coaches and Personal Trainers begin these variations from the hang position. Many Olympic weightlifters perform variations known as the stop clean or stop snatch where the bar is lowered to the proper depth from the standing position and then subsequently lifted with high power output. Progression may continue to the catch and finish phases. Exercises such as the pressing snatch balance and heaving snatch balance teach descent under the bar for the snatch. The top position can be taught by progressing from the behind-the-neck press (snatch grip) to the overhead squat to the snatch balance. The first exercise teaches proper overhead proprioception. The second teaches the lifter to descend/ascend (squat) with the bar overhead. The third requires the lifter to descend into the overhead squat position rather than begin with it.

The primary goal of performing the Olympic lifts is to increase muscle power, speed, and strength. Multiple sets of the Olympic lifts are performed at maximal velocity for usually one to three repetitions at the beginning of a training session. Intensity varies depending on the training phase. Heavy weights may be used during strength and power peaking phases and moderate to moderately heavy loads for other training phases. Peak power is produced at ~70% of 1-RM (18) so loading should encompass this intensity, in part, for advanced power training. Because of the need for high rate of force development and the exercise complexity, Olympic lifts should be performed early in a workout when fatigue is minimal. When multiple Olympic lifts and/or variations are performed, sequencing is based on complexity where the snatch takes precedence over the clean, both take precedence over the jerk, and variations are sequenced based on bar movement (*i.e.*, greater bar displacement means greater complexity and need for high velocity). For example, a hang clean would be performed before a high pull and a snatch below the knee would be performed before a snatch above the knee. Variations (skill transfer exercises) are performed after the full Olympic lifts in sequence. The frequency of Olympic lift inclusion in advanced training varies between 1 and 5 $d \cdot wk^{-1}$. Among Olympic weightlifters, frequencies as high as 18 workouts $\cdot$ wk^{-1} have been reported (19) with multiple short sessions per day. Box 18.4 depicts a sample program integrating multiple Olympic lifts focusing on the barbell snatch.

Box 18.4 Sample Workout Emphasizing the Olympic Lifts

Move	Repetitions	% of 1-RM	Rest Interval (min)
Full snatch	5 × 1–3	75–80	3
Snatch pull	5 × 3	85	3
Overhead squat	4 × 5	70	3
Good morning	3 × 5	85	3
Romanian deadlift (snatch grip)	3 × 5	75–80	3

This type of program may be performed by an Olympic weightlifter or strength/power athlete because it emphasizes total-body power and snatch kinetics and technique. This program consists of five exercises sequenced from most complex to least complex for the Olympic lifts followed by three skill transfer exercises (variations). Each repetition is performed at high velocity for the Olympic lifts. Rest intervals are 3 minutes to allow adequate recovery in between sets.

Plyometric Training

Plyometric training is a form of explosive exercise that targets power development. Historically, plyometric training was known as *shock training* and consisted mostly of depth jumps and variations where the intensity was ultra high (20), but current plyometric training includes lower intensity exercises as well. Plyometric actions encompass the stretch-shortening cycle (SSC) where the lengthening or prestretching of skeletal muscles under loading enables a more forceful CON muscle action. The brief period of time between ECC and CON actions (coupling time) is the *amortization phase*. Minimizing the length of the amortization phase maximizes the use of elastic energy making for a more powerful effort. Although plyometric exercises are classified based on intensity (impact loading and complexity), they are still performed with maximal effort.

Plyometric training increases athletic performance (*e.g.*, jump height and power, sprinting ability, agility, and muscle strength) (21–24). Vertical jump performance may increase an average of 5%–9% (22). Plyometric training is most effective when combined with RT for increasing performance (25,26). For example, plyometric training 2 d · wk^{-1} can easily be integrated with RT. Plyometric training can be performed on separate days from weight training or on the same day. If performed on the same day, plyometric training generally should be given priority and performed first. If only the upper body is resistance trained that day, then lower body plyometrics can be performed at any point in the workout. It is not recommended that high-intensity lower body RT and lower body plyometric training be performed on the same day because the modality trained second would occur in a semifatigued state. Plyometric drills can be incorporated into a weight training workout (*e.g.*, complex training).

Plyometric exercises such as the vertical jump, standing broad jump, and medicine ball pass can be used for maximal power assessment. The maximal vertical jump (performed near a wall or using a commercial device to measure vertical jump) is one of the most common power assessments used for athletes. The higher the jump, the greater the power the client possesses. The standing broad jump is another example of power assessment, testing power during horizontal locomotion. For upper body power, often the medicine ball chest pass (or put) is used. The client is seated (or standing) with his or her back against a support (or wall) and chest passes the ball as far as possible. The farther the ball travels, the greater the power output. The Personal Trainer can easily incorporate these exercises into an assessment battery. Minimal equipment is needed. If the Personal Trainer does not have a commercial device to measure vertical jump, a tape measure can be used for both vertical and standing broad jump drills. Chalk can be used on the finger tips to mark superior position during the highest segment of the vertical jump. A medicine ball, tape measure, chalk, and a bench with back support (for the seated chest pass) are needed for the chest pass. Chalk is placed on the ball and the location is marked (in the center) when the ball lands on the ground.

The distance is measured. Standards are available for the Personal Trainer (5,6) or the individual can develop their own data for comparison.

> The maximal vertical jump (performed near a wall or using a commercial device to measure vertical jump) is one of the most common power assessments used for athletes.

Safety Considerations

Plyometric training is safe for clients of all ages provided it is properly supervised (27). The most common causes of injuries are violation of training guidelines, inadequate warm-up, progressing too fast in volume and intensity, poor technique, poor surface selection, and undisclosed predisposition. Progressing too quickly in volume and intensity could result in overreaching and subsequent of overtraining. Overtrained clients are more susceptible to injury. Inadequate warm-ups fail to prepare the client for intense exercise. Poor technique may limit exercise selection as sufficient coordination, balance, and strength are needed for moderate- to high-intensity plyometric exercises. Improper landing can place the client at greater risk of injury. Caution must be used with large clients. A prior injury or predisposition to injury can place the client at greater risk. Careful monitoring of clients is necessary. An injury may necessitate altering or temporarily discontinuing plyometrics until medical clearance has been obtained.

Plyometric Program Design

Plyometric training variables include exercise selection, order, intensity, volume, frequency, and rest intervals. Designing a plyometric training program is multifactorial and should include planned progressive overload, specificity, and variation. Many factors need to be considered for plyometric training including the age/training status of the client, equipment availability, training surface, recovery in between workouts, nutrition, and the integration of plyometrics with other training modalities. Some critical factors include the following:

- Each repetition should be performed with maximal effort, minimal amortization, and maximal velocity.
- Exercise selection should be as specific to the demands of the sport/activity as possible, comprising unilateral and bilateral drills.
- Plyometric training should take place in an area with sufficient space; for example, a horizontal length of at least 30–40 yards and ceiling height (indoors) should be higher than maximal reach.
- Proper technique should always be instructed.
- Sufficient rest should be given when peak power is the goal.
- Gradual progression with increases in intensity via the addition of complex exercises and some external loading. Low- and moderate-intensity drills should be mastered before progressing to high-intensity drills.
- Volume can be increased with number of contacts and should be progressed gradually.
- High-intensity workouts require longer recovery period in between workouts.

Plyometric exercises consist of jumps-in-place, standing jumps, multiple hops/jumps, bounding, box drills, depth jumps, and throws, preferably on a grass or matted surface (28). The surface should be yielding to reduce joint stress but not too yielding to limit SSC activity. Jumps involve maximizing vertical or horizontal motion. Hops involve maximizing the repeated motion for a specific distance or pattern. Bounds are exaggerated horizontal drills with excessive stride length. Box drills involve jumping on or off boxes of different sizes. Depth jumps involve accentuating the ECC component by stepping off of a box prior to performing an explosive jump while spending minimal time on the ground. Intensity increases as drop height increases. Drop heights of 20–115 cm can be used (20–40 cm to begin with gradual progression) as the optimal depth jump height is debatable and individualized (5). Tosses and passes involve the upper torso and arms releasing the ball/object below or in front of the head. Throws involve the upper torso and arms releasing the ball or object above, over, or across the head. Some drills can be combined to form a more complex drill, that is, adding a sprint or multidirectional hop/jump to a depth jump.

To a certain extent, selection of plyometric exercises depends on equipment availability. Although plyometrics can be performed without equipment, some pieces of equipment are needed for some exercises. Common pieces of equipment include cones, boxes, jump ropes, mini-hurdles, bands, bags, weighted vests, medicine balls, slam balls, and core balls. Cones, bags, and hurdles are used as barriers for various hops and jumps. Boxes are used for box jumps, depth jumps, and variations. Jump ropes come in various forms and sizes with some designed for speed and some provide resistance. Bands provide resistance to jumping. Weighted vests can be used for additional resistance during plyometric drills. Medicine, core, and slam balls come in various sizes and are used for upper and lower body plyometrics.

Exercises are selected based on the client's training status and intensity. Plyometric programs begin with low- and moderate-intensity exercises for novice clients and progresses to high-intensity exercises over time. The intensity of plyometric exercises depends on several factors including complexity, loading (*e.g.*, body mass, external loading via vests, weights), velocity of impact, speed, and height and length of boxes or barriers used. Jumps-in-place are lowest in intensity, followed by standing jumps, multiple hops and jumps, bounding, box drills, and depth jumps (see Chu [28] for exercise explanations). Single-leg jumps are more intense than comparable double-leg jumps. Intensity is increased by using larger barriers or boxes or by setting cones/barriers farther apart (requiring the client to jump higher or farther). Exercises can be sequenced in numerous ways provided adequate recovery is given in between sets. Some strategies include the following:

- Low-intensity drills can be performed anywhere in the sequence (at the beginning following a warm-up or later in the workout after pertinent moderate- and high-intensity drills).

- Moderate- and high-intensity drills are performed near the beginning (following appropriate warm-up and low-intensity drills) while fatigue is minimal.
- When upper body plyometric drills are included, the client may choose to alternate between lower and upper body drills to maximize workout efficiency.

The volume (number of sets and repetitions) of plyometric training varies and depends on intensity and frequency as well as the impact of other modalities such as RT and sprint/agility training. Plyometric volume and intensity are inversely related. Chu (28) has recommended volume guidelines for plyometric training (refer to the reference for specifics). Plyometric training typically takes place 1–4 $d \cdot wk^{-1}$. High-intensity drills may necessitate a lower frequency when depth jumps are performed, and frequency may be lower when other modalities are included. Because of the intense nature of plyometric training, ~48–72 hours of recovery in between training sessions is recommended (28). Trained clients have greater tolerance and can perform high-intensity drills and a higher volume of exercise. Depth jump training requires fewer sets (two to four) of up to five to eight repetitions with long (2–10 min) rest intervals for 1–3 $d \cdot wk^{-1}$ (20). Lower plyometric volume and frequency is needed when training in-season athletes. Sports consist of plyometric actions, so practice and competition are training stimuli.

Adequate rest intervals are needed during plyometric training. Rest interval lengths are exercise specific and intensity dependent. More rest is needed in between sets of high-intensity exercises (*e.g.*, box jumps, depth jumps) than low- or moderate-intensity exercises (*e.g.*, ankle hops). Work-to-rest ratios of 1:5 (for low- and moderate-intensity exercises) to 1:10 (for high-intensity exercises) are recommended (28). Intra-set rest intervals are used for noncontinuous jumps (*e.g.*, depth jump) or throws. Shorter rest intervals minimize recovery and target power endurance. Box 18.5 depicts a sample plyometric program. This workout trains the entire body and alternates between upper and lower body drills to increase efficiency.

Box 18.5 Sample Plyometric Training Program

General warm-up	3- to 5-min jog
Dynamic ROM drills	1 × 5 drills
Linear sprints	3 × 20 yd (half speed)
Tuck jumps	3 × 10
Medicine ball side throws	3 × 8 (each side)
Barrier jumps	5 × 5
Medicine ball back throws	3 × 5
Single-leg push-off	3 × 6 (each leg)
Plyo push-up	3 × 10
Box jumps	3 × 8
Cool-down	Stretching

Ballistic Resistance Training

Ballistic RT is a plyometric modality aimed at increasing muscle power and strength. Traditional resistance exercises are performed in a full ROM where noticeable deceleration of the load occurs prior to completion of the CON phase. Deceleration is inevitable because the lifting action must then be reversed (*e.g.*, lowering the weight prior to lifting the weight for the next repetition). The length of the deceleration phase depends on the weight and velocity but may comprise more than 50% of the CON phase when lifting weights lower than about 85% of 1-RM (29). However, this deceleration phase limits power development throughout the full ROM. Ballistic RT is designed to minimize deceleration by having the client maximally accelerate the bar throughout the full ROM. Maximal acceleration results in releasing the load (throwing the object) or having the client leave the ground (jump) during a squat-type exercise. Some common ballistic exercises include jump squats, bench press throws, and shoulder press throws. If a linear position transducer is available and attached to the barbell, these exercises may be used to assess peak power in clients (5). Caution must be used because the external load and participant's body weight must be absorbed prior to the next repetition. In lieu of these safety concerns, equipment has been designed using various braking systems to catch or decelerate the weight upon descent. Peak power is produced at loads corresponding to 15%–60% of 1-RM for the jump squat and bench press throw (30), although body weight alone may maximize power output during jump squats (31). Personal Trainers may incorporate ballistic training in various ways. It may be integrated into RT and/or plyometric training workouts. Because of the power component, ballistic exercises are prescribed in a similar manner to Olympic lifts in that they receive priority in sequencing. Loading may vary but tends to be low to moderate to enable fast lifting velocities. Another programming alternative is to use potentiation to enhance ballistic exercise performance. For example, a Personal Trainer may have the client perform three heavy sets of squats followed by three sets of jump squats. The heavy squats can facilitate recruitment of fast-twitch motor units so that in the absence of fatigue, the jump squats could be performed with greater power output. In addition to power development, ballistic RT can increase maximal strength (32,33) and augment maximal strength development for some exercises (34).

> Ballistic RT is a plyometric modality aimed at increasing muscle power and strength.

Speed and Agility Training

Speed and agility are essential athletic components. Speed is the change in distance over time. Maximal speed attainment takes ~20–40 m, so acceleration ability (ability to increase velocity) is a critical training component especially following a change of direction, deceleration, or from a static position. Sprints of at least 60–80 m involve acceleration, maximum speed maintenance, and speed endurance (deceleration). Acceleration is related to the ability to react to a stimulus with a quick first response.

Obtaining and maintaining maximal speed are functions of conditioning. Agility comprises the ability to move rapidly while changing direction in response to a stimulus. Agility is complex and requires the optimal integration of several physiological systems and fitness components. The client must coordinate several movements including the ability to react and start quickly, accelerate, decelerate, move in the proper direction, and maintain the ability to change direction as rapidly as possible while maintaining balance and postural control. The rapid change of direction occurs in a variety of stable or unstable positions (*e.g.*, standing [unilateral or bilateral], lying [prone or supine], seated, and/or kneeling positions).

Speed and agility are essential athletic components.

Sprint speed is the product of stride length and frequency (rate). Stride length is determined by leg length, leg strength and power, and sprinting mechanics. Stride frequency refers to the number of foot contacts per period of time. Maximal sprint speed occurs only at the optimal combination of stride length and frequency, which varies based on a person's physical and biomechanical characteristics. Sprint, plyometric, strength, and ballistic training are the most effective ways to increase stride rate and frequency. An integrated approach is most effective where a combination of plyometric, sprint, flexibility, and RT is used. Sprint training increases acceleration and sprint speed and the combination of sprint and RT enhances maximal speed, speed endurance, power, and strength of the lower body.

Agility requires mobility, coordination, balance, power, SSC efficiency, stabilization, proper technique, strength, flexibility, body control, footwork, a rapid ability to accelerate and decelerate, anticipation, and scanning ability (35,36). Agility training includes multiple modalities including strength and power, sprint, specific agility, balance and coordination, and flexibility. Dynamic balance is needed to control the body when the COG is changing. Stability is greatest when the COG is low, the base support is large, and the line of gravity is centered within the base support. Force production is greatest in stable body positions. Performing an exercise unilaterally instead of bilaterally or narrowing the base support may improve balance. Proper posture, foot contact with the ground, and arm action are needed during agility movements. Agility drills involve multiple movements including linear sprints, backpedaling, side shuffling, drop stepping, cariocas, cutting, pivoting, jumps, and crossovers.

Sprint speed can be assessed using runs at top speed of varying distances (20–60 m). Norms are available for these (6), but the most commonly used test is the 40-yard dash. Most standardized tests of agility are only measuring change of direction over various configurations (T-test, pro-agility test, etc.) but have some usefulness in determining improvements to overall agility.

Sprint and Agility Training Program Design

Sprint and agility training consists of drills aimed at targeting linear speed and multicapacity movement development (35,36). Personal Trainers should constantly monitor correct sprinting technique, and be instructional to clients during agility drills. Clients should touch or run around cones in control, stay close to cones, have correct foot placement, lower the COG, decelerate and accelerate maximally, and have correct posture and approach angles. Cone lengths (and the number of cones) modulate the level of changing direction and pattern of acceleration/deceleration. Close distances force the client to change direction rapidly without large windows of acceleration, whereas large distances enable the client to accelerate over greater lengths, which also creates an opportunity for deceleration management upon changing direction. Drills may be integrated to increase complexity. Agility training can be performed with zero (a lined field) or minimal equipment. The Personal Trainer can expand the client's exercise repertoire by having cones of various sizes, agility ladders, rings and agility dots, reaction balls, bags, tires, mini-hurdles, reaction belts, ropes, and/or agility poles. Speed and agility drills include the following:

- **Form drills:** drills used to improve technique and serve as general warm-up/dynamic ROM exercises such as arm swings, "butt kickers," high knees, ankling, marching, and pawing. Drills are usually performed for one to three sets for 20–30 yards.

- **Linear sprints:** sprints of various length. Short sprints (10–20 yd) are used for improving acceleration, moderate sprints (40–60 yd) are used for improving acceleration and maximal speed, and longer sprints (>60 yd) are used for improving all facets of sprinting especially speed endurance. These sprints are performed with maximal effort. Other variations may be used. For example, a drill called *gears* can be used. The client may sprint for 100 yards and cones could be set every 25 yards. The client runs ~50% intensity the first 25 yards, accelerates and runs faster upon reaching the second and third 25-yard markers, and sprints maximally the last 25 yards. This helps improve acceleration ability from a running start and maximal speed. The drill *falling starts* can be used to improve acceleration from an unstable position. The client leans and falls forward (or can be pushed by a partner), braces, and subsequently sprints forward for the desired distance. Linear sprint drills are the most specific way to increase sprint speed.
- **Overspeed training:** allows the client to attain supramaximal speed (by increasing stride length and frequency) or an assisted speed that is greater than maximal effort. Supramaximal speed can be achieved with a tail wind, downhill running (~1°–7° for ~50 m), towing, and high-speed treadmill running. The supramaximal velocity attained should not exceed a value >10% greater than the client's own ability, or technical breakdowns could occur. Overspeed training is most effective when performed early in the workout where the client's energy levels are high and fatigue is minimal. For towing, elastic tubing (bungee cord, latex tubing) can be used and attached around the client's waist. The opposite end can be attached to another client or a stationary object. The force of the tubing (from stretching) propels the client forward thereby allowing an increase in stride length and frequency. If a stationary object is used, the client can attach the tubing in front, back up several yards, and begin running while being towed by the elastic tubing. The farther the distance, the greater the stretching of the tubing because more force will be applied

to the client. The client may connect the other end of the tubing to another client or the Personal Trainer. The client can attach the tubing in front while the other client doing the towing can attach the other end of the tubing to their rear. The lead client begins sprinting and tows the rear client. Towing can be used for other drills such as backpedaling and side-to-side movements as well.

- **Resisted sprint training:** The client sprints maximally against a resistance. Resistance may come in the form of wind (headwind), sleds, speed chutes, sand, weighted vests, harnesses, partner, stairs, and hills. Sleds are made of steel, have a handle and/or harness attachment, and have posts for plate loading. Loads of up to ~10% of body mass (for sprints of 10–50 yd) are typically used for speed training. A speed chute opens, thereby increasing resistance as the client accelerates. Chutes come in different sizes and provide various levels of resistance especially at higher speeds of motion. Weighted vests are light and durable and have the capacity for external loading (perhaps 10–20 lb or more). They are multipurpose and can be used for plyometric, agility, calisthenics, body weight, and sport-specific exercises. A harness can be used between two clients where the trailing client can provide resistance to the lead client. Enough resistance should be applied to allow the lead client to sprint to ~85%–90% of max speed. Some harnesses have a quick release mechanism, which allows the cord to disengage enabling the lead client to continue sprinting without resistance. These can be used for other modalities besides linear sprinting, for example, backpedaling and lateral movements.
- **Programmed agility drills:** those that are preplanned where the client is aware of the movements prior to beginning the drill. Some examples include the T-drill, square drill, 20-yard shuttle, figure-8 drill, and right triangle drill. There are numerous programmed drills that can be prescribed to a client. Drills should encompass the basic movements of linear sprints, accelerations/decelerations, backpedaling, side and diagonal shuffling, cariocas, cutting, and pivoting.

- **Reactive agility drills:** drills continued based on information from a Personal Trainer or object such as a ball. The client must react to a stimulus. Some examples include box jump with multidirection sprint, partner shadow or mirror drills, slap or tag drills, and drills that involve ball tosses and catching (*e.g.*, the blind partner toss).
- **Quickness agility drills**: drills designed to produce fast movements and quick feet. Some examples include agility ladder drills, pop-up drills (from the ground), down-and-up drills (sprawl in wrestling, burpee), and the resisted let-go. Numerous ladder drills can be prescribed to the client. Some common ladder drills include ins and outs, hopscotch, two-in lateral shuffle, and the side rocker.

Novice sprint and agility programs should focus on proper technique and footwork using basic drills. Basic drills have low levels of footwork complexity and change of directions. Complexity increases intensity. High-intensity agility drills include those with complex movement patterns, multiple directions, involve high rates of acceleration/deceleration, are reactive, and may incorporate some moderate to high plyometric drills in addition to basic agility movements. Similar to other modalities of training, variation of volume and intensity of sprint and agility is more conducive to progression rather than just increasing each over time. Box 18.6 depicts a sample combined sprint and agility workout that is an integrated approach, where both components are trained in a single workout. It is important to note that the Personal Trainer can prescribe and supervise independent sprint and agility workouts. In this case, the format may be similar except each workout comprises all speed or agility drills only.

Box 18.6 Sample Combined Sprint and Agility Workout

General warm-up	3- to 5-min jog
Dynamic ROM drills	1 × 5 drills
High knees	2 × 20 yd
Butt kickers	2 × 20 yd
Backpedals	2 × 20 yd
Side shuffles	2 × 20 yd
Cariocas	2 × 20 yd
Ladder ins and outs	3 repetitions
20-yd shuttle	3 repetitions
Sprints	6 × 40 yd
Flying sprints	3 × 40 yd
Cool-down	Stretching

Anaerobic Conditioning

Anaerobic conditioning is a term that refers to high-intensity muscle endurance capacity (5). It comprises the ability to perform near-maximal to maximal exercise for an extended period of time. Anaerobic conditioning consists of exercises targeting speed, power, and strength endurance. Speed and agility endurance enhancement enables the client to maintain maximal speed and agility performance over time. Speed endurance training is characterized by longer sprints (30–>300 yd for running and swimming but possibly longer distances for cycling) and reduced rest intervals in between sets and repetitions of exercise ranging between 75% and 100% of maximal speed (5). Drills consist of repeated sprints, interval sprints, and relays. Interval training allows the client to train at higher intensities while improving anaerobic and aerobic capacities. Low-intensity bouts of exercise interspersed in between high-intensity bouts allow the client to achieve higher net workout intensity. Intervals using a 1:1 ratio target aerobic capacity, whereas greater work-to-relief ratios (*e.g.*, 1:5 or 1:10) target anaerobic conditioning (adenosine triphosphate-phosphocreatine [ATP-PC] and glycolysis energy systems; for more information on energy systems, see Chapter 5). Agility and plyometric drills can be used in standard set format (high repetitions, moderate set duration with rest intervals) or in circuit training format. For speed endurance training involving low- to moderate-intensity drills for moderate distances, 8–20 repetitions have been recommended for advanced clients and 5–12 for novice clients (5). For speed endurance training involving high-intensity drills for short to moderate distances, 4–12 repetitions have been recommended for advanced clients and 4–8 for novice clients (5).

Anaerobic conditioning can also be improved by inclusion of weight training, body weight, or implement training. Circuits allow the client to perform several exercises in a short period of time yielding substantial metabolic and cardiovascular responses that could improve aerobic capacity as well. Circuit progression entails increasing the load, repetitions, duration or length of drill, and reducing the total time needed to complete the entire circuit (*e.g.*, *timed circuits*). Timed circuits are beneficial because they can enhance the power component. Fatigue results in slower repetitions and performance. Thus, a reduced time to complete a circuit indicates improved endurance because the client can maintain a better pace and movement velocity. Metabolic circuits have become popular among athletes and fitness enthusiasts to improve muscle endurance, aerobic capacity, and reduce percentage of body fat.

Circuits allow the client to perform several exercises in a short period of time yielding substantial metabolic and cardiovascular responses that could improve aerobic capacity as well.

Anaerobic capacity can be assessed in many ways. Two common assessments include the 300-yard shuttle and the line drill. The 300-yard shuttle requires two parallel lines 25-yard apart. The client sprints as fast as possible from one line to other line and immediately sprints back to the starting line for six continuous round trips. For the line drill, a basketball court is typically used. The client begins at the baseline, sprints to the foul line and back, sprints from the baseline to the half-court line and back, sprints from the baseline to the far foul line and back, and sprints from the baseline to the far baseline and back without rest, and total time is recorded. Multiple trials can be given for each test and the best time or average of each test can be recorded. These are fatiguing tests, so plenty of rest (at least 3–4 min) should be given in between trials.

SUMMARY

The Personal Training profession has evolved to accommodate athletes and those clients with advanced training status/goals. Personal Trainers have a unique niche in providing one-on-one individualized training services for advanced clients. Thus, Personal Trainers must have knowledge and proficiencies of advanced training concepts before implementing these techniques to maximize safety within client training programs. Advanced training encompasses the potential prescription and supervision of periodized resistance, plyometric, speed, agility, and anaerobic conditioning training programs to clients seeking to maximize several health- and skill-related components of fitness.

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CHAPTER 19

Populations across the Lifespan

OBJECTIVES

Personal Trainers should be able to:

- Describe exercise programming during pregnancy and postpartum.
- Understand the value of physical activity for children and create age-appropriate exercise programs.
- Understand physiological changes with aging and create age-appropriate exercise programs for older adults.

INTRODUCTION

According to the *2018 Physical Activity Guidelines*, only 26% of males, 19% of females, and 20% of adolescents report meeting the physical activity guidelines (1). Physical inactivity is associated with numerous unhealthy conditions, including obesity, hypertension, gestational and Type 2 diabetes, and atherosclerotic cardiovascular disease and contributes worldwide to 5 million deaths (2–4). Although pregnancy is generally considered a time when women are willing to make positive changes in lifestyle behaviors for the benefit of their children, only 23% of pregnant women meet the weekly recommended guidelines for physical activity (5). Furthermore, 21.6% of U.S. children ages 6–19 years meet the current recommendations for weekly physical activity (6). Children are more active than their adult counterparts; however, only the youngest children actually fulfill current physical activity guidelines. Older Americans are the least physically active. About 12% of individuals aged ≥65 years report meeting current physical activity guidelines and less than 5% of individuals aged ≥85 years and older meet these same guidelines (7). Additionally, 19.7% of people aged 45–64 years have difficulties in physical functioning with an increase to 44% in people aged 75 years and older (8). Currently, and over the next couple of decades, millions of baby boomers will continue to turn 65 years of age, and by 2030, 1 in every 5 Americans will be 65 years and older (9–11). This chapter discusses the special considerations and scope of practice of exercise program design for the following subpopulations: pregnancy, children, and older adults.

Programming during Pregnancy and Postpartum

Pregnancy is associated with multiple anatomical and physiological changes. Originally, the prevailing opinion was that physical activity should be discouraged during pregnancy because of the supposed increased maternal and fetal risk of untoward events (12). However, current research suggests that unless a specific obstetric or medical condition is present, the likelihood of adverse events or complications following acute exercise or chronic training in the mother and fetus is minimal (12). Thus, all women who have healthy, uncomplicated pregnancies should be physically active during pregnancy. Even women who were sedentary before pregnancy may begin an exercise regimen during pregnancy (13). The Personal Trainer should adjust the exercise regimen to the needs of each individual pregnant women keeping in mind her specific conditions and/or goals. Furthermore, he or she should recognize that similar to other populations, physical activities in people who are pregnant and those in the postpartum period confer numerous benefits and should be encouraged. Collectively, the Personal Trainer, client, and obstetric health care provider can establish the following exercise program goals: Avoid excessive weight gain, reduce the risk of gestational diabetes, lower the incidence of low back pain, and prevent excessive decreases in cardiorespiratory and muscular fitness (12). These benefits of exercise are targeted directly at the mother; however, there are also notable health benefits of maternal exercise for the developing fetus (14) and her child later in life (14). Thus, given the well-known benefits of exercise during pregnancy for mother and baby, the Personal Trainer should be aware of exercise guidelines and recommendations to enable safe exercise in the pregnant women. The Personal Trainer should also encourage the pregnant women to discuss with her physician potential medical or obstetric contraindications to exercise prior to starting an exercise program. The next section "Preparticipation Screening during Pregnancy and Postpartum" describes this in more detail.

Similar to other populations, physical activities in people who are pregnant and those in postpartum period confer numerous benefits and should be encouraged.

Preparticipation Screening Exercise during Pregnancy and Postpartum

Prior to participation in an exercise program, pregnant women, regardless of physical activity history or lifestyle, should be evaluated by their obstetric provider to determine whether exercise is contraindicated. Having pregnant clients review the Physical Activity Readiness Medical Examination for Pregnancy questionnaire (available at http://www.csep.ca) with their health care provider is recommended to help determine the appropriateness of participation in a fitness routine. This form can be signed by the obstetric provider to verify the safety of exercise and provide recommendations for cardiorespiratory and resistance training activities. Personal Trainers who work with pregnant clients must be knowledgeable of, and able to educate clients on, the potential signs that would warrant the termination of acute exercise listed in Table 19.1 (15–18). Furthermore, Personal Trainers should also be aware of the absolute and relative contraindications of exercise training as listed in Table 19.2. The following guidelines for exercise during pregnancy are for those women who are without contraindications for exercise.

Table 19.1 Warning Signs to Terminate Exercise during Pregnancy

Vaginal bleeding
Regular painful uterine contractions
Amniotic fluid leakage or other vaginal fluid loss including rupture of the membranes
Dyspnea prior to exertion or that is persistent and excessive that does not resolve on rest
Dizziness, syncope, or faintness that does not resolve on rest
Muscle weakness or muscle weakness affecting balance
Calf pain or swelling
Headache
Chest pain

Table 19.2 Absolute and Relative Contraindications to Exercise during Pregnancy

Absolute Contraindications	Relative Contraindications
Ruptured membrane	Recurrent pregnancy loss
Unexplained persistent vaginal bleeding	A history of spontaneous preterm birth
Placenta previa after 28 weeks' gestation	Gestational hypertension
Preeclampsia	Symptomatic anemia
Incompetent cervix	Malnutrition
Intrauterine growth restriction	Eating disorder
High-order multiple pregnancy (*e.g.*, triplets)	Twin pregnancy after the 28th week
Uncontrolled Type 1 diabetes, uncontrolled hypertension, uncontrolled thyroid disease	Mild/moderate cardiovascular or respiratory disease
Other serious cardiovascular, respiratory, or systemic disorder	Other significant medical conditions

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General Exercise Considerations during Pregnancy and Postpartum

Fatigue, nausea, and vomiting may limit exercise, especially during the first trimester. Importantly, the Personal Trainer should recognize the increased nutritional requirements of pregnant clients. Personal Trainers are encouraged to use the metabolic calculations presented in Chapter 15 to estimate the total energy expenditure of the client's exercise program. Pregnancy requires an increase in energy intake to fulfill the metabolic demands of pregnancy. On average, women require an additional 300 kcal · d^{-1} while pregnant (19).

Pregnant women have diminished thermoregulatory control throughout pregnancy. Consequently, they need to be counseled to maintain adequate hydration; wear appropriate clothing that will facilitate heat dissipation; and avoid exercise in hot, humid conditions (12). Women should be encouraged to choose environmentally controlled indoor settings in these situations. Lastly, the Personal Trainer should remind clients that pregnancy is not a time to expect large improvements in fitness, and ultimately, throughout the gestational period, it is normal for numerous fitness parameters to decline (20).

Women who are pregnant should avoid contact sports or activities that have a higher risk of falling to avoid potential trauma to their developing baby. Such activities to avoid during pregnancy include, but are not limited to, nonstationary cycling, downhill or water skiing, gymnastics, and horseback riding (21).

The physiological changes associated with pregnancy persist for 4–6 weeks postpartum; however, women typically can gradually return to exercise provided the delivery was uncomplicated. The *2018 Physical Activity Guidelines* suggest the time needed for women to return to regular physical activity following birth should be discussed with her physician and based off of her own medical safety needs rather than giving a specific time period to resume physical activity (1). Women who are nursing may elect to feed their babies prior to exercise to alleviate the discomfort of engorged breasts and to reduce the likelihood of feeding problems postexercise due to acidity in the breast milk (22).

Aerobic Exercise Prescription during Pregnancy

The general cardiorespiratory training principles of exercise prescription detailed in Chapter 15 apply to pregnant and postpartum women, although the profound anatomical and physiological changes will require the Personal Trainer to make a number of special adaptations to the training program. Table 19.3 lists some of these exercise modifications for pregnancy. All women with healthy, uncomplicated pregnancies, even those who were previously inactive before pregnancy, are encouraged to exercise during pregnancy. Women with gestational diabetes or those who are overweight or obese may benefit greatly from the health benefits of physical activity during pregnancy. The current recommendations for aerobic physical activity during pregnancy according to the 2015 Committee Opinion by the American College of Obstetricians and Gynecologists (and reaffirmed in 2017) and others (1) are that women accumulate *at least* 150 minutes of moderate-intensity exercise each week with bouts of exercise lasting *at least* 20–30 $\text{min} \cdot \text{d}^{-1}$ (22,23). It is highly encouraged for pregnant women to be physically active every day (13,22). Due to the normal physiological changes that occur during pregnancy, perceived exertion may be a better determination of exercise intensity than heart rate. Pregnant women should aim for moderate-intensity exercise, which on a 0 (resting in the seated position) to 10 (maximal exertion) scale would be a 5 or 6 (1). The "talk test" may also be used to assess moderate exercise intensity during pregnancy. If a woman is participating in moderate-intensity exercise, then she should be able to carry on a conversation during exercise but not be able to sing (1,23,24). Recreational and competitive athletes may train safely at higher intensities and volumes throughout pregnancy with the understanding that they are undergoing close obstetric supervision (22).

Table 19.3 Aerobic Exercise Program Modifications for Pregnant Women

Program Component	Program Modification
Exercise mode	■ Walking and cycling may be easier to monitor for exercise intensity. ■ Activities that increase the risk of falls (*e.g.*, skiing and skating), abdominal trauma (*e.g.*, basketball and softball), and rapid changes in movement that impact balance (*e.g.*, tennis) should be avoided and generally are not recommended. ■ Activities at elevations >6,000 ft and scuba diving are contraindicated.
Exercise intensity	■ Target heart rate (*e.g.*, $\%HR_{max}$ or %HRR) should not be employed as a method to monitor exercise intensity due to the variability in maternal resting and maximal heart rate throughout pregnancy. Likewise, target $\dot{V}O_2$ (*e.g.*, $\%\dot{V}O_2R$) is not a valid tool to monitor intensity due to the progressive decrease in cardiorespiratory fitness over the course of the pregnancy.

	■ RPE values of 12–13 (light to somewhat hard) on the 6–20 scale can be used to accurately and safely monitor exercise intensity. ■ The talk test may also be used to monitor appropriate exercise intensity. Pregnant women should exercise at an intensity that permits conversation. Intensity should be decreased when conversation is not possible.
Exercise session duration	■ Accumulating 30 min of exercise in 20–30 min intermittent bouts and adjusted as needed to a total of 150 min · wk^{-1} of vigorous aerobic exercise.
Exercise frequency	■ Moderate-intensity exercise should be regular rather than sporadic in nature. Exercise should be performed 3–5 d · wk^{-1}.

HR_{max}, maximal heart rate; HRR, heart rate reserve; $\dot{V}O_2$, volume of oxygen consumed per unit time; $\dot{V}O_2R$, oxygen uptake reserve.

Adapted from American College of Obstetricians and Gynecologists. ACOG Committee Opinion No. 650. Physical activity and exercise during pregnancy and the postpartum period. *Obstet Gynecol*. 2015 (reaffirmed in 2017);126:e135–42; Artal R, O'Toole M. Guidelines of the American College of Obstetricians and Gynecologists for exercise during pregnancy and the postpartum period. *Br J Sports Med*. 2003;37:6–12; and American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2019.

Resistance Training, Flexibility, and Posture Prescription during Pregnancy

The general resistance and flexibility training principles of exercise prescription detailed in Chapters 14 and 16, with several adjustments that account for morphological and physiological changes, apply to pregnant and postpartum women. After the first trimester, resistance and flexibility training exercises in the supine position should be avoided because of the potential obstruction of venous return and subsequent risk of orthostatic hypotension (22). Instead, the Personal Trainer should modify these positions to a side lying, sitting, or standing position (24). Isometric or heavy resistance training may elicit a pressor response (sudden increase in heart rate and blood pressure) and is not recommended (20). Continuous breathing (inhale on the eccentric phase and exhale on the concentric phase of the lift) should be used during the exercise and the Valsalva maneuver should be avoided at all times (24). Joint range of motion (ROM) will be enhanced during pregnancy because of increased circulating levels of relaxin, and therefore, the potential exists for ligament and joint capsule damage with an overly aggressive flexibility program (20). Consequently, Personal Trainers are encouraged to focus on maintaining normal joint ROM with slow, static stretching throughout pregnancy. Abdominal exercises during pregnancy are not contraindicated, as long as at the abdominal exercise can be done in the side lying or standing position. However, some women develop diastasis recti during pregnancy, which is the separation of the abdominal muscles following rapid expansion of the abdominal region. In these women, abdominal exercises are not recommended (13,24). Lastly, due to the rapidly changing anatomy of a women's body during pregnancy, posture is impacted, which can lead to increased risk of lower back and leg pain. During resistance training, an emphasis should be placed on correct posture and pelvic alignment (25).

Programming for Children

Children and adolescents include individuals 6–17 years of age. *Physical Activity Guidelines* for Americans published in 2008 (26) and later updated in 2018 (1) advocate for children to participate in at least 60 min · d^{-1} of moderate- to vigorous-intensity physical activity and to include resistance exercise and bone-loading activity on at least 3 d · wk^{-1}. Unfortunately, after about age 10 years, most young people do not meet the physical activity guidelines. The guidelines for physical activity are not as clear for children younger than 6 years of age; however, in the past decade, there has been a substantial amount of research regarding this area, which was reviewed in the *2018 Physical Activity Guidelines.* These guidelines suggest that children 3 to 5 years of age experience greater health benefits, such as reduced risk of excessive body weight and adiposity and favorable indicators of bone health, from participating in higher levels of physical activity compared to lower levels of physical activity (1). Similarly, in a systematic review of 119 papers, physical activity interventions in children were found to be positively associated with psychological well-being (*i.e.*, happiness, self-image, satisfaction with life) and overall mental health and inversely associated with psychological ill-being (*i.e.*, stress, depression). In addition, this review found participation in team sports to be strongly associated with positive mental health and to buffer the effects of stressful life events (27). Therefore, decreasing sedentary behavior and encouraging youth to meet the physical activity guidelines not only supports muscle and bone growth and weight management but also mental health awareness. The *2018 Physical Activity Guidelines* recommend that children 3–5 years of age who are not meeting the median time spent in light-, moderate-, or vigorous-intensity physical activity (3 h · d^{-1}), as assessed by physical activity monitors, increase their physical activity levels to meet those recommendations. Furthermore, these young children should also participate in bone and muscle strengthening activities that emphasize jumping, leaping, and landing (1). Due to the lack of evidence for exercise guidelines in children younger than 6 years of age, the evidence provided in this chapter is for the Personal Trainer working with children ages 6–17 years of age unless otherwise also specified for younger children.

> *Physical Activity Guidelines* updated in 2018 continue to advocate for children (6 yr of age and older) to participate in at least 60 min · d^{-1} of moderate- to vigorous-intensity physical activity and to include resistance exercise and bone-loading activity on at least 3 d · wk^{-1}.

Most young people are healthy, and thus, it is safe for them to initiate moderate-intensity activities without medical screening (23). Medical exams and exercise testing prior to participation generally are unnecessary in this population unless clinically indicated by signs or symptoms representative of cardiopulmonary diseases. The physiological responses to acute exercise in children are comparable to their adult counterparts with expected quantitative differences attributable to lean body mass and height disparities between the two populations (23). Table 19.4 indicates some of the key comparisons between adults and children. Children have lower anaerobic capacities compared with adults, which limits their potential for higher intensity exercise performance. When designing an exercise program for children and adolescents, the American College of Sports Medicine (ACSM) recommends three target areas: aerobic endurance, muscular strengthening, and bone strengthening activities (23). Regular endurance, resistance, and bone-loading exercise will confer favorable training adaptations in children, resulting in benefits to cardiovascular, metabolic, and skeletal health.

Table 19.4 Physiological Responses to Acute Exercise in Children Compared to Adults

Variable	Difference
Absolute oxygen uptake ($\dot{V}O_2$ in L · min^{-1})	↓
Relative oxygen uptake ($\dot{V}O_2$ in mL · kg · min^{-1})	↑
Cardiac output	↓
Heart rate	↑
Stroke volume	↓
Respiratory rate	↑
Minute ventilation ($\dot{V}E$)	↓
Respiratory exchange ratio	↓
Systolic blood pressure	↓
Diastolic blood pressure	↓

$\dot{V}O_2$, volume of oxygen consumed per unit time.

Adapted with permission from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2019.

Regular endurance, resistance, and bone-loading exercise will confer favorable training adaptations in children, resulting in benefits to cardiovascular, metabolic, and skeletal health.

Physical Activity for Children

As previously stated, many children do not meet current physical activity guidelines. Thus, a role of the Personal Trainer is to help identify a variety of age-appropriate activities for children that will safely and effectively develop aerobic, muscular, and bone strength. In addition, the Personal Trainer should work with parents/guardians to help develop and implement plans for their children to lessen the amount of time spent in sedentary activities (*e.g.*, watching television or movies, time on computer, or playing video games) while simultaneously increasing activities that encourages physical activity. Children who have been previously sedentary may be unable to initially achieve *at least* 60 min $\cdot$ d^{-1} of moderate- to vigorous-intensity aerobic, resistance, and bone-loading physical activities. In these instances, it is prudent for the Personal Trainer to gradually progress the volume of physical activity upward over several months to ultimately achieve the 60-minute-per-day goal. Table 19.5 describes the health benefits of physical activity in children ages 3 through 17 years.

Table 19.5 Health Benefits Associated with Regular Physical Activity in Children and Adolescents

Improved bone health (ages 3–17 yr)
Improved weight status (ages 3–17 yr)
Improved cardiorespiratory and muscular fitness (ages 6–17 yr)
Improved cardiometabolic health (ages 6–17 yr)
Improved cognition (ages 6–13 yr)
Reduced risk of depression (ages 6–13 yr)

From Physical Activity Guidelines for Americans, 2nd ed., https://health.gov/our-work/physical-activity/current-guidelines

A role of the Personal Trainer is to help identify a variety of age-appropriate activities for children that will safely and effectively develop aerobic, muscular, and bone strength.

In general, the exercise prescription for children should follow the frequency, intensity, time, type, volume, and progression (FITT-VP) framework. Table 19.6 summarizes the youth physical activity guidelines (1). Personal Trainers should design physical activity programs for children with two primary goals in mind (28):

1. The program should fulfill the minimal amount of physical activity needed to achieve the health benefits associated with regular physical activity.
2. Children aged 3–5 years should be encouraged to be physically active throughout the day participating in active play. School-aged children and adolescents (age 6–17 yr) should be encouraged to participate in a variety of physical activities that are enjoyable and age-appropriate. Keeping the activity fun and safe is important when working with children.

Table 19.6 Summary of Aerobic, Resistance, and Bone-Loading Activity Guidelines for Children

Parameter	Aerobic Activity	Resistance Activity	Bone-Loading Activity
Mode	Activities include running, hopping, swimming, dancing, and bicycling.	Can be unstructured (*e.g.*, playing on playground equipment, climbing trees, tug of war) or structured (*e.g.*, lifting weights, use of resistance bands)	Activities include running, jumping rope, basketball, tennis, and hopscotch.

Intensity	Moderate-intensity activity most days; corresponds to noticeable ↑ heart rate and breathing. Vigorous-intensity activity minimum of 3 $d \cdot wk^{-1}$; corresponds to substantial ↑ heart rate and quick breathing	Use body weight as resistance or 8–15 submaximal repetitions to moderate fatigue all performed with good technique.	No specific recommendation; however, avoid extreme intensity.
Duration	≥60 $min \cdot d^{-1}$	Included with the ≥60 $min \cdot d^{-1}$	Included with the ≥60 $min \cdot d^{-1}$
Frequency	Daily	≥3 $d \cdot wk^{-1}$	≥3 $d \cdot wk^{-1}$

Adapted with permission from U.S. Department of Health and Human Services. *2018 Physical Activity Guidelines for Americans* [Internet]. Washington (DC): U.S. Department of Health and Human Services; [cited 2019 May 15]. Available from: http://www.health.gov/PAGuidelines/guidelines/default.aspx; American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2021.

Other Considerations for Children

Traditionally, it was believed that resistance training during adolescence would be harmful to the developing skeleton. However, a plethora of scientific data exists that demonstrates that resistance training, when performed appropriately during childhood, is beneficial for bone formation and growth (29). Traditional resistance training activities for children are generally safe and appropriate provided they receive proper instruction and supervision (23). By age 7 or 8 years, children should be physically and mentally mature enough to initiate a resistance training program (30). The general resistance training principles detailed earlier for adults (see Chapter 14) can also be applied to children. In children who have little experience resistance training, the Personal Trainer should initially emphasize proper lifting form and other safety measures while using low volume (one to two sets) and low to moderate resistance (≤60% one repetition maximum [1-RM]) prior to gradually increasing the load (31). Children who have mastered basic resistance training exercises can then be progressed to exercises, which require more coordination, technical competency, and greater rates of force production (29). The Personal Trainer should have an overall goal of increasing skeletal muscle strength, function, and control in children rather than increasing skeletal muscle size (29). Generally speaking, the Personal Trainer can expect a 30%–40% increase in strength in an untrained youth (29). Modalities could include resistance machines, free weights (preferably dumbbells with younger ages), resistance bands, medicine balls, smaller kettle bells, cable machines, and body weight activities. If resistance machines are to be used, they should be designed to specifically fit children's body size to enhance the training response and decrease risk of injury. Therefore, employing adult-size machines in a child's resistance exercise program should be avoided. For younger children, unstructured muscle-strengthening activities (*e.g.*, playing on playground equipment) can also be included within the 60 min $\cdot$ d^{-1} of physical activity (23).

Children have underdeveloped thermoregulatory systems and subsequently are more prone to heat injuries than their adult counterparts (23). Personal Trainers should ensure that children remain properly hydrated and when possible encourage activity in thermoneutral environments.

Lastly, although most children are healthy, Personal Trainers may encounter children with health issues or disabilities such as asthma, Type 1 diabetes, or cerebral palsy. Furthermore, given that childhood obesity is on the rise, Personal Trainers are likely to encounter obese or overweight children or adolescent clients. Due to excess body fat, certain activities such as jogging or running may hinder performance. Furthermore, the Personal Trainer should be aware that this population is twice as likely to have a physical activity related injury as normal weight children or adolescents (29). In this situation, Personal Trainers should consult with the child's medical team and familiarize themselves with the specific exercise recommendations for the disease or disability present in that child. Then, the Personal Trainer should adapt the physical activity program for these individuals according to their condition, symptoms, and functional capacity (11,28).

Programming for Older Adults

Aging is a universal experience, although perception and experience alter ones late-life outcomes (32). Life expectancy in the United States has risen nearly 30 years since 1900 with those reaching the age of 65 years having an average additional life expectancy of 19.4 years (9,33). Older adults are defined as men and women 65 years and older and/or adults aged 50–64 years with clinically significant chronic conditions and/or functional limitations that impact movement ability, fitness, or physical activity (11). Limitations are defined as difficulty or inability in performing basic tasks of living, such as walking a quarter of a mile or lifting a 10-lb bag of groceries (34). Older adults over 65 years of age are at the highest risk for chronic diseases. Each system in the body responds to aging differently. Thus, one's chronological age cannot be assumed equivalent to one's physiological or functional age. Individuals of similar ages can differ remarkably in functional capacity, which in turn will affect how they respond to exercise.

Although it is inevitable that physiological function declines with age, the rate and magnitude of change are dependent on a complex mixture of genetics, individual health, presence of disease/injury, and exercise history. Safe and effective exercise programming for older adults requires that Personal Trainers have knowledge of these age-related changes on physiological function at rest and throughout the exercise-intensity spectrum. A list of key physiological aspects of aging is presented in Table 19.7.

Table 19.7 Physiological Aspects of Aging

System	Parameter	Change

Cardiovascular	Maximal heart rate and stroke volume	↓
	Maximal cardiac output	↓
	Resting and exercise blood pressure	↑
	Maximal oxygen consumption	↓
Environmental	Cold tolerance (heat production/blood redistribution)	↓
	Heat tolerance (sweat capacity/blood redistribution)	↓
Musculoskeletal	Lean body mass	↓
	Fat mass	↑
	Muscle strength	↓
	Bone mineral density	↓
	Flexibility	↓
Metabolic	Glucose tolerance	↓
	Insulin sensitivity	↓
Other	Balance	↓
	Reaction time	↑[a]

[a]Reaction time increases with age (*i.e.*, it will take longer to accomplish a task).

Adapted from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2021.

Individuals of similar ages can differ remarkably in functional capacity, which in turn will affect how they respond to exercise.

Physiological Changes with Aging

The prevalence of hypertension in Americans older than 50 years of age account for the majority of cases of uncontrolled hypertension (35). For example, those with "normal" blood pressure at age 55 and 65 years have a 90% risk of developing hypertension over the remainder of their life (36). Resting heart rate remains relatively unchanged with aging (37), maximum heart rate declines steadily with increasing age at a rate of almost 0.7 bpm ·

yr^{-1} (38,39). Maximum stroke volume (amount of blood pumped per heartbeat) and maximum cardiac output (blood flow out of the heart per minute) likewise decline with age. Maximum stroke volume and maximum heart rate decline by 10%, and maximum cardiac output declines by 20% in the three decades between age 30 and 60 years (40). These changes lead to reduced exercise capacity with declines in maximal volume of oxygen consumed per unit time of about 9% per decade in healthy sedentary adults, and this rate of decline progressively increases in old age (41). As a result, the functional capacity of the average sedentary person declines by 30% between the ages of 30 and 70 years (40,42).

The ability to recover from submaximal exercise is impaired in the aging population. Most notably, blood lactate levels remain higher in an aging population compared to young population postexercise (43). Total body water declines with increasing age contributing to decreased blood volume and impaired thirst sensation. In males, total body water decreases about 0.3 kg per year after age 30 years, and in females, by 0.7 kg per year after age 70 years (41). These changes predispose the older person to reduced exercise capacity, dehydration, and impaired exercise tolerance in hot and humid weather (44).

Between age 19 and 79 years, there is a progressive decline in brain blood flow (45) and a decrease in brain weight (46); this is likely due to loss of fluid and the slowing of nerve conduction velocity (47) resulting in slower reaction times and slower voluntary movements. These decrements in nerve conduction velocity are thought to contribute to some of the losses in muscular strength and power that occur with advancing age (48,49). However, the main culprit in decreased muscular strength with increasing age is a 30%–50% decrease in muscle mass between age 30 and 80 years due to decrease in the number of muscle fibers and greater atrophy of type II (fast-twitch) muscle fibers compared with type I fibers (41,50,51). As muscular power is a function of both strength and speed of movement, these muscle fiber changes mean that power output declines at a faster rate than strength alone. Lower body strength declines more rapidly than upper body strength (44). Muscular endurance also declines with age, although it does not decrease as quickly as power (44). It is not just the muscles that become weaker with advancing age. The connective tissue, ligaments, cartilage, tendons, and bones also weaken and become less flexible in old age (41,44). The weakening of bones (osteoporosis) occurs in both males and females; however, the problem is more prevalent in females, particularly after menopause. Females lose about 1% of bone density per year after 35 years of age, accelerating to 2%–3% per year for several years after menopause (41,44). Degeneration of the elastic components of connective tissue leads to a loss of mobility and stability in the joints.

Even though muscles and bones become weaker through atrophy, body weight actually increases in the 30s, 40s, and 50s through a progressive accumulation of body fat, particularly in the abdominal region. After age 70 years, body weight starts to decline (44).

Exercise Training Can Make a Difference

One might ask the question whether all these decrements are inevitably caused by biological aging or if exercise can counteract some of them. The answer is that only about 50% of the decrements noted earlier are due to actual aging, whereas the other 50% are due to sedentary living, poor nutrition, tobacco use, and alcohol consumption, which can be altered through exercise (41,44,52,53). Limiting time spent sitting and participation in physical activity reduces the risk of developing major chronic diseases common in older adults (1). Recent findings indicate multicomponent activity programs including aerobic, muscle-strengthening, and balance activities to be appropriate and encouraged for *all* older adults (1). Being regularly active throughout life not only significantly minimizes the normal age-related changes but can also increase aerobic capacity and muscular strength by 20%–30% in older adults (44,54). In older adults, aerobic capacity, muscular strength, body composition, and flexibility improvements are quite similar to those seen in young adults when compared based on relative change (relative to maximal capacity) and can occur at least into the 70s. Aerobic training may actually improve exercise efficiency to a greater extent in the elderly as compared with the young, although older adults are not able to increase their lower body strength to the same magnitude as young adults (55).

> Recent findings indicate multicomponent activity programs including aerobic, muscle-strengthening, and balance activities to be appropriate and encouraged for all older adults.

Successful Aging

Exercise not only improves health-related quality of life and psychological well-being but also increases the length of life. Physical inactivity is among the strongest predictors of physical disability in older adults (56). A meta-analysis of 38 studies found that regular physical activity at a mild to moderate intensity was strongly associated with a reduction in all-cause mortality in active compared with sedentary individuals (57). In everyday life, functional tasks such as getting up out of a chair, climbing stairs, bringing in the groceries, and keeping the house clean require at least minimal levels of cardiovascular endurance, muscular strength, endurance and power, flexibility, and balance. Approaching or falling below these threshold levels has the effect of limiting participation in life and reducing independence. Regular involvement in aerobic, anaerobic, resistance, flexibility, and functional training is a key element of successful aging (1).

> Regular involvement in aerobic, anaerobic, resistance, flexibility, and functional training is a key element of successful aging.

Exercise Testing in Older Adults

The likelihood is high that older adults will have clinically significant or underlying chronic disease. Thus, it is imperative that Personal Trainers complete a thorough preparticipation health screening and assessment (as detailed in Chapters 11 and 12) before beginning an exercise program with this population. A sedentary, asymptomatic older person can initiate low- to moderate-intensity exercise without medical evaluation (23). However, for sedentary older adults with known cardiovascular, metabolic, or renal disease and/or signs or symptoms suggestive of these diseases (see Chapter 11), a medical clearance is recommended before starting an exercise program. Exercise testing can determine functional capacity, help establish a safe exercise prescription, and can enable monitoring of progress in an exercise program. ACSM describes contraindications to exercise testing and participation in older individuals and provides detail on exercise testing (23). The main objective for working with older clients is to enhance and support "successful aging." Personal Trainers should design programs for older adults with three primary goals in mind:

1. Prevent or delay the progression of chronic diseases (and/or possibly "reverse" symptoms as in normalizing blood glucose).
2. Maintain or enhance cardiorespiratory fitness levels (*i.e.*, functional capacity).
3. Prevent functional limitations and disabilities.

Design Considerations for Developing Cardiorespiratory Fitness in Older Adults

Cardiorespiratory fitness is arguably the most important goal of an exercise program for older adults. Low cardiorespiratory fitness contributes to premature mortality in middle-aged and older adults (58,59). However, for every one metabolic equivalent (1-MET) improvement in cardiorespiratory fitness, one may expect a 25% reduction in overall mortality risk (60). Enhanced cardiorespiratory fitness improves insulin sensitivity, blood lipid profile, body composition, blood pressure, and autonomic nervous system function, leading to a decreased overall risk for developing cardiovascular disease (61). Moreover, decreased cardiorespiratory fitness contributes to a reduction in physiological functional capacity and eventually can result in loss of independence. Sometimes because of the natural decline in function associated with aging, the Personal Trainer may need to interpret “no change” or “maintenance of function” as a successful outcome when working with older adults. For example, a Personal Trainer who works with an older client for 2–3 years and observes “no change” in the client’s cardiorespiratory fitness level over that time can conclude that the program was effective. Why? The inevitable decline in physiological function, in this case cardiorespiratory fitness, has been delayed. In summary, normal age-related changes are minimized by being regularly active throughout life; additionally, a restorative function may be seen in cases where a sedentary lifestyle has been replaced by regular physical activity.

> Being regularly active throughout life not only significantly minimizes the normal age-related changes but also restores functional capacity in previously sedentary adults.

An exercise program should be based on exercise testing results, consider the person’s preferences and capabilities, be individualized with attainable goals, and provide regular and meaningful feedback as support for long-term adherence. When working with an older client, plan warm-up (minimum of 5–10 min) with gentle dynamic stretching to gradually ease the person from rest to the chosen exercise intensity. A deliberate cool-down (minimum of 5–10 min) should gradually bring the person back to resting levels after exercise. Time spent in warm-up and cool-down count toward meeting the ACSM physical activity guidelines, as long as the activity is at least moderate intensity (*i.e.*, brisk walking) (62). In general, physical activity programs for older adults should be designed to meet the current recommendations of at least 150–300 minutes of moderate-intensity physical activity a week, spread out across at least 5 days, with a target of 30 min $\cdot$ d^{-1} (even greater benefits are shown for up to 60 min $\cdot$ d^{-1}). If completing vigorous exercise, then the recommendation is a target of 20–30 min $\cdot$ d^{-1} on 3 or more days per week accumulating 75–100 minutes of vigorous-intensity activity per week (23). The exercise does not need to be continuous but can be accumulated in smaller bouts across the day. An equivalent combination of moderate and vigorous activity can also be prescribed. Research has found that aerobic physical activity is most beneficial in reducing the risk of injury and preventing excess fatigue when spread throughout the week on *at least* 3 days (or more for greater benefit) (23). When not feasible for older adults to fulfill these guidelines due to debilitating chronic conditions, Personal Trainers should encourage these individuals to be as physically active as their condition permits. Exercise intensity for older adults is defined relative to individual fitness using a perceived physical exertion scale of 0–10 for which 0 is equivalent to sitting and 10 is maximal effort. Moderate-intensity activity is considered as a 5 or 6 and vigorous-intensity activity as a 7 or 8 (23). However, relative intensity individualized to the person should be used to prescribe aerobic training (1). Walking is the most common activity for older adults, although any activity that does not present excessive orthopedic stress can be included (62). Recent findings suggest multicomponent physical activities to be the most beneficial for specific physical function outcomes such as strength, gait speed, balance, and activities of daily living. Multicomponent activities include more than one type of physical activity including aerobic, muscle strengthening, and balance training (1). In summary, the cardiorespiratory training principles detailed in Chapter 15 apply to older adults, although depending on the disease and functional status of the individual, the Personal Trainer must also consider medications, risk factor profile, and behavioral issues to modify the program accordingly. Table 19.8 outlines some of the program modifications that could be considered when working with older adults with functional impairments.

Table 19.8 Aerobic Exercise Program Modifications for Older Adults

Program Component	Program Modification

Exercise mode	■ Walking is an excellent mode of exercise for many older adults. ■ Modality should not impose excessive orthopedic stress. ■ Aquatic, stationary cycle, and recumbent stepper exercise may be preferable for clients with a diminished ability to tolerate weight-bearing exercise. ■ Modality should be accessible, convenient, and enjoyable to promote adherence. ■ A group setting may provide social reinforcement to adherence.
Exercise intensity	■ To minimize complications and promote long-term compliance, intensity for inactive older adults should start low and progress according to client preference and tolerance. ■ Many adults have clinically diagnosed conditions or likely have underlying chronic diseases; thus, a conservative approach to increasing intensity may be required. ■ Exercise need not be vigorous and continuous to be beneficial ■ Measured peak heart rate is preferable to age-predicted peak heart rate because of the variability in peak heart rate in clients >65 yr and their greater risk for underlying CAD. ■ Activities performed at a given MET level represent greater relative intensities in older adults than in younger clients because of the decrease in peak METs with age (see Table 20.7). ■ Older adults are likely to be taking medications that can influence heart rate. ■ Intensity on a level of physical exertion should be 5–6 for moderate intensity and 7–8 for vigorous, on a scale from 0 to 10.
Exercise session duration	■ To prevent injury, ensure safety, and promote adherence, older adults should increase exercise duration prior to intensity. ■ Duration need not be continuous to produce benefits. Clients who have difficulty sustaining exercise for 30 min or who prefer shorter bouts of exercise can be advised to exercise for 10-min bouts throughout the day. ■ A daily accumulation of 30 min moderate-intensity physical activity can provide health benefits. ■ Even greater benefits are possible with up to 60 $\text{min} \cdot \text{d}^{-1}$ of moderate-intensity physical activity.
Exercise frequency	■ Moderate-intensity exercise should be performed on 5 or more days per week, vigorous-intensity activity on 3 or more days per week, or a combination of moderate and vigorous on 3–5 $\text{d} \cdot \text{wk}^{-1}$.

CAD, coronary artery disease.

From American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2021.

Design Considerations for Developing Muscular Strength in Older Adults

Aging is associated with a reduction in muscle mass, which in turn contributes to decreased muscle strength and a decline in functional capacity. Undeterred, the process can ultimately result in reduced balance ability, mobility problems, and lack of independence for the older adult (63). Furthermore, decreased muscle mass plays a role in the development of glucose intolerance and Type 2 diabetes.

The Personal Trainer should recognize the importance of implementing a resistance training program for older adult clients to attenuate the loss of muscle mass and protein (64). Muscle fiber size and performance, particularly the rate of force development, are consistently higher in older adults who are chronically exposed to strength training (65). Furthermore, some studies have suggested that resistance training can improve cognition, mood, self-confidence, and self-esteem (44,66).

When designing a resistance training program for older individuals, the general resistance training principles detailed earlier (see Chapter 14) can be applied. In fact, in certain elderly clients, even explosive-type, heavy resistance exercise has been shown to be safe and effective (67). However, it is critical that the Personal Trainer provide sufficient instruction on proper lifting technique and good posture. Initially, beginners may benefit from using weight training or resistance machines. Weight training machines leave less room for error in body position, and they safely enable larger absolute loads to be lifted. If weight-training machines are used with small-framed or frail clients, care must be taken that they fit the individual properly. Other modalities such as free weights (*e.g.*, dumbbells), elastic bands, and body weight activities can offer different benefits for those older participants who are experienced in their use. Some major advantages for these types of exercise modalities are that they are inexpensive, can be done at home, and take up minimal space. Additional benefits are that they can promote kinesthetic awareness and help improve balance (68). Power training, a nonconventional type of resistance training, may be beneficial in older adults who are at a greater risk of falls. Power training has been shown to be beneficial in reducing the risk of falls. To increase skeletal muscle power in older individuals, the Personal Trainer should have his or her client do high-velocity exercises including one to three sets of single and multijoint exercises at 30%–60% of 1-RM for 6–10 repetitions (23).

Older participants should move through the full ROM using proper form and avoid breath holding during the lifts. Intensity can be prescribed between moderate (5–6 on the 10-point exertion scale described previously) and vigorous (23). If the client's 1-RM is known, the target is 60%–70% 1-RM, although lower intensities (*e.g.*, 40%–50% 1-RM) are appropriate for beginners. Generally, one set of 10–15 repetitions is recommended when working with older adults (23). One set of 8 to 10 exercises including the major muscle groups should be part of the resistance training program, although two to three sets may be more beneficial (23). As with any resistance training prescription, load should be increased when the number of repetitions that can be completed with proper form exceeds the initially prescribed number (*e.g.*, original prescription is 10 repetitions of 30 lb, and now the client can lift 12 repetitions with proper form and with a rating of perceived exertion [RPE] of 7 on a 10-point scale — then, it is appropriate to increase the load and decrease the number of repetitions back to 10).

In summary, although the resistance training exercise prescription principles detailed in Chapter 14 are appropriate for many older individuals, they may need to be modified when working with those with functional limitations. Table 19.9 outlines modifications for resistance training programs that could be considered when working with older adults.

Table 19.9 Resistance Training Guidelines for Older Adults

Program Component	Program Modification
Exercise mode	■ Perform 8–10 exercises using the major muscle groups. ■ Dynamic muscle-strengthening activities include machine and free weights, weight-bearing calisthenics, resistance bands, and similar

	resistance exercises that use major muscle groups.
Exercise intensity	■ Perform each lift or movement with a resistance that allows for 10–15 repetitions per exercise. ■ Level of effort for muscle-strengthening activities should be light for beginners progressing to moderate to vigorous. On a 10-point scale, where no movement = 0, maximal effort = 10, moderate-intensity effort = 5 or 6, and high-intensity effort = 7 or 8.
Exercise session duration	■ Complete at least one set of each exercise. ■ Allow adequate rest between exercises to prevent carry over fatigue.
Exercise frequency	■ Resistance training should be performed on 2 or more nonconsecutive days per week.

Adapted from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2021.

Design Considerations for Developing Flexibility in Older Adults

Flexibility is an essential component of fitness and decreases with age and physical inactivity. As was discussed in Chapter 16 with increasing age, the ability to move through a full ROM becomes compromised. Aging causes connective tissue to become stiffer, which makes the joint more resistant to bending (41). Additionally, the joint cartilage, ligaments, tendons, synovial fluid, and muscles begin to deteriorate, which may decrease joint ROM (1). The loss of joint flexibility with aging has been reported to range from negligible to 57% with the majority of this loss occurring by age 65 years (41). Poor flexibility, coupled with decreased musculoskeletal strength, has been associated with a diminished ability to perform activities of daily living (1). Consequently, the beneficial effect of stretching on the achievement and maintenance of flexibility should not be overlooked. However, it is not known if flexibility by itself causes a reduction in the risk of exercise-related injuries (69).

Poor flexibility, coupled with decreased musculoskeletal strength, has been associated with a diminished ability to perform activities of daily living.

Over the last decade, much scientific inquiry has considered the topic of stretching. Collectively, the findings indicate that static stretching should only be done when muscles and joints are warm. In other words, static stretching itself should not be considered the "warm-up" prior to cardiorespiratory or resistance exercise. Static stretching done immediately prior to exercise could have potentially detrimental effects in some instances (*i.e.*, decreased muscle strength and endurance, impaired balance, and diminished reaction time) (70). The Personal Trainer should be mindful of this evidence when designing programs for older adult clients and consider sequencing the workout so that stretching follows the cardiorespiratory and/or resistance training components. The exercise prescription principles for flexibility detailed in Chapter 16 are appropriate for older adults. To improve flexibility, older adults should gently increase the length of muscle beyond that used in everyday activities at least 2 d · wk^{-1}. This can be done dynamically, statically, or both. Static held positions to stretch the muscles are to be held for 10–30 seconds and stretching should be employed for all the major muscle groups in the body. As noted in Chapter 16, guidelines for flexibility may need to be modified when working with those with functional limitations such as arthritis or osteoporosis.

Design Considerations for Developing Balance in Older Adults

Fall incidence rates currently pose a serious health problem for older adults with 1 in every 4 individuals aged 65 years and older experiencing one fall a year in the United States (71). Decreased balance with aging can be attributable to a series of declines in multiple physiological and psychological systems. These include decreases in joint and muscle flexibility (ROM), muscular strength, reduced central processing of sensory information, slowed motor responses, and declines in executive function (72). With aging, myelin sheaths sometimes exhibit degenerative change, and there is a loss of nerve fibers from the white matter in the brain (73). These changes contribute to a decline in sensory capability and cognitive function. Cognitive executive function is a key leader in the maintenance of independence in older years (74). Sensory capability is also affected by increasing age. Sight, hearing, taste, balance, vestibular function, and proprioception decline in old age leading to a greater risk of falling (41).

Physical activity programs reduce the risk of fall-related injuries in older adults (1). In addition, community-structured programs may be beneficial in long-term exercise participation to promote overall well-being, physical function, and reduce fall risk. It is recommended to incorporate multicomponent physical activity including gait, coordination, and physical function, as well as recreational activities of yoga, tai chi, gardening, and sports (23). Balance ability and postural control are critical factors for performing ADLs and participating in leisure-time activities (1). Balance and postural stability can be enhanced by combining flexibility with resistance exercise (75,76). Personal Trainers should therefore include balance exercises in older adults' exercise programs. Both static and dynamic balance activities should be employed at least twice a week. Progression should occur in a safe environment where a fall would not injure the participant (having spotters, having nearby secure objects to hang on to, and using mats). Progression can take place by steadily reducing the dynamic or static base of support (52). Although research has yet to identify the optimal frequency, duration, and type of balance exercises, balance training may be performed 2–3 $d \cdot wk^{-1}$ (11,23). Balance training can be integrated into various phases of the exercise session, including warm-up, main component, or cool-down. Sample balance exercises and training progression (from simple to complex) are presented in Table 19.10 and are shown in Figures 19.1–19.3.

Table 19.10 Balance Exercises and Training Progression for Older Adults

Position	Balance Exercise
Sitting	■ Sit upright and complete progressions listed below. ■ Perform leg activities (heel, toe, or single-leg raises, marching).
Standing	■ "Clock" — balance on one leg (other leg at 45° or 90° angle), Personal Trainer calls out time, client moves nonsupport leg to the time called out (*i.e.*, 5 o'clock, 9 o'clock), alternate legs. ■ Perform leg activities (heel, toe, or single-leg raises — 45° or 90° angle, marching). ■ "Spelling" — balance on one leg, Personal Trainer asks the client to spell word working with nonsupport leg (*i.e.*, client's name, day of week, favorite food), alternate legs.
In motion	■ Heel-to-toe walking along 15-ft line on floor (first with and then without partner) ■ "Excursion" — alternating legs, lunge over a space separated by two lines of tape. Progress to hopping or jumping (using single-leg or double-leg) back and forth across the space. ■ Dribble basketball around cones that require the client to change direction multiple times.
Training progression	■ Arm progressions: Use surface for support, hands on thigh, hands folded across chest. ■ Surface progressions: chair, balance discs, foam pad, physioball ■ Visual progressions: open eyes, sunglasses or dim room lighting, closed eyes ■ Tasking progressions: single tasking, multitasking (*i.e.*, balance exercise + pass/catch ball)

Number of repetitions per exercise and rest intervals will be dependent on client conditioning and functional status.

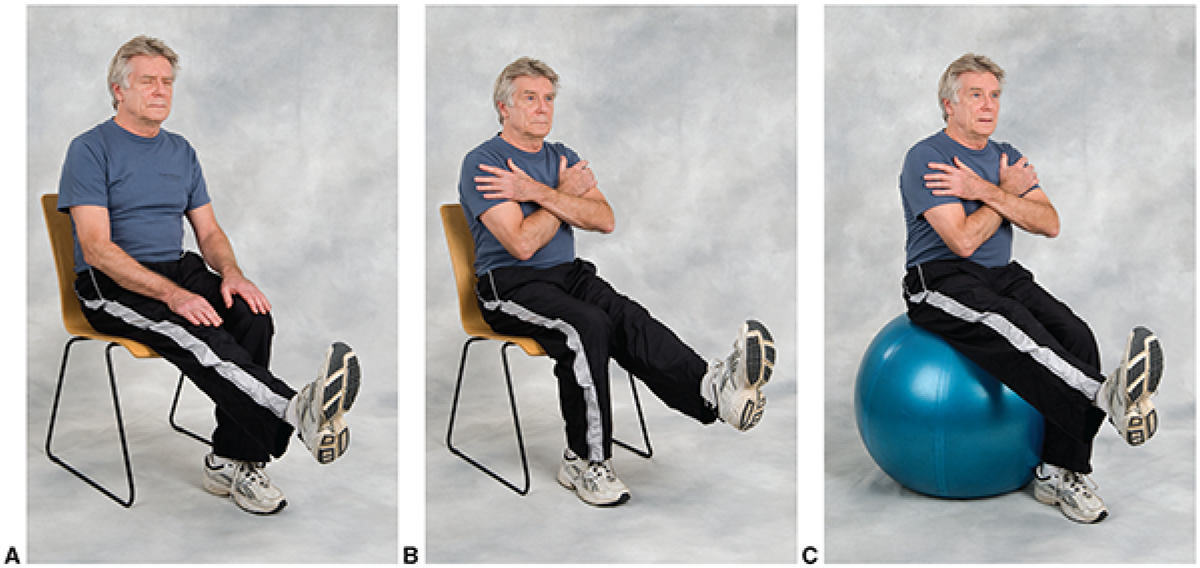

FIGURE 19.1. Sample progression of sitting balance exercises: closed eyes **(A)**, arms crossed **(B)**, and physio ball **(C)**.

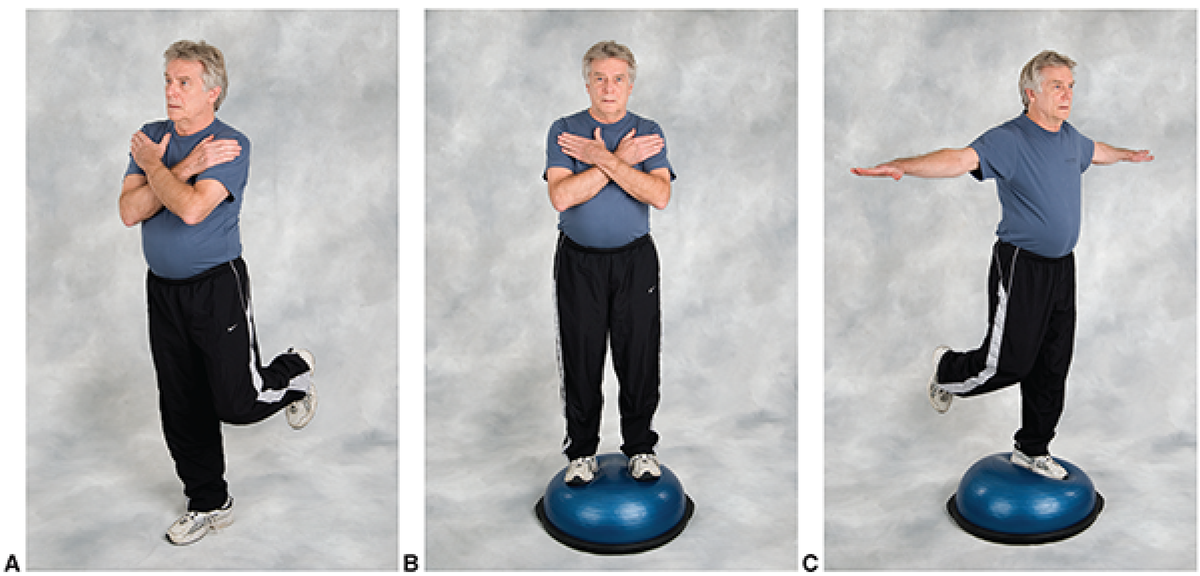

FIGURE 19.2. Sample progression of standing balance exercise, with arms crossed on floor **(A)** and with arms crossed **(B)** and open **(C)** on balance training equipment.

FIGURE 19.3. Sample progression of in-motion balance exercises: heel-to-toe **(A)**, excursion **(B)**, and multitasking **(C)**.

It is critical that Personal Trainers include balance exercises in older adults' exercise programs.

SUMMARY

This chapter examined exercise prescription throughout the lifespan, which encompassed pregnancy, children, and older adults. Personal Trainers should be aware of special considerations regarding exercise program design for special populations to create effective (and safe) exercise regimens for their clientele. By being aware of and using, the evidence-based guidelines noted in this chapter for pregnancy, children, and older adults, the Personal Trainer will minimize risk of injury during exercise and develop a more individualized exercise plan for his or her specific clientele population.

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CHAPTER

20

Metabolic Disease and Cardiovascular Disease Risk Factors

OBJECTIVES

Personal Trainers should be able to:

- Describe exercise programming for clients with cardiovascular disease, diabetes, dyslipidemia, and hypertension.
- Describe exercise programming for obese clients.
- Understand how to create exercise programs for individuals with comorbidities.

INTRODUCTION

According to physical activity data from the National Health and Nutrition Examination Survey, only 23.3% of Americans self-report meeting both the aerobic and muscle-strengthening physical activity guidelines (1). This value drops considerably (9.6%) when physical activity is characterized using physical activity monitoring devices (2). Physical inactivity is associated with numerous unhealthy conditions, including obesity, hypertension, gestational and Type 2 diabetes, and atherosclerotic cardiovascular disease (CVD) and contributes annually to over 5.3 million global deaths (3). In addition, current trends also show that although Americans are living longer, the number of individuals with chronic diseases continues to increase. Collectively, these factors make it increasingly likely that the Personal Trainer will be interacting with clientele who are other than apparently healthy adults. This chapter discusses the special considerations and scope of practice of exercise program design for the following subpopulations: CVD, diabetes mellitus, obesity, hypertension, and individuals with comorbidities.

Programming for Clients with Cardiovascular Disease

According to data from the National Health and Nutrition Examination Survey, 121.5 million American adults have one or more types of CVD (4). Although the prevalence of CVD-related deaths has declined since the 1980s, it remains the leading cause of death in the United States (4). In fact, the most recent statistics from the American Heart Association indicated that more than 360,000 Americans died of heart disease in 2016 (4). Patterns of nutrient intake and physical inactivity underlie the global epidemic of chronic diseases, including obesity, hypertension, dyslipidemia, and Type 2 diabetes, which all serve as risk factors that contribute to the process of coronary artery disease (CAD). Clearly, a main goal of the Personal Trainer is to help clients with the primary prevention of atherosclerotic risk factors. Personal Trainers should know that individuals who are able to reach the age of 50 years with no CVD risk factors have markedly higher survival rates than those with any combination of risk factors (5). However, even those individuals who have only one risk factor at middle age are at a much higher risk for CVD and CAD than middle-aged people with no risk factors (5). Fortunately, exercise programs that can effectively slow and even reverse the process of atherosclerosis can be designed even for individuals with known CAD.

Programming Goals for Cardiovascular Disease

Positive risk factor modification is the primary goal of an aerobic exercise program for clients with CVD. Scientific research has demonstrated that there is a dose-response relation between exercise and multiple health outcomes, including risk of CAD and all-cause mortality, obesity, dyslipidemia, Type 2 diabetes, and, perhaps most importantly, cardiorespiratory fitness (6,7). Maximal cardiorespiratory fitness, or the body's maximal ability to consume oxygen to produce energy, is an important marker for health outcomes and risk stratification (6). Studies have consistently demonstrated an inverse relation between maximal volume of oxygen consumed per unit time ($\dot{V}O_{2max}$) and CVD and total mortality in men and women across the lifespan (8,9). Moreover, it has been shown that risk for CVD is highest for individuals with low levels of cardiorespiratory fitness even when compared with those with traditional risk factors such as hypertension, dyslipidemia, or obesity (10). Each one metabolic equivalent increase ($3.5\ mL \cdot kg^{-1} \cdot min^{-1}$) in cardiorespiratory fitness can reduce the risk of CVD and all-cause mortality by 8%–25% (10,11). Based on the dose-response relation between exercise and health outcomes, both the American

College of Sports Medicine (ACSM) and U.S. Department of Health and Human Services have noted that the health benefits of a program are closely associated with total weekly energy expenditure (12,13). Studies have shown that exercise programs with energy expenditure of 14–23 $\text{kcal} \cdot \text{kg}^{-1} \cdot \text{wk}^{-1}$ lead to significant improvements in cardiorespiratory fitness and other important risk factors for CAD, including dyslipidemia, body composition, and insulin sensitivity (14–19). In some patients with CVD, high-intensity interval training (HIIT) may have potential for improving $\dot{V}O_2$ peak as compared with standard continuous moderate-intensity exercises (20). Although HIIT is safe within this population when patients are on an optimized medication regimen, an in-depth clinical understanding of the patient's condition and the effects of acute and chronic exercise are needed to safely guide the patient through a training session and promote long-term compliance. Thus, when working with those with heart disease, the Personal Trainer should design an individualized aerobic exercise prescription conforming to the FITT-VP principles and parameters (frequency, intensity, time, type, volume, and progression) to fulfill total weekly volume of exercise that has been shown to elicit positive adaptations to CAD risk factors. Achievement of this objective can positively modify the process of atherosclerosis and subsequently reduce the likelihood of future cardiac events and increase survival (21,22).

Design Considerations for Aerobic Exercise Training for Clients with CVD

Exercise training is relatively safe for the majority of clients with CVD provided that appropriate assessment and screening is performed before beginning the program. The likelihood of an adverse event can be markedly reduced with baseline assessments, preparticipation screening, patient education, and client adherence to established exercise recommendations (12,23). All clients with CVD should have their cardiovascular risk assessed by their physician and gain physician clearance prior to participating in a formal exercise program. Additionally, many patients with CVD have a qualifying diagnosis (*i.e.*, myocardial infarction within the last year, percutaneous coronary interventions, coronary artery bypass graft surgery, heart valve repair or replacement, stable angina, heart failure with a reduced ejection fraction, or heart transplantation) to enroll in an outpatient cardiac rehabilitation program, which has received a class I (*i.e.*, highest recommendation provided by major health organizations based on evidence of efficacy) indication by the American Heart Association. Due to relatively low cardiac rehabilitation referral rates, the Personal Trainer is encouraged to promote these programs to clients that may not have been informed of their existence. A major recommendation for all cardiac rehabilitation participants is to perform "home" exercise on noncardiac rehabilitation session days. This can serve as a good opportunity to continue care with a Personal Trainer or wait until the client completes the cardiac rehabilitation program. In the case that a client has or is actively participating in a cardiac rehabilitation program, Personal Trainers should request information regarding the client's participation, including number of sessions of cardiac rehabilitation completed, types, durations, and intensities of exercise performed as well as any history of adverse events in response to exercise or any special considerations/precautions that should be taken during exercise. After establishing that it is safe for the client with CVD to begin, the specific details of an exercise program can be formulated. Most of the cardiorespiratory assessments described in Chapter 12 can be provided to clients with CVD after proper screening and clinical evaluations including a recent clinical exercise test. The overarching goal of an aerobic exercise intervention is to increase the client's cardiorespiratory fitness. To do so, the exercise stimulus must be at an intensity, duration, and frequency that presents a challenge to the cardiovascular, skeletal muscle, neural, and metabolic systems to initiate the adaptive process in the respective systems. Failure to meet minimal threshold values may result in lack of a training effect, whereas increasing intensity and/or volume too quickly may increase the risk of injuries and other adverse events.

An initial exercise prescription will be largely based on the client's physical capabilities, experience with exercise, and availability of peak or maximal exercise test data. Clients starting at a very low fitness level and/or are frail may need to perform intermittent exercise and gradually increase bout duration, decrease rest time, and progress to completing the desired duration of continuous exercise at moderate intensities, followed by a progressive increase in intensity. The frequency of exercise should start at 2–3 $d \cdot wk^{-1}$, with the ultimate goal of performing 4–5 $d \cdot wk^{-1}$ of aerobic exercise. The general principles of determining exercise intensity in patients with CVD closely follow prescription recommendations for apparently healthy adults, with the main caveat being that intensity is relative to the individual's peak cardiorespiratory fitness. When exercise testing data is available, moderate (40%–59% oxygen uptake reserve [$\dot{V}O_2R$] or heart rate reserve [HRR]) and vigorous (60%–80% $\dot{V}O_2R$ or HRR) intensity are recommended. However, details regarding the conditions in which the exercise test was performed must be considered to appropriately create the respective intensity parameters. In many clinical settings, maximal exercise testing is not employed to generate an exercise prescription but rather used as a diagnostic tool to identify underlying causes of CVD-related symptoms. This scenario commonly requires the patient to withhold any heart rate–limiting medications (*i.e.*, β-blockers) to sufficiently "stress" the heart. If heart rate–limiting medications are continued or added after the initial exercise test, heart rate data acquired during the test should not be used to develop a heart rate–based exercise prescription. Moreover, when an exercise test is not available or the condition in which the test was performed does not reflect the current state of the patient's medication regimen, it is appropriate and recommended to use subjective ratings of effort to prescribe light (rating of perceived exertion [RPE] <12 reflecting <40% HRR), moderate/"somewhat hard" (RPE 12–13 reflecting 40%–59% HRR) or vigorous/"hard" (RPE 14–16 reflecting 60%–80% HRR) (12). In cases when patients may have misinterpreted the RPE scale, the talk test (see Chapter 15) is recommended to verify effort. It is also important to note the limitations of using age-predicted maximal heart rate formulas to create a heart rate–based exercise prescription. Even if a formula derived from patient-specific populations (*i.e.*, β-blocked vs. non–β-blocked or men vs. women) is used, a significant level of variation (standard deviations of 10–15 bpm) (24) across age groups greatly reduces the applicability of these formulas in exercise training settings.

For most previously sedentary clients with CVD, the threshold intensity for improving cardiorespiratory fitness can occur at as little as 42%–55% $\dot{V}O_2R$ (25), performed for 25–40 minutes, 3 d · wk^{-1} (~800 kcal · wk^{-1}). Increasing the volume of activity (*i.e.*, 3,000 kcal · wk^{-1}), whether by intensity, duration, frequency, or a combination of all three can promote greater improvements in fitness, improve metabolic profile, and weight loss in obese patients (26). However, the overarching goal of the aerobic exercise program for all patients is to have a steady progression of total weekly energy expenditure ≥1,500 kcal · wk^{-1} (27).

Other exercise intensity considerations for those with CVD are presented in Table 20.1.

Table 20.1 Exercise Intensity Considerations for Clients with Cardiovascular Disease

Program Modification
Deconditioned and low–functional capacity clients may need to start at low intensities (<40% HRR or $\dot{V}O_2R$).
Target exercise intensity should fall 10–15 bpm below a heart rate that has previously elicited abnormal clinical symptoms (*i.e.*, chest pain or other angina symptoms).
β-Blockers and other heart rate–lowering medications will decrease the accuracy of exercise intensity prescription methods based on an age-predicted maximal heart rate.
RPE levels of 11 (fairly light) to 14 (somewhat hard) typically correspond to the target heart rate for clients with CVD first initiating an exercise program. RPE can be progressed (14–16) relative to the patients tolerance of activity, when conditioning has improved and no complications are present.

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Designing Resistance Training Programs for Clients with CVD

Resistance training in patients with CVD improves muscular strength and endurance, decreases cardiovascular demands of a given task, helps prevent/treat other chronic diseases (*e.g.*, osteoporosis, Type 2 diabetes), increases ability to perform daily activities, and improves self-confidence, among other benefits (12). Two primary goals of resistance training for those with CVD are as follows (27):

1. To maintain and improve muscular fitness levels for performing activities of daily living (ADL)
2. To reduce the cardiovascular demands (*e.g.*, lower heart rate and blood pressure) associated with performing these tasks

Resistance training is widely considered to be safe in patients with well-controlled CVD, provided that proper form through movements are followed while the Valsalva maneuver and tight griping of weight handles/bars are avoided. Generally, deconditioned patients are recommended to first perform roughly 4 weeks of aerobic training to adjust to and tolerate exercise and then begin incorporating resistance training. Progression of resistance training should be gradual, but often, the Personal Trainer may need to accept maintenance of strength as a more realistic objective. Exercise should be terminated if signs or symptoms such as dizziness, arrhythmias, unusual shortness of breath, or chest discomfort occur (12,27). General resistance training guidelines for clients with CVDs are presented in Table 20.2.

Table 20.2 Resistance Training Guidelines for Clients with Cardiac Disease

Program Component	Program Modification
Exercise mode	■ Dynamic muscle-strengthening exercises include machine and free weights, weight-bearing calisthenics, resistance bands, and similar resistance exercises that use major muscle groups. ■ Isometric exercise is not recommended for clients with CVD.

Exercise frequency	■ Resistance training should be performed on 2–3 nonconsecutive days per week.
Exercise intensity	■ Perform 10–15 repetitions per exercise to "moderate" fatigue, which approximately corresponds to an RPE range of 11–13 (light to somewhat hard) on the Borg 6–20 scale.
Exercise session duration	■ Complete one set of each exercise initially and build up to three sets. ■ Perform 8–10 different exercises focused on major muscle groups ■ Allow adequate rest between exercises to prevent carry over fatigue.
Progression	■ Increase slowly as patient adapts (~1–5 lb · wk^{-1} [1–2.3 kg] for upper body and 5–10 lb · wk^{-1} [2.3–4.5 kg] for lower body as tolerated).

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Additionally, roughly 16% of patients undergoing a CVD-related procedure undergo a sternotomy (4). To maintain safety, the Personal Trainer is encouraged to inquire with the medical team or cardiac rehabilitation staff (if the client attended cardiac rehabilitation) about limitations one should be aware of when designing the resistance training program. Other unique populations that a Personal Trainer may work with are those with a pacemaker and implantable cardioverter defibrillator (ICD). If working with these patients, it is important to know the heart rate threshold for the ICD to deliver a shock and perform exercise at least 10–15 bpm below the threshold; rigorous upper extremity activities (*i.e.*, swimming, bowling, lifting weights, elliptical machines, and golfing) should be avoided at least 3–4 weeks after device implant. However, lower leg aerobic/resistance exercise is allowed.

Programming for Clients with Diabetes

Diabetes mellitus is a metabolic disorder stemming from abnormal pancreatic insulin production and/or diminished peripheral action of insulin.

Diabetes is positively associated with the development of multiple diseases and disorders of the heart, vascular system (*e.g.*, stroke and hypertension), kidneys, eyes, and nervous system. Diabetes seriously compromises the heart and vascular system such that it is listed as the seventh leading cause of death in the United States (28). Patients with CVD and Type 2 diabetes have a fourfold higher incidence rate of cardiovascular events compared to patients who only have CVD (29). Looking at current data, it is clear that diabetes continues to be a significant problem in the United States. To date, 34.2 million American adults (10.5% of the U.S. adult population) have diabetes mellitus. Of that total, 7.3 million undiagnosed cases for adults reported in 2018 (30).

Two categories are used to classify individuals with diabetes: Type 1 and Type 2. Type 1 diabetes typically results from an autoimmune response whereby the body's own immune system mistakenly destroys the insulin-producing cells in the pancreas. Type 1 diabetes comprises approximately 5%–10% of all diagnosed cases of diabetes. This leaves 90%–95% of all diagnosed adults in the category of Type 2 diabetes. In general, the critical risk factors for Type 2 diabetes are associated with a sedentary lifestyle, whereas the primary risk factors include age, family history, ethnicity, obesity, high alcohol intake, high-fat diet, high blood triglycerides (TGs), high blood pressure, and gestational diabetes (31). Moreover, it is estimated that approximately 84.1 million adult Americans (33.9% of the U.S. adult population) and nearly half of adults 65 years or older have prediabetes, a condition in which blood glucose values are elevated beyond normal levels (*e.g.*, fasting blood glucose of 100–126 $mg \cdot dL^{-1}$); these individuals have a markedly increased risk of developing Type 2 diabetes in their lifetime (30). Although Type 2 diabetes is more commonly associated with adults, it is now on the rise in children, fueled largely by inactivity and poor diets that lead to obesity. Therefore, Personal Trainers should recognize that diabetes prevention is appropriate for all populations not only for the individuals who are obese but also for the older adults and at-risk children.

Diabetes prevention is appropriate for all populations not only for the individuals who are obese but also for the older adults and at-risk children.

Because the growth of diabetes in the U.S. population is not slowing, the demand for competent Personal Trainers to provide appropriate exercise guidance and supervision to individuals with diabetes will continue to increase. Personal Trainers need to prepare to meet this challenge by continuing to enhance their ability to implement diabetes management and prevention programs.

Pathophysiology of Diabetes

Normally, insulin is released in the pancreas in response to a rise in blood glucose following the intake and digestion of food. In Type 1 diabetes, pancreatic β-cells that produce insulin are destroyed by an autoimmune disorder, creating an absolute insulin deficiency (no insulin production) in the body. In Type 2 diabetes, insulin is produced but is ineffective at controlling blood glucose because of insulin resistance in body tissues. The pancreas increases insulin production to overcome this resistance, causing an excess of blood insulin in these individuals. Hyperinsulinemia (elevated blood insulin concentration) over time can contribute to a host of problems such as hypertension, hypercholesterolemia, excessive blood clotting, atherosclerosis, and kidney stones.

The main goal in the management of diabetes is adequately controlling blood glucose levels (12,32). Normal resting blood glucose level is less than 100 mg $\cdot$ dL^{-1}. Diabetes is typically diagnosed when fasting blood glucose is 126 mg $\cdot$ dL^{-1} or greater on two or more occasions or a 2-hour plasma glucose $\geq$200 mg $\cdot$ dL^{-1} during an oral glucose tolerance test or glycolated hemoglobin (HbA1C) $\geq$6.5% or symptoms of hyperglycemia/hyperglycemic crisis and a random plasma glucose $\geq$200 mg $\cdot$ dL^{-1} (33). Although blood glucose numbers describe a single point in time, the HbA1C provides a better measure of glucose control over the last 2–3 months. In people without diabetes, a normal HbA1C value is somewhere between 3.5% and 5.5%. People with diabetes have higher HbA1C values because their bodies have consistently higher levels of blood glucose. A goal level for HbA1C for most people with diabetes is under 7%. Exercise, among other treatment strategies, can be used effectively to achieve this goal (32).

Programming Goals for Those with Diabetes

Exercise training affects many subclinical health factors associated with diabetes and is critical for diabetes management. The main exercise programming goals for individuals with diabetes are to (12,32)

1. Improve insulin sensitivity and blood glucose control and decrease insulin requirements
2. Improve cardiorespiratory fitness
3. Improve blood lipid profiles
4. Reduce blood pressure
5. Improve muscular strength and endurance through enhancing skeletal muscle mass
6. Improve flexibility and joint range of motion
7. Reduce body weight (particularly reduce intra-abdominal fat)
8. Assist with decreasing the risk of diabetic complications

Consistency in a daily routine is the major pillar in diabetes care. This regularity refers to when meals are eaten; the amount and type of food; when medications are taken; and frequency, intensity, and time (duration and time of day) of physical activity. Personal Trainers, when working with clients with diabetes, should maintain regular contact with the client's physician or other health care provider when designing or making changes to the exercise program. This will enable a more consistent and appropriate treatment plan for the client.

Consistency in a daily routine is the major pillar in diabetes care.

Aerobic Training for Clients with Diabetes

The majority of research regarding exercise training and diabetes has been done in the area of aerobic exercise. A hallmark training adaptation to be expected from increased levels of aerobic activity is improved cardiorespiratory fitness; this positive outcome carries tremendous benefit for clients with prediabetes or diabetes. Individuals with higher levels of cardiorespiratory fitness are at decreased risk for mortality from CVD compared with their counterparts with lower cardiorespiratory fitness levels regardless of body mass index (BMI) status (normal, overweight, or obese) (34,35). The positive effects of aerobic exercise on glucose metabolism and insulin sensitivity in clients with diabetes are known to be "subacute" changes, meaning that they are lost within a few days following the cessation of training (32). For Personal Trainers, this provides support for a consistent, almost daily training regimen for clients with diabetes. If these clients are to achieve the full benefits of aerobic exercise, the program must involve frequent exercise activities with daily adherence. Regular exercise in clients with diabetes assists in controlling blood glucose, enhancing insulin sensitivity, decreasing and managing body weight and blood pressure, improving lipid profiles, increasing cardiorespiratory fitness and exercise capacity, and managing some related conditions such as coronary heart disease or peripheral vascular disease (12,32).

Frequency

ACSM recommends 3–7 $d \cdot wk^{-1}$ with no more than 2 consecutive days between sessions of aerobic activity because of the relatively brief exercise-induced improvements in insulin action (32). Greater frequencies of physical activity have been shown to be more effective in improving glucose tolerance and insulin sensitivity with minimal exercise-induced complications (36). Personal Trainers should consider progressing clients to 5 $d \cdot wk^{-1}$, or perhaps daily, with an appropriate mix of intensity and duration. Clients who are obese or are taking insulin may benefit most by a daily schedule because it allows for greater consistency and an opportunity for increasing caloric expenditure for purposes of weight management (32).

Intensity

ACSM recommends a range of 40%–59% of $\dot{V}O_2R$ or HRR for clients with diabetes (12). In the case when exercise testing data is not available, subjective ratings of exertion should be at "moderate" to "very hard." Individual health status is an important consideration when selecting initial exercise intensity. In individuals who are regular exercisers, better blood glucose control may be achieved at higher exercise intensities (≥60% $\dot{V}O_2R$), and these clients may be well suited for HIIT (12).

For clients who are overweight, sedentary, and/or more deconditioned, an appropriate starting point is 40% of $\dot{V}O_2R$ or HRR or slightly lower depending on the initial fitness level and tolerance to exercise. The decision to progress the client through the intensity range is to be made after taking into consideration the client's age, his or her ability to tolerate exercise, and his or her individual goals. In general, frequency and duration goals should be realized before implementing a significant progression in intensity.

Because some clients with a long history of diabetes may incur a condition that can limit the rise in heart rate (and blood pressure) in response to exercise (12,32), Personal Trainers are encouraged to use the RPE scale as an adjunct method for determining intensity, an RPE range of 11–13 (on the 6–20 scale) falls in line with the prescribed $\dot{V}O_2R$ and HRR values with adjustments made on the basis of the percentage values.

Time

ACSM recommends that both Type 1 and Type 2 diabetes clients accumulate a total of at least 150 minutes of moderate- to vigorous-intensity activity per week (12). However, because many individuals with diabetes are also obese, gradually increasing exercise time to 300 min · wk^{-1} is recommended to facilitate improvements in glucose tolerance and insulin sensitivity and potential changes in body weight (36). This amount may seem high for the client who is overweight, deconditioned, or older; however, exercise may be performed in multiple bouts throughout the day to achieve the overall exercise time goal (12,32). Progressing up to 30–40 minutes of continuous activity will help the client achieve his or her caloric expenditure goals.

Type

Guidelines for choosing a mode of exercise are similar to those for an apparently healthy adult. In general, program adherence is improved if the client chooses an exercise modality that he or she enjoys. Walking is the most common form of exercise for clients with diabetes, however, for clients who are obese or experience diabetic complications (peripheral neuropathy is one), Personal Trainers should minimize high-impact, weight-bearing activities or those that require greater balance and coordination (12). Therefore, alternating weight-bearing activities with non–weight-bearing activities, such as cycling, upper body ergometry, and swimming, may enhance the safety and appropriateness of the exercise program.

Progression

Increasing cardiorespiratory fitness and maximizing caloric expenditure are of high priority in clients with Type 2 diabetes (5). Thus, the Personal Trainer should progressively increase exercise duration (either continuous or accumulated) and develop a program that promotes beneficial adaptations while combating boredom.

Resistance Training for Clients with Diabetes

- The ACSM resistance training recommendations for healthy individuals (see Chapter 14) are applicable for people with either prediabetes or Type 1 or Type 2 diabetes, with the understanding that unique contraindications to resistance exercise exist in this population —

including retinopathy, neuropathy — and following recent treatments using laser surgery (12). A resistance training program is essential for clients with diabetes to assist in managing their disease and associated complications as well as maintaining their physiological function through improving strength and endurance. Some data suggests that the increased risk of diabetes with increasing age is partly related to loss of muscle mass. This age-related muscle atrophy negatively impacts the ability to remain recreationally active, perform ADL, and maintain independence (37). Resistance training should be encouraged for individuals with diabetes or prediabetes in the absence of contraindications, such as uncontrolled hypertension, severe proliferative retinopathy, and recent treatments using laser surgery. Higher resistance (*i.e.*, heavier weight) may be beneficial for optimization of skeletal muscle strength, insulin action, and blood glucose (38) control, although moderate resistance may be equally effective in previously sedentary individuals.

- Appropriate progression of resistance exercise is important to prevent injury. Beginning training intensity should be moderate, involving 10–15 repetitions per set, with increases in weight or resistance undertaken with a lower number of repetitions (8–10) only after the target number of repetitions per set can consistently be exceeded. This increase in resistance can be followed by a greater number of sets and lastly by increased training frequency (39).

There has been an accumulation of evidence demonstrating the effectiveness of circuit weight training for managing diabetes (40). Clients would be well advised to perform circuit weight training regularly to regulate blood glucose and prevent age-related muscle atrophy. In fact, for individuals with diabetic complications such as retinopathy, circuit training with fairly light workloads is recommended because blood pressure will not increase or spike as much as it does with higher loads. In summary, using resistance training to maintain skeletal muscle mass is known to be critical for managing and improving glycemic control and insulin sensitivity, decreasing HbA1C levels, reducing intra-abdominal fat, and improving the overall metabolic profile and quality of life in those with diabetes (12,32).

Special Considerations for Clients with Diabetes

When creating individualized training programs for persons with diabetes, there are other health concerns that often accompany diabetes that need to be considered. Clients with diabetes should check their blood glucose before exercise. Ideally, blood glucose levels need to be between 100 and 250 $mg \cdot dL^{-1}$. If they are lower than this, the client should eat a carbohydrate-rich snack. Clients with Type 1 diabetes are recommended to check for urine ketones when blood glucose levels above $\geq$250 $mg \cdot dL^{-1}$ before starting to exercise (12). In the presence of urine ketones, clients are advised not to exercise and should inform the physician managing their diabetes.

Exercise has an insulin-like effect on circulating blood glucose, even in the absence of blood insulin. Thus, hypoglycemia (low blood glucose levels) is one of the most common but potentially serious complications that can occur during or after exercise in individuals with diabetes. The following strategies may be helpful for minimizing a client's risk of developing hypoglycemia.

1. Know the warning signs of hypoglycemia and hyperglycemia (Table 20.3).
2. Avoid exercise during the time when hypoglycemic medication is working at its peak.
3. Client should eat 1–2 hours before exercise (perhaps, eat a snack during exercise if duration is prolonged).
4. Check blood glucose before exercise, and if blood glucose is less than 100 $mg \cdot dL^{-1}$, the client should eat a snack.
5. Client should exercise with a partner for safety reasons.
6. Have fruit juice or candy available if blood glucose gets too low.
7. Check blood glucose after exercise, and if blood glucose is less than 100 $mg \cdot dL^{-1}$, the client should eat a snack.

Table 20.3	Selected Signs and Symptoms of Hyperglycemia and Hypoglycemia
Hyperglycemia (>300 mg · dL^{-1})	Hypoglycemia (<70 mg · dL^{-1} or rapid drop in glucose)
Polyuria	Shakiness
Fatigue	Weakness
Weakness	Abnormal sweating
Increased thirst	Nervousness
Acetone breath	Anxiety
Unexplained weight loss	Tingling of the mouth and fingers
Headache	Hunger
Trouble concentrating	Headache
	Visual disturbances
	Mental dullness
	Confusion
	Amnesia
	Seizures
	Coma

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Clients with diabetes are to work with their physician and/or registered dietitian nutritionist for nutritional recommendations related to controlling blood glucose with exercise. Clients need to be made aware that exercising in the evening may increase risk of hypoglycemia within the 36 hours following exercise compared to exercising in the morning (41). Thus, if evening exercise cannot be avoided, the clients should eat following exercise according to their physicians' or registered dietitian nutritionist's guidelines. Personal Trainers who work with clients with diabetes should be knowledgeable of, and able to educate clients about, the warning signs of hypoglycemia. Table 20.3 includes a list of selected signs and symptoms of hyper- and hypoglycemia.

Clients need to be taught the exercise guidelines that are specific for proper management of diabetes. For example, warm-up and cool-down (5–10 min each) are particularly important in this population to avoid exercise-induced cardiovascular complications. Proper footwear is also critical for clients with diabetes, especially for those with or at risk for peripheral neuropathy and peripheral vascular disease. Clients need to be advised to maintain adequate hydration and avoid exercise in hot/humid environments, which will allow them to tolerate exercise better and will assist in proper blood pressure and body temperature regulation. Also, remember to recommend lighter resistance training workloads to avoid high blood pressure spikes (especially in those with retinopathy).

In summary, the main programmatic considerations for Personal Trainers who work with clients with diabetes involve minimizing the risks involved with exercising while maximizing benefits. In cases where the individual has complications of diabetes such as diabetic retinopathy, peripheral neuropathy, or nephropathy, consult the client's physician before beginning the exercise program. These clients may need referral to a medically supervised environment if the condition limits overall exercise tolerance or if they have signs and/or symptoms of CVD.

Programming for Clients with Dyslipidemia

Elevated plasma lipid levels, or dyslipidemia, is a prevalent health concern in many Westernized countries. Readily available high-fatty foods and low physical activity levels are the primary contributors to the development of dyslipidemia. These clients have elevated plasma levels of total cholesterol or low-density lipoprotein (LDL), elevated levels of TGs, or low levels of high-density lipoprotein (HDL). Nearly half (48.6%) people in the United States older than the age of 40 years are eligible to be medically treated for dyslipidemia according to the 2018 guidelines on the management of blood cholesterol (42). If gone untreated, dyslipidemia poses a significant risk for developing CVD (43).

Adopting healthy living practices (modifying diet and increasing physical activity levels) can facilitate the decrease in lipid levels for those with or without cholesterol lowering medications. Regular aerobic exercise training has been shown to decrease LDL levels by 3–6 $mg \cdot dL^{-1}$ but conflicting findings exist on its ability to alter HDL or TG blood levels (44). Some evidence exists to suggest that resistance training can reduce LDL and TG concentrations by 6–9 $mg \cdot dL^{-1}$, but results have been less consistent as compared to aerobic exercise (45). Furthermore, modifying one's diet and losing weight play a significant role in improving the plasma lipids levels in clients diagnosed with dyslipidemia (46).

Although exercise and a healthy diet are the first-line defense in preventing and managing dyslipidemia, statin therapy has proven to be an effective for the treatment that improves survival by preventing myocardial infarctions and stroke (47). Clients should therefore be encouraged to follow their physician's medication regimen recommendations to treat dyslipidemia in addition to lifestyle changes to prevent future adverse events from occurring (45, 47, 48).

Exercise Prescription

The FITT-VP principle for individuals with dyslipidemia without comorbidities is very similar to the exercise prescription for healthy adults. One major consideration for those with dyslipidemia is that weight maintenance should be a major area of focus. Therefore, the progression of exercise volume should work toward maximizing energy expenditure for weight loss, similar to what is recommended (250–300 $min \cdot wk^{-1}$) for overweight and obese clients (49). Individuals should aim to exercise at least 5 $d \cdot wk^{-1}$ at an intensity of 40%–75% $\dot{V}O_2R$ or HRR. Each exercise session can range from 30 to 60 minutes to promote or maintain weight loss; however, 50–60 $min \cdot d^{-1}$ is recommended (12). Resistance exercise training should also be incorporated into the exercise regimen and not as a replacement for aerobic exercise. Similar resistance exercise prescription recommendations apply to individuals with dyslipidemia as health individuals. It should be performed 2–3 d · wk^{-1}, at moderate (50%–69% of one repetition maximum [1-RM]) to vigorous (70%–85% of 1-RM), two to four sets and 8–12 repetitions per set for strength. To promote muscle endurance, less than or equal to two sets, 12–20 repetitions should be completed (12).

Other Considerations for Working with Clients with Dyslipidemia

- Individuals who have developed dyslipidemia as a result of poor eating habits and a physically inactive lifestyle may also have other conditions such as the metabolic syndrome, obesity, and hypertension. If so, the exercise prescription should be modified to accommodate the condition that presents the greatest limitation as discussed in specific guidelines within this chapter and other ACSM resources (49,50).
- Individuals beginning an exercise program may have low fitness levels that reduce their tolerance to continuous activity. Therefore, intermittent aerobic exercise may be performed to accumulate the duration recommendations (30–60 min per session).

Special Consideration

- Clients taking lipid-lowering medications (*i.e.*, statins and fibric acid) may experience muscle weakness and soreness. Although rare, these medicines can cause direct and severe muscle injury. The Personal Trainer should encourage the client to inform his or her health care provider of persistent muscle soreness when exercising while taking these medications.

Programming for Obese Clients

Obesity is currently defined as having a BMI greater than 30 kg · m^{-2} (28). There has been a considerable rise in the number of people meeting the obesity classification. It has been estimated that 39.8% of U.S. adults are classified as being obese and has been shown to be highest in non-Hispanic Black women with obesity rates of 54.8%, followed closely by Hispanic women (50.6%) (51). More sobering is the continuing rise of overweight/obesity in children and adolescents. The percentage of children 6–11 years of age considered obese increased from 13.9% in 1999–2000 to 18.5% in 2015–2016 (51). These data and the known health consequences of obesity require the widespread application and adoption of healthy lifestyle behaviors, particularly physical activity and exercise training.

Reasons for the rising obesity levels are very complex and result from a number of factors including increased caloric consumption (overconsumption), decreased levels of physical activity, genetic predisposition, disease, and cultural/environmental (home, school, work, and community) influences. The close association of obesity with physical inactivity as well as to numerous chronic health issues such as Type 2 diabetes mellitus, CVD, hypertension, and certain types of cancers tend to obscure understanding its cause and may complicate treatment. Although obesity is linked to an increased risk of disability and all-cause mortality, it is not clear if this is a causal association or a result of inactivity. Personal Trainers who work with obese clientele should be prepared to interact and consult with a variety of professionals to design appropriate and effective exercise programming strategies.

Programming Goals

Personal Trainers can make their greatest impact with obese clients by providing sound exercise programs that focus on promoting adherence to an active lifestyle that matches closely with appropriate dietary strategies. This is a challenge because it is common for overweight or obese individuals to have many deeply rooted negative attitudes and barriers to physical activity behavior that must be addressed before they can truly adhere to a program. The common exercise program goals for obese individuals are to (12,49)

1. Maximize caloric expenditure
2. Maintain or increase lean body mass to maintain resting metabolic rate
3. Improve metabolic profile
4. Lower the risk of comorbidities (*e.g.*, hypertension, diabetes, orthopedic problems)
5. Lower mortality risk
6. Promote appetite control
7. Improve mood state

Aerobic Training for Obese Clients

The most recent ACSM position stand (49) recommends a minimum of 150 $\text{min} \cdot \text{wk}^{-1}$ of moderate-intensity physical activity for overweight and obese adults to improve health and to prevent significant weight gain. However, greater weight loss and enhanced prevention of weight regained will likely need much greater doses (approximately 225–420 $\text{min} \cdot \text{wk}^{-1}$) of moderate-intensity physical activity (49). Importantly, most evidence indicates that exercise alone (without dietary restriction) is fairly ineffective for weight loss, with an average of less than a 3% decrease (49).

> Most evidence indicates that exercise alone (without dietary restriction) is fairly ineffective for weight loss.

Extreme exercise or physical activity that results in a large negative energy balance will clearly result in weight loss. However, it is difficult for most individuals to achieve and sustain these high levels of physical activity. Therefore, most individuals who require substantial weight loss may need additional interventions (*i.e.*, energy restriction) to meet their weight loss goals. In terms of successful weight loss, diet with caloric restriction is the most important predictor. However, regular aerobic exercise should be used in concert with a low-calorie, low-fat, and high-fiber diet plan, thereby helping provide a negative caloric balance to achieve weight loss through maximizing energy expenditure (12). To facilitate 1–2 lb · wk^{-1} weight loss, it is generally recommended to reduce energy intake by 500–1,000 kcal · d^{-1} (12). Most importantly, once weight loss has occurred, regular physical activity in the form of exercise is the most significant predictor of long-term weight management.

Frequency

ACSM recommends a training frequency that builds up to 5 or more days per week to maximize energy expenditure in obese clients (12). Several studies have shown the effectiveness of a high-frequency exercise program on fat loss provided that the intensity is set appropriately (52).

Intensity

Moderate- to vigorous-intensity aerobic activity is encouraged (12). Initial intensities should be determined based on current fitness level (*e.g.*, 40%–59% $\dot{V}O_2R$ or HRR). Later progression into more vigorous intensities (>60% $\dot{V}O_2R$ or HRR) may be appropriate for some obese clients but should be individualized on the basis of the client's goals and history. Past research supports moderate-intensity exercise as an effective method for supporting weight loss and successful weight management (53).

Time

ACSM recommends 30 min · d^{-1} (150 min · wk^{-1}) of exercise while progressing gradually to 60 min · d^{-1} or more (250–300 min · wk^{-1}) per day (12). This amount of exercise is consistent with past research and previous guidelines for weight loss and weight management strategies (49,53). However, some clients may be too severely deconditioned or have conditions that limit their ability to exercise for this long. In these cases, prescribing multiple bouts of exercise (10 min per session or more) may be best to begin with and gradually shift to more continuous exercise later in the program(12,54). Although this is more than the recommended level of exercise needed to support general health and prevent chronic disease, successful weight control may be more likely when obese clients are exercising 45–60 minutes per session (200–300 min · wk^{-1}), expending at least 2,000 kcal or more per week (12).

Type

Regular exercise is important for general health and not only for weight loss. Thus, any type of physical activity that the client will do regularly is recommended. However, the primary mode of exercise for large clients should involve large muscle groups and be aerobic in nature to provide the greatest caloric expenditure during exercise (12). Often, resistance training exercise is an appropriate adjunct mode of exercise for obese clients because it can be done without having to support the added weight of the body. This exercise should be in addition to an overall increase in leisure-time physical activity and decreased sitting time.

Resistance Training for Obese Clients

Resistance training programs are commonly treated as an adjunct to a regular, aerobic exercise program and generally should not be used in lieu of an aerobic program. However, resistance training is a critical component of the total exercise program for obese clients and should be incorporated into the program. The benefits of resistance training for clients who are obese are similar to the apparently healthy adult; thus, following the resistance training guidelines highlighted in Chapter 14 is appropriate for obese and overweight clients.

Although there is little evidence that resistance training will reduce body weight without any modification of diet, resistance training has been associated with improvements in many chronic disease risk factors in the absence of significant weight loss (49). Resistance training has been shown to improve blood cholesterol, improve insulin sensitivity, reduce glucose-stimulated plasma insulin concentrations, and improve systolic and diastolic blood pressure (49). In addition, resistance training may also improve the maintenance of lean body mass in clients following a calorically restricted diet (55).

Resistance training may also improve the maintenance of lean body mass in clients following a calorically restricted diet.

Weight Loss Expectations

One major barrier to increasing exercise behavior in obese clients is an unrealistic weight loss expectation. Most people do not understand that exercise alone is not very effective for reducing weight. The Personal Trainer should explain that exercise is beneficial even if weight loss goals are not met. The ACSM recommends that overweight and obese individuals try to reduce their body weight by a minimum of 5%–10%, a value that is associated with initial improvements in risk factors. However, 150 min · wk^{-1} may only elicit up to 3% weight loss (49). Thus, much higher doses of physical activity combined with diet restriction are typically necessary to elicit significant weight change. For example, those in the National Weight Control Registry, who have lost and maintained a substantial amount of weight, report expending the energy equivalent to walking 25–30 miles · wk^{-1} (or more than 400 min · wk^{-1}) regularly (56).

Unfortunately, sometimes, the unrealistic expectations of clients are fostered by Personal Trainers themselves. In a survey of 500 health and fitness professionals (57), 87% responded that they felt “very competent” to prescribe exercise programs for weight loss. In other words, Personal Trainers believe that they can prescribe the amount of energy expenditure necessary for one to lose weight. However, other research indicates that Personal Trainers cannot deliver on their weight loss promises and that obese clients are extremely dissatisfied with their performance (58,59). Dissatisfaction with treatment results runs deep among persons seeking help for obesity (58). For example, obese clients who were asked about potential weight loss results indicated that a minimum of 25% weight loss was acceptable but not ideal. In addition, they noted that 17% weight loss “could not be viewed as successful in any way” (58). Clearly, there is no exercise prescription that the Personal Trainer can suggest that will elicit a 20% or greater weight loss. This amount of weight loss requires careful caloric restriction that should be done under the supervision of a registered dietitian nutritionist. Thus, Personal Trainers need to be mindful of the inconsistency between reality and expectation when working with obese clients. Thus, whereas obese clients need to understand that exercise is not a quick fix, Personal Trainers also need to understand that obesity is not caused by a simple imbalance in energy expenditure. Obesity is a heterogeneous condition that requires a multifocal treatment plan, and there is wide variability in weight loss outcomes in obese people regardless of program design. There is no singularly appropriate weight loss treatment plan for all obese people.

Personal Trainers are obligated to educate obese clients that inactivity may be the problem not body weight per se. Trainers should instruct their clients that exercise and increasing physical activity will improve health but may not cure obesity. The exercise threshold required to improve one’s health may be far below the exercise threshold required for weight loss (60). In other words, exercise is good for them regardless of whether or not they lose much weight.

Personal Trainers are advised to not generalize that obese individuals lack self-control (61) or rationalize that weight loss failure is solely a consequence of poor client compliance. As stated previously, obesity is a complex issue and successful long-term behavior change takes a multidimensional approach. Personal Trainers are encouraged to obtain further experience in motivational counseling, goal-setting strategies, and determining readiness for change before planning to work with obese clients.

Other Considerations for Working with Obese Clients

First, obese clients do not regulate their body temperature as effectively as leaner clients (12). Therefore, Personal Trainers should educate their clients on proper exercise clothing, hydration, environmental issues (hot/humid environments), and signs of heat exhaustion/stroke. Second, obese clients are at greater risk of experiencing orthopedic injuries because of greater stress on joints due to their overall weight (12). Personal Trainers should keep this in mind during program design, in particular with the intensity portion. Considerations should also be made to include non–weight-bearing modalities when appropriate to minimize orthopedic stress. Also, Personal Trainers should be prepared to modify the exercise program on the basis of the presence of other conditions (diabetes, CAD, hypertension, etc.) that may require an adjustment from the prescription given earlier. Lastly, because of size limitations, some exercise machines may not be able to accommodate an obese client. Personal Trainers may need to be creative in their exercise planning and use equipment that can accommodate their particular clients (12). Table 20.4 includes some additional recommendations to follow for weight loss programs.

Table 20.4 Additional Recommendations for Weight Loss Programs

Gradual weight loss of 1 kg · wk^{-1} or less
Daily, negative caloric balance should not exceed 500–1,000 kcal.
Target a minimal reduction in body weight of at least 3%–10% of initial body weight over 3–6 months.
Employ behavioral modification strategies to enhance adherence.
Balanced diet with fat intake <30% of total calories consumed

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Personal Trainers should be prepared to modify the exercise program on the basis of the presence of other conditions (diabetes, CAD, hypertension, etc.).

Programming for Clients with Hypertension

With nearly half (46%) of the adult population with hypertension, it remains the most prevalent risk factor for CVD in the United States (62). Hypertension is the major contributor to the risk of stroke and is also related to the development of CAD (leading to myocardial infarction), heart failure, kidney disease, peripheral vascular disease, and blindness (12). Hypertension is often called the "silent killer" because of the lack of noticeable signs or symptoms of the disease until the development of serious problems. The updated definition of hypertension is an elevated resting systolic blood pressure of ≥130 mm Hg and diastolic blood pressure of ≥80 mm Hg. However, definitions now recognize elevated blood pressure (systolic blood pressure between 120 and 129 mm Hg with diastolic <80 mm Hg) as an equally important diagnosis (62). These lower blood pressure values indicate the need for early management of moderately elevated levels of blood pressure to help prevent hypertension.

Hypertension is often called the "silent killer" because of the lack of noticeable signs or symptoms of the disease until the development of serious problems.

The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure indicated that in people with blood pressure >115/75 mm Hg, CVD risk doubles for each increment of 20/10 mm Hg (63). Personal Trainers can make a positive impact on their clients who have hypertension or prehypertension through appropriate exercise programming as part of a comprehensive lifestyle management strategy (diet, stress reduction, smoking cessation, lower alcohol consumption, etc.) or medication regimen (64,65).

Programming Goals

General programming goals in the management of hypertension are to (50,62)

1. Lower systolic and diastolic blood pressures at rest and during exercise
2. Lower the risk of mortality from CVD (myocardial infarction, stroke, heart failure, etc.)
3. Lower the risk of other comorbidities (kidney disease, eye problems, diabetes, etc.)
4. Incorporate opportunities for clients to pursue other lifestyle changes (stress management, diet, smoking cessation, weight management, etc.)

Aerobic Training for Clients with Hypertension

Aerobic exercise is the cornerstone activity in the total program for clients with hypertension. On average, clients may experience a decline of approximately 3–5 mm Hg for systolic blood pressure and approximately 2–4 mm Hg for diastolic blood pressure from aerobic exercise training (64,66). Greater change may be seen in those with diagnosed hypertension (~6–8 mm Hg and 5–6 mm Hg in systolic and diastolic blood pressure, respectively) (67). These changes in blood pressure due to physical activity alone may not seem significant; however, when coupled with other treatment strategies (diet, medication, etc.), the effect will be much more appreciable. Several studies have shown that higher cardiorespiratory fitness provides a cardioprotective effect of lower mortality risk from all causes and CVD in individuals with hypertension (68). Thus, improving overall fitness in clients with hypertension may be a worthy goal to pursue, independent of the direct effects exercise may have on lowering blood pressure.

Frequency

ACSM recommends exercise for clients with hypertension on most, if not all, days of the week. This is primarily due to greater decreases in resting blood pressure with increased frequency/duration (>150 min · wk^{-1}) of activity (69). Therefore, Personal Trainers should encourage their clients to participate in daily, regular exercise to promote more controlled and consistent blood pressure levels from day to day, which is ideal for clients with hypertension.

Intensity

ACSM recommends moderate-intensity exercise, 40%–59% of $\dot{V}O_2R$ or HRR, as the primary-intensity prescription for individuals with hypertension (5,7). Personal Trainers should apply the lower end of this range for hypertensive clients who are deconditioned, older, or have comorbid conditions that can affect their risk of experiencing cardiovascular complications during exercise (diabetes, CAD, etc.).

RPE can be used to help determine intensity rather than HR in the presence of certain medications that can affect the client's HR response during exercise (*i.e.*, β-blockers). An RPE range of 12–13 (on a 6–20 scale) is appropriate for these clients to achieve moderate-intensity exercise.

Time

ACSM recommends an exercise time of 30–60 minutes of continuous or accumulated exercise per session. Exercise duration goals are to be based on individual goals and personal history (12). A caloric expenditure goal of 2,000 kcal or more per week is indicated to help treat persons with hypertension especially if weight loss is also a goal.

Type

Clients with hypertension should primarily engage in aerobic endurance activities that involve large muscle groups and are rhythmic in nature. Avoid activities that emphasize isometric muscle contractions or that may elicit large blood pressure responses in your clients.

Progression

The basic principle of progression generally applies to those with hypertension. Specific consideration should be given to blood pressure control, recent changes in blood pressure medications, and the other comorbidities that may be present. Progression must be gradual and avoid large increases in any of the FITT-VP components, especially intensity for most people with hypertension.

Resistance Training for Clients with Hypertension

Resistance training is considered a supplement to aerobic exercise and should not be prescribed as the primary form of activity for clients with hypertension (12). When supplementing with resistance training, intensity should be kept at 60%–70% 1-RM, which may be progressed to 80% of 1-RM (12). Although studies have demonstrated a favorable blood pressure response to resistance training, the overall effect is not as great as the response to aerobic exercise training (70). Specific resistance training recommendations for these clients are similar to those used for apparently healthy adults. In addition, teaching clients proper exercise technique, proper breathing, and avoiding larger amounts of isometric work during resistance training will also help minimize large increase in blood pressure.

Other Considerations for Clients with Hypertension

The primary focus of these considerations is safety during and after exercise. As stated previously, hypertension is often associated with a variety of conditions that may require special attention and specific precautions during exercise. In these cases, the general exercise prescription may need to be modified to address these issues (7).

Hypertension is often associated with a variety of conditions that may require special attention and specific precautions during exercise.

The majority of clients with hypertension are likely to be taking some form of antihypertensive medication. Although a decrease in blood pressure following exercise is to be expected, the greatest risk these medications pose is in eliciting an abnormal drop in blood pressure (hypotension) following exercise. Therefore, engaging in gradual and prolonged cool-down activities will be important in minimizing the risk for excessive postexercise hypotension. The cool-down should never be omitted for sake of time. Antihypertensive medications are diverse in their overall action and number. As stated previously, β-blockers lower the heart rate response to exercise, whereas angiotensin-converting enzyme inhibitors lower blood pressure by preventing vasoconstriction without a significant change in heart rate. Thus, Personal Trainers are encouraged to familiarize themselves regarding the types, names, actions, and what the exercise responses are to these medications before working with hypertensive clients. The *ACSM's Guidelines for Exercise Testing and Prescription* (12) is an excellent text to use as a starting point for this information.

Lastly, Personal Trainers working with this population are encouraged to gain skill or enhance existing skills in blood pressure monitoring. Accurate measurement of blood pressure before, during, and after exercise will enhance the safety and appropriateness of the client's program. Precautions dictate that exercise be avoided if resting blood pressure exceeds 200/110 mm Hg and exercising blood pressures should remain below 220/105 mm Hg (12).

Programming for Clients with Comorbidities

In the past century, life expectancy in the United States increased from less than 50 years to greater than 76 years. The United States Census Bureau has projected that by 2030, the number of adults 65 years of age and older will be approximately 70 million. However, current trends also show that although Americans are living longer, the number of individuals with chronic diseases continues to increase. Approximately 80% of individuals aged 65 years or older are living with at least one chronic health problem (71), and another 62% are living with two chronic conditions (72). Moreover, the presence of chronic conditions is linked with an even greater propensity of comorbidities, and it is, therefore, increasingly likely that the Personal Trainer will be interacting with clientele that have multiple chronic conditions.

> Approximately 80% of individuals aged 65 years or older are living with at least one chronic health problem, and another 62% are living with two chronic conditions.

A clear shortcoming of many health care models for the management of chronic conditions is that treatment has historically been approached in a singular fashion. Patients infrequently receive guidance from medical professionals on prioritizing and managing multiple chronic conditions (73). The challenge of working with individuals with comorbidities is understanding that the presence of multiple conditions may compete with a client's self-management resources, thus reducing the time and energy an individual has remaining to devote to each and every condition (74). For instance, an individual with a severe and symptomatic condition, such as heart failure, will likely have lower prioritization of other conditions (*e.g.*, Type 2 diabetes). In turn, these individuals require additional assistance and resources to ensure that their other conditions are managed effectively. Establishing multidisciplinary partnerships is one mechanism by which the Personal Trainer can ensure clients receive the appropriate clinical attention for respective conditions (64,75).

ACSM and the American Heart Association list sedentary lifestyle as a controllable risk factor for many chronic health conditions (12,76).

Accordingly, exercise is a common therapeutic intervention strategy, and although there are exercise program guidelines for older adult and various chronic-diseased populations, these recommendations exclusively address each group separately. This section explains critical measures that can be taken to design safe and effective exercise programs for clients with multiple chronic conditions or those with comorbidities.

Programming Goals

General programming goals in the management of clients with comorbidities are to

1. Lower the overall risk of mortality by identifying the condition with the highest mortality risk; prioritize exercise program design around this condition.
2. Recognize that the presence of comorbidities may serve as competing demands on client's self-management resources, thus reducing time and energy an individual has remaining to devote to each and every condition; these individuals will require additional guidance and resources provided by the Personal Trainer to ensure that all conditions are managed effectively.
3. Have realistic expectations for the expected improvement for all comorbidities; and there will be instances where maintaining functional capacity or stabilizing the disease process can, and should, be viewed as a successful outcome.

Training for Clients with Comorbidities

Exercise training is relatively safe for the majority of clients with multiple chronic conditions provided that appropriate assessment and screening is performed prior to beginning the program (12). The likelihood of an adverse event, although not entirely preventable, can be markedly reduced with baseline assessments, risk stratification, patient education, and client adherence to established exercise recommendations. It is likely that individuals with multiple chronic conditions will be stratified into a high-risk category and therefore will require physician clearance and consent to participate in an exercise program. Clients with comorbidities require a high degree of monitoring to ensure proper adherence of the established exercise regimen and to determine that the physiological responses to each session are normal. Personal Trainers should be knowledgeable of, and able to educate clients about, the potential signs that would warrant the termination of exercise. Importantly, clients and Personal Trainers alike should consult with the medical team about any specific limitations to be aware of when designing the exercise program.

In general, the exercise prescription for individuals with comorbidities can follow the FITT-VP framework. Table 20.5 provides a summary of the basic evidence-based guidelines for common clinical populations. This resource can assist with establishing the basic parameters of the exercise prescription around the various conditions of an individual. For example, consider an individual who has arthritis, dyslipidemia, hypertension, and Type 2 diabetes. One strategy to employ, when designing the program, is to follow the specific exercise prescription for the chronic condition that poses the greatest risk of mortality for the individual. In this instance, Type 2 diabetes is generally considered to increase the risk for heart disease and all-cause mortality (77) to a greater extent compared to the other conditions. Other chronic conditions and specific limiting symptoms must also be carefully considered when formulating the program. In this instance, the frequency and time parameters of the exercise prescription for each condition are comparable. Yet, there are some marked differences in the exercise intensity recommendations between conditions. Therefore, it is prudent for the exercise professional to adopt the appropriate exercise prescription for the most restrictive condition.

Table 20.5 **A Quick Glance at the Aerobic Exercise Prescription for Common Clinical Populations**

Condition	Frequency	Intensity ($\dot{V}O_2R$ or HRR)	Time

	$(\mathbf{d \cdot wk^{-1}})$		$(\mathbf{min \cdot d^{-1}})$
Arthritis	3–5	40%–59%	20–30
Cardiac disease	3–7	40%–80%	20–60
Dyslipidemia	≥5	40%–75%	30–60
Hypertension	Most, if not all	40%–59%	30–60
Obesity	≥5	40%–59% (with potential progression to more than 60%)	30–60
Osteoporosis	4–5	40%–59%	30–60
Type 2 diabetes	3–7	40%–59% (60% $\dot{V}O_2R$ or HRR or higher for those already active)	20–60

Moderate-intensity resistance exercise is recommended 2–3 $d \cdot wk^{-1}$ in addition to the amount of aerobic exercise specified earlier.

From American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2021.

Occasionally, a chronic condition may become the primary focus for training rather than the comorbidity that has the highest mortality risk. For example, arthritis is characterized by periodic episodes of acute inflammation. Pain and discomfort are common throughout these flares, and without sufficient caution, exercise can actually exacerbate the symptoms (12). Under these circumstances, it would be ill-advised to pursue the exercise prescription guidelines for Type 2 diabetes despite its status as a higher risk for mortality. In this case, an exercise prescription resembling the recommendation guidelines for arthritis would be more suitable and may require consultation with the individual's health care provider.

Other Considerations for Clients with Comorbidities

The greatest challenge for Personal Trainers in designing exercise programs for clients with comorbidities is the amount of planning required. Considerable preparation is involved in designing programs to be safe (during and after exercise) and effective. The complexity of working with clients possessing multiple chronic conditions requires a thorough preparticipation screening. Baseline assessment and screening will help identify central problems that can prove useful in designing the exercise program and recognizing limitations. For example, insulin resistance is likely to be associated with obesity, hypertension, dyslipidemia, and other metabolic disorders. Likewise, a client with Type 2 diabetes may be expected to suffer from complications of neuropathy, retinopathy, or other microvascular complications. Individuals with multiple comorbidities may also possess conditions (*e.g.*, low back pain, lupus, osteoarthritis, fibromyalgia) that fluctuate significantly within or between days in terms of severity. For example, sometimes pain levels "flare" in the early morning other times they increase just before bed. Personal Trainers must be prepared to accommodate an ever-changing chronic condition landscape with these types of clients and constantly adjust the session to best serve the client on any given day.

Although experienced Personal Trainers can work with clients with stable chronic disease who are able to exercise independently, it is important to recognize situations when consultation with medical personnel is necessary and/or when the Personal Trainer should not take on a new client (*e.g.*, inappropriate changes of resting or exercise heart rate or blood pressure; new-onset discomfort in the chest, neck, shoulder, or arm; changes in pattern of discomfort during rest or exercise; shortness of breath at rest or with light exertion; fainting or dizzy spells; and claudication). Personal Trainers need to know the limits of their expertise and consider additional training and certification to work in concert with medical personnel in helping clients with multiple serious or unstable comorbidities.

Although experienced Personal Trainers can work with clients with stable chronic disease who are able to exercise independently, it is important to recognize situations when consultation with medical personnel is necessary and/or when the Personal Trainer should not take on a new client.

SUMMARY

This chapter explored the special considerations of exercise program design for those with CVD, diabetes mellitus, obesity, or hypertension and individuals with comorbidities. Personal Trainers are ultimately responsible for designing safe and effective programs that make a positive difference in the lives of their clients. Personal Trainers are encouraged to use evidence-based practice to guide their selection and use of a specific intervention in a given situation. Evidence-based practice is the integration of best research evidence with professional expertise and client values. The rationale for basing decisions on sound evidence is clear — programs supported by research lead to an informed action plan that minimizes risk and optimizes effectiveness.

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PART
VI

The Business of Personal Training

CHAPTER 21

Business Basics and Planning

OBJECTIVES

Personal Trainers should be able to:

- Compare options for the legal structure of the operation.
- Identify appropriate methods for employee recruitment.
- Apply best practices in employee selection.
- Train and develop staff to meet organization standards.
- Analyze various components of marketing and recognize how they influence the operation.
- Apply a sales process with prospective clients.
- Recognize the operation's cost structure and project revenue to manage a budget.

INTRODUCTION

A Personal Trainer may be very knowledgeable and skilled in exercise science principles and their application in a Personal Training session, but an understanding of the business of Personal Training is equally important for success. Whether working as an entrepreneur, a fitness center employee, or an independent contractor, a Personal Trainer needs business expertise in how to market and sell training services to potential clients and how to maintain professional standards that will protect a business reputation. For success as a self-employed Personal Trainer, business planning, legal structure of the business, and budgeting are also needed before a business can be started.

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The Personal Trainer's Position

A Personal Trainer can work in several different and distinct settings. Some of the more common venues or "job classifications" include the solo (*i.e.*, independent) Personal Trainer, the employee or independent contractor, and the manager or Personal Training business owner. The independent Personal Trainer is commonly known as one who is autonomous of another business entity. This type of Personal Trainer typically operates his or her own business, scheduling and delivering training sessions in the client's home, outdoors, or in a fitness facility. The employee or independent contractor is typically hired by a business owner to provide training services for the business's clients. The Personal Trainer/manager/owner typically supervises the business operations and staff management of a Personal Training business. Whether the Personal Trainer is a sole proprietor or an employee, success will be based on how well he or she can position and sell the training services. Although the mix of specific job tasks might differ from one setting to another, the goal is ultimately the same — to follow sound business practices and develop a profitable enterprise by delivering the optimal level of service to the end user, the client.

There are various compensation models (Table 21.1) for Personal Training services in the fitness center setting. Some facilities compensate Personal Trainers with a percentage of the revenue generated by the services they deliver, otherwise known as commission-based compensation. Other facilities hire Personal Trainers as hourly or salaried employees, possibly with designated work shifts, and may pay them an additional commission for "fee for service" sessions delivered to the members. Individual salaries or commission rates for Personal Trainers typically vary based on education, certification, experience, seniority, job performance, or volume of revenue produced. Regardless of the compensation model, it is important that all program costs be considered when initially planning the Personal Training service or business. General and administrative costs for marketing, administrative support, meetings, uniforms, payroll taxes, liability insurance, and continuing education can dramatically affect the profitability of the Personal Training service (1). Table 21.2 and Figure 21.1 provide employment estimates and average wage estimates for Personal Trainers according to the U.S. Bureau of Labor Statistics (2).

Table 21.1 Sample Compensation Models for Personal Trainers

Sample Compensation Model for Personal Trainers Working as Independent Contractor	
Pay/Salary	**Position Perks**
$42.50 per hour or session	Increase hours or sessions to make more money.
Sample Compensation Model for Personal Trainers at Corporate Fitness Site	

Pay/Salary	Pay by Hours per Week	Position Perks	Limitation
$35,000	37.5 h on average	Benefits Education fund Cash incentives	Working more hours does not increase pay.
$15 per hour or session	$30 per week (2 sessions per week typically)		
$15–$20 hourly + Personal Training fee split 60/40	One-on-one training at $50 per hour: Two sessions per week = $100 5-wk period = $500	Increase hours to make more money or do group training.	Limits to number of extra hours per week for training
$15–$20 hourly + Personal Training fee split 60/40	Group training for 20 clients (in groups of 5) at $10 per client: Two sessions per week = $400 5-wk period = $2,000		Limits to number of extra hours per week for training

Table 21.2 Employment Estimate and Median Wage Estimates for Fitness Trainers and Instructors

Employment	Median Hourly Wage	Median Annual Wage
356,900	$19.15	$39,820
Setting		**Median Annual Wage**
Fitness and recreation sports centers		$41,950
Educational services; state, local, and private		$38,360
Government		$36,250
Civic and social organizations		$33,250

Bureau of Labor Statistics, U.S. Department of Labor. Occupational Outlook Handbook, Fitness Trainers and Instructors [Internet]. Washington, DC: U.S. Department of Labor; [cited 2019 Oct 7]. Available from: https://www.bls.gov/ooh/personal-care-and-service/fitness-trainers-and-instructors.htm.

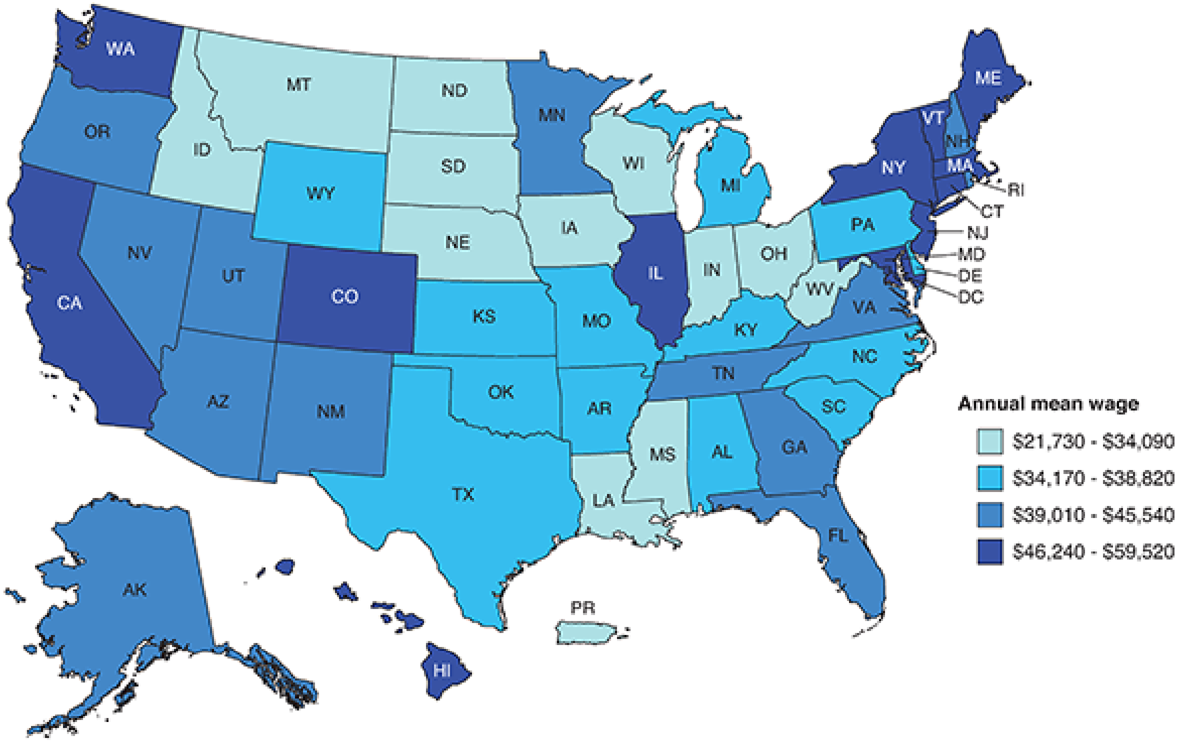

FIGURE 21.1. Annual mean wage of fitness trainers and aerobics instructors by state (May 2018). (Adapted with permission from U.S. Department of Labor, Bureau of Labor Statistics. Occupational Employment and Wages [Internet]. Washington [DC]: Bureau of Labor Statistics; [cited 2019 Oct 11]. Available from: https://www.bls.gov/oes/current/oes399031.htm#st.)

Legal Structure

A Personal Trainer may be an employee of an organization or may operate independently. If working independently, the Personal Trainer will be operating his or her own business. However, before starting the Personal Training business, it is important to determine an appropriate legal structure from which to operate. There are four basic legal structures: sole proprietorship, partnership, corporation, and limited liability company (LLC).

There are four basic legal structures from which to choose for a Personal Training business: sole proprietorship, partnership, corporation, and LLC.

Sole Proprietorship

In a sole proprietorship, one person owns the business. As the simplest, least-expensive legal structure, often the only requirement before starting operations is a license from the state and/or local city where the business will be located. Personal income tax is paid on any business earnings. One key disadvantage to this structure is that personal and business assets are recognized as one, meaning that the sole proprietor is responsible for the debts and obligations of the business. In addition, raising capital for business start-up or growth can be challenging because funds must be provided by the entrepreneur or secured through a bank loan, often with personal assets as collateral (3).

Partnership

A business partnership is formed by two or more people, either with an informal agreement or with a formal written contract filed with local or state government. Partnerships are loosely governed by state and federal regulations and are subject to personal income tax based on each partner's ownership share. Forming a partnership allows pooled financial resources and talents, but ownership transfer among partners may be difficult, and each partner can be held liable if another partner fails to meet business-related obligations (3).

Corporation

A corporation is a legal entity completely separate from its owners and managers. This means that the organization is taxed as such, and in fact, is said to be taxed twice — once on the money it earns and again when dividends are distributed to shareholders. Its financial and legal liabilities are independent of owners and managers, which provides some level of protection for those individuals. Additionally, corporations may have an easier time raising capital than smaller businesses, and ownership can be more easily transferred. However, the cost of incorporating is high, and this structure is more demanding on organizational resources due to regulations pertaining to operations, records, and reporting (3).

The S corporation (or subchapter corporation) is an alternative to the traditional corporate model (called a C corp) that some small businesses may elect to use. The S corp eliminates the double taxation of a C corp, but states vary in how exactly the entity is taxed. Also, in addition to the regulatory requirements of a C corp, the S corp has special requirements that must be met, such as maintaining fewer than 100 shareholders, and all shareholders being U.S. citizens.

Limited Liability Company

An LLC is generally a favorable option for small- to medium-sized businesses because it provides personal liability protection and yet also avoids double taxation. The owners of the LLC are referred to as members, and membership can change if provisions for such are included in the LLC's original agreement (3).

Management

If working in a commercial fitness setting, corporate wellness facility, or a nonprofit community recreation center, a Personal Trainer may be employed to manage the Personal Training department while still maintaining a schedule of training clients. This added responsibility requires sound organizational skills and time management. In addition, skills in hiring, employee training and supervision, marketing, sales, and operations are needed by the Personal Training manager. Finally, depending on the setting and organizational structure, the Personal Training manager may be the individual who determines the vision for the department or service, establishes a set of core values that serve as a compass in decision making, and builds and maintains the culture.

Recruitment and Selection

Author and speaker Simon Sinek said, "*If you hire people just because they can do a job, they'll work for your money. But if you hire people who believe what you believe, they'll work for you with blood and sweat and tears*" (4). The goal of the Personal Training manager or business owner is to find and hire the people who believe in the same values and will execute on the organization's vision. This is not an easy task, but employee recruitment and selection are key to the viability of the business.

Recruitment

Personal Training is all about relationships, communication, and results. The Personal Training manager or business owner should find people who have the knowledge to design successful training programs *and* the people skills to build relationship with clients.

One of the first decisions to make in the recruitment process is whether the new hire will be an employee or an independent contractor. Employees can be more "expensive" to an organization in the forms of payroll taxes, overtime pay, or benefits, whereas an independent contractor receives only the agreed-on compensation, which does not include overtime pay or benefits. However, organizations have more control and influence over *how* the job is done by an employee, so this relationship may be the appropriate one from a legal standpoint. For example, an organization that wants to set its own prices and set standards of behavior of Personal Training staff members needs to hire employees; an organization that is comfortable with simply making a Personal Training service available to its users with no interest in or preference for *how* the job is done and what clients are charged can use the independent contractor arrangement. Organizations that do not choose the appropriate working relationship opens itself up to fines and lawsuits (5).

Regardless of business model or setting, trainer recruitment looks the same in all contexts:

- *Network in the local fitness community*: This approach is easier in larger cities, but even in smaller ones, it is good to know of all the facilities that offer Personal Training; the Personal Trainers who do in-home training;

or those who run online, virtual sessions. Keeping the pulse of who is working where and who might be interested in new opportunities may present recruitment opportunities.

- *Post the position online*: There are many methods available to post available positions, including the organization's Web site and social media channels, print or online ads, and job boards. Job boards may include those of a membership organization, an industry-specific (*e.g.*, fitness, corporate wellness) Web site, or a general recruiting Web site.
- *Scan databases of certifying organizations*: Some certifying bodies post lists of their certified Personal Trainers in online registries, so recruiting efforts may be as easy as entering a zip code. A certification does not necessarily mean that the potential trainer has practical experience, but these databases can provide a pool from which to start a recruiting process.
- *Tap into academic institutions*: If the operation is close to a college or university, there may be a kinesiology department that offers a course on Personal Training and even prepare students to take a national certification. Networking with the administrators and faculty can provide a steady stream of interns and potential trainers.

Selection

The first step in deciding who to hire is to compare every application and résumé, via a checklist or rubric, with its job description. With this method, the Personal Training manager can rank the applications and résumés by how closely they align with the desired profile. Performing this step reduces the pool of candidates to only those who should continue in the selection process.

Remaining candidates should go through a series of standardized interviews. The first interview is often a brief phone screen or online interview conducted by the immediate supervisor and focused on uncovering the basic values, beliefs, attitudes, and skills of the applicant. If the candidate meets the expectations of the first interview, then a second, in-person interview should be conducted with the immediate supervisor or even additional members of the team. This second interview should be more detailed than the first and should focus on behavioral interview questions and role-play situations that are designed to be value indicators of success in the health club business. If the candidate gets through the second interview successfully, then the third interview should be a practical interview in which the candidate demonstrates skills in assessment and exercise instruction with a staff member serving as a mock client.

The following are important steps to follow when selecting a Personal Trainer (Case Study 21.1):

1. Résumé should be reviewed carefully and matched against the job description for educational background, current certifications and credentials, recent training experience with relevant clientele, and innovative training programs.
2. Applicants should be asked to bring copies of current fitness and cardiopulmonary resuscitation (CPR)-automated external defibrillator (AED)/first aid certifications to the interview appointment. This assures that the Personal Trainer's certifications are from valid agencies/organizations and have not expired. Alternately, the online United States Registry of Exercise Professionals may be used to verify fitness certifications from some organizations (6).
3. The Personal Trainer/manager should create a list of standardized questions to ask all Personal training applicants, which ensures fairness and accuracy when comparing candidates. Additionally, the list should include behavioral questions, which ask candidates about specific situations they have faced and how they handled them, including program design for types of clients the candidate is likely to encounter if hired.
4. The Personal Trainer's availability and scheduling preference for appointments should be clearly assessed and agreed to prior to an interview. If the department needs an evening Personal Trainer and the interviewee is already training elsewhere in the evening, both parties need to know this information to determine whether and how to move forward.
5. A practical or "hands-on" component (*i.e.*, demonstration) should be a part of the interview process. With someone serving as a hypothetical

client, the Personal Trainer should demonstrate commonly used assessments and explain the results. Additionally, the candidate should instruct the client on exercises and demonstrate spotting techniques on the fitness floor. The Personal Trainer/manager should observe and assess how the candidate interacts with this person.

Case Study 21.1

Interviewing Candidates for Fitness Staff/Personal Trainer Positions Fitness staff/Personal Trainers need to be knowledgeable, personable, motivating, able to communicate well, interact with all types of clients and personalities, and handle problems professionally.

Interview Questions: Ask common interview questions along with open-ended, behavioral (experience-based) questions. Asking candidates for specific examples of past behavior as they relate to the job requirements and problem-solving skills can provide concrete examples of what they have done in the past and can bring to your facility. The behavioral job interview is based on the logic that past behavior predicts future behavior.

Behavioral interview questions will be more pointed, more probing, and more specific than traditional interview questions. Some examples:

- Give an example of an occasion when you used logic to solve a problem.
- Give an example of a goal you reached and tell me how you achieved it.
- Describe a decision you made that was unpopular and how you handled implementing it.
- Have you gone above and beyond the call of duty? If so, how?
- What do you do when your schedule is interrupted? Give an example of how you handle it.
- Have you had to convince a team to work on a project they were not enthusiastic about? How did you do it?
- Have you ever handled a difficult situation with a coworker? If so, how was the situation handled?
- Tell me about a situation where you worked with a client who was being difficult. How did you handle it?

- Tell me about a time that you had to work effectively under pressure.
- Tell me about a project or program you developed/conducted from which you are most proud. With this project or program, what do you feel you did best, and what could you have done better?
- Describe a time that you failed at something. What would you do differently if you were in that situation again?
- Give me a 30-second elevator speech as to why I should hire you.

Practical Interview: Set up an interview for potential candidates where they will actually go through an abbreviated version of a typical consultation, assessment, and workout by using your staff as a client. This practical assessment provides an excellent opportunity to watch the candidate in what approximates a typical work situation.

- Using another staff member to serve as a client is a great way to observe the candidate's communication skills and see how they interact with the client.
- Prior to the practical interview, you can brief the client on doing some things incorrectly to see if the candidate notices and makes corrections.
- Assessments should include the initial consultation when the candidate reviews the health/history form and application with the client, which allows you to see how candidate conducts the consultation and is able to effectively answer the client's questions.
- Assessments can include various resting measures, muscular strength and endurance, cardiovascular endurance, or functional movement analyses. It is best to have already tested the staff member so that you know whether the candidate's results are accurate.
- For the brief workout, the candidate should select exercises that are relevant to the client's stated goals and assessment results and explain to the client how they are relevant.
- During the assessment and exercise instruction, you are looking for the following:
  - Whether candidates explain what they are doing and why

- How they interpret the results to the client
- Whether they act professionally and appropriately
- Whether they address the client's questions and concerns
- Whether they can make any necessary modifications

Setting Training Standards

The Personal Training manager is ultimately responsible for the safety and customer satisfaction of every Personal Training client. Therefore, it is necessary to set standards for delivering Personal Training services in a manner that is consistent with industry standards and guidelines for safety and will ensure that an excellent experience is consistently delivered. Here are some guidelines for setting the department's service standards:

1. Personal Trainers must give their undivided attention to their clients (see Chapter 10). This means that Personal Trainers must watch clients at all times and spot exercises with appropriate techniques. Behavior expectations should be specific. Using cell a phone, talking with other Personal Trainers or other members, and watching television monitors are examples of unacceptable behaviors that would not meet training standards of practice. In addition, a Personal Trainer who spends much of the training session talking about his or her personal affairs will have difficulty focusing fully on the client's workout and exercise technique (see Chapter 1).
2. The Personal Trainer must demonstrate respect for the client's time and schedule by beginning and ending training sessions on time.
3. There should be a standard dress code or uniform for an organization's Personal Trainers. The shirt, along with established standards for pants and shoes, will ensure a professional and consistent appearance for the Personal Training department.
4. The Personal Trainer should record notes for every client's workout, as well as any measurements, tests, and performance tracking for that client (see Chapters 12 and 13). With the client's written consent, these records

can be made accessible to other Personal Trainers, such as another staff member who may train the client while the Personal Trainer is on vacation or the Personal Training department manager. One record-keeping option is a standardized "training card" provided by the Personal Training department manager (Table 21.3) and kept in a designated locked cabinet when not in use. Another option is a software application accessible via phone, tablet, or PC. Before purchasing the app, however, the Personal Training department manager should learn from the vendor who will own the client data — the software vendor or the customer (Personal Training organization). This becomes relevant when the organization stops using the app because it can acquire and transfer the client data into a new app if it owns the data, whereas it may not be able to acquire the data if the software vendor retains ownership. In addition, the app should have the ability to restrict access of each client record to specific users, such as the client's Personal Trainer and the Personal Training department manager.

5. A client confidentiality policy should be established and Personal Trainers should be trained to avoid discussing any client's personal information with others. Personal Trainers must respect their clients' privacy and be trustworthy (see Chapter 22).
6. Honesty and scope of practice standards should be emphasized (see Chapter 22). If a Personal Trainer does not know the answer to a client's health- or fitness-related question, the Personal Trainer needs to admit that he or she does not have that information but will volunteer to research the topic and provide an answer at the next training session. If the client is asking for medical advice or a diagnosis, the Personal Trainer must not overstep his or her scope of practice but should explain that the client needs to consult his or her physician or health care provider for that information (see Chapter 1) (7). Ideally, the Personal Trainer should establish a network of allied health care professionals through which referrals can be made to physicians, physical therapists, dietitians, psychologists, and other health care experts. See Chapter 22 for more information regarding scope of practice.

7. Personal Trainers must maintain current Personal Training certifications, CPR-AED/first aid certification, and liability insurance if it is not provided by the fitness facility. Records of certification and professional liability insurance should be kept in employee files (1).

Table 21.3 **Sample Training Card**

Sample Workout Log

Name:	**Date:**	**Height:**	**Weight:**	**Goals:**

Weight Training:

Exercise	**Sets/Reps**	**Sets/Reps**	**Sets/Reps**	**Sets/Reps**	**Sets/Reps**	**Sets/Reps**
Leg press						
Calf raise						
Ab curl						
Back extension						
Lat pull-down						
Asstd. chin						
Chest press						
Shoulder press						
Upright row						
Triceps extension						
Biceps curl						

Cardio:

Date	Exercise	Time (min)	Intensity	Comments
	Walk	20	3.5 mph	Flat surface
	Walk/jog	20	Moderate	More challenging
	Water aerobics	45		

Stretching:

Entire Body	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
	Yes	Legs	Yes	Legs/back	Yes	No	No

It is necessary to set standards for delivering Personal Training services in a manner that is consistent with industry standards and guidelines for safety and will ensure that an excellent experience is consistently delivered.

Training and Empowering Personal Trainers

Personal Trainers should be encouraged to continuously read, learn, and stay current on the latest industry standards and changing trends. The Personal Trainer/manager can subscribe to trade journals, publications, and online resources and make them available to the Personal Trainers. Budget permitting, some Personal Trainers/managers can provide an annual educational stipend for each Personal Trainer, which will subsidize his or her participation in continuing education to maintain Personal Training certifications. Others provide continuing education credit (CEC) or units (CEUs) for in-house educational sessions to make it convenient and cost-effective for Personal Trainers to earn credit for continuing education or for recertification. Personal Training managers may also hold regular staff meetings with Personal Trainers and have them take turns giving presentations or workshops to the staff, complete with handouts and group discussion time.

Managers should empower Personal Trainers by encouraging them to share ideas in meetings, help plan and implement new training approaches, such as small-group training or sport-specific training, and share ideas for how to increase clientele and improve sales. Attending professional conferences and workshops is a good way to earn CECs/CEUs, keep current with the latest research, learn about new programming, and network among peers. Personal Trainers should be included in discussions about pricing of training sessions and their compensation rates. They should be treated as professionals, and their creative ideas and opinions should be valued. They should feel like an integral part of the training and business team.

Practices and Policies

To manage a business effectively, the Personal Trainer must work from a business plan, which should include the creation of a business vision, mission statement, business values, a brief description of the business services (Box 21.1), the choice of a legal structure, and the listing of operational policies (8), such as the following:

- Billing (Will clients prepay for each session or will you bill them monthly?)
- Cancellation policy (How many hours of notice will you need without charging the client?)
- Late arrival policy (Will you extend the session or end at the originally scheduled time?)
- Vacation policy (What will this be for both the Personal Trainer and the client?)
- Payment methods (Will the client pay by cash, check, debit/credit card, or automatic deduction? At the facility and/or online?)

Box 21.1 Sample Mission Statement

The Personal Training Academy

Our Mission

- To create value for shareowners through our marketplace leadership in Personal Training and fitness programming that helps all of our clients achieve their goals

Our Vision

- To grow profitably by delighting customers and achieving undisputed leadership in the field of Personal Training

Our Values

- Integrity, honesty, and the highest ethical standards
- Mutual respect and trust in our working relationships
- Innovation and encouragement to challenge the status quo
- Communication that is open, consistent, and involves both assertive messages and active listening
- Teamwork and meeting our commitments to one another
- Continuous improvement, development, and learning in all we do
- Diversity of people, cultures, and ideas
- Performance with recognition for results

Service Description

- The Personal Training Academy provides Personal Training clients with the best possible physical and psychological advantage by improving their focus, discipline, and self-confidence. This is achieved through the most advanced state-of-the-art Personal Training techniques available, thus enhancing the client's ability to compete and achieve success both in fitness and in life.

Additional Managerial Responsibilities

In addition to the earlier text, a Personal Trainer who is an entrepreneur or manager of a fitness department may also be responsible for fitness equipment purchases, maintenance and repairs, emergency action plans, special fitness programming events, health promotion activities, and, in some cases, a group fitness program. Even with all of these responsibilities, a Personal Trainer who serves as fitness manager may still be expected to retain Personal Training clients for additional revenue and to supplement his or her income in addition to that received managing the fitness department.

> The fitness department manager may also be responsible for fitness equipment purchases, maintenance and repairs, emergency action plans, special fitness programming events, health promotion activities, and, in some cases, the group fitness program.

Marketing

Regardless of whether a Personal Trainer operates independently, is an employee, or leads a Personal Training department, it is important to understand basic concepts of marketing to be successful in the marketplace. Contrary to popular belief, marketing is more than simply advertising. The American Marketing Association defines marketing as "the activity . . . and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large" (9). In practical terms, marketing is composed of multiple variables that the Personal Trainer can use to acquire, serve, and retain clients.

Business Planning

To establish and administer a business, the Personal Trainer should first develop a business plan. The business plan includes a demographic and competitor analysis, establishing a budget, developing management policies, marketing, sales, and pricing.

The first step involved in creating a solid business plan is a comprehensive demographic analysis. Acquire data about the population located in the area. Depending on the scope of the Personal Training operation, this may include individuals living in a 2- to 10-mile radius from a specified location. During this phase of the plan, one should examine the total number of people, number of households, household income, number of families, and a variety of other population characteristics. These demographic markers will provide the business operator with the preliminary information necessary to determine whether there is a chance his or her business can be successful in the chosen marketplace.

The first step involved in creating a solid business plan is a comprehensive demographic analysis.

Once the demographic analysis has been conducted, the business operator should thoroughly evaluate the competition inside the market area (a geographic region from which one can expect the primary demand for a specific service provided at a fixed location). Virtually all fitness centers offer Personal Training, so these entities will represent the greatest competitive threat to the viability of the business. Other potential competitors might include boutique fitness studios, gender-specific facilities, and hospital-based wellness programs or medical fitness facilities. The strength or weakness of the competition will help determine the percentage of market share that can reasonably be expected to cultivate within the defined market.

The Marketing Mix

A long-standing concept in marketing is the marketing mix, which has been defined as the set of tools used by individuals and organizations to meet their business objectives and serve consumers (10). For many years, the marketing mix included four types of marketing activities that came to be known as the four Ps: product, place, price, and promotion. Later, “people” was recognized as a fifth P.

- Product: In this case, the product is actually a service (Personal Training), but the concept is the same. This includes attributes such as product/service variety, quality, comprehensiveness, and benefits to the consumer.
- Place: This may be a physical location at which the service is delivered, such as a facility or a park, or it may be virtual, such as content delivered online (*e.g.*, video, newsletters, blogs, e-books).
- Price: The price of the service includes attributes such as the standard price, discounts, promotions, forms of payment, and payment methods.
- Promotion: This is the “P” that comes to mind for many people when they think of marketing. Promotion is composed of channels (print, TV, radio, pay-per-click ads, social media, Web site, etc.), logos, messaging and content, and the sales process.
- People: The Personal Trainer should consider not only who he or she serves but also others involved in the delivery of his or her services, such as employees, vendors, managers, owners/investors, or community partners.

In recent years, other “Ps” have also been recognized as being important to business success, such as process (policies and practices of the Personal Trainer) and physical artifacts (*e.g.*, uniform, equipment, décor).

The Personal Trainer’s unique combination of the factors earlier identify the offerings of the Personal Trainer to the consumer and serve to differentiate him or her (10). This representation in the consumer’s mind is the Personal Trainer’s position in the marketplace and helps the consumer categorize the services of the trainer or organization for consideration. These categories may include price (*e.g.*, low-cost, premium), training type (*e.g.*, endurance training, high-intensity interval training), or facility type (multipurpose, boutique studio, sports performance). The name(s), symbols, colors, and words associated with the Personal Trainer or organization comprise the service provider's brand, which serves as a visual representation of the position and marketing mix of the service provider.

The Market

The Personal Training market includes different groups of people with varying needs. A market niche represents a client group with similar needs and goals. Personal Trainers often choose to focus their efforts on one or several of these groups. For example, a Personal Trainer could select a niche market based on one or more of the following:

- Client type (*e.g.*, gender, age range, fitness level)
- Training needs (*e.g.*, sport-specific training, prenatal fitness, older adult fitness, group training)
- Training location (*e.g.*, in-home training, health fitness facility training, sport location training)

> A market niche represents a client group with similar needs and goals.

Personal Trainers should ask the following questions when selecting their market niches:

- What is the potential for income with this market?
- Is this market accessible in my market area?
- Does this market fit well with my training skills and interest?
- Can I feature my knowledge, services, certifications, and skills in such a way to reach this market as my clientele?

Promotion

One of the best ways to promote Personal Training services is to ask for referrals from satisfied clients. Personal Trainers sometimes are hesitant to do this, but if the Personal Trainer believes that a client has benefited greatly from the training, then other potential clients may want to also receive these same benefits. Other ways of promoting Personal Training services include volunteering to speak at community events and organizations and networking with other business professionals in the community. Advertising on the Internet, newspapers, flyers, and by direct mail can be costly and may not provide a good return on the investment at first. Establishing a Web site that profiles training style and qualifications, creating content (*e.g.*, blogs, videos), and establishing a presence on social media are other approaches for promoting a business and staying competitive in the fitness marketplace.

Personal Training businesses use a variety of methods to attract clients. Among the more common are the following:

- Client referral (the most focused method): The focus here is on generating leads through existing clients, and incentives are typically given to clients for providing referrals. It is usually an ongoing activity.
- Advertising (most expensive and lowest rate of return on investment): In general, this tactic is designed to establish awareness and build brand recognition in the marketplace. Traditional advertising (*e.g.*, print ads, radio) is a shotgun approach to reaching clients, whereas some online advertising (*e.g.*, social media, pay-per-click) may allow for a more targeted approach. Regardless of method, the most effective type of advertising for generating leads provides a “call to action” and typically creates urgency by establishing a deadline.
- Promotional content and materials: This approach can be used to create brand awareness, generate leads, convert leads into prospects, or to enhance relationships with existing clients. Content and materials are designed to create a positive image of the business, educate consumers on general health/fitness and on the business specifically, and position the business as a trusted resource. Examples include Web sites, blogs, videos, social media, flyers, and print brochures.
- Direct mail: This tactic is primarily a technique for creating leads or turning leads into prospects and is surprisingly still relevant in a digital world because it complements other forms of advertising. Direct mail lists from agencies should be used (targeted lists — such as ZIP codes or even specific delivery routes — can be obtained to best match the desired

market area and demographics of the target audience). The piece that is mailed is typically simple, with an attention-grabbing call to action and normally incorporates an incentive to create urgency.

- Community involvement: This method focuses on creating relationships to create brand awareness and uncover leads and prospects, so it is ideal for service- and relationship-driven businesses such as Personal Training. Examples include the following:
  - Become active in community organizations, such as the local chambers of commerce, the Rotary Club, church groups, and other civic organizations.
  - Volunteer as a speaker for community organizations and special events or offer to provide simple screenings at events to advertise your services.
  - Join small business groups and pair up with others and exchange services. For example, you can provide Personal Training to another small business owner in exchange for accounting services.
- Public relations: This tactic is used to create brand awareness and enhance the public image of the organization by establishing positive relationships with the local media. Actions include developing a press kit on the Personal Trainer or the business as a whole (*e.g.*, a background, fact sheet) and regularly issuing press releases of human interest involving the trainer or organization and following up with media contacts.
- Strategic alliances: This method is designed to create partnerships between businesses and organizations with similar target audiences and is helpful with bringing in leads and prospects, as it involves cross-promotion between the businesses. Examples include the following:
  - Partnering with a home fitness equipment retailer to offer equipment purchasers a complimentary "orientation" to the purchased equipment, with the objective of converting them into clients; the retailer benefits by offering consumers a "value-added service" (the Personal Trainer), which might entice the customer to purchase the equipment.

- Exercise is Medicine® (EIM®) (www.exerciseismedicine.org) encourages health care providers to counsel patients about exercise and turns the public's focus to preventive health care through physical activity. This is a valuable and essential opportunity for Personal Trainers to partner with physicians to help educate their patients about physical activity.

Pricing Concepts

Put simply, price is the agreed-on economic value of a product or service. To properly understand and set your price, consider the following:

- What are your costs, and how much revenue do you need to break even? How much to generate your desired profit/income?
- What are your business objectives when setting prices? Do you want to maximize your profits or maximize your market share?
- How does the buyer decide on the worth or value of your services? Is it based on effectiveness of services, location, schedule convenience, staff qualifications and motivational capabilities, competitor prices, or (most likely) a combination of all of the above?
- Who are your competitors, and what do they offer? What are their prices, and who are their customers? Are you competing directly with another trainer or business that caters to your target market?
- Who is the primary leader in establishing the customer's perception of value? Is it you or the competition? What does this do to your pricing strategy and flexibility?
- What signal(s) do you want to send to the marketplace about yourself and your services? That you are a premium provider? That you are affordable and accessible?

Sales

Too often, Personal Trainers simply focus their sales efforts on promotional tactics, such as creating a Web site, signs, or flyers, hoping that clients will flock to them for training. The mistake here is that such efforts on advertising activities that offer a low return on the investment of time, money, and effort, as the Personal Trainer is dependent on the reader to respond to the marketing piece. The key to sales success is for the Personal Trainer to selectively use available resources, proactively cultivate leads and convert them into prospects, and finally, ask the prospect for the sale.

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Before going into the sales process, "sale" must first be defined. A sale is simply an agreement — a quid pro quo — between the Personal Trainer, the client, and, at times, the facility where the training sessions will take place. A sale is not an imposition on the client. All too often, a Personal Trainer is almost apologetic when asking for the sale. In actuality, every sale is a "win–win" situation because all participants position themselves to get what they want. Clients are securing the direction, expertise, or motivation they desire, and the Personal Trainer is contracting his or her professional services. The ingredient needed to fulfill the sale is commitment. The client must commit to what was agreed to at the point of sale (*i.e.*, funds, showing up prepared for each scheduled training session), and the Personal Trainer must commit to deliver on the service "promise" to the client (*i.e.*, delivering a safe, individualized, goal-oriented workout).

In the fitness center environment, the Personal Trainer's primary source of business is the membership base because this captive audience is the main resource for prospects. Outside of this environment, the Personal Trainer may have his or her first in-depth conversation with a prospective client as part of a free consultation, or as a result of that individual's inquiry via e-mail, social media, or phone.

Before meeting with a prospective client, Personal Trainers should have a clear understanding of their objective and what value they bring to the potential client. During the conversation, it is important to be empathetic and see things through the eyes of the prospective client. Why should this person consider Personal Training? What is in it for him or her? The Personal Trainer should know the various benefits of Personal Training and be able speak directly to the goals sought by the client (Box 21.2).

Box 21.2 Benefits of Personal Training

- Client achieves results more quickly.
- Reduces the risk of injury to the client
- Increases the client's motivational levels
- Provides more focused workouts for the client
- Uses the client's time more efficiently
- Educates the client on physical and psychological benefits of regular exercise

The Personal Trainer needs to listen to the prospective client's questions and concerns. What are the prospective client's perceptions of exercise in general and of Personal Training specifically? Will Personal Training help the participant achieve the desired goals? Will the participant benefit in additional ways? Even when an individual understands and believes in the value of Personal Training, he or she might not make the commitment to purchase training sessions. If the prospective client does not, the Personal Trainer should learn what the objections are and address them and then help the prospective client consider how he or she feels about the desired goals and how he or she will feel when they are fulfilled (see Chapter 8).

Outlined on the following pages (and in Box 21.3) is a sample step-by-step sales process that can be used with prospective clients in a variety of settings.

Box 21.3 The Fitness Facility–Based Personal Trainer's Sales Checklist

- Be proactive. Approach prospective clients and always remember to smile — *be positive and upbeat no matter how bad a day you are having*.
- Top priority is to build rapport — develop a relationship of mutual trust and confidence.
  - Listen!
  - Be warm — treat prospective clients with respect.
  - Be genuine — exude sincerity.
  - Be empathetic — see their world as if it was your own.
- Sell *benefits* of Personal Training but key into *how they will feel* when achieving those benefits.
- It's a win–win!
- You must *ask* for the sale! — *It is a numbers game. The more prospects you ask, the more sales you will make*.

Step 1: Making Contact

Getting a foot in the door. The facility-based Personal Trainer needs to proactively approach facility members exercising on the gym floor. The Personal Trainer should greet the member with a smile and offer his or her expertise on the basis of his or her observations of the member. Sample "openings" may include the following:

- "Hi! May I help you with your exercise program?"
- "Hey Mark, would you mind if I show you a more effective way to do this exercise?"
- "Hello Linda, I noticed you're really focusing on your lower body. Can I show you a great new combination of exercises for your hips and thighs?"

Step 2: Building Rapport

Establish trust. Personal Trainers must build rapport and trust so not only that prospective clients believe in their ability to help clients achieve goals but also that the Personal Trainer has clients' best interests in mind. A Personal Trainer builds trust by taking a personal interest in the client, making mental notes of the likes, dislikes, or personal information that the prospective client may share with the Personal Trainer. Information such as a recent business trip or upcoming holiday plans can serve as the basis for rapport-building conversations (see Chapter 7).

Step 3: Assessing Need

Stop talking and listen. The best salespersons are seldom the best talkers — they are usually the best active listeners. The Personal Trainer should key into the prospective client's motivations and not just focus on what he or she wants but also learn *why* the prospective client wants it. Ask simple open-ended questions that encourage the prospective client to share information.

Step 4: The Tease

Show what you can do. In this step, Personal Trainers continue to build trust and demonstrate their value. The simplest ways are to

- Assist a prospective client with another exercise or make program suggestions.
- Observe the individual as he or she is progressing through a workout and suggests a different or more effective approach.
- Literally "train" the client for 5–10 minutes, giving the prospective client a taste of what it is like to work with him or her.

This sampling of the value that the Personal Trainer can provide is the "tease" that should keep the prospective client wanting more.

Step 5: Presenting a Winning Proposition and Closing

Asking for the sale. The Personal Trainer must present a winning solution to the prospective client's needs before asking for the sale. A brief description of what the program would entail and how the Personal Trainer operates frames the pitch so that the prospective client is more likely to respond affirmatively when asked for the sale.

There are various methods the Personal Trainer can use to then close the sale once the conversation has uncovered the prospective client's goals, motivations, decision criteria, and objections. Examples include the following (11):

- *Question close*: "Is there anything that would prevent us from working together?" This asks for the prospective client's commitment or an explanation of any further objections.
- *Assumptive close*: "Does this sound like something that would be of value to you?" Prospective clients who answer "yes" to questions like this lead themselves to an affirmative response to the pitch.
- *Soft close*: "If I could help you reach your goal by your desired date, would that interest you?" This type of question clearly reiterates the value of Personal Training and moves the prospective client closer to firmly committing.

Step 6: The Fall-Back

Opening the backdoor — "the tickler file." Every prospective client that says "no" becomes a "future prospect." The Personal Trainer should maintain a database of contact and personal information (*e.g.*, likes, dislikes, occupation) of these prospective clients for further rapport building, always looking for the opportunity to demonstrate value and once again ask for the sale. E-mailing prospects fitness articles of interest or briefly assisting them on the fitness floor are all examples of how to effectively "drip" on prospects to build a Personal Trainer's value. Personal Trainers in a fitness center setting should also do whatever they can to keep the prospect coming in to work out, even if the individual continues to train on his or her own; doing so helps maintain the Personal Trainer's "warm market" so that the person remains a prospect and possibly even serve as a source of referrals to the Personal Trainer.

Step 7: Keep in Mind

It's a "numbers game." An insurance company study conducted several years back showed that even the worst approach to selling can be successful if the salesperson simply goes through the numbers and "keeps asking." With this in mind, understand that a prospective client is always a potential customer, so practice cautious persistence and always maintain professionalism.

Financials

The Personal Training manager or business owner does not need to be an accountant or financial expert to effectively manage the operation. However, a comfort level with numbers is a necessity so that appropriate decisions can be made regarding pricing, equipment purchases, operational expenses, and trainer compensation and payroll.

Establishing a Budget

A market analysis will make available valuable information useful in developing an annual operating budget. It provides the baseline data to build a budget. Personal Training businesses typically begin with determining sales goals. The sales goals may be set by determining the projected number of training sessions over the course of a week, month, and year multiplied by the average rate per session. These totals will help determine direct expenses over each period of time because direct expenses correlate with sessions delivered multiplied by the cost per session (the Personal Trainer's wages). To establish a budget, the Personal Trainer should consider the following:

1. Estimate business expenses (exclusive of salary) needed to operate annually, which may include the following:
    a. Rent (and rent down payment at lease signing)

b. Gas/vehicle maintenance travel allowance (an expense sometimes paid to Personal Trainers who go to homes, corporations, or other studios or facilities)
c. Income taxes and other required national, state, or local taxes (*e.g.*, Medicare, Social Security, workers compensation, unemployment insurance)
d. Liability insurance, fire, theft prevention insurance (insurance depends on square footage of the facility, number of trainers, and whether in-home or at a commercial location)
e. Telephone and technology (*e.g.*, computers, Internet, music rights use, e-mail and Web site hosting, software)
f. Uniforms, towels, washing service, and amenities (*e.g.*, water, postworkout fruit)
g. Professional memberships/certifications
h. Conferences and continuing education training
i. Business supplies (*e.g.*, computer, office supplies, postage, printing)
j. Fitness equipment including maintenance and cleaning costs
k. Client gifts/awards, retail inventory, and promotional items (*e.g.*, branded water bottles, apparel)
l. Accountant fees
m. Legal fees
n. Health/medical insurance or, if self-insured, a medical savings account contribution
o. If hired trainers are full-time employees, consider paid vacations, sick days, holidays
p. Overtime and exceptional pay (weekends, holidays, nights, etc.)

2. Determine an accurate number of training hours annually that fit into a realistic schedule (factor in vacation days, personal days for medical checkups and family emergencies, sick days, etc.).
3. Determine a dollar charge per training session to achieve a gross annual income that will cover business expenses and personal expenses and will allow some funds to be put aside for savings and/or investments (12). Consider the average price point for Personal Training services in the

region and specifically what the competition is charging (*i.e.*, cost comparisons), along with your average price point if you offer discounts for volume purchases (*e.g.*, 5-pack, 10-pack).

Business Planning

Budgets are necessary to forecast financial expectations and goals, provide accountability, track progress of actual results versus projected results, and allow justification and scrutiny. Completing an accurate, reliable, and analyzable budget without a computer is not easy. Simple accounting software programs are available and recommended, even for the independent Personal Trainer because they will help organize business finances and make tax reporting easier (10).

Although there are many financial resources available for the Personal Trainer/manager/owner, it remains prudent to enlist the guidance of legal and accounting professionals. Additionally, the U.S. Internal Revenue Service Web site is a great resource for obtaining specific tax forms and information. It is accessible at http://www.irs.gov/.

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Professional Standards

A code of ethics for American College of Sports Medicine certified and registered professionals has been established, which helps guide the ethical practice of Personal Trainers. This code (see Chapter 1) helps bring the profession of Personal Training in line with other professions and health care disciplines.

SUMMARY

Contrary to the belief of some, it is not true that a Personal Trainer with tremendous technical skills will be among the most successful. Whether the Personal Trainer operates independently or manages a Personal Training department, today's Personal Trainers need to be proficient in both exercise science and business management. Only by combining these varied skills can they ensure their success and that of their clients.

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CHAPTER

22

Legal Issues and Responsibilities

OBJECTIVES

Personal Trainers should be able to:

- Understand the primary areas of potential legal liability.
- Understand the role of industry standards and guidelines on legal liability issues.
- Learn practical strategies to manage risk.

INTRODUCTION

A Personal Trainer must understand and appreciate the legal risks and responsibilities of the profession before undertaking the task of training any person. Awareness of potential areas of liability, coupled with conformity to professional standards, will permit the Personal Trainer to minimize these risks. The results will be decreased risk of injury to the client and an overall lessening of any legal exposure of the Personal Trainer (whether operating independently or employed with a gym, health facility, or other employer). Personal Trainers need to know what areas of potential liability affect their practice, what industry standards and guidelines direct these areas, and what measures they can take to manage risk effectively.

All physical activity holds the potential risk of injury and death in the extreme case. Working as a Personal Trainer will invariably involve exposure to some liability. To maintain professionalism and protect the longevity of a career, a Personal Trainer needs to proactively anticipate these areas of risk and manage them with common sense and an understanding of the relevant law. This knowledge of, and commitment to, safety, injury prevention, and risk management not only minimizes the likelihood of professional liability but also improves quality of service and may save lives.

All physical activity involves some risk of injury; injuries can and will happen. Death may occur in the extreme case. Management of these risks is key.

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This chapter broadly discusses liability issues related to working with clients and offering Personal Training services. It is structured largely to cover those topics and issues that are addressed in Domain IV (Legal & Professional Responsibilities) of the American College of Sports Medicine Certified Personal Trainer® (ACSM-CPT®) performance domains (see http://www.acsm.org/get-stay-certified/get-certified). Local rules and regulations, definitions of standards of care, and the acceptability of waivers of liability vary from state to state, county to county, and even city to city. This chapter is not intended to serve as legal advice and should not be considered a substitute for legal counsel on particular liability issues pertaining to individual situations and specific jurisdictions.

Effectively Minimizing Risk

Although eliminating all risk is not possible, Personal Trainers can minimize risk by obtaining proper qualifications; using appropriate client screening tools; and providing proper instruction, supervision, equipment and documentation (*e.g.*, preparticipation questionnaire, informed consent, waiver) (1).

Proper Qualifications

Without doubt, the first and most effective step that a Personal Trainer can take in minimizing risk to the client and liability for the Personal Trainer is to be properly qualified to perform the job. What constitutes proper qualifications may vary depending on the local jurisdiction, the facility employing the trainer, or the client(s) being served. Regardless, the initial undertaking of the Personal Trainer should be to become aware of qualifications and/or certifications that are required. Where no specific requirements are dictated by statute or ordinance, employment policies may mandate a particular course of study or training. In many jurisdictions, there may be no formal requirements that one must meet in order to present oneself as a Personal Trainer. However, even when requirements are minimal, professional certifications and adherence to industry-recognized standards will serve to maintain professionalism, minimize liability, and offer guidance to clients as to the trainer's credentials. In addition to requirements imposed by law or policy, the representation of a facility or of a Personal Trainer regarding the qualifications of the Personal Trainer can impose heightened standards and/or qualification requirements on a Personal Trainer. Clients have filed claims after injuring themselves based on the fact that a Personal Trainer did not have the qualifications represented in a facility's advertising literature. These claims were based on the theory of breach of contract because the facility failed to provide Personal Trainers with the level of qualification that it had promised (2). The facility, through its literature, imposed a higher standard as to the level of qualification by marketing these qualifications.

Clients have filed claims after injuring themselves based on the fact that a Personal Trainer did not have the qualifications represented in a facility's advertising literature.

The best evidence that a Personal Trainer can use to show that his or her training services meet professional standards is to maintain industry standard certification(s) and to conduct business according to the knowledge, skills, and abilities that are expected as minimum competencies by the certifying organization(s). The ACSM-CPT® possesses a high school diploma or GED at minimum and works primarily with apparently healthy individuals to enhance fitness. The ACSM-CPT® also works with individuals who have stable health challenges and are cleared to exercise independently. The ACSM-CPT® conducts basic preparticipation health screenings, lifestyle inventories, and fitness assessments for health- and skill-related components of fitness. The ACSM-CPT® assesses behavior adaptation readiness and offers guidance in the development of realistic, client-centered goals related to health, fitness, and wellness. The ACSM-CPT® develops and administers programs designed to promote optimal cardiorespiratory fitness, muscular strength, muscular endurance, flexibility, and body composition as well as agility, balance, coordination, power, speed, and reaction time. The ACSM-CPT® facilitates client motivation and adherence and honors client confidentiality. The ACSM-CPT® adheres to all agreed-on terms with each client and stays within the scope of practice of the ACSM-CPT® credential. The prudent ACSM-CPT® makes referrals to appropriate allied health professionals when clients' needs exceed the ACSM-CPT®'s scope of practice (3).

The issue of a Personal Trainer's responsibility for advising appropriate levels of training intensity is even more critical because more people with health/medical conditions seek to work with Personal Trainers. Personal Trainers who advertise their services to targeted clientele such as older adults or people with conditions such as arthritis, claiming that they are trained to serve these niche markets, need to be sure that they are sufficiently prepared to serve such clients' needs. Evidence of sufficient preparation would include additional education, training, and experience in working with people with particular needs. Personal Trainers should therefore keep written records of all certifications, continuing education, and work-related experience.

Screening and Documentation

A preparticipation screen is used to assess a client's health and medical history. Screening is an important tool to help ensure that a Personal Trainer is well qualified to meet a particular client's specific needs and to develop services that are appropriate for the client. In addition, the Personal Trainer must properly interpret health risks and determine when a medical clearance is necessary. Using tools such as the ACSM exercise preparticipation health screening process (4), which was designed with the goal of identifying individuals who are at risk for adverse exercise-related cardiovascular events is a primary way for the Personal Trainer to do this. Once these precautionary steps are taken, the Personal Trainer can conduct a fitness evaluation to determine the recommended level of training that will be reasonably safe and effective to meet the particular client's needs and goals (4). A written record of these measures should be kept to document the steps taken by the Personal Trainer to create a specific exercise program (4). Documentation from the client's physician regarding medical clearance, if needed, should also be maintained.

Scope of Practice and Professional Collaboration

Scope of practice refers to the range of permissible professional activities that a Personal Trainer may undertake, coupled with an understanding of the boundaries that serve as limits on these activities. See Chapter 1 for additional information regarding scope of practice. This is an important area of potential liability for the Personal Trainer. Because fitness professionals work more closely together with health care providers to deliver a continuum of care to individuals, it is important to define respective roles. According to the ACSM's Code of Ethics for Certified and Registered Professionals, "[Personal Trainers] shall be dedicated to providing competent and legally permissible services within the scope of knowledge and skills of their respective credential/certification, should practice within the scope of their job tasks and will not provide services that are limited by state law to provision by another health care professional" (5). This is particularly true for Personal Trainers with advanced academic degrees or training and when working with clients who may have special exercise considerations. Both criminal and civil actions are possible for practicing medicine or some other allied health care profession without a license. An injunction against a Personal Trainer's practice is also possible. An elevated standard of care is required because malpractice is certainly a viable concern.

The contemporary delivery of health care services itself is in a state of flux because of high costs, insurance coverage, licensure issues, and attempts to reduce costs by expanding the roles of paraprofessionals in the medical context. As a result, states vary widely on what constitutes the practice of medicine and what is appropriate professional behavior for a nurse, physician assistant, or other paraprofessional. According to fitness law experts David L. and William G. Herbert, many states have defined the practice of medicine broadly so that persons engaged in exercise testing and prescription activities could, under some circumstances, fall within the range of such statutes (2). Therefore, Personal Trainers should become familiar with the statutes in the state(s) where they conduct business. Personal Trainers should also avoid *diagnosing*, *prescribing*, *counseling*, and *treating* because such terms describe actions that typically reflect the behaviors of licensed health care providers (1).

Personal Trainers, therefore, need to become familiar with the relevant guidelines for scope of practice that are established at their affiliated organizations and institutions. Personal Trainers who operate their own businesses would be wise to seek the advice of local legal counsel and to take other steps to manage risk effectively, such as maintaining certifications, obtaining releases and waivers or consents when applicable, carrying liability insurance, performing regular facility and equipment inspections and maintenance as per manufacturer's guidelines, and keeping detailed written records.

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Generally, Personal Trainers have not been considered health care providers as defined by states' medical malpractice statutes. Medical malpractice law is determined almost exclusively at the state level and will therefore vary from state to state. The relevant code sections of each state's medical malpractice act will normally define the laws to which health care providers are subjected. Typically, Personal Trainers are not placed in this category of health care providers. However, this has been tested in circumstances when a Personal Trainer's training services were delivered in a medical setting. In a 2003 Indiana case (*Community Hospital v. Avant*, 790 N.E.2d 585; 2005 Ind. App.), a court held that even though a Personal Trainer was employed by a hospital and the fitness facility was owned by the hospital, the client did not meet the definition of patient and the Personal Trainer was not a health care provider; thus, the case did not qualify as a medical malpractice case. The significance of this case, however, is that the client did try to sue both the fitness facility and the hospital on the basis of injuries sustained while engaged in the Personal Training program, and the court did examine the fact that the training occurred in a setting with a close connection to a hospital. Another court might have found that this type of training did meet the standards of health care practitioners (6,7). The Personal Trainer may be subject to different potential liability when training services are delivered in a medical setting. Generally, Personal Trainers have not been deemed health care providers and thus are not subject to medical malpractice laws.

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Medical or Dietary Advice

No cases have yet been litigated to conclusion that involved a client suing a Personal Trainer for faulty medical or dietary advice, except in the case of dietary supplements, which is discussed later in this chapter. However, remember that health care is a highly regulated area. The consequences of stepping over the line into the protected area of a licensed health care practitioner — such as a medical doctor, physical therapist, registered dietitian, or chiropractor — vary by state. Personal Trainers are exposed to potential liability for acting outside the scope of practice if the "advice" could be interpreted as the unauthorized practice of medicine (or some other licensed profession) and if this advice is a substantial factor in a client injury.

Although the Personal Trainer must be cognizant of his or her scope of practice, he or she must also recognize the importance of collaborating with and referring to health care professionals. The Personal Trainer should develop a comprehensive network of allied professionals and actively refer clients who request or require specialized services to an appropriate health care provider (2). Using referrals is important both for those clients who need medical clearance prior to starting an exercise program and for existing clients who require additional assistance. Personal Trainers should maintain open lines of communication between themselves and various health care professionals to optimize client outcomes and aid in the identification of risk factors.

Supplements

Claims related to violations of scope of practice occur most frequently in the area of dietary supplements. A high-profile case brought against a Personal Trainer and a large fitness chain (*Capati v. Crunch Fitness Intern*, *Inc.*, 295 A.D.2d 181, 743 N.Y.S.2d 474; N.Y.A.D. 1 Dept, 2002) involved a scenario in which a Personal Trainer sold supplements, including one that contained ephedra, to a client, who had hypertension, and died after collapsing at the fitness facility. Survivors then filed a lawsuit. In another example, a Personal Trainer sold steroids to a client, who later suffered adverse consequences and filed a claim against the Personal Trainer (6).

In another incident, a Personal Training company combined supplement sales with its fitness packages to increase revenue. The company eventually had a client who was allergic to an ingredient in the supplement. The problem was compounded when the client assumed that if she took more than the recommended dosage, she would see more results. She ended up in the hospital and sued the Personal Trainer and the business. The case was settled out of court, and the Personal Trainer lost his business. The problem was not that the Personal Trainer had sold the client the products, but that he had given her a written plan specifying what to eat and when to take the supplements. The fact that the client overdid it did not matter (6).

According to insurers, the problem with dietary supplements is worsened by the fact that most supplement manufacturers do not carry any insurance coverage. Theoretically, if the manufacturers were insured, this would not only fully compensate the client for any injuries due to their products but also potentially serve to indemnify the Personal Trainer who sold the defective product. Unfortunately, because this is rarely true, there is no third-party insurance that can offer some protection when the Personal Trainer incurs liability. An ancillary consideration to this is that most of the insurance policies for fitness professionals do not include protection for product liability.

In today's market, no one, even registered dietitian nutritionists, can be certain about the ingredients found in many supplements because they are not subject to government regulation. In addition, one can never be certain regarding who may have a severe allergic reaction, including the risk of death, to any particular ingredient. To proactively protect client safety and to minimize the risk of professional liability, Personal Trainers should avoid recommending and/or selling dietary supplements.

Development of a Comprehensive Risk Management Program

Addressing Known Risks

Legal considerations affect many aspects of the Personal Training experience. Areas of potential exposure to liability include the physical setting where program activities occur; the equipment used; the nature and quality of training techniques, advice, and services rendered; the degree of emergency preparedness and responsiveness; and the method of keeping and protecting records (1,8). Although legal principles affect the training environment, as a practical matter, most cases today are settled out of court and therefore never actually create case law. To help Personal Trainers understand the practical ramifications, this chapter is organized according to common types of incidents likely to occur during typical day-to-day business. The application of legal concepts such as negligence to particular circumstances is then examined, and the role of professional standards, guidelines, position statements, and recommendations from professional organizations is considered.

The operation of a Personal Training facility constitutes a business/invitee relationship. The client, or invitee, has been "invited" onto the premises for the financial gain of the business. This relationship heightens the obligation of the business to the invitee. In addition to providing reasonably safe premises, the business that invites persons onto the premises of the business must also exercise reasonable care to maintain the premises in a safe condition and to regularly inspect the premises for the presence of dangerous conditions. When exercising reasonable care, it is important that the Personal Trainer (especially in the case of a self-owned facility) not only perform regular inspections but also establish a policy or guidelines for inspections and a method of record keeping for evidence of these inspections.

> The operation of a Personal Training facility is a business/invitee relationship. In these types of relationships, the obligations and duties of the business to the invitee are heightened.

Reasonably Safe Premises

Although most Personal Trainers focus on educating themselves on the latest training techniques and aspects of program design, in reality, Personal Trainers are vulnerable to professional liability for incidents that result from conditions of the physical setting where program activities occur. In general, any business owner who allows people to enter on land or into a building is required to provide a reasonably safe environment under theories of tort law (Box 22.1) (7). The area of tort law that regulates these issues is termed premises liability. ACSM (9) has identified 35 standards for health/fitness facilities as well as 38 guidelines. These items are included in *ACSM's Health/Fitness Facility Standards and Guidelines*, fifth edition, which is a valuable resource for the Personal Trainer. Because a Personal Trainer may offer services in a variety of locations, including a health/fitness facility, the outdoors, or in a client's home, the Personal Trainer should take basic precautions to help ensure that every training setting is reasonably safe and includes an emergency action plan as part of a comprehensive a risk management plan (1).

Box 22.1 Key Terms

Negligence: a failure to exercise the standard of care that a reasonably prudent person would have exercised in a similar situation

Risk management: a course of action designed to reduce the risk (probability or likelihood) of injury and loss to sport/fitness participants, spectators, employees (*e.g.*, Personal Trainers), management, and businesses (*e.g.*, owner of Personal Training facility)

Tort law: a category of law that encompasses situations in which a civil wrong has been committed

Waiver: a contract in which the participant (*e.g.*, fitness client), in exchange for the right to participate, agrees to relinquish the right to pursue legal action against the service provider (*e.g.*, Personal Trainer) in the event that the ordinary negligence of the provider results in an injury to the participant

Adapted from Cotten DJ, Wolohan. *Law for Recreation & Sport Managers*. 7th ed. Dubuque (IA): Kendall Hunt; 2017. 710 p; Garner BA, editor. *Black's Law Dictionary*. 7th ed. St. Paul (MN): West Group; 2000. 1738 p; Spengler JO, Anderson PM, Connaughton DP, Baker TA III. *Introduction to Sport Law*. 2nd ed. Champaign (IL): Human Kinetics; 2016. 304 p.

The Personal Trainer should take basic precautions such as developing an emergency action plan and a comprehensive risk management plan to help ensure that every training setting is reasonably safe.

Medical Emergency Response

Most Personal Trainer certifications require that Personal Trainers have cardiopulmonary resuscitation (CPR) certification; some also require first aid training and automated external defibrillator (AED) certification. As yet, no specific case has involved a claim against a Personal Trainer for wrongful death in a situation in which a client has had a sudden cardiac arrest or other medical emergency and died while under the supervision of a Personal Trainer. However, it is possible that a claim could be filed against a Personal Trainer who failed to provide an emergency response if that failure led to a death that could have otherwise been avoided. Participation in physical activity, which may be strenuous, particularly in clients who are identified as moderate or high risk based on disease-specific categories, creates a situation where there is a foreseeable risk that the administration of first aid, CPR, or other life-saving measures will be needed. In law, foreseeability is the touchstone for imposing a duty on someone to anticipate and plan for risks. In addition, numerous states have enacted legislation mandating that health/fitness facilities have at least one AED on the premises (9,10). Whether required by statute or by the law as it relates to foreseeability, every Personal Trainer should implement and document appropriate emergency preparedness policies and procedures. This may include, but is not limited to, CPR certification and basic first aid administration, maintaining equipment necessary for the administration of first aid, maintaining AEDs and being familiar with their use, and educating other employees about the emergency preparedness plan. In addition to these measures, which require outside training or certification, foreseeability also includes the routine implementation of policies such as when to call emergency medical services (*e.g.*, 911). All of these measures should be documented, and written policies should be maintained and followed. Consistency is paramount. Although drafting and using emergency preparedness policies can help to thwart potential litigation, the failure of the Personal Trainer to abide by these policies can expose that trainer to liability. Failure to follow one's own policies and procedures may form the basis for plaintiffs asserting that the Personal Trainer breached a duty to the client.

It is possible that a claim could be filed against a Personal Trainer who failed to provide an emergency response if that failure led to a death that could have otherwise been avoided.

The ACSM and the American Heart Association (AHA) published a joint position stand in 1998 with recommendations for health/fitness facilities regarding the screening of clients for the presence of cardiovascular disease, appropriate staffing, emergency policies, equipment, and procedures relative to the client base of a given facility (11). In 2002, the ACSM and the AHA published a joint position stand to supplement the 1998 recommendations regarding the use of AEDs in health/fitness facilities (12), which was supported in 2019 by the ACSM (9). These organizations agree that a comprehensive written emergency plan is essential to promote reasonably safe and effective physical activity.

The AHA, the ACSM, and the International Health, Racquet & Sportsclub Association, as well as other national professional health/fitness organizations, recommend that all fitness facilities have written medical emergency policies and procedures, which are reviewed and practiced regularly, including the use of automated defibrillators (1,9,12). Staff who are responsible for working directly with program participants and providing instruction and leadership in specific modes of exercise must be trained in CPR. These staff should know and practice the facility's emergency plan regularly and be able to respond to medical emergencies in a timely fashion (1,9,12).

As evidence of professional competency, Personal Trainers should keep CPR, first aid, and AED certifications current. Personal Trainers should proactively familiarize themselves with any affiliated organization's emergency action plan and be ready to implement the plan's procedures in case of an emergency. For Personal Trainers who operate a business, creating an emergency action plan should be a top priority. Personal Trainers who provide training services outdoors or in a client's home should also have written emergency policies and procedures. This may include information on when to call emergency medical services (*e.g.*, 911), administration of CPR off-site, and possibly the availability of portable AED devices as these become more readily available.

In addition to having an emergency action plan, Personal Trainers should also document any injury or incident immediately, using an incident report form (Box 22.2) (1,9). The Personal Trainer should include only the facts surrounding the incident and not any opinions regarding what may or may not have caused the incident. In addition, the names and contact information of witnesses should be included. The person who experienced the incident should sign the form. Insurers often provide incident-reporting forms, and the Personal Trainer should always carry extra forms to every training session. These forms should be kept confidential. Whether or not these become discoverable in any potential litigation will vary depending on the facts of a particular situation and on the law regarding formal litigation discovery in the particular state. As a general rule, however, documents created in anticipation of litigation will be covered under what is known as the “work product” rule and will not be available to a plaintiff in a lawsuit.

Box 22.2 Sample Incident Report

INCIDENT REPORT

TO BE COMPLETED BY INSTRUCTOR

CONFIDENTIAL WORK—PRODUCT

Date: ______________

Location/Address of Accident or Incident: ______________________________

Name of Instructor Completing the Form: ______________________________

Date of Accident or Incident: ______________

Approximate Time of Accident or Incident: _________ : _________ am pm

Name of Injured Person: ______________________ Age: _________ Sex: _________

Injured Person's Address ______________________________

City: ____________________ State: _________ Zip Code: _________

Home Phone #: ( ) ______________ Work Phone #: ( ) ______________ Cell Phone #: ( ) ______________

How long has this person been under your instruction: ______________________________

____

Describe the accident/incident: ______________________________

____

____

Describe possible injury (sprained ankle, etc.): ______________________________

____

____

Describe type of equipment involved: ______________________________

____

List any type of treatment performed by you or by a doctor (include doctor, hospital name):

____

____

Were there any witnesses to the incident?: yes _____ no _____

If yes, please have each witness write a brief statement about what happened.

YOUR SIGNATURE: ______________________

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Premise Liability

Slip-and-Fall Injuries

A frequent claim against fitness facilities and professionals is for injuries related to falls on the training premises (6). Courts have consistently held that clients are entitled to “reasonably safe” conditions. Personal Trainers can foster reasonably safe conditions by a regular practice of inspection for, and correction and warning of, any hazards in the workout area and areas used to access the workout location (1,13). For example, if items that may cause a fall are located on the floor, the trainer should clear these away before beginning a session. If floor surfaces are wet and incapable of correction before a session occurs, the session should be either moved or rescheduled. If safety conditions require, it is always better to be conservative and reschedule rather than to continue training in the presence of known hazards. Personal Trainers who work in aquatics facilities need to be particularly vigilant about deck conditions and pool access areas because wet surfaces increase the likelihood of a slip-and-fall incident.

In addition to routinely inspecting locations before and during training sessions, Personal Trainers should follow a procedure of proper equipment storage when equipment is not in use (1,6). Regardless of the training setting, specific storage places should be designated for equipment, so items are not left where people can trip over them. Different types of equipment require different types of storage. For example, free weights require storage designed not only to accommodate their size and shape but also to support their load. Make sure to use storage practices that not only effectively store equipment out of people’s way but also protect it from being used for inappropriate purposes. For example, many types of Personal Training equipment are attractive to young children (*i.e.*, “attractive nuisance”) and may be best stored in locked cabinets if children potentially have access.

Objects that are part of a facility environment but not necessarily fitness equipment can also pose risks. In one case, a client brought suit against a health club after he sustained injuries resulting from a fall that occurred as the client was reaching to adjust a television that was positioned on an overhead rack. The Personal Trainer’s assessment of the fitness facility environment should include all areas and objects. Many legal tests for liability will revolve around the concept of what potential injuries are reasonably foreseeable. In the case of the television, was it foreseeable that a client reaching to adjust it would fall? If yes, then it is the duty of the business owner to properly manage (*i.e.*, eliminate or reduce and warn) this risk. This may be through signage ("Do not adjust television"), through making remote controls available, or through repositioning the television to eliminate any awkward positioning by the client reaching to make adjustments. The important takeaway points are that business owners are obligated to identify and eliminate risks that are reasonably foreseeable and to appropriately warn patrons of any persistently hazardous conditions. In testing for these conditions, the Personal Trainer should attempt to use the equipment as a client would. These actual-use tests can aid in identifying risks that are not readily apparent from visual inspection alone.

Personal Trainers should also educate clients about appropriate clothing and footwear to reduce the risk of injury and to enhance training. Clothing should be comfortable, breathable, and allow movement. In particular, Personal Trainers need to check footwear and should not allow clients to train with inadequate shoes. Factors such as poor fit, excess wear, and unsuitability to the activity all increase the risk of injury. Recognition of foot and leg care issues is especially important if the Personal Trainer works with clients who have diabetes, venous insufficiency, or other medical conditions that may impact the lower extremities. An awareness of these issues will permit the Personal Trainer to make physician referrals when appropriate. Personal Trainers who work with people new to exercise may want to create a client handout that outlines appropriate exercise apparel and other exercise safety issues. If the Personal Trainer trains clients in a setting in which protection is necessary, such as a helmet for bicycling, protective eye goggles for racquetball, or knee/elbow pads for inline skating, the Personal Trainer should make sure that the client wears protective equipment (1,13).

Equipment Issues

Another leading cause for claims against Personal Trainers are injuries resulting from the use of equipment (1,13). These cases are based on legal theories from tort law that a Personal Trainer's duty or standard of care is to exercise reasonable care so that the client does not suffer injury (see Box 22.2). A Personal Trainer who fails to take reasonable precautions, which is determined on the basis of an evaluation of facts surrounding an incident, could be deemed negligent and therefore liable or responsible. Professional organizations such as the ACSM and National Strength and Conditioning Association publish industry standards and guidelines relating to matters of facility and equipment setup, inspection, maintenance, repair, and signage (9). Although these standards and guidelines do not have the force of law, they can be introduced as evidence via expert testimony of the Personal Trainer's duties and/or adherence to the standard of care. Keep in mind that the law does not envision that injuries never happen; laws and industry standards and guidelines exist to encourage proactive safe behavior to avoid preventable injuries.

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As a practical matter, when it comes to using equipment safely, the question then becomes "What steps can Personal Trainers take to prevent foreseeable injuries?" Personal Trainers should always use safe, reliable, and appropriate equipment and use equipment for its intended purposes according to manufacturer guidelines (1,14). Whenever a Personal Trainer directs a client to use equipment, the Personal Trainer should provide proper instruction and supervision. In addition, policies and procedures for routine safety inspections, maintenance, and repair should be in place and observed systematically. Personal Trainers or facility managers should keep written records to demonstrate compliance with these policies and procedures. The importance of thorough documentation cannot be overemphasized. All of these steps are likely to minimize the risk of an equipment-related injury. Then, if an injury occurs, even though everything had been done to prevent it, it is likely to be considered the type of injury that could not have been prevented by taking reasonable precautions.

Many clients will ask Personal Trainers to recommend fitness equipment. It is important for the Personal Trainer to work only with reliable fitness equipment dealers when recommending equipment to clients. Personal Trainers who do not have a reliable vendor with whom to work should not recommend one piece of equipment over another. The topic of product liability is complex and outside the scope of this chapter. However, the Personal Trainer should be warned that equipment product manufacturers are now pursuing clubs and Personal Trainers for improper installation and maintenance in cases that the manufacturers face due to theories of product liability.

Free Weights

For a concrete example of potential liability for client injury from equipment use, consider the common scenario that involves an experienced Personal Trainer supervising an apparently healthy client who is performing a squat or similar exercise with free weights. The Personal Trainer encourages the client to use a heavier weight and perform more repetitions even though the client complains of fatigue. The client suffers a debilitating back injury and sues the Personal Trainer and fitness facility.

Under theories of negligence, the Personal Trainer owes this client a duty to exercise reasonable care to prevent injury. Reasonable steps that a Personal Trainer can take to avoid this type of incident include fostering open communications with the client to encourage feedback and listening when the client communicates that he or she is reaching fatigue. Personal Trainers should know how to spot signs of fatigue and be conservative when implementing reasonable program progressions. Injuries are not uncommonly sustained by clients who are new to exercise. In one instance (*Lumpkin v. Fitness Together I, Inc., et al.*, Jefferson County Circuit Court Case Number CV-2005-6512, Jefferson County, Alabama), a client filed suit alleging that he was pushed too aggressively by a Personal Trainer to continue squats after he reported severe muscle fatigue and pain with accompanying physical symptoms of trembling and an inability to stand. The client subsequently developed rhabdomyolysis (*i.e.*, a condition that occurs when muscle fibers release myoglobin into the bloodstream; in worst-case scenarios, the kidneys cannot filter effectively, and kidney damage occurs) and required hospitalization. Although such an outcome is not always predictable, strong lines of communication increase the likelihood that the attuned Personal Trainer will recognize and can appropriately respond to feedback provided by the client.

Another step that a Personal Trainer could take is to keep detailed records of numbers of repetitions, sets, and weight loads on specific training days. In this manner, a client can follow a reasonable plan of progression that minimizes injury risk. This is particularly important when training individuals new to exercise or returning after a lengthy layoff and/or with certain medical conditions. Before implementing progression in a program, Personal Trainers can discuss the client's feeling of readiness to increase intensity and further evaluate whether the timing is appropriate for such a change. If specific records are maintained, the Personal Trainer is also in a position to evaluate whether or not a client's response to a particular exercise session is abnormal and requires referral to a physician (4).

Weight Machines

Even though machines carry a reduced risk of injury because the client's body is more stable and movement is more restricted than with free weights, injuries still occur. Most injuries happen when a client is encouraged to handle a weight that is too heavy, a weight plate slips and falls because a pin was not properly inserted, or a cable breaks. Weight plates have fallen and crushed ankles and feet or hit people in the head. In turn, clients suffer physical injuries and sue the Personal Trainer, fitness facility, and/or equipment manufacturer.

Here again, to ensure that the client does not suffer this type of injury, a Personal Trainer can exercise reasonable care through a consistent practice of regular inspections and correction of any known hazards such as worn or improperly maintained equipment; through keeping records of what weight the client has been able to properly and safely lift, the number of repetitions, and sets; and through following a conservative plan to increase intensity in close communication with the client. When working with weight training equipment, the Personal Trainer can develop a procedure of instruction and supervision for each exercise that includes an equipment and body scan to check for proper equipment setup and body alignment. Creating this type of instructional technique so that an inspection becomes a routine part of each and every exercise can go a long way toward reducing injuries.

Factors that courts have examined in equipment-related cases include whether or not the equipment has been maintained appropriately and used for its intended purpose per specific manufacturer guidelines. In particular, courts examined whether or not parts had been replaced in a timely manner and whether or not facility owners had ensured that routine inspections and maintenance were conducted and documented (1,6). Regardless of the setting, a Personal Trainer should be proactive in learning about equipment safety inspections, maintenance, and record-keeping policies as well as the procedures for reporting the need for repairs. Before putting a client on any piece of equipment, the Personal Trainer should have firsthand knowledge of its readiness for use.

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Keep in mind that courts also examine appropriateness of use. In one case (*Nelson v. Sheraton Operating Corp*. 87 WN. App. 1038; 1997 Wash. App. Div. 1, 1Lexis 1413; 958 P.2d 316, 1998), hotel management had placed equipment in a hotel gym that was intended for private home use and a cable on the machine snapped which caused a piece of equipment to fall and cause a head injury to the hotel guest. The court found the hotel liable for injuries suffered by the guest. This case demonstrated the importance of a training facility in providing commercial grade equipment; manufacturers do not design home equipment to withstand the wear and tear of frequent use by multiple users. This case also illustrates the importance of a Personal Trainer, particularly those who own or manage a training facility, to carefully inspect and maintain equipment as per the manufacturer's recommendations.

Cardiovascular Machines

Treadmills are currently among the most popular form of exercise equipment in fitness facilities; however, it is imperative that their popularity not lead the Personal Trainer to assume that clients will be familiar with their use. Numerous cases feature instances in which a client loses control and falls from a treadmill. These cases often involve middle-aged or older adult clients who are unfamiliar with the machine's workings and unable to keep up with the movement speed. In one instance (*Corrigan v. Musclemakers, Inc.*, 258 A.D.2d 861, 686 N.Y.S.2d 143; N.Y.A.D.; 3 Dept. 1999), a 49-year-old client who informed the Personal Trainer that she was "very sedentary," had never patronized a gym, and who had never been on a treadmill was placed on one by a Personal Trainer. The Personal Trainer provided no instruction on the use of the machine, including no instruction on how to adjust the speed, stop the belt, or operate the controls. The client, after being thrown from the machine, suffered a fractured ankle. Subsequently, a lawsuit concerning the injury was filed. This case is consistent with others that show that the consequences from falls include back, neck, shoulder, and other joint injuries; fractures; skin/flesh wounds from the treadmill belt; and even death. Clients (or their survivors) sue the Personal Trainer, fitness facility, and/or equipment manufacturer under theories of either negligent instruction or defective product (6).

Of course, these examples should not discourage a Personal Trainer from using equipment to train clients. Equipment is an essential part of creating effective training programs. These incidents simply underscore that whenever equipment is being used, Personal Trainers must remain alert to the special risks presented and take proactive steps to manage and minimize these risks. Furthermore, Personal Trainers should maintain detailed records to document the risk management steps that have been taken (1,13).

Personal Trainers must remain alert to the special risks presented and proactively manage and minimize such risks.

Claims of Sexual Harassment

Sexual harassment claims represent another area of potential liability for Personal Trainers (6). Because the Personal Training relationship can seem “intimate,” it lends itself to creating more opportunity for abusive conduct on the part of the Personal Trainer or for a misinterpretation of actions on the part of the client. Numerous cases involve a male Personal Trainer and a female client. The female client believes that inappropriate touching has occurred and that she has been violated. Or, a personal relationship develops between the Personal Trainer and the client who then raises questions about the legitimacy of the business services rendered. The client believes that undue influence was used to create an exploitive situation.

Sexual harassment can be difficult to prove and often rests on credibility. Personal Trainers, therefore, should be vigilant and act professionally at all times. One strategy to protect against a claim of inappropriate touching is to always ask a client for permission to use tactile spotting and to avoid it unless absolutely necessary. Some Personal Trainers do not touch clients directly but spot them through the use of another prop, such as a ball. Additionally, situations behind closed doors where no one else is present should be avoided when possible. For example, if skinfold body composition assessments are offered, the procedure should be conducted in a room with other Personal Trainers, perhaps behind a folding screen, or with another Personal Trainer or staff member present. If a personal relationship develops with a client, the professional relationship should be discontinued, and the client should be referred to another Personal Trainer.

One strategy to protect against a claim of inappropriate touching is to always ask a client for permission to use tactile spotting and to avoid it unless absolutely necessary.

Continuing Education and Adherence to Ethical Guidelines

In evaluating negligence claims, there are four elements that a plaintiff must prove in order to prevail in a lawsuit. These are duty, breach of duty, proximate cause, and damages. The imposition of a duty may be determined by specific circumstances. Broadly, one general duty is to provide a reasonably safe premise for invitees of a business. This means that there should be no unnecessarily dangerous conditions present in the physical space used for training. Another generally recognized duty for the Personal Trainer is to conform one's activities to the standard of care (*i.e.*, degree of care that a reasonable or prudent Personal Trainer would use under similar circumstances). This standard will vary by jurisdiction and the setting in which training sessions are offered. Other legal duties may be self-imposed by certain conduct or by contract. For example, by advertising certain credentials or guaranteeing outcomes, a Personal Trainer may create duties or legal obligations, which would not otherwise be present under the law. The breach of duty element in negligence law is frequently examined based on whether the person deviated from the standard of care. In establishing what the standard of care is for a Personal Trainer, there are usually no statutory guidelines that prescribe a particular standard. Instead, courts will normally turn to an industry standard — what is customary in the particular industry. Although the customs and norms will vary by locale, there are national entities, which provide initial certification and ongoing and continuing education. Demonstrating adherence to the standard of care then can be best accomplished by closely following and maintaining these professional certifications and continuing education credits as well as operating in accordance to industry standards/guidelines and position stands. In doing so, the Personal Trainer reflects professionalism and commitment to the integrity of the field. In addition to the obligation the Personal Trainer has to stay abreast of new knowledge and skills through continuing education, the Personal Trainer should also select activities that are permitted within the scope of practice and adhere to the ethical guidelines as defined by his or her certifying organization. In the setting of a lawsuit for negligence, even when duty and breach can be proven, a plaintiff must additionally prove damages (some injury or legal harm) and proximate causation that the alleged breach actually led (*i.e.*, was a substantial factor) to the injury. Absent evidence of all four of these elements, a plaintiff cannot prevail on a claim for negligence.

Development of a Business Plan

The structure of the Personal Trainer's business model will vary according to each individual's needs and objectives as well as the laws regarding business organizations by state. There are, however, some overall principles that are broadly relevant. Personal Trainers may be employees of an existing business. Most people are familiar with an employer–employee relationship. This model, although affording many benefits (such as predictable income stream, possibly insurance and other employment-related benefits, etc.), will limit the autonomy of the Personal Trainer.

Alternatively, a Personal Trainer may choose to operate independently or establish a business. Independent operation as a sole proprietor normally does not afford the trainer any protection of personal assets. Most states permit individuals to form business entities, such as a corporation or limited liability company, which will shield personal assets in the event of legal liability, and permit only those assets of the business to be available in the event of claim or judgment. If a trainer chooses to form a business entity (rather than a sole proprietorship or "doing business as"), an attorney and/or a tax professional should be consulted for advice on particular business structures and the tax implications. Operating outside an employer–employee relationship will necessitate research regarding start-up costs, budgeting, purchasing or leasing space, licensing, advertising costs, liability insurance, and many other issues. Proper planning and seeking advice from other professionals will promote a smoother transition into business ownership.

In the event the Personal Trainer is entering into a partnership or business with others, it will be critical to plan for any eventual dissolution through a buy–sale agreement or other operational/organizational contingency plan, which will govern dissolving a business. This may incorporate noncompete agreements and other restrictive language on the trainer's ability to practice. The enforceability of these agreements varies widely by jurisdiction, so include this consideration in discussions with legal counsel.

Risk-Management Strategies

Personal Trainers should manage risk exposure with a multilayered approach that incorporates a number of important risk management strategies. As the first line of defense, Personal Trainers should create written policies, procedures, and forms that meet industry standards and guidelines and maintain detailed written records that document compliance with these policies. This strategy minimizes the likelihood that the Personal Trainer would fail to demonstrate that he or she exercised reasonable care under the circumstances. In other words, the Personal Trainer should make every effort not to be negligent.

As the first line of defense, Personal Trainers should create written policies, procedures, and forms that meet industry standards and guidelines and maintain detailed written records that document compliance with these policies.

The second strategy involves using a release, waiver, or informed consent, depending on which legal document is recognized under the laws of the place (*i.e.*, jurisdiction) where the Personal Trainer conducts business (1,15). The purpose of these documents is either (a) to demonstrate that the Personal Trainer fully informed the client of all of the potential risks of physical activity and the client decided to undertake the activity and waive the Personal Trainer's responsibility or (b) to demonstrate that the client knowingly waived his or her right to file a claim against the Personal Trainer even if the Personal Trainer is negligent. Courts have consistently held that in order for a release to operate as an effective bar to liability, the release should be clear and unambiguous and should refer specifically to the negligence of the party seeking the release. The Personal Trainer should keep these records indefinitely and in a safe place. Consent forms are not infinity contracts so provisions should also be made for an annual signing of these important documents. Each state has its own statutes of limitations on waivers and consent forms. The Personal Trainer is advised to consult with legal counsel, within their jurisdiction, before using these forms regarding the wording and administration of such.

The third strategy is to carry professional liability insurance (1,2,13). This transfers the risk to the insurer. In that instance, even if the Personal Trainer is negligent, the insurance company assumes responsibility for resolving any claims. Most insurers of Personal Trainers provide coverage for certified professionals. The fourth strategy is to incorporate the business to protect personal assets from any potential claims. The fifth strategy is to cultivate strong relationships with clients and colleagues. Clients are much less likely to sue if they perceive a Personal Trainer as caring, responsible, and responsive to their needs. The final strategy is to consult local legal counsel to ensure that business practices meet the requirements of the specific jurisdiction (1,6).

Written Policies, Procedures, and Forms

Personal Trainers should conduct their business according to written policies, procedures, and forms that ensure that their business practices conform to the standards/guidelines set by professional organizations (1,2,4,6,7,9,13,14). In addition to policies discussed in the business practices chapter (see Chapter 21), every Personal Trainer should also have risk management policies that include a preparticipation screening procedure and a written medical emergency action plan.

Personal Trainers should conduct their business according to written policies, procedures, and forms that ensure that their business practices conform to the standards/guidelines set by professional organizations.

The most important forms for a Personal Trainer include the following:

1. Contract/agreement outlining responsibilities of both Personal Trainer and client and reasonable expectations of services to be provided
2. Release, waiver, and/or informed consent
3. Preparticipation screening form such as a Physical Activity Readiness Questionnaire for Everyone
4. Health history questionnaire
5. Physician's statement and medical clearance
6. Fitness assessment or evaluation form
7. Client progress notes
8. Injury/incident reports

As important as *having* these forms is *using* these forms. The Personal Trainer should complete all portions of the forms. A form that is only partially completed is often the source of more questions than answers and may imply that the Personal Trainer was not thorough in its use. When using these forms, blank spaces are unacceptable.

In the event that a Personal Trainer is encouraging a client to train independently on equipment in a particular fitness facility, an equipment orientation form for the client to sign indicates that he or she has received instruction on the proper setup and use of training equipment and would be useful to document equipment instruction.

Informed Consent, Release, or Waiver

In numerous states, courts are holding up waivers more and more as valid means of protection against litigation. For example, in 2001, a California case (*Benedek v. PLC Santa Monica, LLC*, 104 Cal.App.4th 1351, 129 Cal.Rptr. 2d 197; Cal.App. 2 Dist 2002) was dismissed after a court held that the waiver form signed by a facility member when he joined protected the facility and its owners from liability when the member filed a lawsuit claiming that he injured his knee by attempting to return an overhead television toward the equipment he wanted to use. The court concluded the waiver "unambiguously, clearly, and explicitly released the club from liability for any injury the member suffered on the premises, whether using exercise or equipment or not."

In *Kotcherquina v. Fitness Premier Mgmnt., LLC*, (2012 U.S. Dist Lexis 27675; 2012 WL 682733), the plaintiff sued, claiming negligence, for an injury she suffered while under the supervision of a Personal Trainer at Fitness Premier. The plaintiff alleged that the gym failed to provide her with a qualified or certified Personal Trainer and that both (the gym and the Personal Trainer) failed to use reasonable care. The plaintiff had signed both a Membership Agreement and a Personal Training Agreement. The Membership Agreement contained an exculpatory clause entitled "Waiver and Release." The court ruled that both exculpatory agreements were valid and were a complete defense to the plaintiff's claims for damages.

Depending on where a Personal Trainer lives, he or she may need to have a document entitled one of the following:

- Express assumption of the risk
- Informed consent
- Release or waiver of liability

An assumption of the risk or informed consent document (Box 22.3) essentially explains the risks of participating in physical activity to a prospective client. The client then agrees that he or she knowingly understands these risks, appreciates these risks, and voluntarily assumes responsibility for taking these risks. These documents help strengthen the assumption of risk defense for the Personal Trainer when inherent injuries occur but do not provide protection for negligence.

Box 22.3 Sample of Informed Consent Form for a Symptom-Limited Exercise Test

1. **Purpose and explanation of the test**
   You will perform an exercise test on a cycle ergometer or a motor-driven treadmill. The exercise intensity will begin at a low level and will be advanced in stages, depending on your fitness level. We may stop the test at any time because of signs of fatigue or changes in your heart rate, electrocardiogram, or blood pressure or symptoms you may experience. It is important for you to realize that you may stop when you wish because of feelings of fatigue or any other discomfort.
2. **Attendant risks and discomforts**
   There exists the possibility of certain changes occurring during the test. These include abnormal blood pressure; fainting; irregular, fast or slow heartbeat; and, in rare instances, heart attack, stroke, or death. Every effort will be made to minimize these risks by evaluation of preliminary information relating to your health and fitness and by careful observations during testing. Emergency equipment and trained personnel are available to deal with unusual situations that may arise.
3. **Responsibilities of the participant**
   Information you possess about your health status or previous experiences of heart-related symptoms (*e.g.*, shortness of breath with low-level activity; pain; pressure; tightness; heaviness in the chest, neck, jaw, back, and/or arms) with physical effort may affect the safety of your exercise test. Your prompt reporting of these and any other unusual feelings with effort during the exercise test itself is very important. You are responsible for fully disclosing your medical history as well as symptoms that may occur during the test. You are also expected to report all medications (including

nonprescription) taken recently and, in particular, those taken today to the testing staff.

4. **Benefits to be expected**

   The results obtained from the exercise test may assist in diagnosing your illness, in evaluating the effect of your medications, or in evaluating what type of physical activities you might do with low risk.

5. **Inquiries**

   Any questions about the procedures used in the exercise test or the results of your test are encouraged. If you have any concerns or questions, please ask us for further explanations.

6. **Use of medical records**

   The information that is obtained during exercise testing will be treated as privileged and confidential as described in the HIPAA. It is not to be released or revealed to any person except your referring physician without your written consent. However, the information obtained may be used for statistical analysis or scientific purposes with your right to privacy retained.

7. **Freedom of consent**

   I hereby consent to voluntarily engage in an exercise test to determine my exercise capacity and state of cardiovascular health. My permission to perform this exercise test is given voluntarily. I understand that I am free to stop the test at any point if I so desire.

I have read this form, and I understand the test procedures that I will perform and the attendant risks and discomforts. Knowing these risks and discomforts, and having had an opportunity to ask questions that have been answered to my satisfaction, I consent to participate in this test.

Date	Signature of patient
Date	Signature of witness
Date	Signature of physician or authorized delegate

A waiver or release of liability (Box 22.4) document states that the client knowingly waives or releases the Personal Trainer from liability for any acts of negligence on the part of the Personal Trainer (1,9). In other words, the prospective client waives his or her right to sue the Personal Trainer, even if the Personal Trainer is negligent. A Personal Trainer needs to consult with an attorney in his or her location to determine which type of document, or both, is the standard practice for his or her state. For examples of additional forms, please refer to *ACSM's Health/Fitness Facility Standards and Guidelines*, fifth edition (9). Again, these forms should be approved by legal counsel prior to their use.

Box 22.4 Sample Agreement and Release of Liability Form

I, ____, the undersigned, wish to participate in a fitness evaluation, which consists of a submaximal cardiovascular assessment (bike or treadmill), body fat analysis by skinfold, strength, and flexibility assessments, muscular endurance assessment, and individualized exercise program at the <*name of facility*> in <*city, state*>, which is to be conducted on this __________ day of _______________, 20_____. The evaluation will be conducted under the direction of a Personal Trainer. I understand and acknowledge that participation in the fitness evaluation activities involves an inherent risk of physical injury and I assume all such risks. I understand that I will participate in all fitness exercises in said fitness evaluation. I assume all risks of damage or injury, including death, that may be sustained by me while participating in the fitness evaluation test.

For and in consideration of <*name of facility*> allowing me to take the fitness evaluation, I hereby release and covenant not to sue <*name of facility*>, the officers, agents, members, and employees of each, from any and from all claims or actions, including those of negligence, which might arise as a result of any personal injury, including death, or property damage, which I might suffer as a result of my participation in the fitness evaluation on the date set forth above.

By signing this document, I hereby acknowledge that I am at least 18 years of age and have read the above carefully before signing, and agree with all of its provisions this __________ day of _______________, 20_____.

______________________	______________________
Signature of Participant	Witness

Note: This form is presented for information purposes only and should be not considered legal advice or used as such. The use of this form in specific situations requires substantive legal judgments and a licensed attorney should be consulted before using the form.

Professional Liability Insurance

In today's litigious environment, for the most protection, a Personal Trainer should carry professional liability insurance ($2 million per occurrence/claim is recommended), even when working in a business as an employee, where the Personal Trainer may be covered under the business owner's policy. The reason for this is that it is not unusual for a single claim to result in a million dollar, or more, judgment. Purchasing adequate insurance enables the Personal Trainer to practice responsibly and feel confident that his or her business will not be destroyed by one situation. ACSM-CPTs® and ACSM members can purchase professional liability insurance through the ACSM. For more information, go to https://acsm.haysprograms.com/index.php.

Professional liability insurance provides a broad spectrum of protection from claims such as those arising from negligence, breach of contract, or even sexual harassment, and it can provide coverage for both injuries to a person or to property. Another potential consideration is to ensure that policies cover one outside a fitness facility if working with clients outdoors and particularly in challenging environments (*e.g.*, mountain biking, kayaking, rollerblading). Insurance professionals are expert at handling claims and will take care of all of the details, enabling the Personal Trainer to continue to operate his or her business (6). This includes, when necessary, providing the defense to a lawsuit. Frequently, this duty to provide a legal defense for the Personal Trainer is as valuable to the insured as is the duty of the insurance company to pay for covered claims brought against the Personal Trainer.

Professional liability insurance provides a broad spectrum of protection from claims such as those arising from negligence, breach of contract, or even sexual harassment, and it can provide coverage for both injuries to a person or to property.

Client Confidentiality

The failure to protect client confidentiality is another area of potential liability for a Personal Trainer. It is important to protect confidentiality to prevent potential harm to a client's reputation. The Personal Trainer must keep detailed written records from the first client prescreening to notes documenting each training session. These records provide critical evidence that can document that the Personal Trainer exercised reasonable care in performing his or her professional duties. At the same time, the Personal Trainer must exercise care to protect this information. A system should be in place that provides for and protects the complete confidentiality of all user records and meetings. User records should be released only with an individual's signed authorization. Before a Personal Trainer discloses any personal information, even for marketing purposes, such as a client testimonial or "before and after" photos, the Personal Trainer should obtain and store a signed release form. In 2013, the U.S. Congress passed a law that requires health care professionals to have strict policies regarding the safety and security of private records (the Health Insurance Portability and Accountability Act [HIPAA] of 1996, Public Law 104-191). Although it is still unclear whether HIPAA extends to Personal Trainers, it is wise to become familiar with this law and how it may affect the release of any personal information to a third party. It is clear that when a Personal Trainer works under the auspices of a "covered health care provider" as defined by HIPAA (*e.g.*, a hospital, physician office), this law governs the release of client information.

For liability protection, the Personal Trainer must keep detailed written records including the first client prescreening and document each training session.

SUMMARY

The Personal Training industry is continuing to grow and be redefined, as more health care providers acknowledge the need for exercise training as part of a program of preventive health care. In addition, the wellness trend is fueling more and more individuals to assume responsibility for their personal health and to consult with experts such as Personal Trainers to provide training services that enhance the quality of their daily lives. Personal Trainers have great opportunities to work in a variety of settings and make a powerful difference in the lives of their clients.

More professional opportunities, however, increase expectations of responsible professional conduct. More professional responsibility means more potential exposure to liability for failing to act responsibly. Today's Personal Trainer must understand these potential areas of risk exposure and the legal issues and industry standards and guidelines that surround these issues to deliver services confidently and to proactively manage risk. This professionalism in all aspects of doing business not only increases the personal and professional rewards of life as a Personal Trainer but also ensures lasting business success amid the growing complexity of our modern legal environment. Ultimately, the purpose of liability is to protect individuals. The most successful Personal Trainers will always keep in mind that the core of Personal Training is ultimately personal: to protect the best interests of the client at all times and in all ways. To this end, the ACSM has developed a code of ethics for ACSM certified and registered professionals (see Chapter 1) that will help to further the Personal Trainer profession.

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Appendix A

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