

Seventh Edition

Advanced Fitness Assessment and Exercise Prescription

Includes online access
to 44 video clips



Vivian H. Heyward • Ann L. Gibson

Seventh Edition

**Advanced Fitness
Assessment
and
Exercise
Prescription**

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To those who set high expectations and to those who rise to the challenge.

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Preface

Advanced Fitness Assessment and Exercise Prescription, Seventh Edition is written primarily for exercise science students in advanced professional courses dealing with physical fitness appraisal and exercise prescription. This book is also a resource for exercise physiologists or personal trainers working in the public or private sector. Previous editions of this text have been adopted for course use by numerous universities and colleges and have been translated into Chinese, Greek, Italian, Korean, Portuguese, and Spanish. Also, the seventh edition is now available as an electronic book, potentially allowing it to reach a wider audience worldwide.



This book provides exercise scientists with the knowledge and skills needed to assess the physical fitness of apparently healthy individuals rather than individuals who have suspected or documented cardiovascular disease. Since this text is not clinically oriented, it provides limited information on the etiology and pathophysiology of chronic diseases, on clinical exercise testing, and on exercise prescriptions for clinical populations. Exercise scientists working with clinical populations are encouraged to consult clinically oriented books that provide detailed information for exercise testing and prescriptions for these populations.

In its well-balanced approach to the assessment of physical fitness, *Advanced Fitness Assessment and Exercise Prescription* addresses five components:

- Cardiorespiratory endurance
- Muscular fitness
- Body weight and composition
- Flexibility
- Balance

This text is unique in its scope and in the depth of its content, organization, and approach to the subject matter. Introductory texts typically focus on field testing for evaluating physical fitness. Although this text includes some field tests, it emphasizes labora-

tory techniques for assessment. The scope and depth of information make this text an important resource for practitioners, especially those employed in health and fitness settings. Generally, the text is organized around physical fitness components, providing for each of them one chapter on assessment followed by one chapter on exercise prescription. The multidisciplinary approach of this text synthesizes concepts, principles, and theories based on research in exercise physiology, kinesiology, measurement, psychology, and nutrition. The result is a direct and clear-cut approach to physical fitness assessment and exercise prescription.

The scope and organization of the seventh edition of *Advanced Fitness Assessment and Exercise Prescription* are not substantially different from previous editions. Pedagogical tools include Key Questions at the beginning of each chapter and Key Points, Review Questions, and Key Terms at the end of each chapter. Each of the key terms is defined in the glossary at the end of the book. These tools will help you identify the key terms and concepts and test your knowledge and understanding of the material in each chapter.

Pertinent information from the latest edition (2014) of *ACSM's Guidelines for Exercise Testing and Prescription* is incorporated throughout the text. Updated phone numbers and websites for equipment manufacturers and suppliers are included. The following list highlights some of the changes in the chapters of *Advanced Fitness Assessment and Exercise Prescription, Seventh Edition*:

Chapter 1

- Recent global and U.S. statistics on the prevalence of chronic diseases
- New research substantiating the link between physical activity and disease risk
- Expanded information on prediabetes, overweight/obesity, metabolic syndrome, and osteoporosis
- New physical activity recommendations from the U.S. government, the American Heart

Association, and the American College of Sports Medicine (ACSM)

- Information about beneficial effects of physical activity on life expectancy

Chapter 2

- Updated information on risk factor identification and risk stratification
- Inclusion of SCORE system to estimate 10 yr risk of fatal cardiac event due to atherosclerosis
- Latest (2014) ACSM guidelines regarding medical exam and exercise testing requirements prior to beginning exercise programs
- Updated information on automated and hybrid sphygmomanometers
- New information on white coat hypertension and masked hypertension

Chapter 3

- Expanded information about the use of technology and wireless body area networks to monitor physical activity and physiological responses to exertion
- Updated information on the use of exergaming to promote physical activity and exercise for children and older adults
- New information on the use of social networking media to promote physical activity and increase adherence to an exercise program
- Updated information about the certification and licensure of exercise professionals
- Comparison of selected professional certifications

Chapter 4

- Updated statistics on the risk of adverse cardiac events during exercise testing
- Latest (2014) ACSM guidelines for exercise testing
- New field method for predicting maximum heart rate
- New information on the importance of monitoring participants during bench-step tests
- Recumbent stepper submaximal exercise test protocol
- New protocols for assessing the cardiorespiratory fitness level of children
- Expanded number of OMNI pictorial scales for ratings of perceived exertion during exercise

Chapter 5

- Latest (2014) ACSM FITT-VP principle for designing aerobic exercise programs
- Use of kettlebell exercises to improve aerobic fitness
- New information on monitoring exercise intensity with rating of perceived exertion (RPE) scales
- Updated information on high-intensity interval training to improve $\dot{V}O_{2\max}$

Chapter 6

- Clinical methods of isometric muscle testing with endurance norms
- Core stability muscle tests
- Tips for spotting resistance exercises

Chapter 7

- Updated guidelines for developing resistance training programs for novice, intermediate, and advanced weightlifters
- Updated information on designing resistance training programs for older adults
- Whole-body vibration training as an adjunct to resistance training
- Kettlebell training for improving strength, muscle endurance, and cardiorespiratory fitness
- New information about the transcriptome signature of resistance training
- Updated information about the effectiveness of supplements for increasing strength

Chapter 8

- New underwater weighing technique for decreasing amount of time client is fully submerged
- Updated information about air displacement plethysmography and dual-energy X-ray absorptiometry as reference methods for body composition assessment
- Use of bioimpedance spectroscopy and multi-frequency bioimpedance analysis to estimate body composition
- Updated information on digital skinfold caliper systems
- Updated information on using population-specific anthropometric indices to classify disease risk

Chapter 9

- Updated statistics on the global prevalence of obesity in children and adults
- New dietary guidelines for Americans
- MyPlate replaces healthy eating pyramid
- Evaluation of dietary and nutrition supplements for weight loss

Chapter 10

- Updated information on dynamic stretching and constant tension stretching
- Use of stretching and active warm-up for increased flexibility

Chapter 11

- Updated guidelines for designing stretching programs
- Physiological mechanisms underlying improvements in range of motion
- Whole-body vibration training as an adjunct to flexibility training
- Updated information about stretching and its effect on maximal muscle performance
- Comparison of active and passive stretching

Chapter 12

- Definition of neuromotor training and ACSM recommendations for neuromotor training
- Reactive balance tests
- Effects of preactivity stretching on balance performance
- Gait-velocity testing
- Sample progressive balance training program

Appendixes

- Updated websites for professional organizations
- OMNI pictorial scales for assessing ratings of perceived exertion of adults and children
- Age-gender squat and bench press norms for novice to elite lifters

These updates and additions provide a comprehensive approach to physical fitness appraisal and exercise prescription. We hope you will use *Advanced Fitness Assessment and Exercise Prescription, Seventh Edition* to improve your knowledge, skill, and professional competence as an exercise scientist.

ANCILLARY SUPPORT

To ensure fully integrated support for every faculty member, the following ancillaries are available to adopters of *Advanced Fitness Assessment and Exercise Prescription, Seventh Edition* at www.HumanKinetics.com/AdvancedFitnessAssessmentAndExercisePrescription.


- **Instructor guide.** Includes sample syllabi, course outlines, a class project, and activity and lab suggestions.

- **Test package.** Includes more than 250 true-or-false, multiple-choice, fill-in-the-blank, and short-answer questions.

- **Presentation package plus image bank.** Includes more than 400 PowerPoint text slides that highlight material from the text that instructors can use for class discussion and demonstration. Plus, the image bank includes most of the figures, content photos, and tables from the text, sorted by chapter, that can be used to develop a customized presentation based on specific course requirements.

- **Chapter quizzes.** A 25-question quiz at the conclusion of each chapter helps instructors assess students' comprehension of the most important concepts in the chapter. Chapter quizzes can be imported into learning management systems or used in RTF format by instructors who prefer to offer a written quiz.

- **Online video.** Includes over 60 video clips for more than 75 minutes of content, helping readers focus on the content of the text. The video demonstrates exercise assessments, procedures, and common errors and offers tips on interacting with clients. Instructors can use the video in the classroom to help students visualize the techniques. Students will have access to the video, which is cross-referenced to relevant content in the text with

a  in the book's margin.

- Visit www.HumanKinetics.com/AdvancedFitnessAssessmentAndExercisePrescription to find the video clips, which are separated by chapter and intuitively titled for easy cross referencing with the text.

Acknowledgments

The first edition of this textbook was titled *Designs for Fitness* and was published by Burgess Publishing Co. in 1984. It was a softcover book having about 200 pages. Dr. Swede Schoeller took the photos for that edition and Eileen Fletcher, our department secretary, typed the manuscript on her Smith-Corona.

The second edition was published by Human Kinetics Publishers in 1991. This edition was a hardcover book consisting of 350 pages. For this edition, Linda K. Gilkey took the photos. For the first time, the manuscript was typed using a DOS word processing system by the department secretary, Sandi Travis.

In 1998, the third edition was published by HK. The book grew in size from a 7" × 9" format to an 8.5" × 11" format. Once again, Linda K. Gilkey took the photos, and the computer graphics were done by Dr. Robert Robergs, Dr. Brent Ruby, and Dr. Peter Egan.

The fourth edition, published by HK in 2002, was 370 pages. Our colleagues, Dr. Christine Mermier, Dr. Virginia Wilmerding, Dr. Len Kravitz, and Dr. Donna Lockner, shared their excellent ideas and expertise. The developmental editors, Elaine

Mustain and Maggie Schwarzentraub, meticulously edited this edition.

In 2006, the fifth edition was released. For this edition, the total number of pages increased to 425, and HK updated all of the photos. Sarah Ritz did an excellent job organizing and taking these photos. Dr. Dale Wagner contributed the test question bank that accompanied this edition.

The sixth edition was released in May 2010. For the first time, this book was also published as an e-book. The book expanded to 480 pages. Dr. Dale Wagner updated the test question bank, and Dr. Ann Gibson prepared the slides for the presentation package.

The seventh edition is now coauthored with Dr. Ann Gibson. Her knowledge, expertise, and contributions have greatly improved the scope and content of this edition. In addition to being published as an e-book, the seventh edition will be supplemented with instructional videos.

Many individuals have contributed to the continued success of *Advanced Fitness Assessment and Exercise Prescription*. We are indebted to each person who played a role in the metamorphosis of this book.

Accessing the Online Video

New to this seventh edition is online streaming video, including over 65 videos of content demonstrating key concepts from the book, such as assessments, procedures, tips, stretches, and exercises. You can access the online video by visiting www.HumanKinetics.com/AdvancedFitnessAssessmentAndExercisePrescription. If you purchased a new print book, follow the instructions on the orange-framed page at the front of your book. That page includes access steps and the unique key code that you'll need the first time you visit the *Advanced Fitness Assessment and Exercise Prescription* website. If you purchased an e-book from HumanKinetics.com, follow the access instructions that were e-mailed to you after your purchase. If you have purchased a used book, you can purchase access to the online video separately by following the links at www.HumanKinetics.com/AdvancedFitnessAssessmentAndExercisePrescription.

Once at the *Advanced Fitness Assessment and Exercise Prescription* website, select Online Video in the ancillary items box in the upper-left corner of the screen. You'll then see an Online Video page with information about the video. Select the link to open the online video web page.

On the online video page, you will see a set of buttons that correspond to the chapters in the text that have accompanying video. Select the button for the chapter's videos you want to watch. Once you select a chapter, a player will appear. In the player, the clips for that chapter will appear vertically along the right side, numbered as they are in the text. Select the video you would like to watch and view it in the main player window. You can use the buttons at the bottom of the main player window to view the video full screen and to pause, fast-forward, or reverse.

Following is a list of the clips in the online video.

Video 2.1 Resting BP measurement

Video 2.2 Sources of BP measurement error

Video 2.3 Measuring exercise BP

Video 2.4 Measuring resting HR by auscultation

Video 2.5 Measuring resting HR by palpation—
brachial artery

Video 2.6 Measuring resting HR by palpation—
carotid artery

Video 2.7 Measuring resting HR by palpation—
radial artery

Video 2.8 Measuring resting HR by palpation—
temporal artery

Video 2.9 Measuring HR using a heart rate
monitor

Video 2.10 6-lead ECG electrode placement

Video 2.11 12-lead ECG electrode placement

Video 2.12 Exercise ECG

Video 4.1 Calibrating treadmills

Video 4.2 Calibrating cycle ergometers

Video 4.3 Treadmill maximal exercise test

Video 4.4 Cycle ergometer maximal exercise test

Video 4.5 Treadmill submaximal exercise test

Video 4.6 Cycle ergometer submaximal exercise
test

Video 4.7 How to safely mount a treadmill

Video 6.1 Isometric muscle contraction

Video 6.2 Concentric muscle contraction

Video 6.3 Eccentric muscle contraction

Video 6.4 Grip strength testing procedures

Video 6.5 Grip endurance testing procedures

Video 6.6 V-sit test

Video 6.7 Side bridge test

Video 6.8 Spotting over-the-face exercises

Video 6.9 Pull-up tests

Video 6.10 Push-up tests

Video 6.11 Trunk curl tests

Video 7.1 Inclined bench press

Video 7.2 Flat bench press

Video 7.3 Declined bench press

Video 7.4 Pronated arm curl

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Video 7.6 Mid arm curl

Video 7.7 Common errors in performing the squat

Video 7.8 Common errors in performing the bench press

Video 8.1 Guidelines for hydrostatic weighing

Video 8.2 Testing procedures for the Bod Pod

Video 8.3 Whole-body BIA measures

Video 8.4 Upper body BIA measures

Video 8.5 Lower body BIA measures

Video 10.1 Shoulder flexion

Video 10.2 Knee flexion

Video 10.3 Ankle flexion

Video 10.4 Inclinomometer test procedures

Video 10.5 Modified sit-and-reach test

Video 10.6 Modified back-saver sit-and-reach test

Video 11.1 PNF stretching techniques

Video 12.1 Unipedal stance test

Video 12.2 Functional reach test

Video 12.3 Timed up and go test

Video 12.4 Star excursion balance test

Video C4.1 Chest push

Video C4.2 Shoulder pull

Video C4.3 Triceps extension

Video D2.1 Measurement of the chest skinfold

Video D2.2 Measurement of the subscapular skinfold

Video D2.3 Measurement of the midaxillary skinfold

Video D2.4 Measurement of the suprailiac skinfold

Video D2.5 Measurement of the abdominal skinfold

Video D2.6 Measurement of the triceps skinfold

Video D2.7 Measurement of the biceps skinfold

Video D2.8 Measurement of the thigh skinfold

Video D2.9 Measurement of the calf skinfold

Video F1.1 Hamstring stretch

Video F1.2 Chest stretch

Physical Activity, Health, and Chronic Disease

KEY QUESTIONS

- ▶ Are adults in the United States getting enough physical activity?
- ▶ What diseases are associated with a sedentary lifestyle, and what are the major risk factors for these diseases?
- ▶ What are the benefits of regular physical activity in terms of disease prevention and healthy aging?
- ▶ How does physical activity improve health?
- ▶ How much physical activity is needed for improved health benefits?
- ▶ What kinds of physical activities are suitable for typical people, and how often should they exercise?

Although physical activity plays an important role in the prevention of chronic diseases, an alarming percentage of adults in the United States report no physical activity during leisure time. One of the national health objectives for the year 2020 is to increase to 47.9% the proportion of people aged 18 yr and older who regularly (preferably daily) engage in moderate physical activity at least 30 min per day (U.S. Department of Health and Human Services 2010). According to a U.S. national survey, in 2010, a small percentage (20.7%) of adults over the age of 18 met the 2008 federal physical activity guidelines for adults in terms of both aerobic and muscle strengthening activities. Slightly more than half (50.5%) met either the aerobic activity or the muscle-strengthening guideline, but not both (CDC 2011a). Generally, women (54%) are less likely to meet the full aerobic and muscle-strengthening recommendations than men (43.8%), and older (≥ 65 yr) adults are less likely (64.6%) to meet it than younger (18–24 yr) adults (39.4%) (CDC 2011a).

Physical inactivity is not just a problem in the United States; it is a global issue and the fourth leading cause of global mortality (World Health

Organization 2010). Results from survey data collected from 122 countries indicated that 31% of the global adult (≥ 15 yr) population is physically inactive. The prevalence of physical inactivity ranges from approximately 43% in the American and eastern Mediterranean countries to a low of 17% in southeast Asia (Hallal et al. 2012). In 2008, only 39% of men and 29% of women in the United Kingdom met the government's physical activity guidelines (British Heart Foundation 2012). Also, the Canadian Fitness and Lifestyle Research Institute (2009) reported that 52% of Canadians (≥ 20 yr) did not meet the recommended 30 minutes of moderate to vigorous activity in 2007–2008. Thus, as an exercise specialist, you face the challenge of educating and motivating your clients to incorporate physical activity as a regular part of their lifestyles.

This chapter deals with physical activity trends, risk factors associated with chronic diseases, the role of regular physical activity in disease prevention and health, and physical activity guidelines and recommendations for improved health. For definitions of terminology used in this chapter, see the glossary.

PHYSICAL ACTIVITY, HEALTH, AND DISEASE: AN OVERVIEW

Our increased reliance on technology has substantially lessened work-related physical activity, as well as the energy expenditure required for activities of daily living like cleaning the house, washing clothes and dishes, mowing the lawn, and traveling to work. What would have once required an hour of physical work now can be accomplished in just a few seconds by pushing a button or setting a dial. As a result, more time is available to pursue leisure activities. The unfortunate fact is, however, that many individuals do not engage in physical activity during their leisure time.

Although the human body is designed for movement and strenuous physical activity, exercise is not a part of the average lifestyle. One cannot expect the human body to function optimally and to remain healthy for extended periods if it is abused or is not

used as intended. Physical inactivity has led to a rise in chronic diseases. Some experts believe that physical inactivity is the most important public health problem in the 21st century (Blair 2009). Each year at least 1.9 million people die as a result of physical inactivity (Cavill, Kahlmeier, and Racioppi 2006). Data from the Aerobics Center Longitudinal Study (Blair 2009) indicated that low cardiorespiratory fitness accounts for substantially more deaths (16%) compared to other risk factors (i.e., obesity 2–3%; smoking 8–10%; high cholesterol 2–4%; diabetes 2–4%; and hypertension 8–16%). Individuals who do not exercise regularly are at a greater risk for developing chronic diseases such as coronary heart disease (CHD), hypertension, hypercholesterolemia, cancer, obesity, and musculoskeletal disorders (see figure 1.1).

For years, exercise scientists and health and fitness professionals have maintained that regular physical activity is the best defense against the development of many diseases, disorders, and illnesses. The importance of regular physical activity

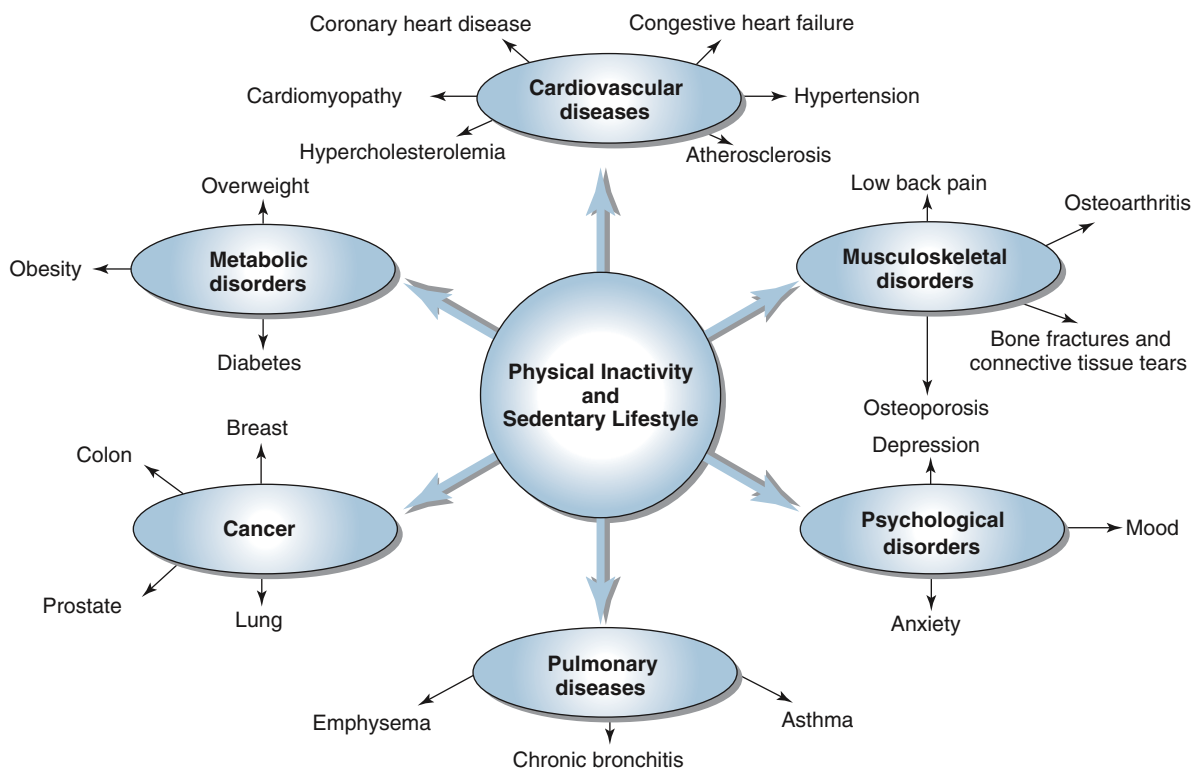


FIGURE 1.1 Role of physical activity and exercise in disease prevention and rehabilitation.

in preventing disease and premature death and in maintaining a high quality of life received recognition as a national health objective in the first U.S. surgeon general's report on physical activity and health (U.S. Department of Health and Human Services 1996). This report identified physical inactivity as a serious nationwide health problem, provided clear-cut scientific evidence linking physical activity to numerous health benefits, presented demographic data describing physical activity patterns and trends in the U.S. population, and made physical activity recommendations for improved health. In 1995, the CDC and the American College of Sports Medicine (ACSM) recommended that every U.S. adult should accumulate 30 min or more of moderate-intensity physical activity on most, preferably all, days of the week (Pate et al. 1995).

Since 1995, new scientific evidence has increased our understanding of the benefits of physical activity for improved health and quality of life. In light of these findings, the American Heart Association (AHA) and the ACSM updated physical activity recommendations for healthy adults and older adults (Haskell et al. 2007; Nelson et al. 2007). These recommendations address how much and what kind of

physical activity are needed to promote health and reduce the risk of chronic disease in adults. Table 1.1 summarizes the ACSM and AHA physical activity recommendations for adults. The recommended amounts of physical activity are in addition to routine activities of daily living (ADLs) such as cooking, shopping, and walking around the home or from the parking lot. The intensity of exercise is expressed in metabolic equivalents (METs). A MET is the ratio of the person's working (exercising) metabolic rate to the resting metabolic rate. One MET is defined as the energy cost of sitting quietly. Moderate-intensity aerobic activity (3.0–6.0 METs or 5 or 6 on a 10-point perceived exertion scale) is operationally defined as activity that noticeably increases heart rate and lasts more than 10 min (e.g., brisk walking for 15 min). Vigorous-intensity activity (>6.0 METs or 7 or 8 on a 10-point perceived exertion scale) causes rapid breathing and increases heart rate substantially (e.g., jogging). For adults (18–65 yr) and older adults (>65 yr), the ACSM recommends a minimum of 30 min of moderate-intensity aerobic activity 5 days per week or 20 min of vigorous-intensity aerobic exercise 3 days per week. They also recommend moderate- to

Table 1.1 ACSM/AHA Physical Activity Recommendations

Population group	AEROBIC ACTIVITY ^a			MUSCLE-STRENGTHENING ACTIVITY			FLEXIBILITY/BALANCE ACTIVITY
	Duration ^b (min/day)	Intensity	Frequency (days/wk)	Sets	Intensity or # of exercises	Frequency (days/wk)	
Healthy adults 18-65 yr	30	Moderate (3.0–6.0 METS)	Minimum 5	1	8- to 12-RM; 8–10 exercises for major muscle groups	≥2 nonconsecutive days	No specific recommendation
	20	Vigorous (>6.0 METS)	Minimum 3				
Older adults >65 yr	30	Moderate (5 or 6 on 10 pt. scale)	Minimum 5	1	10- to 15-RM; 8–10 exercises for major muscle groups; Moderate intensity (5 or 6 on 10 pt. scale) Vigorous intensity (7 or 8 on 10 pt. scale)	2 nonconsecutive days	For flexibility at least 2 days per wk for at least 10 min each day; include balance exercises for those at risk for falls.
	20	Vigorous (7 or 8 on 10 pt. scale)	Minimum 3				

^aCombinations of moderate- and vigorous-intensity may be performed to meet recommendation (e.g., jogging 20 min on 2 days and brisk walking on 2 other days).

^bMultiple bouts of moderate-intensity activity, each lasting at least 10 min, can be accumulated to meet the minimum duration of 30 min.

high-intensity (8- to 12-repetition maximum [RM] for adults and 10- to 15-RM for older adults) resistance training for a minimum of 2 nonconsecutive days per week. Balance and flexibility exercises are also suggested for older adults.

Table 1.2 summarizes the physical activity guidelines (U.S. Department of Health and Human Services 2008) for children and adolescents (6–17 yr), adults (18–64 yr), and older adults (≥65 yr). The key message in these guidelines is that for substantial health benefits, adults should engage in aerobic exercise at least 150 min per week at a moderate intensity or 75 min per week at a vigorous intensity. In addition, adults and older adults should do muscle-strengthening activities at least 2 days per week. Children should do at least 60 min of physical activity every day. Most of the 60 min per day should be either moderate or vigorous aerobic activity and should include vigorous aerobic activities at least 3 days per week. Part of the 60 min or more of daily physical activity should be muscle-strengthening activities (at least 3 days a week) and bone-strengthening activities (at least 3 days a week). The term **exercise deficit disorder (EDD)** has been used to identify children who do not attain at least 60 min of moderate- to vigorous-intensity physical activity on a daily basis. Children having EDD may be susceptible to pathological processes associated with a physically inactive lifestyle (Faigenbaum and Myer 2011).

Exercising 150 min/wk equates to expending approximately 1000 kcal·wk⁻¹. Results from a recent meta-analysis (Sattelmair et al. 2011) indicated that individuals meeting the 2008 physical activity guidelines decrease their risk for coronary heart disease by 14% compared to those reporting no leisure-time physical activity. Participating in moderate-intensity physical activity on a daily basis also reduces the risk of hypertension, diabetes, and stroke, as well as colon and breast cancer (Kesäniemi et al. 2010; McTiernan et al. 2003; U.S. Department of Health and Human Services, 1996). Disease risk is further reduced when the moderate-intensity physical activity (150–180 min/wk) is performed throughout the week (i.e., 30 min/day on 5 days/wk) and in bouts lasting at least 10 min as opposed to in one single session (Kesäniemi et al. 2010).

Sattelmair and colleagues (2011) reported that 300 min/wk of moderate-intensity physical activ-

ity results in a 20% reduction in the risk for CHD. Furthermore, a review of studies on asymptomatic adults (19–65 yr) revealed that 90 min of vigorous-intensity physical activity accumulated throughout the week (90 min/wk) in increments of no fewer than 10 min reduces the risk of all-cause mortality by 30%, as well as the risk for cardiovascular disease (CVD), hypertension, stroke, type 2 diabetes, and breast and colon cancer (Kesäniemi et al. 2010).

In 2009, an international consensus conference was convened to review Canada's *Physical Activity Guide to Healthy Active Living* (Health Canada 2003). The consensus panel recommended that asymptomatic Canadian adults (19–65 yr) accumulate 150 min/wk of moderate-intensity or 90 min/wk of vigorous-intensity physical activity as a primary prevention against cardiovascular disease, stroke, hypertension, colon cancer, breast cancer, type 2 diabetes, and osteoporosis. They also recommended multiple exercise sessions in a week, with each session lasting a minimum of 10 min (Kesäniemi et al. 2010). In addition to the aerobic exercise, they recommended strength activities (2–4 days/wk), and flexibility activities (4–7 days/wk). The duration of the activity depends on the intensity or effort: Perform light activities (e.g., walking, video gaming that promotes light effort, gardening, carrying small children, or hairstyling) for 60 min, moderate activities (e.g., brisk walking, swimming, vacuuming, moving furniture, or chopping wood) for 30 to 60 min, and vigorous activities (e.g., jogging, hockey, wheelchair basketball, felling large trees, or rollerblading) for 20 to 30 min.

Improvements in health benefits depend on the volume (i.e., combination of frequency, intensity, and duration) of physical activity. This is known as the **dose-response relationship** (Bouchard 2001; Canadian Society for Exercise Physiology 2003; Kesäniemi et al. 2001). Because of the dose-response relationship between physical activity and health, the ACSM/CDC physical activity recommendation states that “persons who wish to improve their personal fitness, reduce their risk for chronic diseases and disabilities, or prevent unhealthy weight gain will likely benefit by exceeding the minimum recommended amount of physical activity” (Haskell et al. 2007, p. 1431).

Figure 1.2 illustrates the general dose-response relationship between the volume of physical activity

Table 1.2 2008 Physical Activity Guidelines for Americans

Population group	AEROBIC ACTIVITIES			MUSCLE-STRENGTHENING ACTIVITIES			BONE-STRENGTHENING ACTIVITIES	FLEXIBILITY AND BALANCE ACTIVITIES
	Duration	Intensity ^a	Frequency	Sets	Intensity ^a	Frequency		
Children and adolescents 6-17 yr	≥60 min	Moderate	Daily		Moderate to high	3 days/wk	3 days/wk	
		Vigorous	3 days/wk					
Adults 18-64 yr	Inactive	60-150 min/wk	Light (1.1-2.9 METs) to moderate (3.0-5.9 METs)	1	Light to moderate	1 day/wk		All adults should stretch to maintain flexibility for regular physical activity (PA) and activities of daily living (ADLs)
	Active	150-300 min/wk or 75-150 min/wk	Moderate (3.0-5.9 METs) Vigorous (≥6.0 METs)	≥1	Moderate to high 8- to 12-RM	≥2 days/wk		
	Highly active	>300 min/wk >150 min/wk	Moderate (3.0-5.9 METs) Vigorous (≥6.0 METs)	2 or 3	Moderate to high	≥2 days/wk		
Older adults ≥65 yr	Inactive	150 min/wk	Light (RPE = 3 or 4) to moderate (RPE = 5 or 6)	1	Light (RPE = 3 or 4) to moderate (RPE = 5 or 6)	2 or 3 days/wk		Older adults should stretch to maintain flexibility for regular PA and ADLs. ≥3 days/wk balance
	Active	150-300 min/wk or 75-150 min/wk	Moderate (RPE = 5 or 6) Vigorous (RPE = 7 or 8)	≥1	Moderate (RPE = 5 or 6) to high (RPE = 7 or 8) 8- to 12-RM	≥2 days/wk, nonconsecutive days		

^aIntensity is expressed in METs and repetition maximums (RM) for adults; for older adults, intensity is expressed as a rating of perceived exertion (RPE; 0-10 scale) and RM.

HEALTH BENEFITS OF PHYSICAL ACTIVITY

Lower risk of

- dying prematurely,
- coronary artery disease,
- stroke,
- type 2 diabetes and metabolic syndrome,
- high blood pressure,
- adverse blood lipid profile,
- colon, breast, lung, and endometrial cancers, and
- hip fractures.

Reduction of

- abdominal obesity and
- feelings of depression and anxiety.

Helps in

- weight loss, weight maintenance, and prevention of weight gain,
- prevention of falls and improved functional health for older adults,
- improved cognitive function,
- increased bone density, and
- improved quality of sleep.

Data from USDHHS 2008.

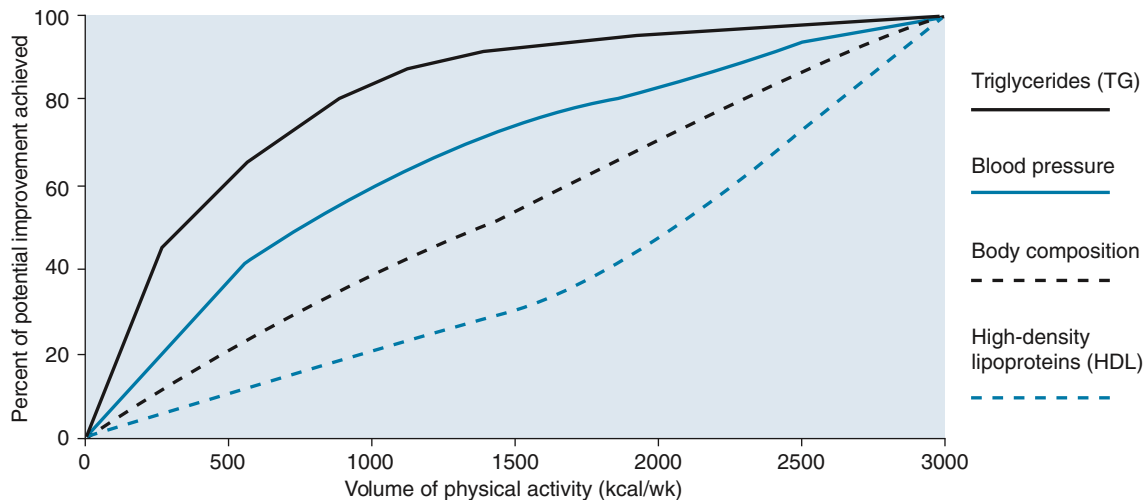


FIGURE 1.2 Dose-response relationship for health benefits and volume of physical activity.

Source: *The Canadian Physical Activity, Fitness & Lifestyle Approach: CSEP-Health & Fitness Program's Health-Related Appraisal and Counselling Strategy*, 3rd Edition © 2003. Reprinted with permission of the Canadian Society for Exercise Physiology. Schematic developed by N. Gledhill and V. Jamnik of York University.

participation and selected health benefits (e.g., muscular strength and aerobic fitness) that do not require a minimal threshold intensity for improvement. The volume of physical activity participation needed for the same degree of relative improvement (%) varies among health benefit indicators. For example, to improve triglycerides from 0% to 40% requires 250 kcal·wk⁻¹ of physical activity compared to 1800 kcal·wk⁻¹ for the same relative improvement

(0–40%) in high-density lipoprotein (HDL; see figure 1.2). Additionally, you should note that too much physical activity, defined as engaging in 5 hr of structured high-intensity activity per week, may be associated with negative health consequences or overuse injuries. For extensive reviews of literature dealing with the dose-response relationship between physical activity and health, see *Medicine & Science in Sports & Exercise* (June 2001, Supplement).

Although the physical activity guideline—a minimum of 150 min per week of moderate-intensity aerobic activity, preferably performed 30 min/day—reduces disease risk, it may not be optimal for maintaining a healthy body weight (Kesäniemi et al. 2010). In 2002, the Institute of Medicine (IOM) recommended 60 min of daily moderate-intensity physical activity. In the IOM report, the expert panel stated that 30 min of daily physical activity is insufficient to maintain a healthy body weight and to fully reap its associated health benefits. The IOM recommendation addresses the amount of physical activity necessary to maintain a healthy body weight and to prevent unhealthful weight gain (Brooks et al. 2004). The IOM recommendation of 60 min of daily physical activity is consistent with recommendations for preventing weight gain made by other organizations (i.e., Health Canada, International Association for the Study of Obesity, and World Health Organization) (Brooks et al. 2004). The bottom line is that 150 min per week of moderate-intensity physical activity provides substantial health benefits but may be insufficient to prevent weight gain for many individuals. It is a good initial goal

and a sufficient amount of activity to move individuals from a sedentary to low physical activity level (Brooks et al. 2004). As individuals adopt regular physical activity and improve their lifestyle and fitness, they should increase the duration of daily physical activity to a level (60 min) that prevents weight gain and provides additional health benefits. This goal is especially important for individuals who have difficulty controlling their body weight (Blair, LaMonte, and Nichaman 2004; Lohman, Going, and Metcalfe 2004), and it is sufficient to move individuals from a sedentary to active physical activity level (Brooks et al. 2004).

The Exercise and Physical Activity Pyramid illustrates a balanced plan of physical activity and exercise to promote health and to improve physical fitness (see figure 1.3). You should encourage your clients to engage in physical activities around the home and workplace on a daily basis to establish a foundation (base of pyramid) for an active lifestyle. They should perform aerobic activities a minimum of 3 days/wk; they should do weight-resistance exercises and flexibility or balance exercises at least 2 days per week. Recreational sport activities

EXAMPLES OF MODERATE-INTENSITY AND VIGOROUS-INTENSITY AEROBIC ACTIVITIES

This list provides several examples of moderate- and vigorous-intensity aerobic activities. Some activities can be performed at varied intensities. This list is not all-inclusive; examples are provided to help people make choices. For a detailed list of energy expenditures (METs) for conditioning exercises, sports, and recreational activities, see appendix E.4. Generally, light activity is defined as <3.0 METs, moderate activity as 3.0 to 6.0 METs, and vigorous activity as >6.0 METs.

Moderate Intensity

- Walking briskly (3.0 mph [4.8 km·hr⁻¹] or faster, but not race walking)
- Water aerobics
- Bicycling slower than 10 mph (16 km·hr⁻¹)
- Tennis (doubles)
- Ballroom dancing
- General gardening

Vigorous Intensity

- Race walking, jogging, or running
- Swimming laps
- Tennis (singles)
- Aerobic dancing
- Bicycling 10 mph (16 km·hr⁻¹) or faster
- Jumping rope
- Heavy gardening (continuous digging or hoeing with heart rate increases)
- Hiking uphill or with a heavy backpack

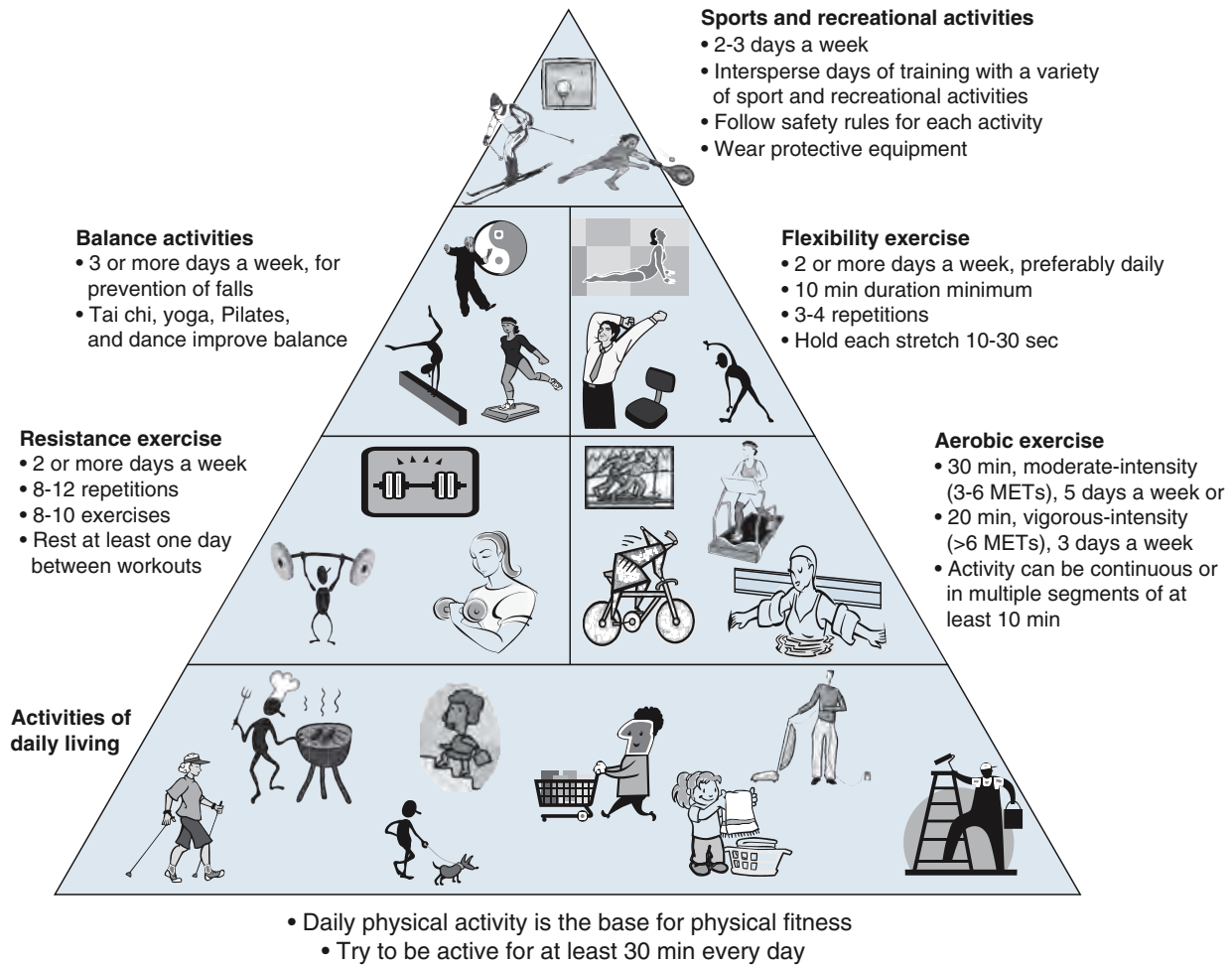


FIGURE 1.3 The Exercise and Physical Activity Pyramid.

Adapted, by permission, from "Exercise and Activity Pyramid" Metropolitan Life Insurance Company, 1995.

(middle levels of pyramid) are recommended to add variety to the exercise plan. High-intensity training and competitive sport (top of pyramid) require a solid fitness base and proper preparation to prevent injury; most adults should engage in these activities sparingly.

CARDIOVASCULAR DISEASE

Cardiovascular disease (CVD) caused 17.3 million deaths (30%) worldwide in 2008, and it is projected to cause more than 26 million deaths by 2030 (World Health Organization 2011b). More than 80% of those cardiovascular deaths occurred in low- and middle-income countries (World Health

Organization 2007a). CVD is the principal cause of premature death in Europe, accounting for more of all deaths before age 75 in women (42%) than men (38%) (Fifth Joint Task Force of the European Society of Cardiology 2012). CVD is also a leading cause of disease burden in developing low- and middle-income countries; deaths due to CVD range from a low of 10% in sub-Saharan Africa to 58% in Eastern Europe (Wagner and Brath 2012). In 2008, diseases of the heart and blood vessels claimed the lives of 811,940 people in the United States alone. CVD accounted for 33% of all deaths (one out of every three) in the United States. More than 82 million Americans have some form of CVD such as hypertension (76.4 million), coronary heart disease (CHD; 16.3 million), or stroke (7 million) (AHA 2012). Among American adults 20 years of age

or older, the estimated age-adjusted prevalence of coronary heart disease is higher for black men and women compared to Mexican-American and white men and women (AHA 2008b).

One myth about CVD is that it is much more prevalent in men than in women. In 2008, the prevalence of CVD in women (35.0%) and men (37.4%) in the U.S. was similar (AHA 2012). Nearly 419,000 females died from CVD in 2008 in the United States. Another misconception about CVD is that it only afflicts the older population. Although it is true that older people are at greater risk, more than 50% of the people in the United States with CVD are younger than 65 yr, and CVD ranks as the second-leading cause of death for children under age 15 (AHA 2012).

Globally, coronary heart disease (CHD) accounts for more deaths than any other disease, with more than 7.6 million people dying from it in 2005 (World Health Organization 2007a). CHD is caused by a lack of blood supply to the heart muscle (**myocardial ischemia**) resulting from a progressive, degenerative disorder known as **atherosclerosis**. Atherosclerosis is an inflammatory process involving a buildup of **low-density lipoprotein (LDL)** cholesterol, scavenger cells (monocytes), necrotic debris, smooth muscle cells, and fibrous tissue. This is how plaques form in the intima, or inner lining, of the medium- and large-sized arteries throughout the cardiovascular system. As more lipids and cells gather in the plaques, they bulge into the arterial lumen (World Health Organization 2011b). In the heart, these bulging plaques restrict blood flow to the myocardium and may produce **angina pectoris**, which is a temporary sensation of tightening and heavy pressure in the chest and shoulder region. A **myocardial infarction**, or heart attack, can occur if a blood clot (thrombus) or ruptured plaque obstructs the coronary blood flow. In this case, blood flow through the coronary arteries is usually reduced by more than 80%. The portion of the myocardium supplied by the obstructed artery may die and eventually be replaced with scar tissue.

CORONARY HEART DISEASE RISK FACTORS

Epidemiological research indicates that many factors are associated with the risk of CHD. The greater

the number and severity of risk factors, the greater the probability of CHD. The positive risk factors for CHD are

- age,
- family history,
- hypercholesterolemia,
- hypertension,
- tobacco use,
- diabetes mellitus or prediabetes,
- overweight and obesity, and
- physical inactivity.

An increased level (≥ 60 mg-dl⁻¹) of high-density lipoprotein cholesterol, or HDL-cholesterol (HDL-C), in the blood decreases CHD risk. If the HDL-C is high, you should subtract one risk factor from the sum of the positive factors when assessing your client's CHD risk.

PHYSICAL ACTIVITY AND CORONARY HEART DISEASE

Approximately 6% of CHD deaths worldwide can be attributed to a lack of physical activity (World Health Organization 2010). As an exercise scientist, you must educate your clients about the benefits of physical activity and regular exercise for preventing CHD. Physically active people have lower incidences of myocardial infarction and mortality from CHD and tend to develop CHD at a later age compared to their sedentary counterparts (Berlin and Colditz 1990). Individuals who exercise regularly reduce their relative risk of developing CHD by a factor of 1.5 to 2.4 (AHA 1999; Powell et al. 1987). Leading a physically active lifestyle may prevent 20% to 35% of cardiovascular diseases (Department of Health, Physical Activity, Health Improvement and Protection 2011). Physical activity exerts its effect independently of smoking, hypertension, hypercholesterolemia, obesity, diabetes, and family history of CHD (Bouchard, Shephard, and Stephens 1994). Also, in a meta-analysis of studies dealing with the dose-response effects of physical activity and cardiorespiratory fitness on CVD and CHD risk, Williams (2001) reported that cardiorespiratory fitness and physical activity have significantly