CHAPTER 5

Aerobic Exercise for Older Adults

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ABSTRACT

Older adults move less, making them prone to deconditioning and a host of other consequences including stiffness, weakness, cardiovascular changes, decreased balance, cognitive disorders, insomnia, mood changes, and adverse effects on appetite, to name a few. Because the benefits of aerobic exercise and physical activity are so powerful and pervasive in reversing the consequences of inactivity, the Centers for Disease Control and Prevention (CDC) have established guidelines for all adults of 150 minutes of moderate-intensity physical activity comprising aerobic and strengthening activity. Yet, the majority of older adults do not engage in *any* aerobic activity (CDC, 2013). Aerobic exercise is so important for health and chronic disease management that its prescription is a core competency for most health-care providers. This chapter reviews the effects of aging on aerobic capacity, the benefits of aerobic exercise across many common chronic diseases, and an evidence-based exercise prescription based on appropriate screening for a variety of conditions common to older adults.

BENEFITS OF AEROBIC EXERCISE

It is well known that participation in a regular exercise program is an effective way to reduce and/or prevent functional decline and the burdens of many chronic diseases associated with aging (Taylor, 2014). Aerobic or endurance training can

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help to maintain various aspects of heart and lung function and cardiac output. Aerobic activity enables the body to burn calories, a function referred to as a metabolic equivalent (MET). Aerobic activity is defined as any activity that uses large muscle groups, can be maintained continuously, and is rhythmic in nature (American College of Sports Medicine [ACSM], 2010). Examples of aerobic activities include swimming, running, walking, skiing, aerobic dance, and biking.

Broadly, the three categories of exercise are aerobic training, resistance training, and flexibility training. The benefits of exercise are listed in Table 5.1, which include reducing the burden of chronic diseases seen so frequently in older adults, improving quality of life and well-being, and maintaining function and independence. This chapter highlights the use of aerobic exercise for the maintenance of health and management of chronic disease. The specific and compelling benefits of aerobic/endurance exercise are listed in Table 5.2.

DESCRIPTION OF AEROBIC EXERCISE

For aerobic exercise to be effective, a training effect must occur. A training effect is when the total training load exceeds loads encountered during daily life and when adaptations occur that promote cardiovascular fitness (Pescatello, Arena, Riebe, & Thompson, 2014). Aerobic exercise below a certain level, such as light activities, is unlikely to achieve health-related changes (Taylor, 2014). The ACSM and the Centers for Disease Control and Prevention (CDC) together recommend 150 minutes per

TABLE 5.1
Benefits of Exercise

Reduce the risk of premature death
Reduce the risk of developing and/or dying from heart disease
Reduce high blood pressure or the risk of developing high blood pressure
Reduce high cholesterol or the risk of developing high cholesterol
Reduce the risk of developing colon cancer and breast cancer
Reduce the risk of developing diabetes
Reduce or maintain body weight or body fat
Build and maintain healthy muscles, bones, and joints
Reduce depression and anxiety
Improve psychological well-being
Enhance work, recreation, and sport performance

Source: Pescatello, Arena, Riebe, and Thompson (2014).

TABLE 5.2
Benefits of Aerobic Exercise

Increased maximal oxygen consumption (VO_2max)
Improvement in cardiovascular/cardiorespiratory function (heart and lungs)
Increased maximal cardiac output (amount of blood pumped every minute)
Increased maximal stroke volume (amount of blood pumped with each beat)
Increased blood volume and ability to carry oxygen
Reduced workload on the heart (myocardial oxygen consumption) for any given submaximal exercise intensity
Increased blood supply to muscles and ability to use oxygen
Lower heart rate and blood pressure at any level of submaximal exercise
Increased threshold for lactic acid accumulation
Lowered resting systolic and diastolic blood pressure in people with high blood pressure
Increased HDL cholesterol (the good cholesterol)
Decreased blood triglycerides
Reduced body fat and improved weight control
Improved glucose tolerance and reduced insulin resistance

Note: HDL = high-density lipoprotein.
Source: Gostic (2005).

week of moderate-intensity aerobic activity (i.e., brisk walking) *or* 75 minutes per week of vigorous-intensity aerobic activity. For greater health benefits, older adults should increase their activity to 300 minutes per week of moderate-intensity aerobic activity or 150 minutes of vigorous-intensity aerobic activity (CDC, 2013). This volume of exercise should occur for at least 10 minutes at a time.

MEASURES OF AEROBIC EXERCISE INTENSITY

Intensity of exercise is measured in terms of METs, which indicates how much energy is burned during exercise and physical activities (Table 5.3). METs are used to standardize energy expenditure, which differs from calorie counts, which is dependent on body weight. One MET equals 3.5 mLO_2/kg of body weight per minute, which is what the human body requires at rest. The more effort an activity requires, the higher the MET value. This value is the same for most people, regardless of fitness level. Variations may occur with gender, age, and body

TABLE 5.3
Aerobic Intensity

Activity	RPE (1–10)
Light-intensity activities are defined as 1.1 MET to 2.9 METs.	3–4
Moderate-intensity activities are defined as 3.0 to 5.9 METs.	5–6
Walking at 3.0 mph requires 3.3 METs of energy expenditure and is therefore considered a moderate-intensity activity.	
Vigorous-intensity activities are defined as 6.0 METs or more.	7–8
Running at 10 minutes per mile (6.0 mph) is a 10 MET activity and is therefore classified as vigorous intensity.	8–10

Note: MET = metabolic equivalent; mph = miles per hour; RPE = rate of perceived exertion.

Source: Pescatello et al. (2014).

composition. However, because maximal aerobic capacity declines with age, the relative exercise intensity level (maximum oxygen consumption [VO_2 max]) will be higher for older adults for the same MET level. Even so, physically active older adults may have aerobic capacities comparable to or greater than sedentary younger adults (Pescatello et al., 2014).

Cardiorespiratory fitness is related to the ability to use large muscles in a dynamic way at moderate-to-high intensities for prolonged periods. VO_2 max is the accepted criterion measure of cardiorespiratory fitness. The exercise guidelines by the CDC and ACSM mentioned in the previous section are based on MET levels. Five hundred to 1,000 MET minutes of activity per week is equal to 150 minutes of moderate-intensity activity per week (3.3 METs for 150 minutes per week). A MET level of 6.0 is equivalent to 75 minutes of vigorous activity per week (Office of Disease Prevention and Health Promotion, 2015). Based on these guidelines using MET level as the basis for the recommendations, 1 minute of vigorous-intensity activity is equal to 2 minutes of moderate-intensity activity.

When the energy requirement for an activity exceeds a person's aerobic capacity, the individual can no longer perform that activity. Thus, the ability to maintain a high aerobic capacity is directly related to an older adult's functional independence. Morey et al. established the optimal cut point of a peak VO_2 of ~18 mL/kg/min, which differentiates low versus high function in a group of community-dwelling adults aged 65–90 years (Morey, Pieper, & Cornoni-Huntley, 1998). A healthy 50-year-old man should have a capacity of at least 9.2 METS, a healthy 50-year-old woman should be able to achieve 8.2 METs or higher. METs for common exercise modes and activities are listed in Table 5.4.

TABLE 5.4

Metabolic Equivalents for Aerobic Exercise Modes and Activities

Moderate Activity (3.0–6.0 METs)	Vigorous Activity (>6.0 METs)
Walking at a moderate or brisk pace of 3 to 4.5 mph (20–12.33 min/mile) on a level surface inside or outside such as • Walking to class, work, or the store • Walking for pleasure • Walking the dog • Walking as a break from work Walking downstairs or down a hill Using crutches Hiking	Racewalking and aerobic walking—5 mph or faster (<12 min/mile) Jogging or running Walking and climbing briskly up a hill Backpacking Mountain climbing
Bicyclying 5–9 mph, level terrain, or with few hills Stationary cycling—using moderate effort	Bicycling more than 10 mph or bicycling on steep uphill terrain Stationary bicycling—using vigorous effort
Aerobic dancing—high impact Water aerobics	Aerobic dancing—high impact Step aerobics Water jogging Teaching an aerobic dance class
Calisthenics—light Yoga Gymnastics General home exercises, light or moderate effort, getting up and down from the floor Using a stair-climber machine at a light-to-moderate pace Using a rowing machine with moderate effort	Calisthenics—push-ups, pull-ups, vigorous effort Karate, judo, tae kwon do, jujitsu Jumping rope Performing jumping jacks Using a stair-climber at a fast pace Using a rowing machine—with vigorous effort Using an arm cycling machine—with vigorous effort
Ballroom dancing Line dancing Square dancing Folk dancing Modern dancing, disco Ballet	Professional ballroom dancing—energetically Square dancing—energetically Folk dancing—energetically Clogging

(*Continued*)

TABLE 5.4

MET Equivalent for Aerobic Exercise Modes and Activities (Continued)

Moderate Activity (3.0–6.0 METs)	**Vigorous Activity (>6.0 METs)**
Table tennis—competitive Tennis—doubles	Tennis—singles
Golf—wheeling or carrying clubs	
Playing Frisbee Badminton	Handball—general or team Racquetball Squash
Swimming—recreational Treading water—slowly, moderate effort Diving—springboard or platform Aquatic aerobics Waterskiing Snorkeling Surfing, board or body	Swimming, steady-paced laps Synchronized swimming Treading water—fast, vigorous effort Water jogging Water polo Water basketball Scuba diving
Canoeing or rowing a boat at less than 4 mph Rafting—whitewater Sailing—recreational or competition Paddle boating Kayaking—on a lake, calm water	Canoeing or rowing—4 or more mph Kayaking in whitewater rapids
Fishing while walking along a riverbank or while wading in a stream—wearing waders	
Gardening or yard work; raking the lawn bagging grass or leaves, digging, hoeing, light shoveling (less than 10 lb per min), or weeding while standing or bending Planting trees, trimming shrubs and trees, hauling branches, stacking wood Pushing a power mower or tiller	Gardening and yard work: heavy or rapid shoveling (more than 10 lb per minute), digging ditches or carrying heavy loads Felling trees, carrying large logs, swinging an ax, hand-splitting logs, or climbing and trimming trees Pushing a nonmotorized lawn mower
Shoveling light snow	Shoveling heavy snow

(*Continued*)

TABLE 5.4
MET Equivalent for Aerobic Exercise Modes and Activities (*Continued*)

Moderate Activity (3.0–6.0 METs)	Vigorous Activity (>6.0 METs)
Moderate housework: scrubbing the floor or bathtub while on hands and knees, hanging laundry on a clothesline, sweeping an outdoor area, cleaning out the garage, washing windows, moving light furniture, packing or unpacking boxes, walking and putting household items away, carrying out heavy bags or trash or recyclables (e.g., glass, newspapers, and plastics), or carrying water or firewood	Heavy housework: moving or pushing heavy furniture (75 lb or more), carrying household items weighing 25 lb or more up a flight of stairs Standing, walking, or walking down a flight of stairs while carrying objects weighing 50 lb or more
Actively playing with children—walking, running, or climbing while playing with children Walking while carrying a child weighing less than 50 lb Walking while pushing or pulling a child in a stroller or an adult in a wheelchair Carrying a child weighing less than 25 lb up a flight of stairs Child care: handling uncooperative young children (e.g., chasing, dressing, lifting into car seat) or handling several young children at one time Bathing and dressing an adult	Vigorously playing with children—running longer distances or playing strenuous games with children Racewalking or jogging while pushing a stroller designed for sport use Carrying an adult or child weighing 25 lb or more up a flight of stairs Standing or walking while carrying an adult or a child weighing >50 lb

Note: lb = pound; MET = metabolic equivalent; min = minute; mph = miles per hour.

Source: Centers for Disease Control and Prevention (2014).

The rate of perceived exertion (RPE; Russell, 1997) is a subjective measure of effortful exertion (Borg, 1998). The RPE correlates numerical descriptors with heart rate and exercise intensity on a scale of 6–20 with 6 equating to a heart rate of 60 and so on. The RPE has been validated for older adults and is particularly useful for those who may have a blunted heart rate response, such as when taking β-blockers. A rate of 11–15 on the Borg RPE corresponds to a percentage of 60%–80% VO_2 max. The original and modified RPE scale that uses anchors of 1–10

TABLE 5.5

Rate of Perceived Exertion

Modified Scale	Original Scale	Percent Effort	Perceived Workload
	6	20%	
	7	30%	Very, very light
	8	40%	
1	9	50%	Very light
2	10	55%	
3	11	60%	Fairly light
	12	65%	
4	13	70%	Moderately hard
	14	75%	
5	15	80%	Hard
6	16	85%	
7	17	90%	Very hard
8	18	95%	
9	19	100%	Very, very hard
10	20	Exhausted	

Source: Avers and Brown (2009).

is illustrated in Table 5.5. Working at an intensity of 5–6 on the modified RPE scale is recommended for a training effect (Pescatello et al., 2014). It is important to be aware that self-perception of RPE among older adults who have not been physically active may be exaggerated, so minimal activity might be perceived as hard effort (high intensity). Musculoskeletal factors that can give the perception of hard effort without a concurrent increase in physiological response include leg fatigue related to inadequate strength, joint pain, and obesity (Hulens, Vansant, Claessens, Lysens, & Muls, 2003; Sutbeyaz, Sezer, Koseoglu, Ibrahimoglu, & Tekin, 2007). If musculoskeletal problems persist in limiting the ability to perform aerobic activity, physical therapy interventions may be indicated.

EFFECTS OF AGING ON AEROBIC CAPACITY

The aging process affects all systems, but of particular importance to aerobic activity is how aging affects the cardiovascular system. In the vessels, arterial walls become stiff and thickened due to collagen deposition, elastin loss, and hypertrophy of the smooth muscle cells (Wan & Wong, 2014). These changes make the blood pressure higher and the heart work harder, which may lead to hypertrophy of the heart muscle. Most older adults have a moderate increase in blood pressure. The baroreceptors, receptors that monitor blood pressure and make changes to maintain blood pressure during rest and activity, become less sensitive with age. The reduced sensitivity of baroreceptors may cause orthostatic hypotension.

The heart's pacemaker system, the sinoatrial (SA) node loses some of its cells with age, which may result in a slightly lower heart rate. The heart's left ventricle may fill more slowly because of a slight increase in the size of the heart and it has less contractility. Heart changes and disease cause arrhythmias such as atrial fibrillation. Lipofuscin, an aging pigment, can be deposited in the heart wall, and the heart muscle cells may degenerate slightly. The heart's valves may thicken and become stiffer, which may result in a heart murmur (Montero, Roberts, & Vinet, 2014).

VO_2 max is the most frequent indicator of overall cardiovascular function and maximum capacity. Consistent findings indicate that VO_2 max decreases approximately 5%–15% per decade beginning at 25–30 years of age (Fletcher et al., 1996). This decline in VO_2 max is attributed to age-related reductions in both maximal cardiac output and maximal arteriovenous oxygen (a-v O_2) difference. Maximal heart rate decreases about 6–10 beats per minute per decade and is responsible for much of the age-associated decrease in maximal cardiac output. The reduction in stroke volume during maximal exercise also contributes to the decline in cardiac output.

The blood in an aging person thickens as a result of less fluid, so blood volume decreases. There is a slower response to blood loss and anemia because red blood cells are not produced as quickly (MedlinePlus, 2015). Neutrophils decrease in number and therefore have less ability to fight off bacteria, reducing the ability to fight off infection. Decreases in vascular capacity and local blood flow regulation, along with a decline in muscle oxidative capacity contribute to the overall reduction in maximal a-v O_2 difference with age. Coupled with poor oxygen delivery mechanisms, mitochrondrial alterations also lead to a reduction in maximum capacity to utilize oxygen at the level of the skeletal muscle (Petrella, 2000).

All of these changes in combination result in decreased VO_2 at a minimum rate of 8%–10% per decade in healthy men and women (Fleg & Lakatta, 1988), which may accelerate to 20%–25% per decade in those aged 70 or above (Fleg et al., 2005). While fitness level can keep the aerobic capacity at a higher level than that for unfit individuals, the decline is the same across all individuals.

Fortunately, even in the face of all these changes, older adults can adapt to a program of regular aerobic training as well as younger people (American College of Sports Medicine et al., 2009). Older adults can achieve the same 10%–30% increase in VO_2 max in response to aerobic/endurance exercise training as younger adults. The magnitude of these adaptations in VO_2 max is a function of training intensity; low-intensity training elicits only marginal changes. The increase in VO_2 max in older adults is a result of improvements in both maximum cardiac output and a-v O_2 difference.

AEROBIC EXERCISE TESTING AND PRESCRIPTION

Preparticipation Health Screening

The purpose of preparticipation health screening is to determine eligibility for participation in exercise and physical activity. The goal of preparticipation health screening is identification of individuals not known to be at risk, discernment of those with medical contraindications for certain types of exercise, recognition of individuals with clinically significant disease(s) or conditions, and detection of individuals who should undergo a medical evaluation and/or exercise testing before beginning an exercise program (Fletcher et al., 2013; Pescatello et al., 2014).

The revised ACSM 2014 preexercise evaluation recommendations reduce the emphasis on the need for medical evaluation prior to initiating a progressive exercise regimen for healthy, asymptomatic individuals to reduce a barrier to initiating a physical activity and exercise program *except* for those individuals at high risk (Pescatello et al., 2014). However, the ACSM recommendations emphasize the identification of clients or classification of participants with known disease, because these individuals are at the greatest risk for an exercise-related cardiac event. The ACSM risk stratification for exercise testing is described in Table 5.6.

All older individuals wishing to initiate a physical activity program should complete a self-report medical history or health risk appraisal questionnaire called a preparticipation health screening. Preparticipation health screening may include cost-effective self-assessments such as the Physical Activity Readiness Questionnaire (PAR-Q; Thomas, Reading, & Shephard, 1992), the exercise and screening test (Exercise Assessment and Screening for You [EASY]; Ory & Resnick, 2008), or the modified AHA/ACSM Health/Fitness Facility Preparticipation Screening Questionnaire (Balady et al., 1998). The PAR-Q asks questions that focus mostly on symptoms that might suggest angina pectoris but that have not been validated on adults above 65. The questionnaire of the Wisconsin Affiliate of the American Heart Association, the AHA/ACSM

TABLE 5.6
New ACSM Recommendations for Exercise Testing Prior to Exercise-Diagnosed Cardiovascular Disease

Unstable or new or possible symptoms of cardiovascular disease
Diabetes mellitus and at least one of the following:
Age > 35 years OR
Type 2 diabetes mellitus > 10-year duration OR
Type 1 diabetes mellitus > 15-year duration OR
Hypercholesterolemia (total cholesterol ≥ 240 mg/L) OR
Hypertension (systolic blood pressure ≥140 or diastolic ≥ 90 mmHg) OR
Smoking OR
Family history of CAD in first-degree relative <60 years OR
Presence of microvascular disease OR
Peripheral artery disease OR
Autonomic neuropathy
End-stage renal disease
Patients with symptomatic or diagnosed pulmonary disease including COPD, asthma, interstitial lung disease, or cystic fibrosis

Note: ACSM = American College of Sports Medicine; CAD = coronary artery disease; COPD = chronic obstructive pulmonary disease.

Source: Pescatello et al. (2014).

Health/Fitness Facility Preparticipation Screening Questionnaire, is slightly more complex than the PAR-Q and uses history, symptoms, and risk factors to determine appropriateness either to participate in an exercise program or to contact their physician or appropriate health-care provider (physician-provider) before participation. The EASY test, an online tool, was more recently developed to screen readiness to exercise and to help individuals follow up on any medical problems that need to be addressed (e.g., new onset of dizziness); it helps the individual match an appropriate exercise program with the underlying medical problems (e.g., exercises that are good to do when one has arthritis; Resnick et al., 2008).

The need for follow-up is determined by the individual's answers to any question in the tools mentioned in the preceding text. Individuals at moderate risk with two or more cardiovascular risk factors listed in Table 5.7 should consult with a health-care provider prior to initiating a physical activity program of a vigorous intensity. However, the majority of these individuals can begin a light- to medium-intensity exercise program such as walking without consulting with their health-care provider. Routine exercise testing is recommended only for individuals at high risk including those diagnosed with cardiovascular disease (CVD), symptoms suggestive of new or changing CVD, diabetes mellitus and additional CVD risk factors, end-stage renal disease, and specified lung disease as listed in Table 5.7 (Pescatello et al., 2014).

TABLE 5.7

Cardiovascular Risk Factors and Defining Criteria

Risk Factor	Defining Criteria
Age	Men ≥ 45 years; women ≥ 55 years
Family history	Myocardia infarction, coronary revascularization, or sudden death before 55 years in father or other male first-degree relative or before 65 years in mother or other female first-degree relative
Cigarette smoking	Current cigarette smoker or those who quit within the previous 6 months or exposure to environmental tobacco smoke
Sedentary lifestyle	Not participating in at least 30 min of moderate-intensity physical activity (40% to <60% VO_2R) on at least 3 days of the week for at least 3 months
Obesity	Body mass index ≥ 30 *or* waist girth > 102 cm (40 in.) for men and >88 cm (35 in.) for women
Hypertension	Systolic blood pressure ≥ 140 mmHg and/or diastolic ≥ 90 mmHg, confirmed by measurements on at least two separate occasions, or on antihypertensive medication
Dyslipidemia	LDL cholesterol ≥ 130 or HDL cholesterol < 40 or on lipid-lowering medication. If total serum cholesterol is all that is available, use ≥200
Prediabetes	Impaired fasting glucose = fasting plasma glucose ≥100 and ≤125 or impaired glucose tolerance = 2 h values in oral glucose tolerance test ≥140 and ≤199 confirmed by measurements on at least two separate occasions
Negative Risk Factors	
HDL cholesterol	≥60

Note: h = hour; HDL = high-density lipoprotein; LDL = low-density lipoprotein; in. = inch.

Source: American College of Sports Medicine (2010); Pescatello et al. (2014).

Individuals With Impaired Aerobic Capacity

For those individuals with known impaired aerobic capacity, performing a careful history and systems review is important. The history should include risk factors for CVD, presence of symptoms such as shortness of breath at rest or with mild exertion, pain or discomfort (or other angina equivalent) in the chest, neck, jaw, arms, or other areas that may result from cardiac ischemia, orthopnea, paroxysmal nocturnal dyspnea, bilateral ankle edema, palpitations, tachycardia, intermittent leg claudication, known heart murmur, and undue fatigue with usual activities (LaPier, 2012). Positive information may, at a minimum, inform the exercise prescription and lead the exercise professional to revise the program to best meet the needs of the participant. A general rule of thumb is to start low and slow, gradually building the program's intensity based on the participant's response. (Fitness program: 5 steps to get started—Mayo Clinic.)

A systems review should then be conducted that will include, at a minimum, physiological baseline measures of blood pressure, heart rate and rhythm, edema, and respiration rate. Screening for integrity of the musculoskeletal, neurological, and integumentary systems will also yield useful information. Table 5.8 lists recommended history items and system review tests. While it is beyond the scope of this chapter to provide detailed interpretation of each question and test, it is assumed the reader recognizes when a question or test is not normal and its implications.

Clinical Measures of Aerobic Impairment

In the presence of aerobic impairments, it is useful to obtain cardiovascular and pulmonary response to functional activity. Obtaining baseline measures of the patient's physiological measures such as heart rate, blood pressure, respiratory rate, and oxygen saturation will yield useful information about the individual's response to activity. Normal and abnormal responses to exercise are listed in Table 5.9. Describing the parameters of graded exercise testing is outside the scope of this chapter; however, it is common to perform submaximal tests such as the 6-minute walk test to ascertain an individual's physiological response to exercise before designing the exercise prescription, described in the following text.

Timed Walk Tests

The 6-minute and 2-minute walk tests are modifications of Cooper's original 12-minute walk test. Walk tests are inexpensive, efficient, require minimal equipment, and can be done anywhere. Walk tests can be used on a wide variety of patients and settings and have norms for many chronic diseases. The 6-minute

TABLE 5.8
History and Systems Review for the Individual With Impaired Aerobic Capacity

Chart Review and/or Oral History	Clinical Findings
	Other significant medical problems
	Current medications
	Risk factors for heart disease
	Lifestyle history (smoking, physical activity, etc.)
	Laboratory data (cholesterol, blood glucose)
	Electrocardiogram
	Pulmonary function tests
	Arterial blood gases
	Diagnostic tests
	Occupational history
	Presence of dizziness or excessive fatigue
Systems Review	Vital signs (heart rate, rhythm, blood pressure, respiration)
	Heart sounds
	Pulmonary auscultation
	BMI, waist circumference
	Range of motion and strength evaluation
	Sensation
	Skin integrity and peripheral circulation (pedal pulses)
	Chest excursion
	Edema
	Oxygen saturation

Note: BMI = body mass index.

walk test is a valid and reliable indicator of aerobic fitness. The average distance walked in a 6-minute walk test of 400 meters correlates to the average distance of a trip or errand in the community and so serves as a useful goal (Shumway-Cook et al., 2002). Assistive devices may be used, but the individual must be able to walk independently. Distance and physiological responses are the main outcomes of walk tests.

TABLE 5.9
Normal and Abnormal Responses to Exercise

Measure	Normal Response	Abnormal Response
Heart rate	60–100 bpm Increases proportionately to the metabolic demand (10 bpm per MET)	Inadequate increase or a sudden drop, which may be attributed to β-blockers, sinus node dysfunction, or chronotropic incompetence and may be an indication to stop exercise (Fletcher et al., 2013; Guccione, Wong, & Avers, 2012; LaPier, 2012). Excessive increase of 120–150 bpm: Use precaution in initiating an exercise program, consult with a physician-provider
Heart rate recovery	Rapid fall within 30 seconds after exercise, followed by a slower return to preexercise level	Slower recovery can be prognostic of cardiovascular disease or poor fitness (Dimkpa, 2009)
Systolic blood pressure (SBP) (reflecting cardiac output)	100–140 mmHg: Increase in proportion to the metabolic demand (pronounced in women as opposed to men). Average rise during a progressive exercise test is about 10 mmHg/MET (Fletcher et al., 2013) After maximum exercise, SBP declines, reaching preexercise levels or lower within 6 min. It can remain lower than preexercise levels for several hours	Inadequate rise of <20–30 mmHg (Exercise Assessment and Screening for You; Fletcher et al., 2013) >200 mmHg: contraindication to exercise, refer to physician-provider (LaPier, 2012)

(*Continued*)

TABLE 5.9
Normal and Abnormal Responses to Exercise (Continued)

Measure	Normal Response	Abnormal Response
Diastolic blood pressure (reflecting peripheral resistance)	70–90 mmHg	Increases are prognostic of cardiac disease (Akhras & Jackson, 1991) >115 mmHg: contraindicated to continue exercise, refer to physician-provider (LaPier, 2012)
Respiratory rate	Increases with mild- to moderate-intensity aerobic exercise, then plateaus as exercise intensity continues to increase	Abnormally high response may indicate coronary heart disease (Robbins et al., 1999)
Oxygen saturation	≥90%	Declines indicate heart failure, lung disease 86%–89%: Consider adding supplemental 0_2 and may be an indication to stop exercise. ≤85%: Add or increase supplemental 0_2; contraindication for continuing exercise/activity; refer to physician-provider if remains <90%

Note: bpm = beats per minute; MET = metabolic equivalent; min = minute.

Directions for Walk Tests

Prior to the test, a standard distance of at least 20 feet is mapped. Vital signs are recorded prior to the test. The individual is instructed to walk as far as possible for up to 6 minutes without sitting. The individual is allowed to stop but not allowed to lean or to sit. If sitting or leaning is necessary, the test is terminated at that point and the distance walked to that moment is the result of the test, with the time recorded in addition to the distance. Vital signs are recorded immediately at the end of the test with continuous monitoring until the vital signs return to baseline. It is useful to record how long it took the vital signs to return to baseline. Additionally, the RPE should be recorded. Normative distances for healthy older adults are listed in Table 5.10.

The 2-minute walk test was designed as a modification of the 6-minute walk test for individuals with amputations who could not walk a full 6 minutes (Brooks, Parsons, Hunter, Devlin, & Walker, 2001). The individual walks for 2 minutes and the distance recorded is the result of the test. However, there are no norms for the 2-minute walk test to the degree there are for the 6-minute walk test, and since 2 minutes is a far shorter time than what is required of the average errand in the community, this may have limited usefulness. The 6-minute walk test can still be used for individuals who cannot walk 6 minutes (Guccione, Wong, & Avers, 2012).

The 400-meter walk test is similar to the 6-minute walk test, but it defines a distance to walk (400 meters) versus a length of time. Some have suggested that knowing the distance to walk makes it easier for individuals to pace themselves and therefore achieve a greater effort (Simonsick, Montgomery, Newman, Bauer, & Harris, 2001). Similar to the other walk tests, vital signs are recorded

TABLE 5.10

Normative Values for 6-Minute Walk Test (Rikli & Jones, 1998) and 400-Meter Walk Test

6-Minute Walk Test			400-Meter Walk Test
Age	**Men**	**Women**	
60–69	572 m	538 m	
70–79	527 m	471 m	
80–89	417 m	392 m	
			>5 min 30 s is indicative of functional limitations
			Mean time to complete 400 meters is 5 min 11s (Simonsick et al., 2001)

Note: m = meter; min = minute; s = second.

prior to and immediately after the test and the RPE is recorded immediately after. The result is the time it took to complete the 400 meters. Normative results for healthy older adults are listed in Table 5.10. Interestingly, normative scores for the 400 meter walk test are very close to 6 minutes.

Exercise Prescription

Once the health-care provider has evaluated the individual, it is time to design an appropriate aerobic program to match the individuals' abilities. The exercise prescription for healthy older adults does not differ appreciably from that for younger adults. As indicated previously, the exercise recommendation for aerobic exercise is 150 minutes of moderate-intensity exercise per week or 75 minutes of vigorous-intensity exercise per week. The CDC recommends supplementing aerobic exercise with strengthening exercise on at least 2 days per week (CDC, 2015).

Setting Participant Goals and Identifying Barriers and Motivators

The first step in designing an exercise prescription, following screening and testing, is to be clear about the individual's goals. Common goals may be to lose weight, to feel better, to keep up with the grandkids, to lower blood pressure or cholesterol, and so forth. With each of these goals, encouraging regular physical activity and reducing time spent in sedentary activities as part of a healthy lifestyle will yield the most benefits. Addressing real or perceived barriers at the time of eliciting goals can also be beneficial.

Barriers and Motivators

Barriers to sustaining an exercise program differ from those for young people, who cite time as the most significant barrier to exercise, whereas older adults cite poor health as the leading barrier to both physical activity and exercise, as shown

TABLE 5.11
Barriers to Exercise for Older People

Health concerns
Pain
Fear of injury
Safety concerns of physical environment
Accessibility to exercise facility, park or footpath
Lack of counseling from physician-provider
Inadequate knowledge of health benefits of moderate exercise
Lack of social support

Source: Schutzer and Graves (2004).

in Table 5.11 (Schutzer & Graves, 2004). Fear of injury is also a real concern as is a lack of knowledge about how physical activity and exercise can improve chronic health conditions. Thus, counseling by a health professional knowledgeable about the health benefits of physical activity and exercise may be helpful.

Several studies have cited the importance and benefits of the physician-provider's advice and counseling in starting and continuing a physical activity and exercise program in later years (Balde, Figureras, Hawking, & Miller, 2003; CDC, 2012; Weiss, Wolfson, Yaffe, Shrier, & Puts, 2012). Effective counseling can be as simple as writing the CDC's recommended guidelines on a prescription pad (Swinburn, Walter, Arroll, Tilyard, & Russell, 1998).

Pedometers are known to promote exercise adherence and a higher intensity of exercise (Bravata et al., 2007; Mansi, Milosavljevic, Baxter, Tumilty, & Hendrick, 2014; Snyder, Colvin, & Gammack, 2011). One study found that in a group of postmenopausal women (age 45–75 years), 2,800 steps per session met 50% of the minimum exercise recommendation, 5,500 steps per session met 100% of the minimum exercise recommendation, and 6,500 steps per exercise session met 150% of the minimum exercise recommendation (Jordan, Jurca, Locke, Church, & Blair, 2005).

To promote and maintain health, the CDC's recommendations for aerobic exercise are a good place to start, that is, 150 minutes per week of moderate-intensity physical activity on 3–5 days a week, in 30-minute sessions. It is recommended that if participating in aerobic exercise 5 days per week, the individual should include a variety of exercise modes such as walking and swimming or cycling to place different impact-stresses on the body and to utilize different muscle groups. It is also recommended to incorporate strengthening and flexibility into the exercise program.

Because there is a positive dose–response relationship of health benefits that results from increasing exercise intensity, continuous challenge is important. Considering the physical stress theory (Mueller & Maluf, 2002), exercise must be beyond the threshold that maintains fitness. In other words, the body must be challenged sufficiently to incur health benefits. Therefore, it will be necessary to progressively increase the intensity throughout the program, when the perceived exercise effort drops below 5 on a 1–10 scale if more than maintenance is desired.

Exercise Duration and Progression

The duration of any single exercise session should be 30 minutes on 5 or more days per week for a total of 150 minutes *or* vigorous-intensity aerobic exercise done for at least 20–25 minutes 3 or more days per week. To promote or maintain weight loss, 50–60 minutes per day to total 300 minutes of moderate or 150 minutes vigorous daily exercise is recommended (Pescatello et al., 2014). However, as little as 10 minutes of intermittent exercise to accumulate the minimum-duration recommendations is effective. At least 3,000–4,000 steps a day of moderate- to vigorous-intensity walking is another way of looking at duration and intensity.

The rate of progression of the aerobic program is dependent on the level of fitness, exercise tolerance, health status, and individual goals. In the beginning, increasing the minutes of an exercise session is recommended. An increase of 5–10 minutes every 1–2 weeks over the first 4–5 weeks is reasonable for the average adult (Mazzeo et al., 1998). Once the duration has reached 60 minutes in a session or has reached the time available for exercise, intensity should be increased and duration reduced. A good rule of thumb is an activity intensity that allows conversation while breathing rapidly.

Aerobic Exercise Options

The types of exercise that are rhythmic and involve large muscle groups and thus considered aerobic are listed in Table 5.12. Specificity of training is key

TABLE 5.12
Types of Aerobic Exercise

Exercise Group	Description	Recommended for	Examples
A	Endurance activities requiring minimal skill or physical fitness to perform	All adults	Walking, leisurely cycling, aquarobics, slow dancing
B	Vigorous-intensity endurance activities requiring minimal skill	Adults with regular exercise program and/or at least average physical fitness	Jogging, running, rowing, aerobics, spinning, elliptical exercise, stepping exercise, fast dancing, boxing
C	Endurance activities requiring skill to perform	Adults with acquired skill and/or at least average physical fitness levels	Swimming, cross-country skiing, skating, rowing
D	Recreational sports	Adults with a regular exercise program and at least average physical fitness	Racquet sports, basketball, soccer, downhill skiing, hiking, team sports

Source: Pescatello et al. (2014).

with respect to the individual's goals and functional demands. Exercises of Type A are recommended for all older adults, as they require little skill and are easily adapted to all levels of fitness. Type B exercises are best suited for those who exercise regularly and Type C exercises require skill to perform, and therefore safety can be a concern. Type D exercises are considered recreational and should supplement other types of aerobic exercise rather than be the only type of aerobic exercise done.

Each exercise has its advantages and disadvantages. Walking comes close to the "perfect" exercise as it is safe, low impact, is easily progressed in both duration and intensity, and is ideal for beginning an exercise program. Jogging has the same advantages as walking but may cause joint and muscle discomfort, so it is not recommended for those just beginning an exercise program. Good shoes are recommended for both walking and jogging. Swimming and aquarobics is generally less effective for weight loss compared to walking or jogging and does not reduce the risk of bone loss since it does not involve impact. However, for those very overweight, swimming may be preferred because the water will help support the body weight and reduce the pressure on joints. Risk of injury can be low in swimming and aquarobics. Aquarobics can involve a social aspect that can promote adherence. Outdoor cycling, although putting less stress on joints, can have safety concerns and requires equipment. Riding a stationary bicycle and spinning classes can alleviate the safety concerns. Other aerobic exercises require some degree of skill and should be attempted when some minimal level of exercise tolerance has been achieved with a walking, cycling, or swimming program. Regardless of the type of aerobic exercise chosen, the best exercise is the one the individual is most likely to do. Therefore, convenience and individual preference may be the most important considerations. Fitness level will also dictate what activity is considered aerobic. Any activity, such as gardening or even pushing a grocery cart, that increases heart rate for 10 minutes can be considered aerobic and will have beneficial effects.

EXERCISE PRESCRIPTION FOR SELECTED CHRONIC DISEASES

Arthritis and Obesity

Even though aerobic exercise such as walking or group exercise classes can reduce pain and self-reported physical function in individuals with body mass index ≥ 30, one of the reasons most often cited for not exercising is painful symptoms (Stubbs, Hurley, & Smith, 2015). However, the effect of aerobic exercise on weight loss in individuals with painful osteoarthritis is less known (Khoja, Susko, Josbeno, Piva, & Fitzgerald, 2014). Individuals may have difficulty sustaining, in the presence of painful osteoarthritis, the 50–60 minutes/session that is required to lose weight. The addition of specific dietary interventions can help facilitate weight loss (Miller et al., 2013). Varying the mode of aerobic exercise from weight bearing (walking) to less-impact modes such as cycling or swimming within a week's session may be a helpful adaption. Additionally, supportive braces, good shoes that absorb impact, and strengthening exercises may be of benefit to help sustain the program. Every feasible mechanism to help the individual sustain an exercise program to promote weight loss will have the additional benefit of significantly reducing musculoskeletal symptoms (Messier, Gutekunst, Davis, & DeVita, 2005).

Diabetes Mellitus

Physical activity and exercise have beneficial effects on both glucose metabolism and insulin sensitivity (Fletcher et al., 2013). An aerobic exercise program of 150 minutes per week and weight reduction of 7% led to a 58% reduction in the incidence of Type 2 diabetes mellitus as compared with a control group, over 2.8 years of follow-up (Knowler et al., 2002).

Aerobic exercise and resistive exercise appear equivalent in their reduction of glycosylated hemoglobin (Yang, Scott, Mao, Tang, & Farmer, 2014). Aerobic exercise also reduced adipose tissue and promoted weight loss. Therefore, promoting aerobic exercise for individuals with diabetes is important. However, there are some concerns that should be addressed when prescribing aerobic exercise. Diabetic retinopathy may pose safety concerns, and therefore indoor exercise may be a better place to start. Foot care and appropriate footwear is critical. Silica gel or midsoles as well as socks of polyester or polyester–cotton blend to prevent blisters and keep the feet dry are recommended (Castaneda, 2003). Careful monitoring of blood glucose before, during, and after exercise to avoid hypoglycemic events is critical, especially as better glycemic control is achieved through exercise. Adjustment in the timing of exercise in relation to medication use and meals as well as food composition may be required (Zinker, 1999).

Cardiac Disease, Hypertension

The benefits of a regular, aerobic program are well known for individuals with cardiac disease and hypertension. Exercise training lowers resting blood pressure in normotensive and hypertensive individuals and in patients with and without CVD. The ACSM guidelines for beginning an aerobic exercise program described earlier with special attention to monitoring the physiological response before, during, and after exercise should provide a safe and effective framework to begin the program.

Heart Failure

Heart failure (HF) can be left or right sided. Dyspnea is the hallmark symptom of HF, although roughly two-thirds of individuals are also limited by leg fatigue during exercise (Norberg, Boman, & Lofgren, 2010). Leg fatigue may be due to the heart's inability to supply adequate blood and oxygen to the working muscles. While chronic HF patients were traditionally counseled to rest and avoid exercise to delay disease progression and to promote diuresis induced by bed rest, it is now known that most HF patients who exercise can markedly improve their functional status and quality of life (McMurray et al., 2012).

Exercise training leads to reduced peripheral vasoconstriction, improved endothelial function, and enhanced endothelial repair, which address the symptom of edema. Regular exercise also addresses muscle wasting and improves peak VO_2 (De Maeyer, Beckers, Vrints, & Conraads, 2013). In a large randomized controlled trial (RCT), exercise lowered the relative risk of mortality over a period of 30 months by 11%, in spite of only 30% of patients reaching a targeted 120 minutes of training per week, and it was safe (O'Connor et al., 2009; Smart & Marwick, 2004). In a further analysis, Keteyian and colleagues found that every 6% increase in VO_2 peak was associated with a 7% lower risk of mortality. Furthermore, moderate exercise volumes of 3 to <5 METs were associated with risk reduction exceeding 30% (Keteyian et al., 2012).

While characteristics of exercise programs vary, a gradual approach is recommended (Piepoli et al., 2011). Long warm-ups are important to promote vasodilation before the demands of exertion. A protocol of at least 10 minutes of stretching, slow walking, or other exercise can increase blood flow to muscles without raising the pulse above 40%–50% of maximum heart rate (Keteyian, 2011).

Interval training with 2 to 4 minutes of exercise followed by 1–3 minutes of rest for up to 38 minutes of exercise led to improvements in aerobic capacity in individuals with left ventricular ejection fraction of 29% and was determined to be safe (Rognmo et al., 2012; Wisloff et al., 2007). These studies indicate the feasibility of interval programs that allow patients to progress gradually until they can sustain continuous exercise for 30–40 minutes. Because one of the goals of exercise is to improve function, exercise intensities up to 90% of VO_2 peak and as low as 40% VO_2 peak have been investigated and found safe and effective (De Maeyer et al., 2013).

Aerobic exercise in the form of cycling, walking, and so forth, is recommended as baseline activity. Stationary cycling at very low workloads with continuous monitoring of heart rate, rhythm, and blood pressure is the most preferred mode of exercise for individuals with HF because of its reproducible power output and low injury rate (De Maeyer et al., 2013; Myers, 2008). Recommended training intensity using RPE 11–13 on the Borg scale of 6–20 (i.e., perceived exertion ranging between "light" and "somewhat hard") is equivalent to a training range (Carvalho, Bocchi, & Guimaraes, 2009). Exercise frequency and duration should be individually determined based on exercise tolerance and may range from as little as 5 minutes to a full 30 minutes for 3–5 sessions per week. Swimming is not appropriate for individuals with HF because of the increases in heart rate, hydrostatically induced volume loading of the thorax and heart, and higher mean pulmonary artery and capillary pressures (Meyer, 2006; Meyer & Leblanc, 2008).

Specific strategies recommended by ACSM for individuals with HF include (Meyers, 1997):

- Close monitoring for signs of decompensation, rapid changes in weight or blood pressure, worse-than usual dyspnea or angina on exertion, or increases in dysrhythmias
- Prolonged warm-up and cool-down sessions
- Low-intensity/long-duration sessions
- Interval training
- Perceived exertion and dyspnea scales take precedence over heart rate and workload targets
- Electrocardiogram (ECG) monitoring for persons with a history of ventricular tachycardia, cardiac arrest (sudden death), or exertional hypotension

Osteoporosis

Low-impact exercise, such as the kind seen with some forms of aerobic exercise can benefit individuals with osteoporosis. For example, a meta-analysis demonstrated that bone density improved at the hip in women who regularly walked (Kelley, 1998). Another study demonstrated the effectiveness of weight-bearing activity, such as walking, on the spine. Modes of aerobic exercise such as elliptical training machines, low-impact aerobics, stair-step machines, and walking may be particularly beneficial.

Peripheral Artery Disease

Much evidence exists that demonstrates the effectiveness of a graduated walking program on the symptoms of peripheral artery disease (PAD). Following the standard recommendations for beginning an exercise program of 3–5 days per week progressing to a total of 30–60 minutes will achieve health benefits and symptom improvement of PAD. Intensity and duration should be monitored by symptoms. Walking into leg pain to a level of 3–4 out of 5 (severe pain) is recommended. Stopping exercise for a short rest when pain reaches a 4 and then beginning again until 30 minutes is reached will increase duration. Ideally, exercise durations should be at least 5 minutes without stopping to rest (Cleveland Clinic, 2015).

Pulmonary Diseases

Individuals with increased airway resistance (chronic bronchitis and asthma), abnormalities of gas exchange (emphysema, pulmonary fibrosis, chronic obstructive pulmonary disease [COPD]), and other lung disease may particularly benefit from aerobic exercise through improving pulmonary blood flow and peripheral muscle conditioning, cardiovascular reconditioning, desensitization to dyspnea, and improved ventilatory efficiency (Maltais et al., 2014). For example, physical conditioning of leg muscles through exercise training reduces lactate production and decreases ventilatory burden. In turn, a lower ventilatory burden allows the patient to breathe more slowly during exercise, thereby reduction dynamic hyperinflation. These effects reduce exertional dyspnea, even without a change in forced expiratory volume (FEV; Spruit et al., 2013).

The general principles of exercise training in individuals with chronic pulmonary disease are no different from those for healthy individuals. The aims are to condition the muscles of ambulation and improve cardiorespiratory fitness to allow an increase in physical activity that is associated with a reduction in breathlessness and fatigue (Spruit et al., 2013). A high level of intensity of continuous exercise (>60% maximal work rate) for 20–60 minutes per session maximizes physiologic benefits. Walking and biking are optimal exercise modalities, if tolerated (Jenkins, Hill, & Cecins, 2010).

Management to minimize symptoms during exercise can include breathing techniques, supplemental oxygen when arterial oxygen tension falls below 88%, and emphasis on interval sessions of 5–10 minutes with adequate rest until the individual builds up tolerance to a full 30-minute session (Lacasse, Goldstein, Lasserson, & Martin, 2006; Nonoyama, Brooks, Lacasse, Guyatt, & Goldstein, 2007).

Pulmonary rehabilitation is a nonpharmacologic therapy, comprehensive and multidisciplinary in its approach that includes patient-centered interventions that include exercise training, self-management education, and psychosocial support. It is usually provided in an outpatient hospital-based program for 6–12 weeks (Nici, Lareau, & ZuWallack, 2010). A recent Cochrane systematic review investigated the effects of pulmonary rehabilitation or respiratory rehabilitation on COPD (McCarthy et al., 2015). The results of 65 RCTs demonstrated moderately large effects for the improvement of dyspnea and fatigue, improvement in emotional function, and enhancement of an individual's control over his or her condition.

Alzheimer's Disease

Aerobic exercise training is increasingly suggested as a therapeutic intervention for Alzheimer's disease (AD) because of its potential effect on cognition (Erickson & Kramer, 2009). While the exact mechanism is unclear, aerobic exercise may positively affect cerebral structure and function, improve neuronal survivability and function, increase cerebral vascularization and neuroendocrine response to stress, decrease neuroinflammation, and reduce certain waste products that are by-products of AD (Fang, 2011). Low cardiovascular fitness has been linked to a greater loss of gray matter and cognitive decline in cognitively nonimpaired individuals (Angevaren, Aufdemkampe, Verhaar, Aleman, & Vanhees, 2008; Erickson et al., 2010). Additionally, cognitive improvement is reported after aerobic exercise training (Buchman, Wilson, & Bennett, 2008), and there is some evidence that participation in an aerobics program improves psychological and behavior symptoms in persons with AD (Hogan, 2005). While no exercise prescription exists for those with AD, incorporating the CDC and ACSM recommendations of 150 minutes per week of moderate intense exercise is a goal. Involving the caregiver as a partner in the aerobic program may improve adherence for the individual with Alzheimers and may help reduce the stress of caregiving. Participating in familiar modes of exercise, such as walking may also improve adherence.

SUMMARY

Aerobic exercise has widespread beneficial effects for older adults, positively affecting all body systems and effectively managing symptoms from many chronic diseases. Aerobic exercise costs little to implement, is readily accessible, and can enhance quality of life. It may be said that aerobic exercise is essential to an older person's well-being for an investment of as little as 30 minutes 5 days a week.

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