CHAPTER

10

Exercise Prescription for Populations with Other Chronic Diseases and Health Conditions

This chapter contains the exercise prescription (Ex R_x) guidelines and recommendations for individuals with chronic diseases and other health conditions. The Ex R_x guidelines and recommendations are presented using the *F*requency, *I*ntensity, *T*ime, and *T*ype (*FITT*) principle of Ex R_x based on the available literature. For information relating to volume and progression, health/fitness, public health, clinical exercise, and health care professionals are referred to *Chapter 7*. Information is often lacking regarding volume and progression for the chronic diseases and health conditions presented in this chapter. In these instances, the guidelines and recommendations provided in *Chapter 7* for apparently healthy populations should be adapted with good clinical judgment for the chronic disease(s) and health condition(s) being targeted.

ARTHRITIS

Arthritis and rheumatic diseases are leading causes of pain and disability. Among adults in the United States ≥18 yr, 22.2% (49.9 million) reported having a doctor's diagnosis of arthritis and 9.4% (21.1 million) reported having an arthritis-related activity limitation (32). The prevalence of arthritis is expected to increase substantially by 2030 because of the aging population and rising prevalence of obesity (14,77,109). There are over 100 rheumatic diseases — the two most common being osteoarthritis and rheumatoid arthritis. *Osteoarthritis* is a local degenerative joint disease that can affect one or multiple joints (*i.e.*, most commonly the hands, hips, spine, and knees). *Rheumatoid arthritis* is a chronic, systemic inflammatory disease in which there is pathological activity of the immune system against joint tissues (130). Other common rheumatic diseases include fibromyalgia (discussed later in this chapter), systemic lupus erythematosus, gout, and bursitis.

Medications are core components of the treatment of arthritis that includes analgesics, nonsteroidal anti-inflammatory drugs, and disease-modifying antirheumatic drugs for rheumatoid arthritis. However, optimal treatment of arthritis involves a multidisciplinary approach including patient education in self-management, physical therapy, and occupational therapy (200,274). In the later stages of disease when pain is refractory to conservative management, total joint replacement and other surgeries can provide substantial relief. Although pain and functional limitations can present challenges to physical activity among individuals with arthritis, regular exercise is essential for managing these conditions. Specifically, exercise reduces pain, maintains muscle strength around affected joints, reduces joint stiffness, prevents functional decline, and improves mental health and quality of life (208,274).

EXERCISE TESTING

Most individuals with arthritis tolerate symptom-limited exercise testing consistent with recommendations for apparently healthy adults (see *Chapters 4* and *5*). The following are special considerations for individuals with arthritis:

- High intensity exercise is contraindicated when there is acute inflammation (*i.e.*, hot, swollen, and painful joints). If individuals are experiencing acute inflammation, exercise testing should be postponed until the flare has subsided.
- Although some individuals with arthritis tolerate treadmill walking, use of cycle leg ergometry alone or combined with arm ergometry may be less painful for some and allow better assessment of cardiorespiratory function. The mode of exercise chosen should be the least painful for the individual being tested.
- Allow ample time for individuals to warm up at a light intensity level prior to beginning the graded exercise test.
- Monitor pain levels during testing. There are many validated scales available including the Borg CR10 Scale (see *Figure 9.1*) (27) and visual numeric scale (see *Figure 10.1*) (205). Testing should be stopped if the patient indicates pain is too severe to continue.
- Muscle strength and endurance can be measured using typical protocols (see *Chapter 4*). However, pain may limit maximum muscle contraction in affected joints.

EXERCISE PRESCRIPTION

Pain can be a major barrier to beginning and maintaining a regular exercise program. Therefore, when prescribing exercise for individuals with arthritis, a key guiding principle should be identifying a program that minimizes pain while gradually progressing toward levels that provide greater health benefits (155). In general, recommendations for Ex R_x are consistent with those for apparently

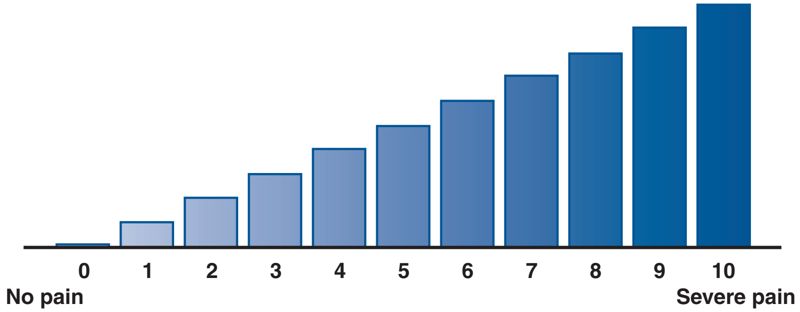

FIGURE 10.1. Visual numeric pain scale. (Reprinted with permission from [205].)

healthy adults (see *Chapter 7*), but FITT recommendations should take into account an individual's' pain, stability, and functional limitations.

FITT RECOMMENDATIONS FOR INDIVIDUALS WITH ARTHRITIS

FITT

Aerobic, Resistance, and Flexibility Exercise

Frequency: Aerobic exercise 3–5 d · wk^{-1}; resistance exercise 2–3 d · wk^{-1}; flexibility/range of motion (ROM) exercises are essential and should be performed daily if possible.

Intensity: Although an optimal intensity of aerobic exercise has not been determined, light-to-moderate intensity, physical activities are recommended because they are associated with lower risk of injury or pain exacerbation compared to higher intensity activities. A 40%–<60% oxygen consumption reserve ($\dot{V}O_2R$) or heart rate reserve (HRR) is appropriate for most individuals with arthritis. Very light intensity, aerobic exercise (*e.g.*, 30%–<40% $\dot{V}O_2R$ or HRR) is appropriate for individuals with arthritis who are deconditioned.

The appropriate intensity for resistance exercise for patients with arthritis has not been determined, and both light and higher intensity resistance training have shown improvements in function, pain, and strength among patients with rheumatoid arthritis and osteoarthritis (60,104,112,117,255). However, most studies have focused on light or moderate intensity resistance training; that is, a higher number of repetitions (10–15) at a lower percentage of one repetition maximum (1-RM) (40%–60% 1-RM). For patients with rheumatoid arthritis and considerable damage in weight-bearing joints, there is some evidence that more intense physical activity may result in greater progression of joint damage (48). Therefore, lower intensity resistance exercise or physical activity is recommended for these patients (75).

Time: A goal of ≥150 min · wk^{-1} of aerobic exercise is appropriate for many individuals with arthritis, but long continuous bouts of exercise may be difficult for some of these individuals. Therefore, it is appropriate to start with short bouts of 10 min (or less if needed), according to an individual's pain levels. The optimal number of sets and repetitions of resistance exercise is not known. Guidelines for healthy adults typically apply (see *Chapter 7*) with consideration of pain levels.

Type: Aerobic exercise activities with low joint stress are appropriate including walking, cycling, or swimming. High-impact activities such as running, stair climbing, and those with stop and go actions are not recommended if limited by lower body arthritis. Resistance exercise should include all major muscle groups as recommended for healthy adults (see *Chapter 7*). Include flexibility exercise with ROM exercises of all major muscle groups.

Progression: Progression of aerobic, resistance, and flexibility exercises should be gradual and individualized based on an individual's pain and other symptoms.

SPECIAL CONSIDERATIONS

Additional considerations when prescribing exercise for individuals with arthritis are the following (155,157):

- Avoid strenuous exercises during acute flare ups and periods of inflammation. However, it is appropriate to gently move joints through their full ROM during these periods.
- Adequate warm-up and cool-down periods (5–10 min) are critical for minimizing pain. Warm-up and cool-down activities can involve slow movement of joints through their ROM.
- Individuals with significant pain and functional limitation may need interim goals of lower than the recommended ≥150 min · wk^{-1} of aerobic exercise and should be encouraged to undertake and maintain any amount of physical activity that they are able to perform.
- Inform individuals with arthritis that a small amount of discomfort in the muscles or joints during or immediately after exercise is common, and this does not necessarily mean joints are being further damaged. However, if the patient's pain rating 2 h after exercising is higher than it was prior to exercise, the duration and/or intensity of exercise should be reduced in future sessions.
- Encourage individuals with arthritis to exercise during the time of day when pain is typically least severe and/or in conjunction with peak activity of pain medications.
- Appropriate shoes that provide shock absorption and stability are particularly important for individuals with arthritis. Shoe specialists can provide recommendations for appropriate shoes to meet individual biomechanical profiles.
- Incorporate functional exercises such as the sit-to-stand and step-ups as tolerated to improve neuromotor control, balance, and maintenance of activities of daily living (ADL).
- For water exercise, the temperature should be 83° to 88° F (28° to 31° C) because warm water helps to relax muscles and reduce pain.

THE BOTTOM LINE

- Exercise is an essential tool for managing osteoarthritis pain and other symptoms. Moderate aerobic activities with low joint stress are appropriate. Adequate warm-up, cool-down, and stretching are important for minimizing pain. The FITT principle of Ex R_x should accommodate individuals' pain levels.

Online Resources

Arthritis Foundation:
http://www.arthritis.org

CANCER

Cancer is a group of nearly 200 diseases characterized by the uncontrolled growth and spread of abnormal cells resulting from damage to deoxyribonucleic acid (DNA) by internal factors (*e.g.*, inherited mutations) and environmental exposures (*e.g.*, tobacco smoke). Most cancers are classified according to the cell type from which they originate. Carcinomas develop from the epithelial cells of organs and compose at least 80% of all cancers. Other cancers arise from the cells of the blood (leukemias), immune system (lymphomas), and connective tissues (sarcomas). The lifetime prevalence of cancer is one in two for men and one in three for women (5). Cancer affects all ages but is most common in older adults. About 76% of all cancers are diagnosed in individuals ≥55 yr (5); hence, there is a strong likelihood that individuals diagnosed with cancer will have other chronic diseases (*e.g.*, cardiopulmonary disease, diabetes mellitus, osteoporosis, arthritis).

Treatment for cancer may involve surgery, radiation, chemotherapy, hormones, and immunotherapy. In the process of destroying cancer cells, some treatments also damage healthy tissue. Patients may experience side effects that limit their ability to exercise during treatment and afterward. These long-term and late effects of cancer treatment are described elsewhere (152). Furthermore, overall physical function is generally diminished because of losses of aerobic capacity, muscle tissue, and ROM. Even among cancer survivors who are 5 yr or more posttreatment, more than half report physical performance limitations including crouching/kneeling, standing for 2 h, lifting/carrying 10 lb (4.5 kg), and walking 0.25 mi (0.4 km) (170). In the following sections, the National Coalition for Cancer Survivorship definition of cancer survivor is used; that is, from the time of diagnosis to the balance of life including the time period during treatment (165).

EXERCISE TESTING

A diagnosis of cancer and curative cancer treatments pose challenges for multiple body systems involved in performing exercise and/or affected by exercise. For example, survivors of breast cancer who have had lymph nodes removed may respond differently to inflammation and injury on the side of the body that underwent surgery, having implications for exercise testing and Ex R_x. Cancer and cancer therapy have the potential to affect the health-related components of physical fitness (*i.e.*, cardiorespiratory fitness [CRF], muscular strength and endurance, body composition, and flexibility) as well as neuromotor function.

Understanding how an individual has been affected by his or her cancer experience is important prior to exercise testing and designing the Ex R_x for survivors of cancer during and after treatment (121). Every individual with cancer can have a unique experience and response. Because of the diversity in this patient population, the safety guidance for preexercise evaluations of cancer survivors focuses on general as well as cancer site–specific recommendations of the medical assessments (see *Table 10.1*) (221).

TABLE 10.1. Preexercise Medical Assessments for Individuals with Cancer

Cancer Site	Breast	Prostate	Colon	Adult Hematologic (No HSCT)	Adult HSCT	Gynecologic
General medical assessments recommended prior to exercise	Recommend evaluation for peripheral neuropathies and musculoskeletal morbidities secondary to treatment regardless of time since treatment. If there has been hormonal therapy, recommend evaluation of fracture risk. Individuals with known metastatic disease to the bone will require evaluation to discern what is safe prior to starting exercise. Individuals with known cardiac conditions (secondary to cancer or not) require medical assessment of the safety of exercise prior to starting. There is always a risk that metastasis to the bone or cardiac toxicity secondary to cancer treatments will be undetected. This risk will vary widely across the population of survivors. Fitness professionals may want to consult with the patient's medical team to discern this likelihood. However, requiring medical assessment for metastatic disease and cardiotoxicity for all survivors prior to exercise is not recommended, as this would create an unnecessary barrier to obtaining the well-established health benefits of exercise for the majority of survivors, for whom metastasis and cardiotoxicity are unlikely to occur.					
Cancer site specific medical assessments recommended prior to starting an exercise program	Recommend evaluation for arm/shoulder morbidity prior to upper body exercise.	Evaluation of muscle strength & wasting.	Patient should be evaluated as having established consistent and proactive infection prevention behaviors for an existing ostomy prior to engaging in exercise training more vigorous than a walking program.	None	None	Patients with morbid obesity may require additional medical assessment for the safety of activity beyond cancer-specific risk. Recommend evaluation for lower extremity lymphedema prior to vigorous aerobic exercise or resistance training.

HSCT, hematopoietic stem cell transplantation.

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Standard exercise testing methods are generally appropriate for patients with cancer who have been medically cleared for exercise with the following considerations:

- Ideally, patients with cancer should receive a comprehensive assessment of all components of health-related physical fitness (see *Chapter 4*). However, requiring a comprehensive physical fitness assessment prior to starting exercise may create an unnecessary barrier to starting activity. For this reason, no assessments are required to start a light intensity walking, progressive strength training, or flexibility program in survivors.
- Be aware of a survivor's health history, comorbid chronic diseases and health conditions, and any exercise contraindications before commencing health-related fitness assessments or designing the Ex R_x.
- Health-related fitness assessments may be valuable for evaluating the degree to which musculoskeletal strength and endurance or CRF may be affected by cancer-related fatigue or other commonly experienced symptoms that impact function (150).
- There is no evidence the level of medical supervision required for symptom-limited or maximal exercise testing needs to be different for patients with cancer than for other populations (see *Chapter 2*).
- Understanding the most common toxicities associated with cancer treatments including increased risk for fractures, cardiovascular events, and neuropathies related to specific types of treatment and musculoskeletal morbidities secondary to treatment is important (152).
- The evidence-based literature indicates 1-RM testing is safe among survivors of breast cancer (221).

EXERCISE PRESCRIPTION

Survivors of cancer should avoid inactivity during and after treatment; however, there is insufficient evidence to provide precise recommendations regarding the FITT principle of Ex R_x. The recent American College of Sports Medicine (ACSM) expert panel on guidelines for exercise in adult survivors of cancer concluded there is ample evidence exercise is safe both during and after treatment for all types of cancer reviewed (*i.e.*, breast, prostate, colon, hematologic, and gynecologic cancers) (221). Overall recommendations for survivors of cancer are consistent with the guidelines provided in *Chapter 7* and with the American Cancer Society's recommendation of 30–60 min of moderate-to-vigorous intensity, physical activity at least 5 d · wk^{-1} (56). It is important to note, however, that the FITT principle of Ex R_x recommendations for individuals with cancer that follow are based on limited literature. Special considerations needed to ensure the safety of this potentially vulnerable population are in *Table 10.2* (221). To date, there are no recommendations regarding the supervision of exercise across the continuum of survivorship and/or in various exercise settings (*e.g.*, home, health/fitness, clinical). Health/fitness, clinical exercise, and health care professionals should use good judgment in deciding the level of exercise supervision needed on an individual basis.

FITT RECOMMENDATIONS FOR INDIVIDUALS WITH CANCER

FITT

Aerobic, Resistance, and Flexibility Exercise

The appropriate FITT recommendations will vary across the cancer experience and requires individualization of the Ex R_x.

Frequency: For those who have completed treatment, the goal for aerobic exercise should be to increase gradually from the current physical activity level to 3–5 d · wk^{-1} with resistance training 2–3 d · wk^{-1}. Flexibility activities can occur daily, even during treatment. Evidence indicates even those currently undergoing systemic cancer treatments can increase daily physical activity sessions over the course of 1 mo (221).

Intensity: Exercise tolerance may be highly variable during active treatment. Survivors who have completed treatment may increase intensity slowly for all physical activities. Heart rate (HR) may be less reliable for monitoring intensity for cancer survivors currently undergoing treatment. Therefore, educating survivors to use perceived exertion to monitor intensity may be advisable (see *Chapter 7*). If tolerated without adverse effects of symptoms or side effects, exercise intensity need not differ from healthy populations. Aerobic exercise should be moderate (*i.e.*, 40%–<60% $\dot{V}O_2R$ or HRR; rating of perceived exertion [RPE] of 12–13 on a scale of 6–20 [27]) to vigorous (60%–85% $\dot{V}O_2R$ or HRR or RPE of 12–16 on a scale of 6–20 [27]) intensity. Moderate intensity resistance exercise should be 60%–70% 1-RM. Flexibility intensity should be mindful of ROM restrictions resultant to surgery and/or radiation therapy (151).

Time: Several short bouts per day rather than a single bout may be useful, particularly during active treatment. Survivors who have completed treatment can increase duration as tolerated for all activities. When tolerated without exacerbation of symptoms or side effects, exercise session duration should be no different than that for healthy populations. Aerobic exercise should be 75 min · wk^{-1} of vigorous intensity or 150 min · wk^{-1} of moderate intensity activity or an equivalent combination of the two. Resistance training should be at least 1 set of 8–12 repetitions.

Type: Aerobic exercise should be prolonged, rhythmic activities using large muscle groups (*e.g.*, walking, cycling, swimming). Resistance exercise should be weights, resistance machines, or weight-bearing functional tasks (*e.g.*, sit-to-stand) targeting all major muscle groups. Flexibility exercise should be stretching or ROM exercises of all major muscle groups also addressing specific areas of joint or muscle restriction that may have resulted from treatment with steroids, radiation, or surgery.

Progression: Slower progression may be needed among survivors of cancer compared to healthy adults. Awareness of the highly variable impact of exercise on symptoms in survivors of cancer undergoing treatment is needed (222). If exercise progression leads to an increase in fatigue or other common adverse symptoms as a result of prescribed exercise, the FITT principle of Ex R_x should be reduced to a level that is better tolerated.

TABLE 10.2. Review of U.S. DHHS Physical Activity Guidelines (PAGs) for Americans and Alterations Needed for Cancer Survivors

	Breast	Prostate	Colon	Adult Hematologic (No HSCT)	Adult HSCT	Gynecologic
General Statement	Avoid inactivity, return to normal daily activities as quickly as possible after surgery. Continue normal daily activities and exercise as much as possible during and after non-surgical treatments. Individuals with known metastatic bone disease will require modifications to avoid fractures. Individuals with cardiac conditions (secondary to cancer or not) may require modifications and may require greater supervision for safety.					
Aerobic exercise training (volume, intensity, progression)	Recommendations are the same as age appropriate guidelines from the PAGs for Americans.				Ok to exercise every day, lighter intensity and lower progression of intensity recommended.	Recommendations are the same as age appropriate guidelines from the PAGs for Americans. Women with morbid obesity may require additional supervision and altered programming.
Cancer site specific comments on aerobic exercise training prescriptions	Be aware of fracture risk.	Be aware of increased potential for fracture.	Physician permission recommended for patients with an ostomy prior to participation in contact sports (risk of blow).	None	Care should be taken to avoiding overtraining given immune effects of vigorous exercise.	If peripheral neuropathy is present, a stationary bike might be preferable over weight bearing exercise.
Resistance training (volume, intensity, progression)	Altered recommendations. See below.	Recommendations same as age appropriate PAGs.	Altered recommendations. See below.	Recommendations same as age appropriate PAGs.		Altered recommendations. See below.
Cancer site specific comments on resistance training prescription	Start with a supervised program of at least 16 sessions and very low resistance, progress resistance at small increments. No upper limit on the amount of weight to which survivors can progress. Watch for arm/shoulder symptoms, including	Add pelvic floor exercises for those who undergo radical prostatectomy. Be aware of risk for fracture.	Recommendations same as age-appropriate PAGs. For patients with a stoma, start with low resistance and progress	None	Resistance training might be more important than aerobic exercise in BMT patients. See	There is no data on the safety of resistance training in women with lower limb lymphedema secondary to gynecologic cancer. This

	lymphedema, and reduce resistance or stop specific exercises according to symptom response. If a break is taken, lower the level of resistance by 2 wk worth for every wk of no exercise (*e.g.*, a 2 wk exercise vacation = lower to the resistance used 4 wk ago). Be aware of risk for fracture in this population.		resistance slowly to avoid herniation at the stoma.		text for further discussion on this point.	condition is very complex to manage. It may not be possible to extrapolate from the findings on upper limb lymphedema. Proceed with caution if the patient has had lymph node removal and/or radiation to lymph nodes in the groin.
Flexibility training (volume, intensity, progression)	Recommendations are the same as age appropriate PAGs for Americans.		Recommendations same as age appropriate PAGs, with care to avoid excessive intraabdominal pressure for patients with ostomies.	Recommendations are the same as age appropriate PAGs for Americans.		
Exercises with special considerations (*e.g.*, yoga, organized sports, and Pilates)	Yoga appears safe as long as arm and shoulder morbidities are taken into consideration. Dragon boat racing not empirically tested, but the volume of participants provides face validity of safety for this activity. No evidence on organized sport or Pilates.	Research gap.	If an ostomy is present, modifications will be needed for swimming or contact sports. Research gap.	Research gap.	Research gap.	Research gap.

BMT, bone marrow transplantation; HSCT, hematopoietic stem cell transplantation, PAGS, physical activities guidelines; U.S. DHHS, U.S. Department of Health and Human Services.
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SPECIAL CONSIDERATIONS

- Up to 90% of all survivors of cancer will experience cancer-related fatigue at some point (238). Cancer-related fatigue is prevalent in patients receiving chemotherapy and radiation and may prevent or restrict the ability to exercise. In some cases, fatigue may persist for months or years after treatment completion. However, survivors are advised to avoid physical inactivity, even during treatment.
- Bone is a common site of metastases in many cancers, particularly breast, prostate, and lung cancer. Survivors with metastatic disease to the bone will require modification of their exercise program (*e.g.*, reduced impact, intensity, volume) given the increased risk of bone fragility and fractures.
- Cachexia or muscle wasting is prevalent in individuals with advanced gastrointestinal cancers and may limit exercise capacity, depending on the extent of muscle wasting.
- Identify when a patient/client is in an immune suppressed state (*e.g.*, taking immunosuppressive medications after a bone marrow transplant or those undergoing chemotherapy or radiation therapy). There may be times when exercising at home or a medical setting would be more advisable than exercising in a public fitness facility.
- Swimming should not be prescribed for patients with indwelling catheters or central lines and feeding tubes, those with ostomies, those in an immune suppressed state, or those receiving radiation.
- Patients receiving chemotherapy may experience fluctuating periods of sickness and fatigue during treatment cycles that require frequent modifications to the Ex R_x such as periodically reducing the intensity and/or time (duration) of the exercise session during symptomatic periods.
- Safety considerations for exercise training for patients with cancer are presented in *Table 10.3*. As with other populations, the risks associated with physical activity must be balanced against the risks of physical inactivity for survivors of cancer. As with other populations, exercise should be stopped if unusual symptoms are experienced (*e.g.*, dizziness, nausea, chest pain).

THE BOTTOM LINE

- Individuals who have had a diagnosis of cancer should avoid physical inactivity as long as physical activity does not worsen symptoms/side effects. Daily exercise is generally safe, even during intensive active therapies such as bone marrow transplant. The appropriate exercise testing, prescription, and supervision recommendations will vary across the cancer experience, with the greatest need for caution during periods of active treatment, as exercise tolerance will vary during periods of adjuvant curative therapy (*e.g.*, chemotherapy, radiotherapy). Symptom response should be the primary guide to the Ex R_x during active treatment. Even after treatment is over, starting at light

TABLE 10.3. Contraindications for Starting Exercise, Stopping Exercise, and Injury Risk for Cancer Survivors

	Breast	Prostate	Colon	Adult Hematologic (No HSCT)	Adult HSCT	Gynecologic
General contraindications for starting an exercise program common across all cancer sites	Allow adequate time to heal after surgery. The number of weeks required for surgical recovery may be as high as 8. Do not exercise individuals who are experiencing fever, extreme fatigue, significant anemia, or ataxia. Follow *ACSM Guidelines* for exercise prescription with regard to cardiovascular and pulmonary contraindications for starting an exercise program. However, the potential for an adverse cardiopulmonary event might be higher among cancer survivors than age matched comparisons given the toxicity of radiotherapy and chemotherapy and long term/late effects of cancer surgery.					
Cancer specific contraindications for starting an exercise program	Women with acute arm or shoulder problems secondary to breast cancer treatment should seek medical care to resolve those issues prior to exercise training with the upper body.	None	Physician permission recommended for patients with an ostomy prior to participation in contact sports (risk of blow), weight training (risk of hernia).	None	None	Women with swelling or inflammation in the abdomen, groin, or lower extremity should seek medical care to resolve these issues prior to exercise training with the lower body.
Cancer specific reasons for stopping an exercise program. (Note: General *ACSM Guidelines* for stopping exercise remain in place for this population.)	Changes in arm/shoulder symptoms or swelling should result in reductions or avoidance of upper body exercise until after appropriate medical evaluation and treatment resolves the issue.	None	Hernia, ostomy related systemic infection.	None	None	Changes in swelling or inflammation of the abdomen, groin, or lower extremities should result in reductions or avoidance of lower body exercise until after appropriate medical evaluation and treatment resolves the issue.

(*continued*)

TABLE 10.3. Contraindications for Starting Exercise, Stopping Exercise, and Injury Risk for Cancer Survivors (*Continued*)

	Breast	Prostate	Colon	Adult Hematologic (No HSCT)	Adult HSCT	Gynecologic
General injury risk issues in common across cancer sites	Patients with bone metastases may need to alter their exercise program with regard to intensity, duration, and mode given increased risk for skeletal fractures. Infection risk is higher for patients that are currently undergoing chemotherapy or radiation treatment or have compromised immune function after treatment. Care should be taken to reduce infection risk in fitness centers frequented by cancer survivors. Patients currently in treatment and immediately following treatment may vary from exercise session to exercise session with regard to exercise tolerance, depending on their treatment schedule. Individuals with known metastatic disease to the bone will require modifications and increased supervision to avoid fractures. Individuals with cardiac conditions (secondary to cancer or not) will require modifications and may require increased supervision for safety.					
Cancer specific risk of injury, emergency procedures	The arms/shoulders should be exercised, but proactive injury prevention approaches are encouraged, given the high incidence of arm/shoulder morbidity in breast cancer survivors. Women with lymphedema should wear a well-fitting compression garment during exercise. Be aware of risk for fracture among those treated with hormonal therapy, a diagnosis of osteoporosis, or bony metastases.	Be aware of risk for fracture among patients treated with ADT, a diagnosis of osteoporosis or bony metastases	Advisable to avoid excessive intra-abdominal pressures for patients with an ostomy.	Multiple myeloma patients should be treated as if they are osteoporotic.	None	The lower body should be exercised, but proactive injury prevention approaches are encouraged, given the potential for lower extremity swelling or inflammation in this population. Women with lymphedema should wear a well-fitting compression garment during exercise. Be aware of risk for fractures among those treated with hormonal therapies, with diagnosed osteoporosis, or with bony metastases.

ADT, androgen deprivation therapy; HSCT, hematopoietic stem cell transplantation.
Reprinted with permission from (221).

intensity for a short period of time (duration) and progressing slowly will assist with avoiding the onset or exacerbation of, and may assist with treatment or prevention of, persistent adverse treatment effects such as fatigue or lymphedema.

Online Resources

American Cancer Society:
http://www.cancer.org

American College of Sports Medicine:
http://www.acsm.org to access the expert panel report on exercise and cancer

National Academies Press (85):
http://www.nap.edu/catalog.php?record_id=11468#toc From Cancer Patient to Survivor: Lost in Transition

CEREBRAL PALSY

Cerebral palsy (CP) is a nonprogressive lesion of the brain occurring before, at, or soon after birth that interferes with normal brain development. CP is caused by damage to areas of the brain that control and coordinate muscle tone, reflexes, posture, and movement. The resulting impact on muscle tone and reflexes depends on the location and extent of the injury within the brain. Consequently, the type and severity of dysfunction varies considerably among individuals with CP. In developed countries, the incidence of CP is reported to be between 1.5 and 5 live births per 1,000.

Despite its diverse manifestations, CP predominantly exists in two forms: spastic (70% of those with CP) (142) and athetoid (248). *Spastic CP* is characterized by an increased muscle tone typically involving the flexor muscle groups of the upper extremity (*e.g.*, biceps brachii, brachialis, pronator teres) and extensor muscle groups of the lower extremities (*e.g.*, quadriceps, triceps surae). The antagonistic muscles of the hypertonic muscles are usually weak. *Spasticity* is a dynamic condition decreasing with slow stretching, warm external temperature, and good positioning. However, quick movements, cold external temperature, fatigue, or emotional stress increases hypertonicity. *Athetoid CP* is characterized by involuntary and/or uncontrolled movement that occurs primarily in the extremities. These extraneous movements may increase with effort and emotional stress.

CP can further be categorized topographically (*e.g.*, quadriplegia, diplegia, hemiplegia); however, in the context of Ex R_x, a functional classification as developed by the Cerebral Palsy International Sport and Recreation Association (CP-ISRA) is more relevant (33). CP-ISRA has developed an eight-part comprehensive functional classification scheme for sports participation based on the degree of neuromotor function (see *Table 10.4*). Athletes are classified in

TABLE 10.4. Cerebral Palsy International Sports and Recreation Association (CP-ISRA) Functional Classification System (33)

Class	Functional Ability
1	Severe involvement in all four limbs; limited trunk control; unable to grasp; poor functional strength in upper extremities, often necessitating the use of an electric wheelchair for independence.
2	Severe-to-moderate quadriplegic, normally able to propel a wheelchair very slowly with arms or by pushing with feet; poor functional strength and severe control problems in the upper extremities.
3	Moderate quadriplegia, fair functional strength and moderate control problems in upper extremities and torso; uses wheelchair.
4	Lower limbs have moderate-to-severe involvement; good functional strength and minimal control problem in upper extremities and torso; uses wheelchair.
5	Good functional strength and minimal control problems in upper extremities; may walk with or without assistive devices for ambulatory support.
6	Moderate-to-severe quadriplegia; ambulates without walking aids; less coordination; balance problems when running or throwing; has greater upper extremity involvement.
7	Moderate-to-minimal hemiplegia; good functional ability in nonaffected side; walks/runs with noted limp.
8	Minimally affected; may have minimal coordination problems; able to run and jump freely; has good balance.

eight classes, with Class 1 representing an athlete with severe spasticity and/or athetosis resulting in poor functional ROM and poor functional strength in all extremities and the trunk. The athlete will be dependent on a power wheelchair or assistance for mobility. An athlete classified in Class 8 will demonstrate minimal neuromotor involvement and may appear to have near normal function (33).

The variability in motor control pattern in CP is large and becomes even more complex because of the persistence of primitive reflexes. In normal motor development, reflexes appear, mature, and disappear; whereas other reflexes become controlled or mediated at a higher level (*i.e.*, the cortex). In CP, primitive reflexes (*e.g.*, the palmar and tonic labyrinthine reflexes) may persist and higher level reflex activity (*i.e.*, postural reflexes) may be delayed or absent. Severely involved individuals with CP may primarily move in reflex patterns, whereas those with mild involvement may be only hindered by reflexes during extreme effort or emotional stress (142).

EXERCISE TESTING

The hallmark of CP is disordered motor control; however, CP is often associated with other sensory (*e.g.*, vision, hearing impairment) or cognitive (*e.g.*, intellectual disability, perceptual motor disorder) disabilities that may limit participation as much as or perhaps more than the motor limitations (45). Associated conditions such as convulsive seizures (*i.e.*, epilepsy), which occur in about 25% of those with CP, may significantly interfere with exercise testing and programming. Exercise testing may be done in individuals with CP to uncover challenges or barriers to regular physical activity, to identify risk factors for secondary health conditions, to determine the functional capacity of the individual, and/or to prescribe the appropriate exercise intensity for aerobic and strengthening exercises.

Individuals with CP have decreased physical fitness levels compared with their able-bodied peers. However, investigation in this area is limited focusing almost entirely on children and adolescents and involving primarily individuals with minimal or moderate involvement (*i.e.*, those who are ambulatory) (46,53,187,248). As they age, adolescents with CP may show a decline in gross motor capacity related to loss of ROM, postural changes, or pain as well as reduced aerobic capacity. The decline in aerobic capacity with age appears to be greater in girls than boys (19,258). There are several documented disability-related changes in older adults with CP such as greater physical fatigue, impaired motion/problematic joint contractures, and loss of mobility, which would impact the overall fitness level of the older adult with CP (239).

When exercise testing individuals with CP, consider the following issues:

- Initially, a functional assessment should be taken of the trunk and upper and lower extremity involvement that includes measures of functional ROM, strength, flexibility, and balance. This assessment will facilitate the choice of exercise testing equipment, protocols, and adaptations. Medical clearance should be sought before any physical fitness testing.
- All testing should be conducted using appropriate, and if necessary, adaptive equipment such as straps and holding gloves, and guarantee safety and optimal testing conditions for mechanical efficiency.
- The testing mode used to assess CRF is dependent on the functional capacity of the individual and — if an athlete with CP — the desired sport. In general,
    - Arm and leg ergometry are preferred for individuals with athetoid CP because of the benefit of moving in a closed chain.
    - In individuals with significant involvement (Classes 1 and 2), minimal efforts may result in work levels that are above the anaerobic threshold and in some instances may be maximal efforts.
    - Wheelchair ergometry is recommended for individuals with moderate involvement (Classes 3 and 4) with good functional strength and minimal coordination problems in the upper extremities and trunk.
    - In highly functioning individuals (Classes 5 through 8) who are ambulatory, treadmill testing may be recommended, but care should be taken at the final stages of the protocol when fatigue occurs and the individual's walking or running skill may deteriorate.
- Because of the heterogeneity of the CP population, a maximal exercise test protocol cannot be generalized. It is recommended to test new participants at two or three submaximal levels, starting with a minimal power output before determining the maximal exercise protocol.
- Because of poor economy of movement in this population, true maximal CRF testing may not be appropriate or accurate. Therefore, maximal CRF testing should involve submaximal steady state workloads at levels comparable with sporting conditions. Movement during these submaximal workloads should be controlled to optimize economy of movement (*i.e.*, mechanical efficiency).

For example, with cycle leg ergometry, the choice of resistance or gearing is extremely important in individuals with CP. Some individuals will benefit from a combination of low resistance and high segmental velocity, whereas others will have optimal economy of movement with a high resistance, low segmental velocity combination.

- In individuals with moderate and severe CP, motion is considered a series of discrete bursts of activity. Hence, the assessment of anaerobic power derived from the Wingate anaerobic test gives a good indication of the performance potential of the individual.
- In individuals with athetoid CP, strength tests should be performed through movement in a closed chain (*e.g.*, exercise machines that control the path of the movement). Before initiating open kinetic chain strengthening exercises (*e.g.*, dumbbells, barbells, other free weights), always check the impact of primitive reflexes on performance (*i.e.*, position of head, trunk, and proximal joints of the extremities) and whether the individual has adequate neuromotor control to exercise with free weights.
- In children with CP, eccentric strength training increases eccentric torque production throughout the ROM while decreasing electromyographic (EMG) activity in the exercising muscle. Eccentric training may decrease cocontraction and improve net torque development in muscles exhibiting increased tone (197).
- Results from any exercise test in the same individual with CP may vary considerably from day to day because of fluctuations in muscle tone.

EXERCISE PRESCRIPTION/SPECIAL CONSIDERATIONS

Generally, the FITT principle of Ex R_x recommendations for the general population should be applied to individuals with CP (see *Chapter 7*) (87,102). It is important to note, however, that the FITT principle of Ex R_x recommendations for individuals with CP that follow are based on a very limited literature. For this reason and because of the impact of CP on the neuromotor function, the following FITT principle of Ex R_x recommendations and special considerations are combined in this section:

- The FITT principle of Ex R_x needed to elicit health/fitness benefits in individuals with CP is unclear. Even though the design of exercise training programs to enhance health/fitness benefits should be based on the same principles as the general population, modifications to the training protocol may have to be made based on the individual's functional mobility level, number and type of associated conditions, and degree of involvement of each limb (204).
- Because of lack of movement control, energy expenditure (EE) is high even at low power output levels. In individuals with severe involvement (Classes 1 and 2), aerobic exercise programs should start with frequent but short bouts of moderate intensity (*i.e.*, 40%–50% $\dot{V}O_2R$ or HRR or RPE of 12–13 on a

scale of 6–20). Recovery periods should begin each time this intensity level is exceeded. Exercise bouts should be progressively increased to reach an intensity of 50%–85% $\dot{V}O_2R$ for 20 min. Because of poor economy of movement, some severely involved individuals will not be able to work at these intensity levels for 20 min, so shorter durations that can be accumulated should be considered.

- In moderately to minimally involved individuals, aerobic exercise training should follow the FITT principle of Ex R_x including progression for the general population (see *Chapter 7*). If balance deficits during exercise are an issue, leg ergometry with a tricycle or recumbent stationary bicycle (82) for the lower extremities and hand cycling for the upper extremities are recommended because (a) they allow for a wide range of power output; (b) movements occur in a closed chain; (c) muscle contraction velocity can be changed without changing the power output through the use of resistance or gears; and (d) there is minimal risk for injuries caused by lack of movement or balance control.
- Individuals with CP fatigue easily because of poor economy of movement. Fatigue has a disastrous effect on hypertonic muscles and will further deteriorate the voluntary movement patterns. Training sessions will be more effective, particularly for individuals with high muscle tone, if (a) several short training sessions are conducted rather than one longer session; (b) relaxation and stretching routines are included throughout the session; and (c) new skills are introduced early in the session (30,209).
- Resistance training increases strength in individuals with CP without an adverse effect on muscle tone (53,179). However, the effects of resistance training on functional outcome measures and mobility in this population are inconclusive (158,223). Emphasize the role of flexibility training in conjunction with any resistance training program designed for individuals with CP.
- Resistance exercises designed to target weak muscle groups that oppose hypertonic muscle groups improve the strength of the weak muscle group and normalize the tone in the opposing hypertonic muscle group through reciprocal inhibition. For example, slow concentric elbow extensor activity will normalize the tone in a hypertonic elbow flexor. Other techniques, such as neuromuscular electrical stimulation (179) and whole body vibration (1), increase muscle strength without negative effects on spasticity. Dynamic strengthening exercises over the full ROM that are executed at slow contraction speeds to avoid stretch reflex activity in the opposing muscles are recommended.
- Hypertonic muscles should be stretched slowly to their limits throughout the workout program to maintain length. Stretching for 30 s improves muscle activation of the antagonistic muscle group, whereas sustained stretching for 30 min is effective in temporarily reducing spasticity in the muscle being stretched (269). Ballistic stretching should be avoided.
- Generally, the focus for children with CP is on inhibiting abnormal reflex activity, normalizing muscle tone, and developing reactions to increase

equilibrium. The focus with adolescents and adults is more likely to be on functional outcomes and performance. Experienced athletes will learn to use hyperactive stretch reflexes and primitive reflexes to better execute sport specific tasks.

- During growth, hypertonicity in the muscles — and consequently, muscle balance around the joints — may change significantly because of inadequate adaptations in muscle length. Training programs should be adapted continuously to accommodate these changing conditions (179). Medical interventions such as Botox injections, a medication which decreases spasticity, may drastically change the functional potential of the individual.
- For athletes with CP, sport-specific fitness testing may be effective in determining fitness/performance areas for improvement and in planning a fitness-related intervention program for addressing the specific sports-specific goals of the athlete (125).
- Good positioning of the head, trunk, and proximal joints of extremities to control persistent primitive reflexes is preferred to strapping. Inexpensive modifications that enable good position such as Velcro gloves to attach the hands to the equipment should be used whenever needed.
- Individuals with CP are more susceptible to overuse injuries because of their higher incidence of inactivity and associated conditions (*i.e.*, hypertonicity, contractures, and joint pain) (1).

THE BOTTOM LINE

- Exercise provides improvements in the health-related components of physical fitness among individuals with CP (*i.e.*, CRF, muscular strength and endurance, and flexibility). The relationships among the FITT principle of Ex R_x and associated short- and long-term functional improvements have yet to be established.

Online Resources

National Institutes of Neurological Disorders and Stroke:
http://www.ninds.nih.gov/disorders/cerebral_palsy/cerebral_palsy.htm

DIABETES MELLITUS

Diabetes mellitus (DM) is a group of metabolic diseases characterized by an elevated blood glucose concentration (*i.e.*, hyperglycemia) as a result of defects in insulin secretion and/or an inability to use insulin. Sustained elevated blood glucose levels place patients at risk for microvascular and macrovascular diseases as well as neuropathies (peripheral and autonomic). Currently, 7% of the United States population has DM, with 1.5 million new cases diagnosed each year (12). Four types of diabetes are recognized based on etiologic origin: Type 1, Type 2, gestational (*i.e.*, diagnosed during pregnancy), and other specific origins (*i.e.*, genetic defects and drug induced); however, most patients have Type 2 (90% of all cases) followed by Type 1 (5%–10% of all cases) (6).

Type 1 DM is most often caused by the autoimmune destruction of the insulin producing β cells of the pancreas, although some cases are idiopathic in origin. The primary characteristics of individuals with Type 1 DM are absolute insulin deficiency and a high propensity for ketoacidosis. Type 2 DM is caused by insulin-resistant skeletal muscle, adipose tissue, and liver combined with an insulin secretory defect. A common feature of Type 2 DM is excess body fat with fat distributed in the upper body (*i.e.*, abdominal or central obesity) (6). Central obesity and insulin resistance often progress to prediabetes.

Prediabetes is a condition characterized by (a) elevated blood glucose in response to dietary carbohydrate, termed *impaired glucose tolerance* (IGT); and/or (b) elevated blood glucose in the fasting state, termed *impaired fasting glucose* (IFG) (see *Table 10.5*). Individuals with prediabetes are at very high risk to develop diabetes as the capacity of the β cells to hypersecrete insulin diminishes over time and becomes insufficient to restrain elevations in blood glucose. It is also increasingly recognized many individuals with DM do not fit neatly into the Type 1 and Type 2 delineations, especially individuals with little or no capacity to secrete insulin but without the obvious presence of antibodies to insulin producing β cells (10).

The fundamental goal for the management of DM is glycemic control using diet, exercise, and, in many cases, medications such as insulin or oral hypoglycemic agents (see *Appendix A*). Intensive treatment to control blood glucose reduces the risk of progression of diabetic complications in adults with Type 1 and Type 2 DM (6). The criteria for diagnosis of DM and prediabetes (12) are presented in *Table 10.5*. Glycosylated hemoglobin (HbA1C) reflects mean blood glucose control over the past 2–3 mo with a general patient goal of <7%. HbA1C may be used as an additional blood chemistry test for patients with DM to provide information on long-term glycemic control (6) (see *Chapter 3*). Although the American Diabetes Association and World Health Organization endorse

TABLE 10.5. Diagnostic Criteria for Diabetes Mellitus (12)

Normal	Prediabetes	Diabetes Mellitus
Fasting plasma glucose <100 mg · dL^{-1} (5.55 mmol · L^{-1})	IFG = Fasting plasma glucose 100 mg · dL^{-1} (5.55 mmol · L^{-1})–125 mg · dL^{-1} (6.94 mmol · L^{-1})	Symptomatic with casual glucose ≥200 mg · dL^{-1} (11.10 mmol · L^{-1})
	IGT = 2-h plasma glucose 140 mg · dL^{-1} (7.77 mmol · L^{-1})–199 mg · dL^{-1} (11.04 mmol · L^{-1}) during an OGTT	Fasting plasma glucose ≥126 mg · dL^{-1} (6.99 mmol · L^{-1}) 2-h plasma glucose ≥200 mg · dL^{-1} (11.10 mmol · L^{-1}) during an OGTT

IFG, impaired fasting glucose (at least 8 h); IGT, impaired glucose tolerance; OGTT, oral glucose tolerance test.

using HbA1c >6.5% as a diagnostic tool for diabetes, most diagnoses are still based on elevated fasting glucose.

EXERCISE TESTING

The following are special considerations for exercise testing in individuals with DM:

- When beginning an exercise program of light-to-moderate intensity (*i.e.*, equivalent to noticeable increases in HR and breathing such as walking), exercise testing may not be necessary for individuals with DM or prediabetes who are asymptomatic for cardiovascular disease (CVD) and low risk (<10% risk of cardiac event over a 10-yr period) (252) (see *Tables 2.1* and *2.3*).
- Individuals with DM or prediabetes with ≥10% risk of a cardiac event over a 10-yr period and who want to begin a vigorous intensity exercise program (*i.e.*, ≥60% $\dot{V}O_2R$ that substantially increases HR and breathing) should undergo a medically supervised graded exercise test (GXT) with electrographic (ECG) monitoring (6,39).
- If positive or nonspecific ECG changes in response to exercise are noted or nonspecific ST and T wave changes at rest are observed, follow-up testing may be performed (227). However, consider the Detection of Ischemia in Asymptomatic Diabetes (DIAD) trial involving 1,123 individuals with Type 2 DM and no symptoms of coronary artery disease (CAD) found screening with adenosine-stress radionuclide myocardial perfusion imaging for myocardial ischemia over a 4.8 yr follow-up period did not alter rates of cardiac events (273); thus, the cost-effectiveness and diagnostic value of more intensive testing remains in question.
- Silent ischemia in patients with DM often goes undetected (262). Consequently, annual CVD risk factor assessment should be conducted by a health care provider (6).

EXERCISE PRESCRIPTION

The benefits of regular exercise in individuals with Type 2 DM and prediabetes include improved glucose tolerance, increased insulin sensitivity, and decreased HbA1C. In individuals with Type 1 DM and those with Type 2 DM using insulin, regular exercise reduces insulin requirements. Important exercise benefits for individuals with either Type 1 or Type 2 DM or prediabetes include improvement in CVD risk factors (*i.e.*, lipid profiles, blood pressure [BP], body weight, and functional capacity) and well-being (2,6). Regular exercise participation may also prevent or at least delay the transition to Type 2 DM for individuals with prediabetes who are at very high risk for developing DM (132) (see *Table 10.5*).

The FITT principle of Ex R_x for healthy adults generally applies to individuals with DM (see *Chapter 7*). Participating in an exercise program confers benefits that are extremely important to individuals with Type 1 and Type 2 DM. Maximizing the cardiovascular health–related benefits resulting from exercise is a key outcome for both diabetes subtypes. For those with Type 2 DM and prediabetes, exercise enhances sensitivity to the insulin increasing cellular uptake of glucose from the blood that facilitates improved control of blood glucose (49). For those with Type 1 DM, greater insulin sensitivity has little impact on pancreatic function but often lowers requirements for exogenous insulin (50). Healthy weight loss and maintenance of appropriate body weight are often more pressing issues for those with Type 2 DM and prediabetes, but excess body weight and fat can be present in those with Type 1 DM as well, and an exercise program can be useful in either context (see the sections of this chapter on overweight, obesity, and the metabolic syndrome).

FITT RECOMMENDATIONS FOR INDIVIDUALS WITH DIABETES MELLITUS

FITT

Aerobic, Resistance, and Flexibility Exercise

The aerobic exercise training FITT principle of Ex R_x recommendations for those with DM are the following:

Frequency: 3–7 d · wk^{-1}.

Intensity: 40%–<60% $\dot{V}O_2R$ corresponding to an RPE of 11–13 on a 6–20 scale (27). Better blood glucose control may be achieved at higher exercise intensities (≥60% $\dot{V}O_2R$), so individuals who have been participating in regular exercise may consider raising the exercise intensity to this level of physical exertion.

Time: Individuals with Type 2 DM should engage in a minimum of 150 min · wk^{-1} of exercise undertaken at moderate intensity or greater. Aerobic activity should be performed in bouts of at least 10 min and be spread throughout the week. Moderate intensity exercise totaling 150 min · wk^{-1} is associated with reduced morbidity and mortality in observational studies in all populations. Additional benefits are accrued by increasing to ≥300 min · wk^{-1} of moderate-to-vigorous intensity, physical activity.

Type: Emphasize activities that use large muscle groups in a rhythmic and continuous fashion. Personal interest and desired goals of the exercise program should be considered.

Progression: Because maximizing caloric expenditure will always be a high priority, progressively increase exercise duration (either continuous or accumulated). As individuals improve physical fitness, adding higher intensity physical activity to promote beneficial adaptations and combat boredom may be warranted.

Resistance training should be encouraged for individuals with DM or prediabetes in the absence of contraindications (see *Chapters* 2 and 3), retinopathy, and recent treatments using laser surgery. The recommendations for healthy individuals generally apply to individuals with DM (see *Chapter 7*). Given that many patients may present with comorbidities, it may be necessary to tailor the resistance Ex R_x accordingly.

There is some evidence that a combination of aerobic and resistance training improves blood glucose control more than either modality alone (50). Whether the added benefits are caused by a greater overall caloric expenditure or are specific to the combination of aerobic and resistance training has not yet been resolved.

No more than two consecutive days of physical inactivity per week should be allowed. A greater emphasis should eventually be placed on vigorous intensity exercise if CRF is a primary goal. On the other hand, greater amounts of moderate intensity exercise that result in a caloric EE of $\geq$2,000 kcal $\cdot$ wk^{-1} (>7 hr $\cdot$ wk^{-1}), including daily exercise, may be required if weight loss maintenance is the goal, as is the case for most individuals with Type 2 DM (54) (see this chapter and other relevant ACSM position stands [6,54]).

SPECIAL CONSIDERATIONS

- Hypoglycemia is the most serious problem for individuals with DM who exercise and is mainly a concern for individuals taking insulin or oral hypoglycemic agents that increase insulin secretion (*e.g.*, sulfonylurea drugs) (6) (see *Appendix A*). Hypoglycemia, that is, blood glucose level <70 mg $\cdot$ dL^{-1} (<3.89 mmol $\cdot$ L^{-1}), is relative (6). Rapid drops in blood glucose may occur with exercise and render patients symptomatic even when blood glucose is well above 70 mg $\cdot$ dL^{-1}. Conversely, rapid drops in blood glucose may occur without generating noticeable symptoms. Common symptoms associated with hypoglycemia include shakiness, weakness, abnormal sweating, nervousness, anxiety, tingling of the mouth and fingers, and hunger. Neuroglycopenic symptoms may include headache, visual disturbances, mental dullness, confusion, amnesia, seizures, and coma (3). Importantly, hypoglycemia may be delayed and can occur up to 12 h postexercise.
- Blood glucose monitoring before and for several hours following exercise, especially when beginning or modifying the exercise program, is prudent.
- The timing of exercise should be considered in individuals taking insulin or hypoglycemic agents. For individuals with diabetes using insulin, changing insulin timing, reducing insulin dose, and/or increasing carbohydrate consumption are effective strategies to prevent hypoglycemia both during and after exercise.
- Physical activity combined with oral hypoglycemic agents has not been well studied and little is known about the potential for interactions.

Sulfonylurea drugs, glucagon-like peptide 1 (GLP-1) agonists, and other compounds that enhance insulin secretion probably do increase the risk for hypoglycemia because the effects of insulin and muscle contraction on blood glucose uptake are additive (86). The few data that exist on the common biguanide (*e.g.*, metformin) and thiazolidinedione drugs suggest the interactions are complex and may not be predictable based on individual effects of the drug or exercise alone (226) (see *Appendix A*). Extra blood glucose monitoring is prudent when beginning a program of regular exercise in combination with oral agents to assess whether changes in medication dose are necessary or desirable.

- Adjust carbohydrate intake and/or medications before and after exercise based on blood glucose levels and exercise intensity to prevent hypoglycemia associated with exercise (230).
- For individuals with Type 1 DM using insulin pumps, insulin delivery during exercise can be markedly reduced or the pump can be disconnected depending on the intensity and duration of exercise. Reducing basal delivery rates for up to 12 h postexercise may be necessary to avoid hypoglycemia.
- The use of continuous glucose monitoring can be very useful to detect patterns in blood glucose across multiple days and evaluate both the immediate and delayed effects of exercise (4). Adjustments to insulin dose, oral medications, and/or carbohydrate intake can be fine-tuned using the detailed information provided by continuous glucose monitoring.
- Exercise with a partner or under supervision to reduce the risk of problems associated with hypoglycemic events.
- Hyperglycemia with or without ketosis is a concern for individuals with Type 1 DM who are not in glycemic control. Common symptoms associated with hyperglycemia include polyuria, fatigue, weakness, increased thirst, and acetone breath (3). Individuals who present with hyperglycemia, provided they feel well and have *no* ketone bodies present in either the blood or urine, may exercise; but they should test blood sugar often and refrain from vigorous intensity exercise until they see that blood glucose concentrations are declining (10,230).
- Dehydration resulting from polyuria, a common occurrence of hyperglycemia, may contribute to a compromised thermoregulatory response (259). Thus, a patient with hyperglycemia should be treated as having an elevated risk for heat illness requiring more frequent monitoring of signs and symptoms (see *Chapter 8* and other relevant ACSM positions stands [7,9]).
- Individuals with DM and retinopathy are at risk for retinal detachment and vitreous hemorrhage associated with vigorous intensity exercise. However, risk may be minimized by avoiding activities that dramatically elevate BP. Thus, for those with severe nonproliferative and proliferative diabetic retinopathy, vigorous intensity aerobic and resistance exercise should be avoided (6,230).

- During exercise, autonomic neuropathy may cause chronotropic incompetence (*i.e.*, a blunted BP response), attenuated $\dot{V}O_2$ kinetics, and anhydrosis (*i.e.*, water deprivation) (6,259). In these situations, the following should be considered:
  - Monitor the signs and symptoms of hypoglycemia because of the inability of the individual to recognize them. Also, monitor the signs and symptoms of silent ischemia such as unusual shortness of breath or back pain because of the inability to perceive angina.
  - Monitor BP before and after exercise to manage hypotension and hypertension associated with vigorous intensity exercise (259) (see the section on hypertension in this chapter).
  - The HR and BP responses to exercise may be blunted. RPE should also be used to assess exercise intensity (259).
- Given the likelihood thermoregulation in hot and cold environments is impaired, additional precautions for heat and cold illness are warranted (see *Chapter 8* and other relevant ACSM positions stands [7,9,31]).
- For individuals with peripheral neuropathy, take proper care of the feet to prevent foot ulcers (6). Special precautions should be taken to prevent blisters on the feet. Feet should be kept dry and the use of silica gel or air midsoles as well as polyester or blend socks should be used.
- For individuals with nephropathy (6,11), although protein excretion acutely increases postexercise, there is no evidence vigorous intensity exercise accelerates the rate of progression of kidney disease. Although there are no current exercise intensity restrictions for individuals with diabetic nephropathy, it is prudent to encourage sustainable exercise programming that more likely includes tolerable moderate intensity.
- Most individuals with Type 2 DM and prediabetes are overweight (see the section on overweight and obesity in this chapter and the relevant ACSM position stand [54]).
- Most individuals with prediabetes or either subtype of DM are at high risk for or have CVD (see *Chapter 9*).

THE BOTTOM LINE

- The benefits of regular exercise in individuals with prediabetes and Type 2 DM include improved glucose tolerance and increased insulin sensitivity. Regular exercise reduces insulin requirements in individuals with Type 1 DM. The general FITT principle of Ex R_x generally applies to individuals with DM. Individuals with retinopathy or recent treatments using laser surgery may need to avoid resistance training. Hypoglycemia is the most serious problem for individuals with DM who exercise and is mainly a concern for those taking insulin or oral hypoglycemic agents that increase insulin secretion.

Online Resources

American College of Sports Medicine:
http://www.acsm.org to access the position stand on exercise and Type 2 DM

American Diabetes Association:
http://www.diabetes.org

National Institute of Diabetes and Digestive and Kidney Diseases:
http://www2.niddk.nih.gov/

DYSLIPIDEMIA

Dyslipidemia refers to abnormal blood lipid and lipoprotein concentrations. Dyslipidemia exists when there are elevations in low-density lipoprotein cholesterol (LDL) or triglyceride concentrations or when there is a reduction in high-density lipoprotein cholesterol (HDL). *Table 3.2* provides the National Cholesterol Education Program (NCEP) blood lipid and lipoprotein classification scheme (164). Severe forms of dyslipidemia are usually caused by genetic defects in cholesterol metabolism, but marked dyslipidemia can be "secondary" or caused by other systemic disease. Substantial increases in LDL are often caused by genetic defects related to the hepatic LDL receptor activity but can also be produced by hypothyroidism and the nephritic syndrome. Similarly, some of the highest triglyceride concentrations are produced by insulin resistance and/or DM and marked reductions in HDL are caused by the use of oral anabolic steroids. Dyslipidemia is a major modifiable cause of CVD (164).

Improvements in cholesterol awareness and more effective treatments primarily using statins or hydroxymethylglutaryl-CoA (HMG-CoA) reductase inhibitors are responsible for the decline in the prevalence of elevated blood cholesterol levels in recent years. These improvements have contributed to a 30% decline in CVD (244). Recent clinical trials indicate the added value of cholesterol lowering therapy in high risk individuals (see *Chapters 2* and *3*), individuals with DM, and older individuals with a treatment goal to lower baseline LDL concentrations by 30%–40% (92). Current detection, evaluation, and treatment guidelines for dyslipidemia are available in the NCEP Adult Treatment Panel (ATP) III report (92) (see *Chapter 3*). The NCEP ATP III report recognizes the importance of lifestyle modification in the treatment of dyslipidemia (164). These recommendations include increased physical activity and weight reduction if warranted, but except for the hypertriglyceridemia associated with insulin resistance, most hyperlipidemia requires medication therapy in addition to diet and exercise modification. Nevertheless, exercise is valued for controlling other CVD risk factors and should be a primary component to leading a healthy lifestyle. The ACSM makes the following recommendations regarding exercise testing and training of individuals with dyslipidemia.

EXERCISE TESTING

- Individuals with dyslipidemia should be screened and risk classified prior to exercise testing (see *Chapters* 2 and 3).
- Use caution when testing individuals with dyslipidemia because underlying CVD may be present.
- Standard exercise testing methods and protocols are appropriate for use with individuals with dyslipidemia cleared for exercise testing. Special consideration should be given to the presence of other chronic diseases and health conditions (*e.g.*, metabolic syndrome, obesity, hypertension) that may require modifications to standard exercise testing protocols and modalities (see the sections of this chapter and other relevant ACSM positions stands on these chronic diseases and health conditions [54,183]).

EXERCISE PRESCRIPTION

The FITT principle of Ex R_x for individuals with dyslipidemia without comorbities is very similar to the Ex R_x for healthy adults (87,102) (see *Chapter* 7). A major difference in the FITT principle of Ex R_x for individuals with dyslipidemia compared to healthy adults is that healthy weight maintenance should be emphasized. Accordingly, aerobic exercise becomes the foundation of the Ex R_x. Resistance and flexibility exercises are adjunct to an aerobic training program designed for the treatment of dyslipidemia primarily because these modes of exercise do not substantially contribute to the overall caloric expenditure goals that appear to be beneficial for improvements in blood lipid and lipoprotein concentrations.

FITT RECOMMENDATIONS FOR INDIVIDUALS WITH DYSLIPIDEMIA

FITT

Aerobic Exercise

The FITT principle of Ex R_x recommended for individuals with dylipidemia:

Frequency: $\geq$5 d · wk^{-1} to maximize caloric expenditure.

Intensity: 40%–75% $\dot{V}O_2R$ or HRR.

Time: 30–60 min · d^{-1}. However, to promote or maintain weight loss, 50–60 min · d^{-1} or more of daily exercise is recommended (54). Performance of intermittent exercise of at least 10 min in duration to accumulate these duration recommendations is an effective alternative to continuous exercise.

Type: The primary mode should be aerobic physical activities that involve the large muscle groups. As part of a balanced exercise program, resistance training and flexibility exercise should be incorporated. Individuals with dyslipidemia without comorbidities may follow the resistance training and flexibility guidelines for healthy adults (see *Chapter* 7).

The FITT recommendations for individuals with dyslipidemia are consistent with the recommendations for healthy weight loss maintenance of $>250 \text{ min} \cdot \text{wk}^{-1}$ (see the sections on overweight and obesity in this chapter and the relevant ACSM position stand [54]).

SPECIAL CONSIDERATIONS

- The FITT principle of Ex R_x may need to be modified should the individuals with dyslipidemia present with other chronic diseases and health conditions such as metabolic syndrome, obesity, and hypertension (see the sections in this chapter and other relevant ACSM position stands on these chronic diseases and health conditions [54,183]).
- Individuals taking lipid-lowering medications that have the potential to cause muscle damage (*i.e.*, HMG-CoA reductase inhibitors or statins and fibric acid) may experience muscle weakness and soreness termed *myalgia* (see *Appendix A*). Physicians should be consulted if an individual experiences unusual or persistent muscle soreness when exercising while taking these medications.

THE BOTTOM LINE

- Dyslipidemia is a major modifiable cause of CVD. Cholesterol-lowering therapy and lifestyle behavioral modifications are important in the management of individuals with dyslipidemia. The FITT principle of Ex R_x for individuals with dyslipidemia without comorbidities is similar to that of healthy adults, although healthy weight maintenance should be emphasized.

Online Resources

National Heart Lung and Blood Institute:
http://www.nhlbi.nih.gov/guidelines/cholesterol/atp4/index.htm

FIBROMYALGIA

Fibromyalgia is a syndrome characterized by widespread chronic nonarticular (soft tissue) musculoskeletal pain. Fibromyalgia affects approximately 2%–4% of the population in the United States (137). Individuals with fibromyalgia do not show signs of inflammation or neurological abnormalities and do not develop joint deformities or joint disease. Therefore, fibromyalgia is not considered a true form of arthritis. Fibromyalgia is primarily diagnosed in women (*i.e.*, seven women for every one man), and its prevalence increases with age.

Signs and symptoms of fibromyalgia include chronic diffuse pain and tenderness, fatigue, sleep disturbance, morning stiffness, and depression. Irritable bowel syndrome, tension headaches, cognitive dysfunction, fine motor weakness, restless leg syndrome, temperature chemical sensitivities, and paresthesia (*i.e.*, burning, prickling, tingling, or itching of the skin with no apparent physical cause) may also be present. Pain has typically been present for many years, but there is no pattern (*i.e.*, fibromyalgia can appear and subside and present in different areas of the body at different times). Fatigue affects approximately 75%–80% of individuals with fibromyalgia and often is linked to poor sleep. Approximately 30% of individuals with fibromyalgia have a diagnosis of depression. Fibromyalgia symptoms may become worse caused by emotional stress, poor sleep, high humidity, physical inactivity, or excessive physical activity (44).

Because of the nature of fibromyalgia, a confirmed diagnosis can be difficult. The 2010 preliminary diagnostic criteria (271) include (a) determining where the individual has pain; (b) the severity of symptoms; (c) if the symptoms have been present at the same level for a minimum of 3 mo; and (d) confirming an individual's pain cannot be attributed to another disorder. Specific areas of the body where pain is assessed are the shoulder girdle, upper and lower arms and legs, hips, jaw, chest, abdomen, upper and lower back, and neck. Level of severity is determined for three symptoms: fatigue, waking unrefreshed, and cognitive symptoms.

Individuals with fibromyalgia have reduced aerobic capacity, muscle function (*i.e.*, strength and endurance), and ROM, as well as overall reductions in physical activity, functional performance (*e.g.*, walking, stair climbing), and physical fitness (29,76). In general, these reductions are caused by the chronic widespread pain that limits the individual's abilities to complete his or her everyday activities, ultimately resulting in continued deconditioning and a loss of physiologic reserve.

Treatment for individuals with fibromyalgia includes medications for pain, sleep, and mood, as well as educational programs, cognitive behavioral therapy, and exercise. Aerobic exercise is beneficial for improving physical function and overall well-being in individuals with fibromyalgia (29). There is also evidence resistance exercise, especially strength training, improves pain, tenderness, depression, and overall well-being (29). In general, exercise improves flexibility, neuromotor function, cardiorespiratory function, functional performance, physical activity levels, pain, and other symptoms of fibromyalgia as well as self-efficacy, depression, anxiety, and quality of life. *Lifestyle physical activity*, defined as accumulating 30 min of moderate intensity, physical activity above one's regular physical activity 5–7 d $\cdot$ wk^{-1}, improves function and reduces pain (79).

Based on the potential for pain and exacerbation of symptoms, an individual's medical history and current health status must be reviewed prior to conducting exercise tests or prescribing an exercise program. Objectively assessing physiologic and functional limitations will allow for the proper exercise testing and most optimal exercise training.

EXERCISE TESTING

Individuals with fibromyalgia can generally participate in symptom-limited exercise testing as described in *Chapter 5*. In this population, the 6-min walk test is also frequently used to measure aerobic performance (29). However, some special precautions should be considered when conducting exercise testing among those with fibromyalgia. These include the following:

- Review symptoms prior to testing to determine the severity and location of pain and the individual's level of fatigue.
- Assess previous and current exercise experience to determine the probability of the individual having an increase in symptoms after testing.
- For individuals with depression, provide high levels of motivation using constant verbal encouragement and possibly rewards for reaching certain intensity levels to have the individual perform to a peak level during testing.
- For individuals with cognitive dysfunction, determine their level of understanding when following through with verbal and written testing and training directions.
- The appropriate testing protocol (see *Chapters 4* and *5*) should be selected based on an individual's symptomatology. Individualize test protocols as needed.
- The order of testing must be considered to allow for adequate rest and recovery of different physiologic systems and/or muscle groups. For example, depending on the most prevalent symptoms (*e.g.*, pain, fatigue) and their locations on the day of testing, endurance testing may be completed before strength testing and alternate between upper and lower extremities.
- Monitor pain and fatigue levels continuously throughout the tests. Visual analog scales (see *Figure 10.1*) are available for these symptoms and easy to administer during exercise. The Fibromyalgia Impact Questionnaire is most often used for individuals with fibromyalgia to assess physical function, general well-being, and symptoms (28).
- Care should be taken to position the individual correctly on the testing or training equipment to allow for the most pain-free exercise possible. This accommodation may require modification to equipment such as adjusting the seat height and types of pedals on a cycle leg ergometer, raising an exercise bench to limit the amount of joint (*e.g.*, hip, knee, back) flexion or extension when getting on or off the equipment, or providing smaller weight increments on standard weight machines.
- If the individual with fibromyalgia has pain in the lower extremities prior to testing, consider a non–weight-bearing type of exercise (*e.g.*, cycle leg ergometry) to achieve a more accurate measurement of CRF, thereby allowing the individual to perform to a higher intensity prior to stopping because of pain.
- Prior to exercise testing and training, educate the individual on the differences between postexercise soreness and fatigue and normal fluctuations in pain and fatigue experienced as a result of fibromyalgia.

EXERCISE PRESCRIPTION

It is important to note the FITT principle of Ex R_x recommendations for individuals with fibromyalgia are based on very limited literature. For this reason, the FITT principle of Ex R_x is generally consistent with the Ex R_x for apparently healthy adults (see *Chapter 7*) with the following considerations:

- Monitor an individual's pain level and location.
- Give appropriate recovery time between exercises within a session and between days of exercise. Exercises should be alternated between different parts of the body or different systems (*e.g.*, musculoskeletal vs. cardiorespiratory).
- Individuals with fibromyalgia are commonly physically inactive because of their symptoms. Prescribe exercise, especially at the beginning, at a physical exertion level that the individual will be able to do or do without undue pain.
- Begin the exercise progression at a low enough level and progress slowly so as to allow for physiologic adaptation without an increase in symptoms (44). In general, this population has poor exercise adherence that is not only because of an increase in symptoms but also because of the mixed and sometimes contradictory information they receive from their various health care providers (212). Individuals with fibromyalgia typically have several different professionals on their health care team (*i.e.*, rheumatologist, primary care physician, clinical exercise physiologist, nurse practitioner, and physical therapist) and may get conflicting advice from several members (212).
- The individual's symptoms always determine the starting point and rate of progression for any type of exercise (27,76,211,242).

FITT RECOMMENDATIONS FOR INDIVIDUALS WITH FIBROMYALGIA

FITT

Aerobic Exercise (29,76)

Frequency: Begin 2–3 d · wk^{-1} and progress to 3–4 d · wk^{-1}.

Intensity: Begin at ≤30% $\dot{V}O_2R$ or HRR and progress to <60% $\dot{V}O_2R$ or HRR.

Time: Begin with 10 min increments and accumulate to a total of at least 30 min · d^{-1} and progress to 60 min · d^{-1}.

Type: Low impact/non–weight-bearing exercise (*e.g.*, water exercise [147], cycling, walking, swimming) initially to minimize pain that may be caused by exercise.

Resistance Exercise

Resistance exercise generally includes muscular strength and endurance to train the muscles for improved performance of functional activities. Resistance training improves muscular strength and endurance in individuals with fibromyalgia, although the level of evidence is less than that for aerobic exercise (129,211,213,242).

Frequency: 2–3 d · wk^{-1}.

Intensity: 50%–80% 1-RM. If the individual cannot complete at least 3 repetitions easily and without pain at 50% 1-RM, it is advised the starting intensity be reduced to a level where no pain is experienced.

Time: If the goal is muscular strength, perform 3–5 repetitions per muscle group, increasing to 2–3 sets. If the goal is muscular endurance, perform 10–20 repetitions per muscle group, increasing to 2–3 sets; or some combination thereof as long as the muscle groups are alternated. Typically, the strength exercises are completed first followed by a 15–20 min rest period before completing endurance exercises (76).

Type: Elastic bands, cuff/ankle weights, and weight machines.

Flexibility Exercise

Simple stretching exercises in combination with other exercises improve functional activities, symptoms, and self-efficacy in individuals with fibromyalgia (120,211), but the evidence is very limited.

Frequency: 1–3 times · wk^{-1}, progress to 5 times · wk^{-1}.

Intensity: Active and gentle ROM stretches for all muscle tendon groups in the pain-free range. The stretch should be held to the point of tightness or slight discomfort.

Time: Initially hold the stretch for 10–30 s. Progress to holding each stretch for up to 60 s.

Type: Elastic bands and unloaded (non–weight-bearing) stretching.

Functional Activity Recommendation

Functional activities (*e.g.*, walking, stair climbing, rising from chair, dancing) are daily activities that can be performed without using specialized equipment. For individuals with symptoms such as pain and fatigue, functional activities are recommended to allow for maintenance of light-to-moderate intensity, physical activity even when symptomatic.

Progression

The rate of progression of the FITT principle of Ex R_x for individuals with fibromyalgia will depend entirely on their symptoms and recovery from or reduction in symptoms on any particular day. They should be educated on how to reduce or avoid certain exercises when their symptoms are exacerbated. Individuals with fibromyalgia should be advised to attempt low levels of exercise during flare ups but listen to their bodies regarding their symptoms in order to minimize the chance of injury.

SPECIAL CONSIDERATIONS

- Teach and have individuals with fibromyalgia demonstrate the correct mechanics for performing each exercise to reduce the potential for injury.
- Teach individuals with fibromyalgia to avoid improper form and exercising when they are excessively fatigued because these factors can lead to long-term exacerbation of symptoms.
- Consider lesser amounts of exercise if symptoms increase during or after exercise. Good judgment should be used to determine which aspect of the FITT principle of Ex R_x needs to be adjusted.
- Avoid the use of free weights for individuals with fibromyalgia when they are fatigued or experiencing excessive pain.
- Individuals with fibromyalgia should exercise in a temperature and humidity controlled room to prevent exacerbation of symptoms.
- Consider group exercise classes because they have been shown to provide a social support system for individuals with fibromyalgia for reducing physical and emotional stress. In addition, they assist in promoting exercise adherence (212).
- Consider including complementary therapies such as tai chi (265) and yoga because they have been shown to reduce symptoms in individuals with fibromyalgia.

THE BOTTOM LINE

- In general, the FITT principle of Ex R_x for healthy adults generally applies to individuals with fibromyalgia. However, it is recommended that symptoms, especially pain and fatigue, are closely monitored because they are tightly linked to the ability to exercise effectively. Including appropriate rest and recovery as part of the Ex R_x is important. In addition, progression should be slower regarding intensity and time (duration) than for healthy individuals so as to minimize the exacerbation of symptoms and promote long-term exercise adherence.

Online Resources

Arthritis Foundation:
http://www.arthritis.org

National Fibromyalgia Association:
http://www.FMaware.org

HUMAN IMMUNODEFICIENCY VIRUS

Broad use of antiretroviral therapy (ART) by industrialized countries to reduce the viral load of human immunodeficiency virus (HIV) has significantly increased life expectancy following diagnosis of HIV infection (263).

ART dramatically reduces the prevalence of the wasting syndrome and immunosuppression. However, ART is associated with metabolic and anthropomorphic health conditions including dyslipidemia, abnormal distribution of body fat (*i.e.*, abdominal obesity and subcutaneous fat loss), and insulin resistance (15). Emerging data suggest an association of HIV infection, cardiac dysfunction, and an increased risk of CVD among individuals living with HIV. With the migration of HIV infection into predominantly minority and lower socioeconomic classes, individuals with HIV are now beginning therapy with higher body mass index (BMI) and reduced muscle strength and mass. They are also more likely to have personal and environmental conditions that predispose them to high visceral fat and obesity (169,229). It is unclear how the aging process will interact with HIV status, sociodemographic characteristics, chronic disease risk, and the extended life expectancy associated with ART use. In addition to standard pharmacological interventions for HIV, physical activity and dietary counseling are treatment options. Additional treatment options include anabolic steroids, growth hormone, and growth factors (272).

Aerobic and resistance exercise provide important health benefits for individuals with HIV/acquired immunodeficiency syndrome (AIDS) (100). Exercise training enhances functional aerobic capacity, cardiorespiratory and muscular endurance, and general well-being. Additionally, physical activity can reduce body fat and indices of metabolic dysfunction. Although there are less data on effects of resistance training, progressive resistance exercise increases lean tissue mass and improves muscular strength. There is also evidence of enhanced mood and psychological status with regular exercise training. Of importance, there is no evidence to suggest regular participation in an exercise program will suppress immune function of asymptomatic or symptomatic individuals with HIV (100,101).

EXERCISE TESTING

The increased prevalence of cardiovascular pathophysiology, metabolic disorders, and the complex medication routines of individuals with HIV/AIDS require physician consultation before exercise testing. The following list of issues should be considered with exercise testing:

- Exercise testing should be postponed in individuals with acute infections.
- Variability of results will be higher for individuals with HIV than in a healthy population.
- When conducting cardiopulmonary exercise tests, infection control measures should be employed (123). Although HIV is not transmitted through saliva, a high rate of oral infections necessitates thorough sterilization of reusable equipment and supplies when disposables are not available.
- The increased prevalence of cardiovascular impairments and particularly cardiac dysfunction requires monitoring of BP and the ECG.
- Because of the high prevalence of peripheral neuropathies, testing should be adjusted if necessary to the appropriate exercise type, intensity, and ROM.

- Typical limitations to stress testing by stage of disease include the following:
  - Asymptomatic — normal GXT with reduced exercise capacity likely related to sedentary lifestyle.
  - Symptomatic — reduced exercise time, peak oxygen consumption ($\dot{V}O_{2peak}$), and ventilatory threshold (VT)
  - AIDS will dramatically reduce exercise time and $\dot{V}O_{2peak}$. Reduced exercise time will likely preclude reaching VT, and achieving $\dot{V}O_{2peak}$ will potentially produce abnormal nervous and endocrine responses

EXERCISE PRESCRIPTION

The chronic disease and health conditions associated with HIV infection suggest health benefits would be gained by regular participation in a program of combined aerobic and resistance exercise. Indeed, numerous clinical studies have shown participation in habitual physical activity results in physical and mental health benefits among this population (98,99). The varied presentation of individuals with HIV requires a flexible approach. Notably, no clinical study of the effects of physical activity on symptomatology of HIV infection has shown an immunosuppressive effect. Further, data indicate individuals living with HIV adapt readily to exercise training, with some studies showing more robust responses than would be expected in a healthy population (101). Therefore, the general FITT principle of Ex R_x is consistent with that for apparently healthy adults (see *Chapter 7*), but the management of CVD risk should be emphasized. However, health/fitness, clinical exercise, and health care professionals should be mindful of the potentially rapid change in health status of this population, particularly the high incidence of acute infections, and should adjust the FITT principle of Ex R_x accordingly.

FITT RECOMMENDATIONS FOR INDIVIDUALS WITH HUMAN IMMUNODEFICIENCY VIRUS

FITT

Aerobic, Resistance, and Flexibility Exercise

Frequency: Aerobic exercise 3–5 d · wk^{-1}; resistance exercise 2–3 d · wk^{-1}.

Intensity: Aerobic exercise 40%–<60% $\dot{V}O_2R$ or HRR. Resistance exercise 8–10 repetitions at approximately 60% 1-RM.

Time: Aerobic exercise, begin with 10 min and progress to 30–60 min · d^{-1}. Resistance exercise, approximately 30 min to complete 2–3 sets of 10–12 exercises that target major muscle groups. Flexibility activities should be incorporated into exercise sessions following the guidelines for healthy adults (see *Chapter 7*).

Type: Modality will vary with the health status and interests of the individual. Presence of osteopenia will require weight-bearing physical activities. Contact and high-risk (*e.g.*, skateboarding, rock climbing) sports are not recommended because of risk of bleeding.

Progression: Aerobic and resistance exercise programs for this population should be initiated at a low volume and intensity. Because of virus and drug side effects, progression will likely occur at a slower rate than in healthy populations. However, the long-term goals for asymptomatic individuals with HIV/AIDS should be to achieve the ACSM FITT principle of Ex R_x recommendations for aerobic and resistance exercise for healthy adults with appropriate modifications for symptomatic individuals with HIV/AIDS.

SPECIAL CONSIDERATIONS

- There are no currently established guidelines regarding contraindications for exercise for individuals with HIV/AIDS. For asymptomatic individuals with HIV/AIDS, *ACSM Guidelines* for healthy individuals should generally apply (see *Chapter 7*). The FITT principle of Ex R_x should be adjusted accordingly based on the individual's current health status.
- Supervised exercise, whether in the community or at home, is recommended for symptomatic individuals with HIV/AIDS or those with diagnosed comorbidities.
- Individuals with HIV/AIDS should report increased general feelings of fatigue or perceived effort during activity, lower gastrointestinal distress, and shortness of breath if they occur.
- Minor increases in feelings of fatigue should not preclude participation but dizziness, swollen joints, or vomiting should. The high incidence of peripheral neuropathy may require adjustment of exercise type, intensity, and ROM.
- Regularly monitoring the health/fitness benefits related to physical activity and CVD risk factors is critical for clinical management and continued exercise participation.

THE BOTTOM LINE

- Aerobic and resistance exercises provide important health benefits for individuals with HIV/AIDS. No clinical study has demonstrated an immunosuppressive effect of exercise in this population. With exercise testing and Ex R_x, it is important to be mindful of the potential rapid changes in health status. The exercise program should be initiated at a lower volume and intensity, and progression will likely occur at a slower rate than in healthy populations.

Online Resources

Centers for Disease Control:
http://www.cdc.gov/hiv/

HYPERTENSION

Approximately 76 million Americans have *hypertension* defined as having a resting systolic blood pressure (SBP) ≥140 mm Hg and/or diastolic blood pressure (DBP) ≥90 mm Hg, taking antihypertensive medication, or being told by a physician or other health care professional on at least two occasions that an individual has high BP (see *Chapter 3 Table 3.1*) (224). Hypertension leads to an increased risk of CVD, stroke, heart failure, peripheral artery disease (PAD), and chronic kidney disease (CKD) (183,224). BP readings as low as 115/75 mm Hg are associated with a higher than desirable risk of ischemic heart disease and stroke. The risk of CVD doubles for each incremental increase in SBP of 20 mm Hg or DBP of 10 mm Hg (35,214). The underlying cause of hypertension is not known in approximately 90% of the cases (*i.e.*, essential hypertension). In the other 5%–10% of cases, hypertension is secondary to a variety of known diseases including CKD, coarctation of the aorta, Cushing syndrome, and pheochromocytoma (35).

Recommended lifestyle changes include smoking cessation, weight management, reduced sodium intake, moderation of alcohol consumption, an overall healthy dietary pattern consistent with the Dietary Approaches to Stop Hypertension diet, and participation in habitual physical activity (35,214). There are a variety of medications that are effective in the treatment of hypertension (see *Appendix A*). Most patients may need to be on at least two medications to achieve targeted BP levels (35,214).

EXERCISE TESTING

Recommendations regarding exercise testing for individuals with hypertension vary depending on their BP level and the presence of other CVD risk factors, target organ disease, or clinical CVD (183) (see *Chapter 2 Figures 2.3* and *2.4* and *Chapter 3 Table 3.1*). Recommendations include the following:

- Individuals with hypertension whose BP is not controlled (*i.e.*, resting SBP ≥140 mm Hg and/or DBP ≥90 mm Hg) should consult with their physician prior to initiating an exercise program. When medical evaluation and management is taking place, the majority of these individuals may begin light-to-moderate intensity (<40%–<60% $\dot{V}O_2R$) exercise programs such as walking without consulting their physician.
- Individuals with hypertension in the high risk category (see *Chapters* 2 and 3) should have a medical evaluation before exercise testing. The extent of the evaluation will vary depending on the exercise intensity to be performed and the clinical status of the individual being tested.
- Individuals with hypertension in the high risk category (see *Chapters* 2 and 3) or with target organ disease (*e.g.*, left ventricular hypertrophy, retinopathy) who plan to perform moderate (40%–<60% $\dot{V}O_2R$) to vigorous intensity exercise (≥60% $\dot{V}O_2R$) should have a medically supervised symptom-limited exercise test.

- Resting SBP ≥200 mm Hg and/or DBP ≥110 mm Hg are relative contraindications to exercise testing (see *Chapter 3 Box 3.5*).
- If the exercise test is for nondiagnostic purposes, individuals may take their prescribed medications at the recommended time. When exercise testing is performed for the specific purpose of designing the Ex R_x, it is preferred individuals take their usual antihypertensive medications as recommended. When testing is for diagnostic purposes, BP medication may be withheld before testing with physician approval.
- Individuals on β-blockers will have an attenuated HR response to exercise and reduced maximal exercise capacity. Individuals on diuretic therapy may experience hypokalemia and other electrolyte imbalances, cardiac dysrhythmias, or potentially a false-positive exercise test (see *Appendix A*).
- The exercise test should generally be stopped with SBP >250 mm Hg and/or DBP >115 mm Hg.

EXERCISE PRESCRIPTION

Aerobic exercise training leads to reductions in resting BP of 5–7 mm Hg in individuals with hypertension (183). Exercise training also lowers BP at fixed submaximal exercise workloads. Emphasis should be placed on aerobic activities; however, these may be supplemented with moderate intensity resistance training. Flexibility exercise should be performed after a thorough warm-up and/or during the cool-down period following the guidelines for healthy adults (see *Chapter 7*).

In individuals with hypertension, the following Ex R_x is recommended.

FITT RECOMMENDATIONS FOR INDIVIDUALS WITH HYPERTENSION

FITT

Aerobic and Resistance Exercise

Frequency: Aerobic exercise on most, preferably all days of the week; resistance exercise 2–3 d · wk^{-1}.

Intensity: Moderate intensity, aerobic exercise (*i.e.*, 40%–<60% $\dot{V}O_2R$ or HRR; RPE 11–13 on a 6–20 scale) supplemented by resistance training at 60%–80% 1-RM.

Time: 30–60 min · d^{-1} of continuous or intermittent aerobic exercise. If intermittent, use a minimum of 10 min bouts accumulated to total 30–60 min · d^{-1} of exercise. Resistance training should consist of at least one set of 8–12 repetitions for each of the major muscle groups.

Type: Emphasis should be placed on aerobic activities such as walking, jogging, cycling, and swimming. Resistance training using either machine weights or free weights may supplement aerobic training. Such training programs should consist of 8–10 different exercises targeting the major muscle groups (see *Chapter 7*).

Progression: The FITT principle of Ex R_x relating to progression for healthy adults, generally apply to those with hypertension. However, consideration should be given to the level of BP control, recent changes in antihypertensive drug therapy, medication-related adverse effects, and the presence of target organ disease and/or other comorbidities, and adjustments should be made accordingly. Progression should be gradual, avoiding large increases in any of the FITT components of the Ex R_x, especially intensity for most individuals with hypertension.

SPECIAL CONSIDERATIONS

- Patients with uncontrolled severe hypertension (*i.e.*, resting SBP ≥180 mm Hg and/or DBP ≥110 mm Hg) should add exercise training to their treatment plan only after first being evaluated by their physician and being prescribed appropriate antihypertensive medication.
- For individuals with documented CVD such as ischemic heart disease, heart failure, or stroke, vigorous intensity exercise training is best initiated in rehabilitation centers under medical supervision (see *Chapter 9*).
- Resting SBP >200 mm Hg and/or DBP >110 mm Hg, is a relative contraindication to exercise testing. When exercising, it appears prudent to maintain SBP ≤220 mm Hg and/or DBP ≤105 mm Hg.
- β-Blockers and diuretics may adversely affect thermoregulatory function. β-Blockers may also increase the predisposition to hypoglycemia in certain individuals (especially patients with DM who take insulin or insulin secretagogues) and mask some of the manifestations of hypoglycemia (particularly tachycardia). In these situations, educate patients about the signs and symptoms of heat intolerance (7,9) and hypoglycemia, and the precautions that should be taken to avoid these situations (see the section on DM in this chapter and *Appendix A*).
- β-Blockers, particularly the nonselective types, may reduce submaximal and maximal exercise capacity primarily in patients without myocardial ischemia (see *Appendix A*). Using perceived exertion to monitor exercise intensity is especially beneficial in these individuals (see *Chapters 4* and *7*).
- Antihypertensive medications such as α-blockers, calcium channel blockers, and vasodilators may lead to sudden excessive reductions in postexercise BP. Extend and carefully monitor the cool-down period in these individuals.
- Individuals with hypertension are often overweight or obese. Ex R_x for these individuals should focus on increasing caloric expenditure coupled with reducing caloric intake to facilitate weight reduction (see the section on overweight and obesity in this chapter and the relevant ACSM position stand [54]).

- A majority of older individuals will have hypertension. Older individuals experience similar exercise induced BP reductions as younger individuals (see *Chapter 8* and the relevant ACSM position stand [8]).
- The BP-lowering effects of aerobic exercise are immediate, a physiologic response referred to as *postexercise hypotension*. To enhance exercise adherence, educate these individuals about the acute or immediate BP-lowering effects of exercise, although investigation is limited that education about BP effects of acute exercise will improve adherence.
- For individuals with documented episodes of ischemia during exercise, the exercise intensity should be set below the ischemic threshold (≤10 beats · min^{-1}).
- Avoid the Valsalva maneuver during resistance training.

THE BOTTOM LINE

- Recommendations regarding exercise testing for individuals with hypertension vary depending on their BP level and the presence of other CVD risk factors, target organ disease, or CVD, as well as the intensity of the exercise program. Patients with uncontrolled severe hypertension (*i.e.*, resting SBP ≥180 mm Hg and/or DBP ≥110 mm Hg) should add exercise training to their treatment plan only after first being evaluated by their physician and being prescribed appropriate antihypertensive medication. Although vigorous intensity aerobic exercise (*i.e.*, ≥60% $\dot{V}O_2R$) is not necessarily contraindicated in patients with hypertension, moderate intensity aerobic exercise (*i.e.*, 40%–<60% $\dot{V}O_2R$) is generally recommended in preference to vigorous intensity aerobic exercise to optimize the benefit to risk ratio.

Online Resources

American College of Sports Medicine:
http://www.acsm.org to access the position stand on exercise and hypertension

American Heart Association:
http://www.american heart.org

National Heart Lung and Blood Institute:
http://www.nhlbi.nih.gov/hbp

INTELLECTUAL DISABILITY AND DOWN SYNDROME

Intellectual disability (ID) (older terminology referred to ID as *mental retardation*) is the most common developmental disorder in the Unites States with an estimated prevalence of 3% of the total population (66). ID is defined as (a) significant subaverage intelligence (*i.e.*, two standard deviations below the mean or an IQ <70 for mild ID and <35 for severe/profound ID); (b) having limitations in two or more adaptive skills areas such as communication, self-care, home living, social skills, community use, self-direction, health and safety, functional academics, leisure and work, and the level of care the individual requires (66); and (c) evident before 18 yr. Over 90% of all individuals with ID are classified with mild ID (17,69). The cause of ID is often not known, but genetic disorders, birth trauma, infectious disease, and maternal factors contribute, in addition to behavioral and societal factors including maternal drug and alcohol use, malnutrition, and poverty (17). The most commonly identified cause is fetal alcohol syndrome followed by Down syndrome (DS) or trisomy 21 (17,134).

Most individuals with ID live in the community either at home or in group homes. Furthermore, although mortality is much higher in individuals with ID than in the general population, life expectancy has been increasing rapidly in this population approaching that of the general population (181). Thus, it is highly likely that health/fitness and clinical exercise professionals will encounter individuals with ID in need of both exercise testing and training. Although there are many subpopulations of individuals with ID with their own unique attributes and considerations, the existing literature has focused on two main subpopulations — those with and without DS. Cardiovascular and pulmonary disorders are the most common medical problems in individuals with ID except for individuals with DS (103,210). For individuals with DS, infections, leukemia, and early development of Alzheimer disease are the most frequent causes of mortality and morbidity. However, as in individuals with ID but without DS, life expectancy for individuals with DS has also been increasing to ~60 yr with case reports of individuals living into their 80s (20).

In general, individuals with ID are perceived to have low levels of physical fitness and physical activity and high levels of obesity compared to the general population (20). However, supporting data are inconsistent, and these perceptions may only apply to individuals with DS and not to individuals with ID but without DS (20).

EXERCISE TESTING

Individuals with DS are unique as their response to exercise is clearly different from individuals without DS. Thus, concerns and considerations for exercise testing and Ex R_x are often different for individuals with and without DS. Exercise testing in general appears to be fairly safe in individuals with ID, and safety related to cardiovascular complications may not differ from the general population (68). However, although reports of exercise complications are rare or nonexistent, there is no scientific evidence either for or against the safety of exercise testing in individuals with ID. Concerns have been raised regarding validity and reliability of exercise testing in this population, but individualized treadmill laboratory tests appear to be reliable and valid, as do tests using the Schwinn Airdyne (see *Box 10.1*) (69). However, only a few field tests are valid for estimating CRF in this population (see *Box 10.1*) (69). It is recommended individuals with ID receive a full health-related physical fitness assessment including CRF, muscle strength and endurance, and body composition (see *Chapter 4*).

BOX 10.1 Fitness Tests Recommendations for Individuals with Intellectual Disability (69)

	Recommended	Not Recommended
Cardiorespiratory fitness	• Walking treadmill protocols with individualized walking speeds • Schwinn Airdyne using both arms and legs with 25-W stages • 20-m shuttle run • Rockport 1-mi walk	• Treadmill running protocols • Cycle ergometry • Arm ergometry • 1–1.5-mi runs
Muscular strength and endurance	• 1-RM using weight machines • Isokinetic testing • Isometric maximal voluntary contraction	• 1-RM using free weights • Push-ups • Flexed arm hang
Anthropometrics and body composition	• Body mass index • Waist circumference • Skinfolds • Air plethysmography • DEXA	
Flexibility	• Sit and reach • Joint-specific goniometry	

1-RM, one repetition maximum; DEXA, dual energy X-ray.

Nevertheless, the following general points should be considered in order to ensure appropriate test outcomes (67,73):

- Preparticipation health screening should follow general *ACSM Guidelines* (see *Chapter 2*), with the exception of individuals with DS. Because up to 50% of individuals with DS also have congenital heart disease and there is a high incidence of atlantoaxial instability (*i.e.*, excessive movement of the joint between C1 and C2 usually caused by ligament laxity in DS), a careful history and physical evaluation of these individuals is needed. In addition, physician supervision of preparticipation health screening exercise tests is also recommended for these individuals regardless of age.
- Familiarization with test procedures and personnel is usually required. Test validity and reliability have only been demonstrated following appropriate familiarization. The amount of familiarization will depend on the level of understanding and motivation of the individual being tested. Demonstration and practice is usually preferred. Thus, several visits to the test facility may be required.

TABLE 10.6. Formulas for Predicting $\dot{V}O_{2max}$ from Field Test Performance in Individuals with Intellectual Disability

20-m shuttle run (72):
$\dot{V}O_{2max}$ (mL · kg^{-1} · min^{-1}) = 0.35 (number of 20-m laps) − 0.59 (BMI) − 4.5 (gender: 1 = boys, 2 = girls) + 50.8
600-yard run/walk (72):
$\dot{V}O_{2max}$ (mL · kg^{-1} · min^{-1}) = −5.24 (600-yard run time in min) − 0.37 (BMI) − 4.61 (gender: 1 = boys, 2 = girls) + 73.64
1-mi Rockport Walk Fitness Test (240):
$\dot{V}O_{2max}$ (L · min^{-1}) = −0.18 (walk time in min) + 0.03 (body weight in kg) + 2.90

BMI, body mass index; $\dot{V}O_{2max}$, maximal oxygen consumption.

- Provide an environment in which the participant feels valued and like a participating member. Give simple, one-step instructions and reinforce them verbally and regularly. Provide safety features to ensure participants do not fall or have a fear of falling.
- Select appropriate tests (see *Box 10.1*) and individualize test protocols as needed. Only some tests of CRF have been shown to be valid and reliable in individuals with ID, whereas others have been shown to be of poor value because of poor reliability or questionable validity. Apply the population-specific formulas in *Table 10.6* when using CRF field tests.
- CRF field tests are reliable but not valid for individual prediction of aerobic capacity in individuals with DS.
- Because maximal heart rate (HR_{max}) is different in individuals with ID, especially in individuals with DS, the standard formula of 220 − age to predict HR_{max} should never be used. It is recommended that the following population-specific formula be used as a guide during exercise testing but should not be used for Ex R_x (71): HR_{max} = 210 − 0.56 (age) − 15.5 (DS); (insert 1 for no DS and 2 for DS into the equation).
- Individuals with ID but without DS may not differ from their peers without disabilities except in muscle strength, which is low in this population (69).
- Conversely, individuals with DS exhibit low levels of aerobic capacity and muscle strength and are often overweight and obese (20,42).

EXERCISE PRESCRIPTION

The FITT principle of Ex R_x for individuals with ID is very similar to an Ex R_x for healthy adults (102). However, because physical activity levels are low and body weight is often greater than desired, especially in individuals with DS, a focus on daily physical activity and caloric expenditure is desirable (68). The aerobic exercise training recommendations that follow are consistent with achieving an EE of ≥2,000 kcal · wk$-^{1}$. However, it is likely that several months of participation is needed before this EE can be achieved.

FITT RECOMMENDATIONS FOR INDIVIDUALS WITH INTELLECTUAL DISABILITY

FITT

Aerobic Exercise

Frequency: 3–7 d · wk^{-1} is encouraged to maximize caloric expenditure but 3–4 d · wk^{-1} should include moderate and vigorous intensity exercise, whereas light intensity, physical activity should be emphasized on the remaining days.

Intensity: 40%–80% $\dot{V}O_2R$ or HRR; RPE may not be an appropriate indicator of intensity in this population.

Time: 30–60 min · d^{-1}. To promote or maintain weight loss, as much daily activity as tolerated is recommended. Use of intermittent exercise bouts of 10–15 min in duration to accumulate these duration recommendations may be an attractive alternative to continuous exercise.

Type: Walking is recommended as a primary activity, especially in the beginning of the program. Progression to running with use of intermittent runs is recommended. Swimming and combined arm/leg ergometry are also effective. Because muscle strength is low in individuals with ID, a focus on muscle strength exercise is desirable (68).

Resistance Exercise

Frequency: 2–3 d · wk^{-1}.

Intensity: Begin with 12 repetitions at 15–20-RM for 1–2 wk; progress to 8–12-RM (75%–80% of 1-RM).

Time: 2–3 sets with 1–2 min rest between sets.

Type: Use machines targeting 6–8 major muscle groups. Closely supervise the program for the first 3 mo.

SPECIAL CONSIDERATIONS FOR INDIVIDUALS WITH INTELLECTUAL DISABILITY

- Most individuals with ID require more encouragement during both exercise testing and training than individuals without ID. Motivation can be a problem. Asking if they are tired will automatically yield an answer of "yes" in most individuals with ID, regardless of exercise intensity or amount of work performed. For this reason, this question should be avoided. Instead, ask or suggest, "you don't look tired, you can keep going can't you?"
- Many individuals with ID are on various types of medications. These include such medications as antidepressants, anticonvulsants, hypnotics, neuroleptics, and thyroid replacement (see *Appendix A*).
- Many individuals with ID have motor control problems and poor coordination creating balance and gait problems. Thus, most individuals with ID need to use the handrail during treadmill testing. Exercise activities that do not require substantial motor coordination should be chosen or attention to

correctly performing complex movements should be minimized (*e.g.*, if using dance movements, allow each individual to just do what they can).
- Most individuals with ID have a short attention span. Plan exercise testing and programming accordingly.
- Provide appropriate familiarization and practice before actual testing because individuals with ID are often not able to adequately perform exercise tests or exercise training.
- During exercise testing and training, careful supervision is required. Some individuals with ID will eventually be able to perform exercise training in an unsupervised setting but most will require supervised exercise sessions.
- Careful spotting and supervision is needed during the beginning phases of resistance exercise training even when using machines.
- Because individuals with ID have limited attention span and limited exposure to exercise, varied activities are suggested to maximize enjoyment and adherence. Consider using music and simple games as part of the exercise training program. Also consider encouraging participation in sports programs such as Special Olympics.
- Individualize exercise training as much as possible. Large group-based programs are likely to be less effective.

SPECIAL CONSIDERATIONS FOR INDIVIDUALS WITH DOWN SYNDROME

- Individuals with DS have very low levels of aerobic capacity and muscle strength, often at levels approximately 50% of the level expected based on age and sex.
- Individuals with DS are often obese, and severe obesity is not uncommon (see the section on overweight and obesity in this chapter and the relevant ACSM position stand [54]).
- Almost all individuals with DS have low HR_{max} likely caused by reduced catecholamine response to exercise (70).
- The likelihood of congenital heart disease is high in individuals with DS.
- It is not unusual for individuals with DS to have atlantoaxial instability. Thus, activities involving hyperflexion or hyperextension of the neck are contraindicated.
- Many individuals with DS exhibit skeletal muscle hypotonia coupled with excessive joint laxity. Increasing muscle strength, especially around major joints (*e.g.*, knee), is a priority. Also, caution should be used regarding involvement in contact sports.
- Physical characteristics such as short stature, limbs, and digits commonly coupled with malformations of feet and toes, and small mouth and nasal cavities with a large protruding tongue may negatively impact exercise performance.

THE BOTTOM LINE

- Individuals with and without DS have different responses to exercise, and individuals with DS often exhibit a greater number of special considerations such as congenital heart disease, atlantoaxial instability, low levels of physical fitness, and reduced HR_{max}. Exercise testing is generally safe but should be conducted with physician supervision for individuals with congenital heart disease and atlantoaxial instability. Exercise tests need to be carefully selected because some tests are not valid and reliable in this population. The FITT principle of Ex R_x is very similar to individuals without disabilities but supervision is recommended. Issues with attention span, motivation, and behavior may also be present, and the FITT principle of Ex R_x should be appropriately adjusted.

Online Resources

American Association for Physical Activity and Recreation/Adapted Physical Education and Activity:
http://www.aahperd.org/aapar/careers/adapted-physical-education.cfm

American Association on Intellectual and Developmental Disabilities:
http://www.aamr.org

National Association for Down Syndrome:
http:// www.nads.org

National Center on Physical Activity and Disability (NCPAD):
http://www.ncpad.org

National Consortium for Physical Education and Recreation for Individuals with Disabilities:
http://www.ncperid.org

National Down Syndrome Society:
http://www.ndss.org

KIDNEY DISEASE

Individuals are diagnosed with CKD if they have kidney damage evidenced by microalbuminuria or have a glomerular filtration rate $<60 \text{ mL} \cdot \text{min}^{-1} \cdot 1.73 \text{ m}^{-2}$ for ≥3 mo (166). Based on National Kidney Foundation's Kidney Disease Outcomes Quality Initiative (K/DOQI) *Guidelines*, CKD is divided into five stages primarily depending on the glomerular filtration rate of the individual and the presence of kidney damage (166) (see *Table 10.7*). Approximately 23 million Americans have CKD, and the prevalence of the disease is estimated to be 11.5% (139). Hypertension, DM, and CVD are very common in the CKD population with the prevalence of these comorbidities rising incrementally from stage 1 to stage

TABLE 10.7. Stages of Chronic Kidney Disease (166)

Stage	Description	GFR ($\text{mL} \cdot \text{min}^{-1} \cdot 1.73 \text{ m}^{-2}$)
1	Kidney damage with normal or ↑ GFR	≥90
2	Kidney damage with mild ↓ GFR	60–89
3	Moderate ↓ GFR	30–59
4	Severe ↓ GFR	15–29
5	Kidney failure	<15 (or dialysis)

GFR, glomerular filtration rate.

5 CKD (254). When individuals progress to stage 5 CKD (*i.e.*, glomerular filtration rate <15 mL · min^{-1} · 1.73 m^{-2}) their treatment options include renal replacement therapy (hemodialysis or peritoneal dialysis) or kidney transplantation.

EXERCISE TESTING

Because CVD is the major cause of death in individuals with CKD, diagnostic exercise testing is indicated. Exercise testing is included in the pretransplantation workup for kidney recipients (140). However, some authorities believe diagnostic testing for patients with end-stage renal disease (*i.e.*, stage 5 CKD) is not warranted because their performance on a symptom-limited exercise test is affected by muscle fatigue, and such testing may act as an unnecessary barrier to their participation in a training program (177). Exercise testing of individuals with CKD should be supervised by trained medical personnel, with the use of standard test termination criteria and test termination methods (see *Chapter 5*).

Most research on patients with CKD has been done on individuals classified with stage 5 CKD. Current evidence suggests these individuals tend to have low functional capacities with values that are approximately 60%–70% of those seen in healthy age and sex-matched controls (175). $\dot{V}O_{2peak}$ ranges between 17–28.6 mL · kg^{-1} · min^{-1} (175), and can be increased with training by approximately 17% but never reach the values achieved by age and sex-matched controls (119). This reduced functional capacity is thought to be related to several factors including a sedentary lifestyle, cardiac dysfunction, anemia, and musculoskeletal dysfunction. The following exercise testing considerations should be noted:

- Medical clearance should be obtained from both the patient's primary care physician and nephrologist.
- Individuals with CKD are likely to be on multiple medications including those that are commonly used in the treatment of hypertension and DM (see *Appendix A*).
- When performing a graded exercise test on individuals with stage 1–4 CKD, standard testing procedures should be followed (see *Chapter 5*). However, in patients receiving maintenance hemodialysis, testing should be scheduled for nondialysis days and BP should be monitored in the arm that does not contain the arteriovenous fistula (177).
- Patients receiving continuous ambulatory peritoneal dialysis should be tested without dialysate fluid in their abdomen (177). Standard procedures are used to test patients that are transplant recipients.
- Both treadmill and cycle leg ergometry protocols have been used to test individuals with kidney diseases, with the treadmill being more popular. Because of the low functional capacity in this population, more conservative treadmill protocols such as the modified Bruce protocol, Balke, Naughton, or branching protocols are appropriate (176) (see *Chapter 5*). If cycle leg ergometry is used, initial warm-up work rates should be 20–25 W with the work rate increased by 10–30 W increments every 1–3 min (38,260).
- In patients receiving maintenance hemodialysis, peak heart rate (HR_{peak}) is approximately 75% of age-predicted maximum (178). Because HR may not

always be a reliable indicator of exercise intensity in patients with CKD, RPE should always be monitored (see *Chapter 4*).

- Isotonic strength testing should be done using a 3-RM or higher load (*e.g.*, 10–12-RM) because 1-RM testing is generally thought to be contraindicated in patients with CKD because of the fear of spontaneous avulsion fractures (25,119,177,215).
- Muscular strength and endurance can be safely assessed using isokinetic dynamometers employing angular velocities ranging from 60 degrees to 180 degrees · s^{-1} is recommended (52,105,176).
- As a result of the very low functional capacities of individuals with CKD, with an estimated 50% not being able to perform symptom-limited testing, traditional exercise tests may not always yield the most valuable information (175). Consequently, a variety of physical performance tests that have been used in other populations (*e.g.*, older adults) can be used (see *Chapter 8*). Tests can be chosen to assess CRF, muscular strength, balance, and flexibility (174,175).

EXERCISE PRESCRIPTION

The ideal FITT principle of Ex R_x for individuals with CKD has not been fully developed, but based on the research that has been done, programs for these patients should consist of a combination of aerobic and resistance training (37,119). It seems prudent to modify the recommendations for the general population; initially using light-to-moderate intensities and gradually progressing over time based on individual tolerance. Medically cleared recipients of kidney transplants can initiate exercise training as early as 8 d following the transplant operation (156,175).

FITT RECOMMENDATIONS FOR INDIVIDUALS WITH CHRONIC KIDNEY DISEASE

FITT

Aerobic, Resistance, and Flexibility Exercise

The following FITT principle of Ex R_x is recommended for individuals with CKD:

Frequency: Aerobic exercise 3–5 d · wk^{-1}; resistance exercise 2–3 d · wk^{-1}.

Intensity: Moderate intensity, aerobic exercise (40%–<60% $\dot{V}O_2R$, RPE 11–13 on a scale of 6–20); resistance exercise, 70%–75% 1-RM.

Time: Aerobic exercise 20–60 min of continuous activity; however, if this amount cannot be tolerated, 3–5 min bouts of intermittent exercise aiming to accumulate 20–60 min · d^{-1} is recommended; Resistance training, a minimum of 1 set of 10–15 repetitions. Choose 8–10 different exercises to work the major muscle groups. Flexibility exercise should be performed following the guidelines for healthy adults (see *Chapter 7*).

Type: Walking, cycling, and swimming are recommended aerobic activities. Use either machine weights or free weights for resistance exercise.

SPECIAL CONSIDERATIONS

- Individuals with CKD should be gradually progressed to a greater exercise volume over time. Depending on the clinical status and functional capacity of the individual, the initial intensity selected for training should be light (*i.e.*, 30%–<40% $\dot{V}O_2R$) and for as little as 10–15 min of continuous activity or whatever amount the individual can tolerate. The duration of the physical activity should be increased by 3–5 min increments weekly until the individual can complete 30 min of continuous activity before increasing the intensity.
- The clinical status of the individual is important to consider. The progression may need to be slowed if the individual has a medical setback.
- Some individuals with CKD are unable to do continuous exercise and therefore should perform intermittent exercise with intervals as short as 3 min interspersed with 3 min of rest (*i.e.*, 1:1 work-to-rest ratio). As the individual adapts to training, the duration of the work interval can be increased, whereas the rest interval can be decreased. Initially, a total exercise time of 15 min can be used, and this can be increased within tolerance to achieve up 20–60 min of continuous activity.
- Individuals with CKD performing resistance exercise should be asked to perform at least 1 set of 10 repetitions at 70% 1-RM twice per week. Consider adding a second set when the individual can easily complete 15 repetitions at a specific weight.
- Hemodialysis.
  - Exercise can be performed on nondialysis days and should *not* be done immediately postdialysis.
  - If exercise is done during dialysis, exercise should be attempted during the first half of the treatment to avoid hypotensive episodes.
  - Place great emphasis on the RPE because HR is unreliable.
  - Patients may exercise the arm with the arteriovenous access as long as they do not directly rest weight on that area (119). Measure BP in the arm that does not contain the fistula.
- Peritoneal Dialysis.
  - Patients on continuous ambulatory peritoneal dialysis may attempt exercising with fluid in their abdomen; however, if this produces discomfort then they should be encouraged to drain the fluid before exercising (119).
- Recipients of Kidney Transplants.
  - During periods of rejection, the FITT principle of Ex R_x should be reduced but exercise can still be continued (174).

THE BOTTOM LINE

- Individuals with CKD tend to be very deconditioned depending on their age and disease status. Based on current evidence, exercise is safe for these individuals if performed at moderate intensity and if progression occurs gradually. Exercise testing should be done under medical supervision and may involve the use of functional tests rather than the traditional GXT.

Online Resources

National Institute of Diabetes and Digestive and Kidney Diseases:
http://www2.niddk.nih.gov/

National Kidney Foundation:
http://www.kidney.org/

United States Renal Data System:
http://www.usrds.org/atlas.htm

METABOLIC SYNDROME

The *metabolic syndrome* is characterized by a constellation of risk factors that are associated with increased incidence of CVD, DM, and stroke. A consensus on the definition of the metabolic syndrome has been somewhat controversial; however, the criteria set by the NCEP ATP III *Guidelines* are most commonly used for diagnosis (164). Typically, individuals with the metabolic syndrome are overweight/obese and have elevated plasma triglycerides, hypertension, and elevated plasma glucose. Diagnosis is made when at least three of the risk factors shown in *Table 3.3* are present. At this time, it is underdetermined whether the metabolic syndrome represents a distinct pathophysiologic condition or disease (83). Nonetheless, the metabolic syndrome as a clinical entity is useful in clinical and health/fitness settings.

Although the primary cause is debatable, the root causes of the metabolic syndrome are overweight/obesity, physical inactivity, insulin resistance, and genetic factors. Age-adjusted prevalence data from the National Health and Nutrition Examination Survey (NHANES) 2003–2006 indicates 34% of adults in the United States meet the criteria for the metabolic syndrome (59), an increase compared with the prevalence of 27% in NHANES 1999–2000 (81). The International Diabetes Federation (IDF) proposed a new definition for the metabolic syndrome in 2005 (113) that was based on the presence of abdominal adiposity and two additional CVD risk factors shown in *Table 3.3*. When the metabolic syndrome classifications are compared, the NCEP and IDF definitions provide the same classification of 93% of individuals having the metabolic syndrome (80), indicating their compatibility.

The treatment guidelines for the metabolic syndrome recommended by NCEP ATPIII focus on three interventions including weight control, physical activity, and treatment of the associated CVD risk factors that may include pharmacotherapy (164) (see *Chapter 3*). The IDF *Guidelines* for primary intervention include (113) (a) moderate restriction in energy intake to achieve a 5%–10% weight loss within 1 yr; (b) moderate increases in physical activity consistent with the consensus public health recommendations of 30 min of moderate intensity, physical activity on most days of the week (102,250); and (c) change in dietary intake composition that may require changes in macronutrient composition consistent with modifying specified CVD risk factors.

The IDF secondary intervention includes pharmacotherapy for associated CVD risk factors (49,113).

EXERCISE TESTING

- Special consideration should be given to associated CVD risk factors as outlined in *Chapters 2* and *3* on exercise testing and in this chapter for individuals with dyslipidemia, hypertension, and hyperglycemia.
- Because many individuals with the metabolic syndrome are either overweight or obese, exercise testing considerations specific to those individuals should be followed (see the section on overweight and obesity in this chapter and the relevant ACSM position stand [54]).
- The potential for low exercise capacity in individuals who are overweight or obese may necessitate a low initial workload (*i.e.*, 2–3 metabolic equivalents [METs]) and small increments per testing stage (0.5–1.0 MET).
- Because of the potential presence of elevated BP, strict adherence to protocols for assessing BP before and during exercise testing should be followed (183) (see *Chapters 3* and *5*).

EXERCISE PRESCRIPTION/SPECIAL CONSIDERATIONS

The FITT principle of Ex R_x is consistent with the recommendations for healthy adults regarding aerobic, resistance, and flexibility exercise (see *Chapter 7*). Similarly, the minimal dose of physical activity to improve health/fitness outcomes is consistent with the consensus public health recommendations of 150 min · wk^{-1} or 30 min of physical activity on most days of the week (102,249). For these reasons and because of the impact of the clustering of chronic diseases and health conditions that accompany the metabolic syndrome, the following FITT principle of Ex R_x and special considerations are combined in this section:

- Individuals with the metabolic syndrome will likely present with multiple CVD and DM risk factors (*i.e.*, dyslipidemia, hypertension, obesity, and hyperglycemia). Special consideration should be given to the FITT principle of Ex R_x recommendations based on the presence of these associated CVD risk factors and the goals of the participant and/or health care provider (see other sections of this chapter on the FITT principle Ex R_x for these other chronic diseases and health conditions as well as relevant ACSM position stands [6,54,183]).
- To reduce risk factors associated with CVD and DM, initial exercise training should be performed at a moderate intensity (*i.e.*, 40%–<60% $\dot{V}O_2R$ or HRR) and when appropriate, progress to a more vigorous intensity (*i.e.*, ≥60% $\dot{V}O_2R$ or HRR), totaling a minimum of 150 min · wk^{-1} or 30 min · d^{-1} most days of the week to allow for optimal health/fitness improvements.
- To reduce body weight, most individuals with the metabolic syndrome may benefit by gradually increasing their physical activity levels to approximately

300 min · wk^{-1} or 50–60 min on 5 d · wk^{-1} when appropriate (54,216,251). This amount of physical activity may be accumulated in multiple daily bouts of at least 10 min in duration or through increases in other forms of moderate intensity lifestyle physical activities. For some individuals to promote or maintain weight loss, progression of 60–90 min · d^{-1} may be necessary (see the Ex R_x recommendations for those with overweight and obesity in this chapter and the relevant ACSM position stand [54]).

THE BOTTOM LINE

- The prevalence of the metabolic syndrome in the United States is increasing. Many individuals with the metabolic syndrome are overweight or obese and present with multiple CVD and DM risk factors. Special consideration should be given to exercise testing and the FITT principle of Ex R_x based on the clustering of these chronic diseases and health conditions. The goal of the Ex R_x is to reduce the risk factors associated with CVD and DM and reduce body weight.

Online Resources

American College of Sports Medicine:
http://www.acsm.org to access relevant position stands to the metabolic syndrome

American Heart Association:
http://www.heart.org

MULTIPLE SCLEROSIS

Multiple sclerosis (MS) is a chronic inflammatory demyelinating disease of the central nervous system (CNS) that currently affects an estimated 2.1 million individuals worldwide (167). The onset of MS usually occurs between 20 and 50 yr and affects women at a rate two to three times more than men. Initial symptoms often include transient neurological deficits such as numbness or weakness and blurred or double vision. Although the exact cause of MS is still unknown, most researchers believe it involves an autoimmune response that is influenced by a combination of environmental, infectious, and genetic factors. During an exacerbation, activated T cells cross the blood–brain barrier precipitating an autoimmune attack on myelin in the CNS. Following the initial inflammatory response, damaged myelin forms scarlike plaques that can impair nerve conduction and transmission (167). This can lead to a wide variety of symptoms; the most common of which include visual disturbances, weakness, sensory loss, fatigue, pain, coordination deficits, bowel or bladder dysfunction, and cognitive and emotional changes (144,225).

The disease course of MS is highly variable from individual to individual and within a given individual over time. However, several distinct disease courses are now recognized as well as the relative frequency of each including (a) *relapsing remitting MS* (RRMS; 85%) characterized by periodic exacerbations followed by full or partial recovery of deficits; (b) *primary progressive MS* (PPMS; 10%) characterized by continuous disease progression from onset with little or no plateaus or improvements; and (c) *progressive relapsing MS* (PRMS; 5%) characterized by a progression from onset with distinct relapses superimposed on the steady progression (144). For the 85% of individuals who have an initial disease course of RRMS, many will eventually (10–25 yr later) develop a *secondary progressive MS* (SPMS) disease course, which is characterized by a slow but steady decline in function. The level of disability related to the progression of MS is commonly documented using the Kurtzke Expanded Disability Status Scale (EDSS), which ranges from 0 to 10. EDSS scores from 0 to 2.5 are indicative of no to minimal disability, 3–5.5 moderate disability and ambulatory without device, 6–7 significant disability but still ambulatory with a device, 7.5–9 essentially chairbound or bedbound, and 10 death because of MS (135).

With respect to CRF, individuals with MS generally have lower maximal aerobic capacity than age- and sex-matched adults without MS. Furthermore, aerobic capacity continues to decrease with increasing levels of disability (189,191). HR and BP responses to GXT are generally linear with respect to work rate but tend to be blunted compared to healthy controls (189). This attenuation of HR and BP may be a result of cardiovascular dysautonomia (236). Following 3–6 mo of progressive aerobic training, individuals with MS who have mild-to-moderate disability have consistently demonstrated improvements in $\dot{V}O_{2peak}$, functional capacity, lung function, and delayed onset of fatigue (162,184,190).

Decreased muscle performance is also a common impairment associated with MS. Individuals with MS have lower isometric and isokinetic force production as well as total work of the quadriceps muscle when compared to age- and sex-matched norms (47,136,190). Changes in muscle performance appear to be associated with central (neural drive and conduction) and peripheral (decreased oxidative capacity) factors associated with the disease process as well as the secondary effects of disuse atrophy (124,199). Although limited, current research demonstrates individuals with MS can improve strength and function with progressive resistance training with greater gains being realized by individuals with less disability because of MS (268).

EXERCISE TESTING

- Generalized fatigue is common in individuals with MS. Because fatigue generally worsens throughout the day, performing exercise testing earlier in the day is likely to yield a more accurate and consistent response.
- Avoid testing during an acute exacerbation of MS symptoms.
- Problems with balance and coordination may require use of an upright or recumbent cycle leg ergometer. When using a cycle leg ergometer, the use

of foot straps may be needed to prevent the foot from falling off the pedal because of weakness and/or spasticity.

- A recumbent stepping ergometer (*e.g.*, NuStep) that allows for the use of upper and lower extremities may be advantageous because it distributes work to all extremities, thus minimizing the potential influence of local muscle fatigue on maximal aerobic testing.
- Depending on the disability and physical fitness level of the individual, use a continuous or discontinuous protocol of 3–5 min stages increasing work rate for each stage from 12 to 25 W.
- Heat sensitivity is common in individuals with MS so it is important to use a fan or other cooling strategies during testing.
- Assessment of joint ROM and flexibility is important because increased tone and spasticity can lead to contracture formation.
- Isokinetic dynamometry can be used to accurately evaluate muscle performance. However, use of an 8–10-RM or functional testing (*e.g.*, 30 s sit-to-stand test) can also be used to measure muscular strength and endurance in the clinical or community setting.
- Use physical performance tests as needed to assess endurance (6-min walk test) (see *Chapter 4*), strength (5 repetition sit-to-stand), gait (walking speed) (see *Chapter 8*), and balance (Berg Balance Scale [23], and Dynamic Gait Index [107]).

EXERCISE PRESCRIPTION

For individuals with minimal disability (EDSS 0–2.5), the FITT principle of Ex R_x is generally consistent with those outlined in *Chapter 7* for healthy adults. As MS symptoms and level of disability increase, the following modifications outlined may be required.

FITT RECOMMENDATIONS FOR INDIVIDUALS WITH MULTIPLE SCLEROSIS

FITT

Aerobic Exercise

Frequency: 3–5 d · wk^{-1}.

Intensity: 40%–70% $\dot{V}O_2R$ or HRR; RPE 11–14.

Time: Increase exercise time initially to a minimum of 10 min before increasing intensity. Progress to 20–60 min. In individuals with excessive fatigue, begin with lower intensity and discontinuous bouts of exercise.

Resistance Exercise

Frequency: 2 d · wk^{-1}.

Intensity: 60%–80% 1-RM.

Time: 1–2 sets of 8–15 repetitions. When strengthening weaker muscle groups or easily fatigued individuals, increase rest time (*e.g.*, 2–5 min) between sets and exercises as needed to allow for full muscle recovery. Focus on large antigravity muscle groups and minimize total number of exercises performed.

Flexibility Exercise

Frequency: 5–7 d · wk^{-1}, 1–2 times · d^{-1}.

Intensity: Stretch to the point of feeling tightness or mild discomfort.

Time: Hold static stretch 30–60 s, 2–4 repetitions.

SPECIAL CONSIDERATIONS

- In spastic muscles, increase the frequency and time of flexibility exercises. Muscles and joints with significant tightness or contracture may require longer duration (several minutes to several hours), and lower load positional stretching to achieve lasting improvements.
- Whenever possible, incorporate functional activities (*e.g.*, stairs, sit-to-stand) into the exercise program to promote optimal carryover.
- Use RPE in addition to HR to evaluate exercise intensity. With individuals who have significant paresis, consider assessing RPE of the extremities separately using the 6–20 scale (27) to evaluate effects of local muscle fatigue on exercise tolerance.
- During an acute exacerbation of MS symptoms, decrease the FITT of the Ex R_x to the level of tolerance. If the exacerbation is severe, focus on maintaining functional mobility and/or focus on activities such as aerobic exercises and flexibility.
- Commonly used disease-modifying medications such as Avonex, Betaseron, Rebif, and Copaxone can have transient side effects such as flu-like symptoms and localized irritation at the injection site. Take medication side effects into consideration with exercise testing and scheduling.
- Systemic fatigue is common in MS but tends to improve with increased physical fitness. It is important to help the individual understand the difference between more general centrally mediated MS fatigue and temporary peripheral exercise-related fatigue. Tracking the effects of fatigue may be helpful using an instrument such as the Modified Fatigue Impact Scale (168).
- Heat sensitivity is common in MS. Use of fans, evaporative cooling garments, and cooling vests can increase exercise tolerance and reduce symptoms of fatigue.
- HR and BP responses may be blunted because of dysautonomia so that HR may not be a valid indicator of exercise intensity. RPE can be used in addition to HR to evaluate exercise intensity (see *Chapters 4* and *7*).
- Some individuals may restrict their daily fluid intake because of bladder control problems. They should be counseled to increase fluid intake with increased physical activity levels to prevent dehydration.

- Many individuals with MS have some level of cognitive deficit that may affect their understanding of testing and training instructions. They may also have short-term memory loss that requires written instructions and frequent verbal cueing and reinforcement.
- Watch for signs and symptoms of the *Uhthoff Phenomenon*. Uhthoff phenomenon typically involves a transient (<24 h) worsening of neurological symptoms, most commonly visual impairment associated with exercise and elevation of body temperature. Symptoms can be minimized by using cooling strategies and adjusting exercise time and intensity as appropriate.

THE BOTTOM LINE

- Individuals with MS generally have a lower $\dot{V}O_{2peak}$ compared to a healthy population. Fatigue is common in individuals with MS but can be improved with exercise training in individuals who have mild-to-moderate disability. The HR response to exercise may be blunted; RPE can be used in addition to HR to evaluate exercise intensity.

Online Resources

National Center on Physical Activity and Disability:
http://www.ncpad.org

National Institute for Neurological Disorders and Stroke:
http://www.ninds.nih.gov/multiple_sclerosis/multiple_sclerosis.htm

National MS Society:
http://www.nationalmssociety.org

OSTEOPOROSIS

Osteoporosis is a skeletal disease that is characterized by low bone mineral density (BMD) and changes in the microarchitecture of bone that increase susceptibility to fracture. The burden of osteoporosis on society and the individual is significant. More than 10 million individuals in the United States ≥50 yr have osteoporosis, and another 34 million are at risk (253). Hip fractures, in particular, are associated with increased risk of disability and death. The 2007 official position of the International Society of Clinical Densitometry, which has been endorsed by the American Association of Clinical Endocrinologists, the American Society for Bone and Mineral Research, the Endocrine Society, the North American Menopause Society, and the National Osteoporosis Foundation, defines osteoporosis in postmenopausal women and in men ≥50 yr as a BMD T-score of the lumbar spine, total hip, or femoral neck of ≤−2.5 (18). However, it is important to recognize that osteoporotic fractures may occur at BMD levels above this threshold, particularly in the elderly.

Physical activity may reduce the risk for osteoporotic fractures by enhancing the peak bone mass achieved during growth and development, by slowing the rate of bone loss with aging, and/or by reducing the risk of falls via benefits on muscle strength and balance (21,133,206,253). Accordingly, physical activity plays a prominent role in primary and secondary prevention of osteoporosis (253). Physical activity is inversely associated with risk of hip and spine fracture, and exercise training can increase or slow the decrease in spine and hip BMD (186).

EXERCISE TESTING

There are no special considerations for exercise testing of individuals at risk for osteoporosis regarding when a test is clinically indicated beyond those for the general population. However, when exercise tests are performed in individuals with osteoporosis, the following issues should be considered:

- Use of cycle leg ergometry as an alternative to treadmill exercise testing to assess CRF may be indicated in patients with severe vertebral osteoporosis for whom walking is painful.
- Vertebral compression fractures leading to a loss of height and spinal deformation can compromise ventilatory capacity and result in a forward shift in the center of gravity. The latter may affect balance during treadmill walking necessitating handrail support or an alternative modality.
- Maximal muscle strength testing may be contraindicated in patients with severe osteoporosis, although there are no established guidelines for contraindications for maximal muscle strength testing.

EXERCISE PRESCRIPTION

The FITT principle of Ex R_x for individuals with osteoporosis are categorized into two types of populations: (a) individuals at risk for osteoporosis defined as having ≥1 risk factor for osteoporosis (*e.g.*, current low bone mass, age, being female) (253); and (b) individuals with osteoporosis.

FITT RECOMMENDATIONS FOR INDIVIDUALS AT RISK FOR AND WITH OSTEOPOROSIS

FITT

Aerobic and Resistance Exercise

Individuals at Risk for Osteoporosis

In individuals *at risk* for osteoporosis, the following FITT principles of Ex R_x are recommended to help *preserve bone health*:

Frequency: Weight-bearing aerobic activities 3–5 d · wk^{-1} and resistance exercise 2–3 d · wk^{-1}.

Intensity: Aerobic: Moderate (*e.g.*, 40%–<60% $\dot{V}O_2R$ or HRR) to vigorous ≥60% ($\dot{V}O_2R$ or HRR) intensity; resistance: moderate (*e.g.*, 60%–80%

1-RM, 8–12 repetitions with exercises involving each major muscle group) to vigorous (*e.g.*, 80%–90% 1-RM, 5–6 repetitions with exercises involving each major muscle group) intensity in terms of bone loading forces.

Time: 30–60 min · d^{-1} of a combination of weight-bearing aerobic and resistance activities.

Type: Weight-bearing aerobic activities (*e.g.*, tennis, stair climbing/ descending, walking with intermittent jogging), activities that involve jumping (*e.g.*, volleyball, basketball), and resistance exercise (*e.g.*, weight lifting).

Individuals ~~at Risk for~~ Osteoporosis

In individuals *with osteoporosis*, the following FITT principle of Ex R_x is recommended to help *prevent disease progression*:

Frequency: Weight-bearing aerobic activities 3–5 d · wk^{-1} and resistance exercise 2–3 d · wk^{-1}.

Intensity: Moderate intensity (*i.e.*, 40%–<60% $\dot{V}O_2R$ or HRR) for weight-bearing aerobic activities and moderate intensity (*e.g.*, 60%–80% 1-RM, 8–12 repetitions of exercises involving each major muscle group) in terms of bone loading forces, although some individuals may be able to tolerate more intense exercise.

Time: 30–60 min · d^{-1} of a combination of weight-bearing aerobic and resistance activities.

Type: Weight-bearing aerobic activities (*e.g.*, stair climbing/descending, walking, other activities as tolerated) and resistance exercise (*e.g.*, weight lifting).

SPECIAL CONSIDERATIONS

- It is difficult to quantify exercise intensity in terms of bone loading forces. However, the magnitude of bone loading force generally increases in parallel with exercise intensity quantified by conventional methods (*e.g.*, $\%HR_{max}$ or %1-RM).
- There are currently no established guidelines regarding contraindications for exercise for individuals with osteoporosis. The general recommendation is to prescribe moderate intensity exercise that does not cause or exacerbate pain. Exercises that involve explosive movements or high-impact loading should be avoided. Exercises that cause twisting, bending, or compression of the spine should also be avoided.
- BMD of the spine may appear *normal* or *increased* after osteoporotic compression fractures have occurred or in individuals with osteoarthritis of the spine. Hip BMD is a more reliable indicator of risk for osteoporosis than spine BMD (141).
- For older women and men at increased risk for falls, the Ex R_x should also include activities that improve balance (see *Chapter 8* and the relevant ACSM position stand [8]).

- In light of the rapid and profound effects of immobilization and bed rest on bone loss and poor prognosis for recovery of mineral after remobilization, even the frailest elderly should remain as physically active as his or her health permits to preserve musculoskeletal integrity.

THE BOTTOM LINE

- Physical activity plays an important role in the primary and secondary prevention of osteoporosis by enhancing peak bone mass during growth, slowing the rate of bone loss with aging, and preventing falls. Weight-bearing aerobic and resistance exercise are essential to individuals at risk for and with osteoporosis. It is difficult to quantify the magnitude of bone loading forces, but they generally increase in parallel with exercise intensity.

Online Resources

American College of Sports Medicine:
http://www.acsm.org to access the position stand on osteoporosis

National Osteoporosis Foundation:
http://www.nof.org

OVERWEIGHT AND OBESITY

Overweight and *obesity* are characterized by excess body weight with BMI commonly used as the criterion to define these conditions. Recent estimates indicate that more than 68% of adults are classified as overweight (BMI $\geq$25 kg · m^{-2}), 32% as obese (BMI $\geq$30 kg · m^{-2}), and 5% extremely obese (BMI $\geq$40 kg · m^{-2}) (77). Obesity is also an increasing concern in youth with ~14%–18% of children and adolescents classified as overweight, defined as $\geq$95th percentile of BMI for age and sex (173). Overweight and obesity are linked to numerous chronic diseases including CVD, DM, many forms of cancer, and numerous musculoskeletal problems (36). It is estimated obesity-related conditions account for ~7% of total health care costs in the United States, and the direct and indirect costs of obesity are in excess of $113.9 billion annually (245).

The management of body weight is dependent on energy balance that is determined by energy intake and EE. For an individual who is overweight or obese to reduce body weight, EE must exceed energy intake. A weight loss of 5%–10% provides significant health benefits (36), and these benefits are more likely to be sustained through the maintenance of weight loss and/or participation in habitual physical activity (241). Weight loss maintenance is challenging with weight regain averaging approximately 33%–50% of initial weight loss within 1 yr of terminating treatment (270).

Lifestyle interventions for weight loss that combine reductions in energy intake with increases in EE through exercise and other forms of physical activity typically result in an initial 9%–10% reduction in body weight (270). However, physical activity appears to have a modest impact on the magnitude of weight loss observed across the initial weight loss intervention compared with reductions in energy intake (36). The level of impact of exercise on weight loss further decreases when energy intake is reduced to levels that are insufficient to meet the resting metabolic rate (54). Thus, the combination of moderate reductions in energy intake with adequate levels of physical activity maximizes weight loss in individuals with overweight and obesity (36,115). Physical activity appears necessary for most individuals to prevent weight regain (36,115,216,251). However, the literature is absent of well-designed, randomized controlled trials with supervised exercise, known EE of exercise, and energy balance measures upon which to provide evidence-based recommendations for quantity and quality of exercise to prevent weight regain (54).

Based on the existent scientific evidence and practical clinical guidelines (54), the ACSM makes the following recommendations regarding exercise testing and training for individuals with overweight and obesity.

EXERCISE TESTING

- The presence of other comorbidities (*e.g.*, dyslipidemia, hypertension, hyperinsulinemia, hyperglycemia) may increase the risk classification for individuals with overweight and obesity, resulting in the need for additional medical screening before exercise testing and/or appropriate medical supervision during exercise testing (see *Chapters* 2 and 3).
- The timing of medications to treat comorbidities relative to exercise testing should be considered.
- The presence of musculoskeletal and/or orthopedic conditions may require modifications to the exercise testing procedure that may necessitate the need for leg or arm ergometry.
- The potential for low exercise capacity in individuals with overweight and obesity may necessitate a low initial workload (*i.e.*, 2–3 METs) and small increments per testing stage of 0.5–1.0 MET.
- Because of the ease of test administration, consider a cycle leg ergometer (with an oversized seat) versus a treadmill.
- Exercise equipment must be adequate to meet the weight specification of individuals with overweight and obesity for safety and calibration purposes.
- Adults with overweight and obesity may have difficulty achieving traditional physiologic criteria indicative of maximal exercise testing so that standard termination criteria may not apply to these individuals (see *Chapter* 5).
- The appropriate cuff size should be used to measure BP in individuals who are overweight and obese to minimize the potential for inaccurate measurement.

EXERCISE PRESCRIPTION

FITT RECOMMENDATIONS FOR INDIVIDUALS WITH OVERWEIGHT AND OBESITY

FITT

Aerobic, Resistance, and Flexibility Exercise

Frequency: ≥5 d · wk^{-1} to maximize caloric expenditure.

Intensity: Moderate-to-vigorous intensity aerobic activity should be encouraged. Initial exercise training intensity should be moderate (*i.e.*, 40%–<60% $\dot{V}O_2R$ or HRR). Eventual progression to more vigorous exercise intensity (*i.e.*, ≥60% $\dot{V}O_2R$ or HRR) may result in further health/fitness benefits.

Time: A minimum of 30 min · d^{-1} (*i.e.*, 150 min · wk^{-1}) progressing to 60 min · d^{-1} (*i.e.*, 300 min · wk^{-1}) of moderate intensity, aerobic activity. Incorporating more vigorous intensity exercise into the total volume of exercise may provide additional health benefits. However, vigorous intensity exercise should be encouraged in individuals who are both capable and willing to exercise at a higher than moderate intensity levels of physical exertion with recognition that vigorous intensity exercise is associated with the potential for greater injuries (182). Accumulation of intermittent exercise of at least 10 min is an effective alternative to continuous exercise and may be a particularly useful way to initiate exercise (116).

Type: The primary mode of exercise should be aerobic physical activities that involve the large muscle groups. As part of a balanced exercise program, resistance training and flexibility exercise should be incorporated (see *Chapter 7* on the FITT principle Ex R_x recommendations for resistance training and flexibility).

SPECIAL CONSIDERATIONS

Weight Loss Maintenance

Clear evidence from correctly designed studies is lacking for the amount of physical activity that may be required to prevent weight regain. However, there is literature that suggests it may take more than the consensus public health recommendation for physical activity of 150 min · wk^{-1} or 30 min of physical activity on most days of the week (54,102,250) to prevent weight regain. For these reasons, the following special considerations should be noted:

- Adults with overweight and obesity may benefit from progression to approximately >250 min · wk^{-1} because this magnitude of physical activity may enhance long-term weight loss maintenance (54,115,216,251).
- Adequate amounts of physical activity should be performed on 5–7 d · wk^{-1}.
- The duration of moderate-to-vigorous intensity, physical activity should initially progress to at least 30 min · d^{-1} (102,250) and when appropriate progress to >250 min · wk^{-1} to enhance long-term weight management (54).

- Individuals with overweight and obesity may accumulate this amount of physical activity in multiple daily bouts of at least 10 min in duration or through increases in other forms of moderate intensity lifestyle physical activities. Accumulation of intermittent exercise may increase the volume of physical activity achieved by previously sedentary individuals and may enhance the likelihood of adoption and maintenance of physical activity (145).
- The addition of resistance exercise to energy restriction does not appear to prevent the loss of fat-free mass or the observed reduction in resting EE (55). However, resistance exercise may enhance muscular strength and physical function in individuals with overweight and obesity. Moreover, there may be additional health benefits of participating in resistance exercise such as improvements in CVD and DM risk factors and other chronic disease risk factors (55,243) (see *Chapter 7* for additional information on the FITT principle of Ex R_x recommendations for resistance training).

WEIGHT LOSS PROGRAM RECOMMENDATIONS (115)

- Target a minimal reduction in body weight of at least 5%–10% of initial body weight over 3–6 mo.
- Incorporate opportunities to enhance communication between health care professionals, dietitians, and health/fitness and clinical exercise professionals and individuals with overweight and obesity following the initial weight loss period.
- Target changing eating and exercise behaviors because sustained changes in both behaviors result in significant long-term weight loss.
- Target reducing current energy intake by 500–1,000 kcal · d^{-1} to achieve weight loss. This reduced energy intake should be combined with a reduction in dietary fat to $<$30% of total energy intake.
- Progressively increase to a minimum of 150 min · wk^{-1} of moderate intensity, physical activity to optimize health/fitness benefits for adults with overweight and obesity.
- Progress to greater amounts of physical activity (*i.e.*, $>$250 min · wk^{-1}) to promote long-term weight control.
- Include resistance exercise as a supplement to the combination of aerobic exercise and modest reductions in energy intake to lose weight.
- Incorporate behavioral modification strategies to facilitate the adoption and maintenance of the desired changes in behavior (see *Chapter 11*).

BARIATRIC SURGERY

Surgery for weight loss may be indicated for individuals with a BMI $\geq$40 kg · m^{-2} or those with comorbid risk factors and BMI $\geq$30 kg · m^{-2}. Comprehensive treatment following surgery includes exercise; however, this has not been studied systematically. Exercise will likely facilitate the achievement and maintenance of energy balance postsurgery. A multicenter National Institutes of Health–sponsored trial is underway (*i.e.*, Longitudinal Assessment of Bariatric

Surgery or "LABS") (143). When the results are published, they will provide the most comprehensive findings for exercise and bariatric surgery to date (128). Individuals with severe obesity do not perform a great deal of exercise; and in similar fashion with the general population, the amount of exercise is inversely related to weight (114,128). Likewise, the achievement of a minimum of 150 min $\cdot$ wk^{-1} has been associated with greater postoperative weight loss at 6 and 12 mo (61). Once individuals are cleared for exercise by their physician after surgery, a progressive exercise program should follow the FITT principle of Ex R_x for healthy adults (see *Chapter 7*). Because of the weight placed on joints and probable history of previous low levels of exercise, intermittent exercise or non–weight-bearing exercise may initially contribute to a successful exercise program. Subsequently, continuous exercise and weight-bearing exercise such as walking can make up a greater portion of the exercise program. Because the goal of exercise postbariatric surgery is the prevention of weight regain, the ACSM recommends ≥250 min $\cdot$ wk^{-1} of moderate-to-vigorous intensity exercise (54).

THE BOTTOM LINE

- Weight management relies on the relative contributions of energy intake and expenditure or "energy balance." To achieve weight loss, reduce current energy intake by 500–1,000 kcal $\cdot$ d^{-1}, progressively increase to a minimum of 150 min $\cdot$ wk^{-1} of moderate intensity, physical activity to optimize health/fitness benefits for overweight and obese adults, and progress to greater amounts of exercise (*i.e.*, >250 min $\cdot$ wk^{-1}) of physical activity to promote long-term weight control.

Online Resources

American College of Sports Medicine:
http://www.acsm.org to access the position stand on overweight and obesity

National Heart, Lung, and Blood Institute. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults; The evidence report: National Institutes of Health, 1998:
http://www.nhlbi.nih.gov/guidelines/obesity/ob_home.htm

Physical Activity Guidelines Advisory Committee Report to the Secretary of Health and Human Services, 2008:
http:www.health.gov/PAGuidelines/committeereport.aspx

PARKINSON DISEASE

Parkinson disease (PD) is one of the most common neurodegenerative diseases. More than 1.5 million individuals in the United States are believed to have PD, and 70,000 new cases are diagnosed each year (97). It is estimated 6 million

BOX 10.2 Common Movement Disorders in Individuals with Parkinson Disease (160)

Bradykinesia	Reduced movement speed and amplitude; at the extreme, it is known as *hypokinesia*, which refers to "poverty" of movement
Akinesia	Difficulty initiating movements
Episodes of freezing	Motor blocks/sudden inability to move during the execution of a movement sequence
Impaired balance and postural instability	Difficulty maintaining upright stance with narrow base of support in response to a perturbation to the center of mass or with eyes closed; difficulty maintaining stability in sitting or when transferring from one position to another; can manifest as frequent falling
Dyskinesia	Overreactivity of muscles; wriggling/writhing movements
Tremor	Rhythmic activity alternating in antagonistic muscles, resembling a pill-rolling movement; usually resting tremor
Rigidity	Muscular stiffness throughout the range of passive movement in both extensor and flexor muscle groups in a given limb
Adaptive responses	Reduced activity, muscle weakness, reduced muscle length, contractures, deformity, reduced aerobic capacity

individuals worldwide are currently living with PD (247). *PD* is a chronic, progressive neurological disorder characterized clinically by symptoms consisting of resting tremor, bradykinesia, rigidity, postural instability, and gait abnormalities (see *Box 10.2*). PD is the result of damage to the dopaminergic nigrostriatal pathway, which results in a reduction in the neurotransmitter dopamine. The cause of PD is unknown; however, genetics and the environment are thought to be factors. Aging, autoimmune responses, and mitochondrial dysfunction may also contribute to the disease process (193).

The severity of PD can be classified as (a) *early disease*, characterized by minor symptoms of tremor or stiffness; (b) *moderate disease*, characterized by mild-to-moderate tremor and limited movement; and (c) *advanced disease*, characterized by significant limitations in activity regardless of treatment or medication (193). The progression of symptoms is described more comprehensively by the Hoehn and Yahr scale (108) (see *Table 10. 8*).

The symptoms of PD affect movement, and individuals with moderate and severe PD may have difficulty performing ADL. Resting tremors are often evident but can be suppressed by voluntary activity, sleep, and complete relaxation of axial muscles. Stress and anxiety increase resting tremors. Rigidity makes

TABLE 10.8. The Hoehn and Yahr Staging Scale of Parkinson Disease (108)

Stage 0.0 = No signs of disease	
Stage 1.0 = Unilateral disease	
Stage 2.0 = Bilateral disease, without impairment of balance	
Stage 2.5 = Mild bilateral disease, with recovery on pull test	
Stage 3.0 = Mild-to-moderate bilateral disease; some postural instability; physical independent	
Stage 4.0 = Severe disability; still able to walk or stand unassisted	
Stage 5.0 = Wheelchair bound or bedridden unless aided	

movement difficult and may increase EE. This increases the patient's perception of effort on movement and may be related to feelings of fatigue, especially postexercise fatigue. Bradykinesia and akinesia are characterized by a reduction or inability to initiate and perform purposeful movements. Postural instability or impaired balance is a serious problem in PD that leads to increased episodes of falling and exposes individuals with PD to the serious consequences of falls. Generally, patients with PD demonstrate slowed, short-stepped, shuffling walk with decreased arm swing and forward-stooped posture. Difficulties and slowness in performing turning, getting up, transfer, and ADL are common. Other problems including excessive salivation or drooling, soft, slurred speech, and small handwriting also impact quality of life.

Drug therapy is the primary intervention for the treatment of symptoms related to PD. Levodopa remains the mainstay of treatment for PD and is the single most effective drug available to treat all cardinal features of the disease. Despite its significant benefit, the effectiveness is limited to an average of approximately 10 yr. Long-term use is associated with motor complications including motor fluctuations and dyskinesias in about 50% of patients within 5 yr (185, 237). Other side effects include nausea, sedation, orthostatic hypotension, and psychiatric symptoms (especially hallucinations). Levodopa is now always combined with carbidopa to prevent systemic adverse effects (198). Other adjunctive drug groups are catechol-O-methyltransferase inhibitors, monoamine oxidase B inhibitors (selegiline, rasagiline), amantadine, anticholinergics, and dopamine agonists. These drugs are used as a monotherapy or adjunct therapy to provide symptomatic relief in PD.

Individuals with severe PD may undergo surgical treatment. *Deep brain stimulation* (DBS) is an electrical stimulation of the deep brain nuclei. The internal globus pallidus and subthalamic nucleus are two main stimulation targets in PD. It is the surgical intervention of choice when motor complications are inadequately managed with the medications. The stimulation is adjustable and reversible. Improvement in motor function after either stimulation target is similar (78). DBS is more effective than medical therapy in advanced PD in improving dyskinesia, motor function, and quality of life (266).

Exercise is a crucial adjunct treatment in PD management. Regular exercise will decrease or delay secondary sequelae affecting musculoskeletal and cardiorespiratory systems that occur as a result of reduced physical activity. Because PD is a chronic progressive disease, sustained exercise is necessary to maintain benefits. Evidence demonstrates exercise improves gait performance, quality of life, reduces disease severity, and improves aerobic capacity in individuals with PD (24,106,219). Exercise might also play a neuroprotective role in individuals with PD.

EXERCISE TESTING

Most individuals with PD have impaired mobility and problems with gait, balance, and functional ability, which vary from individual to individual. These impairments are often accompanied by low levels of physical fitness (*e.g.*, CRF, muscular strength and endurance, flexibility). The following are special considerations in performing exercise testing for individuals with PD:

- Tests of balance, gait, general mobility, ROM, flexibility, and muscular strength are recommended before exercise testing is performed. Results of the tests can guide how to safely exercise test the individual with PD.
- Fall history should also be recorded. Patients with PD with more than one fall in the previous year are likely to fall again within the next 3 mo (126).
- Manual muscle testing, arm curl tests, weight machines, dynamometers, and chair rise tests (89) can be used for strength evaluation.
- Flexibility can be measured by using goniometry, the sit-and-reach test, and the back scratch test (202).
- The 6-min walk test can be used to assess CRF (63).
- The Timed Get Up and Go test (146) and chair sit-to-stand test (228) can be used to measure functional mobility. Gait observation can be done during the 10-m walk test at a comfortable walking speed (127,218).
- Balance evaluation and physical limitations of the individual should be used in making decisions regarding testing modes for test validity and safety. Clinical balance tests include the Functional Reach test (57), the Get Up and Go test (146,148,149), tandem stance (180), single limb stance (233), and pull tests (163,180,233). Static and dynamic balance evaluation of sitting and standing should be performed prior to the exercise test for safety.
- Decisions regarding exercise testing protocols may be influenced by the severity of PD (see *Table 10.8*) or physical limitations of the individual. Use of a cycle leg ergometer alone or combined with arm ergometry may be more suitable for individuals with severe gait and balance impairment or with a history of falls (192) because they reduce fear of falling on a treadmill and increase confidence during the test. However, use of leg/arm ergometers may preclude individuals with PD from achieving a maximum cardiorespiratory response because of early muscular fatigue before the maximal cardiorespiratory levels are attained (267). Treadmill protocols can be used safely in individuals with a mild stage of PD (Hoehn and Yahr [HY] stage 1–2) (267). Submaximal tests may be most appropriate in advanced cases (HY stage ≥3) or with severe mobility impairment.
- Individuals with very advanced PD (HY stage ≥4) and those unable to perform a GXT for various reasons, such as inability to stand without falling,

severe stooped posture, and deconditioning, may require a radionuclide stress test or stress echocardiography.

- For an individual who is deconditioned, demonstrates lower extremity weakness, or has a history of falling, care and precautions should be taken, especially at the final stages of the treadmill protocol when fatigue occurs and the individual's walking may deteriorate. A gait belt should be worn and an individual should stand by close to the subject to guard during the treadmill test.
- Use of symptom-limited exercise testing is strongly recommended. Symptoms include fatigue, shortness of breath, abnormal BP responses, and deteriorations in general appearance. Monitoring physical exertion levels during testing by using a scale such as the Borg perceived exertion scale (26) is recommended.
- Individuals with PD may experience orthostatic hypotension because of the severity of PD and medications (234). Antiparkinsonian medication intake should be noted prior to performing the exercise test. Different medications have different adverse effects (see *Table 10.9*).
- Issues to consider when conducting a GXT in individuals with PD include conducting the test during peak medication effect when an individual has optimal mobility, providing practice walking on a treadmill prior to testing, and using the modified Bruce protocol (see *Chapter 5*). These factors allow individuals with PD the opportunity to achieve maximal exercise (267). Although the Bruce protocol is the most commonly used protocol for exercise testing on a treadmill (122), it is an aggressive protocol that may be too strenuous for individuals with PD (267).

TABLE 10.9. Antiparkinsonian Medications (118,198,234)

Drug	Adverse Effects
Levodopa	Nausea, hypotension, and diaphoresis
Rasagiline	Weight loss, vomiting, anorexia, balance difficulty
Oral selegiline	Nausea, dizziness, sleep disorder, impaired cognition, orthostatic hypotension
Selegiline	Dizziness, dyskinesias, hallucinations, headache, dyspepsia
Bromocriptine	Nausea, hypotension, hallucinations, psychosis, peripheral edema, pulmonary fibrosis, sudden onset of sleep
Pergolide	Nausea, hypotension, hallucinations, psychosis, peripheral edema, pulmonary fibrosis, sudden onset of sleep, restrictive valvular heart disease
Cabergoline	Nausea, hypotension, hallucinations, psychosis, peripheral edema, pulmonary fibrosis, sudden onset of sleep, dyskinesia
Lisuride	Nausea, headaches, tiredness, dizziness, drowsiness, sweating, dry mouth, vomiting, sudden decreases in blood pressure (BP), nightmares, hallucinations, paranoid reactions, states of confusion, weight gain, sleep disorders
Pramipexole	Nausea, hypotension, hallucinations, psychosis, peripheral edema, sudden onset of sleep
Ropinirole	Nausea, hypotension, hallucinations, psychosis, peripheral edema, sudden onset of sleep
Tolcapone	Diarrhea, dyskinesia, liver toxicity (monitoring required)
Entacapone	Exacerbation of levodopa side effects, diarrhea, discolored urine
Amantadine	Cognitive dysfunction, hallucinations, peripheral edema, skin rash, anticholinergic effects

- For individuals with DBS, the signal from the DBS pulse generator interferes with the ECG recording. It is possible to perform the test when the DBS is deactivated; however, without the stimulation, the patient will be at a compromised mobile state and will not be able to achieve maximal tolerance. Potential risks when the DBS is deactivated are physical discomfort, tremor, cramping, and emotional symptoms (*e.g.*, nervousness, anxiety, pain). Clinicians should consult with a neurologist prior to performing the exercise test in these patients. Deactivation of the DBS should be done by a trained clinician or neurologist. HR monitoring can be used when DBS is not activated. RPE should be used to monitor during exercise testing.
- In addition to the aforementioned concerns, standard procedures, contraindications to exercise testing, recommended monitoring intervals, and standard termination criteria are used to exercise test individuals with PD (see *Chapter 5*).

EXERCISE PRESCRIPTION

Individualized programming should be used when prescribing exercise for individuals with PD. The main goal of exercise is to delay disability, prevent secondary complications, and improve quality of life as PD progresses. The FITT principle of Ex R_x should address flexibility, CRF, muscle strength, functional training, and motor control. Because PD is a chronic and progressive disorder, an exercise program should be prescribed early when the individual is first diagnosed and continued on a regular, long-term basis. The Ex R_x should be reviewed and revised as PD progresses because different physical problems occur at different stages of the disease.

Four key health outcomes of an exercise program designed for individuals with PD are improved (a) gait; (b) transfers; (c) balance; and (d) joint mobility and muscle power to improve functional capacity (126). However, it is important to note the FITT principle of Ex R_x recommendations for individuals with PD are based on a very limited literature.

FITT RECOMMENDATIONS FOR INDIVIDUALS WITH PARKINSON DISEASE

Aerobic Exercise

The FITT principle of Ex R_x for healthy adults generally applies to those with PD (207); however, the limitations imposed by the disease process should be assessed and the Ex R_x should be tailored accordingly.

Frequency: 3 d · wk^{-1}.

Intensity: 40%–$<$60% $\dot{V}O_2R$ or HRR or RPE of 11–13 on a scale of 6–20 (27).

Time: 30 min of continuous or accumulated exercise.

Type: Aerobic activities such as walking, cycling, swimming, or dancing. Dance provides cardiorespiratory and neuromotor exercise. Tango dancing and waltz/foxtrot improves endurance in PD more than tai chi or no exercise (95). However, the selection of the exercise type is dependent on the individual's clinical presentation of PD severity. A stationary bicycle, recumbent bicycle, or arm ergometer are safer modes for individuals with more advanced PD.

Resistance Exercise

It is important to note that the FITT principle of Ex R_x recommendations for resistance training in individuals with PD are based on a very limited literature. In general, resistance training increases strength in individuals with PD, but the majority of interventions has been conservative (64). After a resistance training program, strength improvements are similar in individuals with PD compared to neurologically normal controls (217). Therefore, recommendations for resistance exercise in neurologically healthy, older adults may be applied to individuals with PD (217).

Frequency: 2–3 $d \cdot wk^{-1}$.

Intensity: 40%–50% of 1-RM for individuals with PD beginning to improve strength; 60%–70% 1-RM for more advanced exercisers.

Time: ≥1 set of 8–12 repetitions; 10–15 repetitions in adults with PD starting an exercise program.

Type: Emphasize extensor muscles of the trunk and hip to prevent faulty posture, and on all major muscles of lower extremities to maintain mobility.

Flexibility Exercise

Frequency: 1–7 $d \cdot wk^{-1}$.

Intensity: Full extension, flexion, rotation, or stretch to the point of slight discomfort.

Time: Perform flexibility exercises for each major muscle–tendon unit. Hold stretches for 10–30 s.

Type: Slow static stretches for all major muscle groups should be performed. Flexibility and ROM exercises should be emphasized for the upper extremities and trunk as well as all major joints in all severity stages of the disease (192). Spinal mobility and axial rotation exercises are recommended for all severity stages (218). Neck flexibility exercises should be emphasized as neck rigidity is correlated with posture, gait, balance, and functional mobility (84).

RECOMMENDATIONS FOR NEUROMOTOR EXERCISE FOR INDIVIDUALS WITH PARKINSON DISEASE

Balance impairment and falls are major problems in individuals with PD. Balance training is a crucial exercise in all individuals with PD. A recent systemic review reported physical activity and exercise improved postural instability and balance performance in individuals with mild-to-moderate PD (51). Static, dynamic, and balance training during functional activities should be included. Clinicians should take steps to ensure the individual's safety (*e.g.*, using a gait belt and nearby rails or parallel bars and removing clutter on the floor) when using physical activities that challenge balance. Training programs may include a variety of challenging physical activities (*e.g.*, stepping in all directions, step up and down, reaching forward and sideways, obstacles, turning around, walking with suitable step length, standing up and sitting down) (131,160). Tai chi, tango, and waltz are other forms of exercise to improve balance in PD (58,94).

SPECIAL CONSIDERATIONS

- Incorporate functional exercises such as the sit-to-stand, step-ups, turning over, and getting out of bed as tolerated to improve neuromotor control, balance, and maintenance of ADL.
- Individuals with PD also suffer from autonomic nervous system dysfunction including cardiovascular dysfunction, especially in advanced stages. Orthostatic hypotension, cardiac arrhythmias, sweating disturbances, HR, and BP should be observed carefully during exercise.
- Some medications used to treat PD further impair autonomic nervous system functions (93) (see *Table 10.9*). Levodopa/carbidopa may produce exercise bradycardia and transient peak dose tachycardia and dyskinesia. Caution should be used in testing and training an individual who has had a recent change in medications because the response may be unpredictable (194). Several nonmotor symptoms may burden exercise performance (34,188) (see *Box 10.3*).
- The outcome of exercise training varies significantly among individuals with PD because of the complexity and progressive nature of the disease (193).
- Cognitive decline and dementia are common nonmotor symptoms in PD and burden the training and progression (234).
- Incorporate and emphasize fall prevention/reduction and education into the exercise program. Instruction on how to break falls should be given and practiced to prevent serious injuries. Most falls in PD occur during multiple tasks or long and complex movement (159,161).
- Avoid using dual tasking or multitasking with novice exercisers. Individuals with PD have difficulty in paying full attention to all tasks. One activ-

BOX 10.3 Nonmotor Symptoms in Parkinson Disease (34,189)

Domains	Symptoms
Cardiovascular	Symptomatic orthostasis; fainting; light-headedness
Sleep/fatigue	Sleep disorders; excessive daytime sleepiness; insomnia; fatigue; lack of energy; restless legs
Mood/cognition	Apathy; depression; loss of motivation; loss of interest; anxiety syndromes and panic attacks; cognitive decline
Perceptual problems/ hallucinations	Hallucinations; delusion; double vision
Attention/memory	Difficulty in concentration; forgetfulness; memory loss
Gastrointestinal	Drooling; swallowing; choking; constipation
Urinary	Incontinence; excessive urination at night; increased frequency of urination
Sexual function	Altered interest in sex; problems having sex
Miscellaneous	Pain; loss of smell/taste and appetite/weight; excessive sweating; fluctuating response to medication

ity should be completed before commencing of the next activity (127). Multitasking may better prepare an individual with PD for responding to a balance perturbation (231) and can be incorporated into training when they perform well in a single task.

- Although no reports exist suggesting resistive exercise may exacerbate symptoms of PD, considerable attention must be paid to the development and management of fatigue (88).

THE BOTTOM LINE

- The symptoms of PD include resting tremors, slow movement, rigidity, postural instability, and gait abnormalities. Prior to conducting an exercise test, balance, gait, mobility, ROM, muscular strength, and fall history should be assessed to guide the selection of the testing protocol. Limited research has been conducted regarding the most effective Ex R_x for individuals with PD. In general, the FITT principle of Ex R_x for healthy adults applies to those with PD but may require tailoring because of limitations imposed by the disease process. Balance training should be emphasized in all individuals with PD.

Online Resources

American Parkinson Disease Association:
http://www.apdaparkinson.org/userND/index.asp

Davis Phinney Foundation:
http://www.davisphinneyfoundation.org/site/c.mvKWLaMOIqG/b.5109589/k.BFE6/Home.htm

Michael J. Fox Foundation for Parkinson's Research:
http://www.michaeljfox.org

National Institute of Neurological Disorders and Stroke:
http://www.ninds.nih.gov/parkinsons_disease/parkinsons_disease.htm

National Parkinson Foundation:
http://www.parkinson.org/

WE MOVE:
http://www.wemove.org/

PULMONARY DISEASES

Chronic pulmonary diseases are significant causes of morbidity and mortality. Individuals with these diseases are increasingly referred to pulmonary rehabilitation of which exercise is the cornerstone. The majority of the research supporting exercise as an adjunct treatment for patients with chronic respiratory disease has been done in individuals with chronic obstructive pulmonary disease (COPD). However, evidence is now accumulating that shows exercise is of benefit to those with other respiratory diseases. A list of respiratory diseases in which exercise is of potential benefit is shown in *Box 10.4*.

ASTHMA

Asthma is a chronic inflammatory disorder of the airways that is characterized by episodes of bronchial hyperresponsiveness, airflow obstruction, and recurring wheeze, dyspnea, chest tightness, and coughing that occur particularly at night or early morning and are variable and often reversible (90). Asthma symptoms can be provoked or worsened by exercise, which may contribute to reduced participation in sports and physical activity and ultimately to deconditioning and lower CRF. With deconditioning, the downward cycle continues with asthma symptoms being triggered by less intense physical activity and subsequent worsening of exercise tolerance.

Although pharmacologic treatment should prevent exercise-induced bronchoconstriction and associated symptoms, individuals with moderate-to-severe persistent asthma may be referred to pulmonary rehabilitation programs to improve exercise tolerance. Systematic review (195) of exercise training studies indicates the primary exercise-related benefits are increased CRF, work capacity, and decreased exertional dyspnea with little or no effect on resting pulmonary

BOX 10.4 Patients with Pulmonary Disease Benefitting from Pulmonary Rehabilitation and Exercise

- Chronic obstructive pulmonary disease (COPD) — a mostly irreversible airflow limitation consisting of
  - Bronchitis — a chronic productive cough for 3 mo in each of two successive years in a patient in whom other causes of productive chronic cough have been excluded.
  - Emphysema — the presence of permanent enlargement of the airspaces distal to the terminal bronchioles, accompanied by destruction of their walls and without obvious fibrosis.
- Asthma — airway obstruction because of inflammation and bronchospasm that is mostly reversible.
- Cystic fibrosis — a genetic disease causing excessive, thick mucus that obstructs the airways (and other ducts) and promotes recurrent and ultimately chronic respiratory infection.
- Bronchiectasis — abnormal chronic enlargement of the airways with impaired mucus clearance.
- Pulmonary fibrosis — scarring and thickening of the parenchyma of the lungs.
- Lung cancer — one of the deadliest cancers with cigarette smoking being a common etiology.

function. Several recent randomized controlled trials suggest exercise training may also reduce airway inflammation, severity of asthma, number of days with symptoms, number of visits to the emergency department, and symptoms of anxiety and depression, and also improve health-related quality of life (65,153,154,246,264).

EXERCISE TESTING

- Assessment of physiologic function should include cardiopulmonary capacity, pulmonary function (preexercise and postexercise), and oxyhemoglobin saturation via noninvasive methods.
- The mode of exercise testing is typically a motor-driven treadmill or an electronically braked cycle leg ergometer.
- Age-appropriate (*i.e.*, child, adult, and older adult) standard progressive maximal testing protocols may be used (see *Chapter 5*).
- Administration of an inhaled bronchodilator (*i.e.*, β_2-agonists) (see *Appendix A*) prior to testing may be indicated to prevent exercise-induced bronchoconstriction, thus providing optimal assessment of cardiopulmonary capacity.
- Assessment of exercise-induced bronchoconstriction should be assessed via vigorous intensity exercise (*i.e.*, 80% of predicted HR_{max} or 40%–60% of measured or estimated maximal voluntary ventilation) lasting 4–6 min on a motor-driven treadmill or an electronically braked cycle leg ergometer

and may be facilitated by inhalation of cold, dry air. The testing should be accompanied by spirometry performed prior to and 5, 10, 15, and 20 min following the exercise challenge (13,43). Use of age-predicted HR_{max} for setting exercise intensity or for estimation of $\dot{V}O_{2peak}$ may not be appropriate because of possible ventilatory limitation to exercise.

- Evidence of oxyhemoglobin desaturation ≤80% should be used as test termination criteria in addition to standard criteria (13).
- Measurement of exertional dyspnea may also be useful by adapting the Borg CR10 Scale to determine dyspnea versus its intended purpose (see *Figure 9.1*) (171). Patients and clients should be instructed to relate the wording on the scale to their level of breathlessness. Patients and clients should be informed that 0 or nothing at all corresponds to no discomfort with your breathing, whereas 10 or maximal corresponds to the most severe discomfort with your breathing that you have ever experienced or could imagine experiencing.
- 6-min walk testing may be used in individuals with moderate-to-severe persistent asthma when other testing equipment is not available (16).

EXERCISE PRESCRIPTION

The following Ex R_x for aerobic exercise is suitable for all levels of disease severity (mild-to-severe persistent) (195).

FITT RECOMMENDATIONS FOR INDIVIDUALS WITH ASTHMA

FITT

Aerobic Exercise

Frequency: At least 2–3 d · wk^{-1} (65,153,154,195).

Intensity: Approximately at the ventilatory anaerobic threshold or at least 60% $\dot{V}O_{2peak}$ determined from progressive exercise testing with measurement of expired gases (153,195) or 80% of maximal walking speed determined from the 6-min walk test (246).

Time: At least 20–30 min · d^{-1} (65,153,195,246).

Type: Aerobic activities using large muscle groups such as walking, running, or cycling. Swimming (preferably in a nonchlorinated pool) is less asthmogenic, and therefore a better tolerated form of exercise.

Progression: After the first month, if the Ex R_x is well tolerated, greater health/fitness benefits may be gained by increasing the intensity to approximately 70% $\dot{V}O_{2peak}$, the time of each exercise session to 40 min · d^{-1}, and frequency to 5 d · wk^{-1}.

Resistance Exercise

The Ex R_x for resistance training and flexibility should follow the same FITT principles of Ex R_x for healthy adults (see *Chapter 7*).

SPECIAL CONSIDERATIONS

- Individuals experiencing exacerbations of their asthma should not exercise until symptoms and airway function have improved.
- Use of short-acting bronchodilators may be necessary before or after exercise to prevent or treat exercise-induced bronchoconstriction (see *Appendix A*).
- Individuals on prolonged treatment with oral corticosteroids may experience peripheral muscle wasting and may benefit from strength training as presented in *Chapter 7*.
- Exercise in cold environments or those with airborne allergens or pollutants should be limited to avoid triggering bronchoconstriction in susceptible individuals. Exercise-induced bronchoconstriction can also be triggered by prolonged exercise durations or high intensity exercise sessions.
- There is insufficient evidence supporting individuals with asthma have clinical benefit from inspiratory muscle training in individuals with asthma (196).

CHRONIC OBSTRUCTIVE PULMONARY DISEASE

COPD is defined by the Global Initiative for Chronic Obstructive Lung Disease (GOLD) program as a preventable and treatable disease with some significant extrapulmonary effects that are characterized by an airflow limitation that is not fully reversible (see *Box 10.4*) (91). COPD consists of chronic bronchitis and/or emphysema, and patients may be staged into one of four disease severities based on the results of pulmonary function tests (see *Table 10.10*). Dyspnea or shortness of breath with exertion is a cardinal symptom of COPD resulting in physical activity limitations. Consequently, deconditioning occurs causing COPD patients to experience dyspnea at even lower levels of physical exertion further limiting their activity. This adverse downward spiral can lead to eventual functional impairment and disability. Exercise is an effective and potent intervention that lessens the development of functional impairment and disability in all patients with COPD regardless of disease severity (171,201). The beneficial effects of exercise occur mainly through adaptations in the musculoskeletal and cardiovascular systems that in turn reduce stress on the pulmonary system during exercise (232).

TABLE 10.10. Global Initiative for Chronic Obstructive Lung Disease (GOLD) Classification of Disease Severity in Patients with Chronic Obstructive Pulmonary Disease Based on the $FEV_{1.0}$ Obtained from Pulmonary Function Tests (91)

Disease Severity	Postbronchodilator FEV_1/FVC	Postbronchodilator FEV_1%
Mild	<0.70	$FEV_{1.0}$ ≥80% of predicted
Moderate	<0.70	50% ≤ $FEV_{1.0}$ <80% of predicted
Severe	<0.70	30% ≤ $FEV_{1.0}$ <50% of predicted
Very severe	<0.70	$FEV_{1.0}$ <30% of predicted or $FEV_{1.0}$ <50% of predicted with respiratory failure

$FEV_{1.0}$, forced expiratory volume in 1 s; FVC, forced vital capacity.

EXERCISE TESTING

- Assessment of physiologic function should include CRF, pulmonary function, and determination of arterial blood gases or arterial oxyhemoglobin saturation (SaO_2) via direct or indirect methods.
- Perceptions of dyspnea should be measured during exercise testing using the Borg CR10 Scale (see *Figure 9.1*).
- Modifications of traditional protocols (*e.g.*, smaller increments, slower progression) may be warranted depending on functional limitations and the early onset of dyspnea. Additionally, it is now recommended the duration of the GXT be between 5 and 9 min in patients with severe and very severe disease (22).
- The measurement of flow volume loops using commercially available instruments may help identify individuals with dynamic hyperinflation and increased dyspnea because of expiratory airflow limitations. Use of bronchodilator therapy may be beneficial for such individuals (172).
- Submaximal exercise testing may be used depending on the reason for the test and the clinical status of the patient. However, it should be noted individuals with pulmonary disease may have ventilatory limitations to exercise; thus, prediction of $\dot{V}O_{2peak}$ based on age-predicted HR_{max} may not be appropriate. In recent years, the 6-min walk test has become popular for assessing functional exercise capacity in individuals with more severe pulmonary disease and in settings that lack exercise testing equipment (16).
- In addition to standard termination criteria, exercise testing may be terminated because of severe arterial oxyhemoglobin desaturation (*i.e.*, $SaO_2 \leq 80\%$) (13).
- The exercise testing mode is typically walking or stationary cycling. Walking protocols may be more suitable for individuals with severe disease who may lack the muscle strength to overcome the increasing resistance of cycle leg ergometers. Furthermore, if arm ergometry is used, upper extremity aerobic exercise may result in increased dyspnea that may limit the intensity and duration of the activity.

EXERCISE PRESCRIPTION

Because individuals with COPD are typically older adults, the FITT principle of Ex R_x presented in *Chapter 8* for older adults generally applies. For detailed guidelines for the FITT principle of Ex R_x for individuals with COPD, see the following resources (171,201,232).

FITT RECOMMENDATIONS FOR INDIVIDUALS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE

FITT

Aerobic Exercise

Frequency: At least 3–5 d · wk^{-1}.

Intensity: For patients with COPD, vigorous (60%–80% of peak work rates) and light (30%–<40% of peak work rates) intensities have been recommended (171,201). Light intensity training results in improvements in symptoms, health-related quality of life, and performance of ADL, whereas vigorous intensity training has been shown to result in greater physiologic improvements (*e.g.*, reduced minute ventilation and HR at a given workload). Because of these greater physiologic improvements, high intensity training can be encouraged if tolerated. However, it should be recognized that some patients may not be able to exercise at these intensities, and light intensity exercise is recommended for such patients. Intensity may be based on a dyspnea rating of between 4 and 6 on the Borg CR10 Scale (see *Figure 9.1*) (171).

Time: Individuals with moderate or severe COPD may be able to exercise only at a specified intensity for a few minutes at the start of the training program. Intermittent exercise may also be used for the initial training sessions until the individual tolerates exercise at sustained higher intensities and durations of activity. Shorter periods of vigorous intensity exercise separated by periods of rest (*i.e.*, interval training) have been used with those with COPD and shown to result in lower symptom scores despite high training work rates (261).

Type: Walking and/or cycling.

Resistance and Flexibility Exercise

Resistance and flexibility training should be encouraged for individuals with COPD. The Ex R_x for resistance and flexibility training with pulmonary patients should follow the same FITT principle of Ex R_x for healthy adults and/or older adults (see *Chapters 7* and *8*).

SPECIAL CONSIDERATIONS

- Pulmonary diseases and their treatments not only affect the lungs but skeletal muscles as well (232). Resistance training of skeletal muscle should be an integral part of Ex R_x for individuals with COPD. The Ex R_x for resistance training with pulmonary patients should follow the same FITT principle of Ex R_x for healthy adults and older adults (see *Chapters 7* and *8*, respectively).
- Because individuals with COPD may experience greater dyspnea while performing ADL involving the upper extremities, it may be beneficial for these individuals to focus on the muscles of the shoulder girdle when performing resistance exercises.
- Inspiratory muscle weakness is a contributor to exercise intolerance and dyspnea in those with COPD. In patients receiving optimal medical therapy who still present with inspiratory muscle weakness and breathlessness, inspiratory muscle training is recommended. Training of the inspiratory muscles

increases respiratory muscle strength and endurance and may lead to improvements in exercise tolerance (171,201).

- The guidelines for *inspiratory muscle training* are the following:
  - **Frequency:** A minimum of 4–5 d · wk^{-1}.
  - **Intensity:** 30% of maximal inspiratory pressure measured at functional residual capacity.
  - **Time:** 30 min · d^{-1} or two 15 min sessions · d^{-1}.
  - **Type:** Three types of inspiratory muscle training have been used in patients with COPD. These are inspiratory resistive training, threshold loading, and normocapnic hyperpnea. There are no data to suggest that one method is superior to the other (171).
- Regardless of the prescribed exercise intensity, the health/fitness, clinical exercise, or health care professional should closely monitor initial exercise sessions and adjust intensity and duration according to individual responses and tolerance. In many cases, the presence of symptoms, particularly dyspnea/breathlessness, supersedes objective methods of Ex R_x.
- The traditional method for monitoring the exercise intensity is HR as discussed in *Chapter 7*. As previously mentioned, an alternative approach to HR is using the dyspnea rating obtained from a GXT test as a "target" intensity for exercise training (111). Most patients with COPD accurately and reliably produce a dyspnea rating obtained from an incremental exercise test as a target to regulate/monitor exercise intensity. A dyspnea rating between 4 and 6 on a scale of 0–10 is the recommended exercise intensity (see *Figure 9.1*) (171).
- Unlike most healthy individuals and individuals with CVD, patients with moderate-to-severe COPD may exhibit oxyhemoglobin desaturation with exercise. Therefore, a measure of blood oxygenation, either the partial pressure of arterial oxygen (P_aO_2) or $\%SaO_2$, should be made during the initial GXT. In addition, oximetry is recommended for the initial exercise training sessions to evaluate possible exercise-induced oxyhemoglobin desaturation and to identify the workload at which desaturation occurred.
- Based on the recommendations of the Nocturnal Oxygen Therapy Trial (40), supplemental oxygen (O_2) is indicated for patients with a $P_aO_2 \leq 55$ mm Hg or a $\%SaO_2 \leq 88\%$ while breathing room air. These same guidelines apply when considering supplemental oxygen during exercise. Additionally, there is evidence to suggest the administration of supplemental O_2 to those who do not experience exercise-induced hypoxemia may lead to greater gains in exercise endurance (201).
- In selected patients with severe COPD, using noninvasive positive pressure ventilation as an adjunct to exercise training produces modest gains in exercise performance. Because of the difficulty administering such an intervention, it is only recommended in those patients with advanced disease (171,201).
- Individuals suffering from acute exacerbations of their pulmonary disease should limit exercise until symptoms have subsided.

THE BOTTOM LINE

- Exercise training is beneficial for improving CRF and exercise tolerance in individuals with asthma, and growing evidence suggests training may reduce inflammation and disease severity and improve health-related quality of life. COPD is a treatable disease characterized by nonreversible airflow limitation. In addition to its damage to the lungs, the disease has significant extrapulmonary effects. These extrapulmonary effects should be considered when using exercise as a treatment for COPD.

Online Resources

American Lung Association:
http://www.lungusa.org/lung-disease/copd/

Expert Panel Report 3 (EPR3) American Thoracic Society (41):
http://www.thoracic.org/clinical/copd-guidelines/index.php

EPR3: Guidelines for the Diagnosis and Management of Asthma (62):
http://www.nhlbi.nih.gov/guidelines/asthma/asthgdln.htm

Global Initiative for Asthma:
http://www.ginasthma.org

Global Initiative for Chronic Obstructive Lung Disease:
http://www.goldcopd.com/guidelinesresources.asp?l1=2&l2=0

SPINAL CORD INJURY

Spinal cord injury (SCI) results in a complete or incomplete loss of somatic, sensory, and autonomic functions below the lesion level. Lesions in the cervical (C) region typically result in tetraplegia, whereas lesions in the thoracic (T), lumbar (L), and sacral (S) regions lead to paraplegia. Approximately 50% of those with SCI have tetraplegia, and 80% are men (235). SCI of traumatic origin often occurs at an early age. Individuals with SCI have a high risk for the development of secondary complications (*e.g.*, shoulder pain, urinary tract infections, skin pressure ulcers, osteopenia, chronic pain, problematic spasticity, depression, CVD, obesity, Type 2 DM). Proper exercise and physical activity reduce the prevalence of secondary complications and improve the quality of life for individuals with SCI.

The SCI level has a direct impact on physical function and metabolic and cardiorespiratory responses to exercise. It is crucial to take into account the SCI lesion level when exercise testing and prescribing exercise for those with SCI. Those with complete SCI lesions from:

- L2–S2 lack voluntary control of the bladder, bowels, and sexual function; however, the upper extremities and trunk usually have normal function.

- T6–L2 have respiratory and motor control that depends on the functional capacity of the abdominal muscles (*i.e.*, minimal control at T6 to maximal control at L2).
- T1–T6 can experience autonomic dysreflexia (*i.e.*, an uncoordinated, spinally mediated reflex response called the *mass reflex*), poor thermoregulation, and orthostatic hypotension. In instances in which there is no sympathetic innervation to the heart, HR_{peak} is limited to ~115–130 beats · min^{-1}. Breathing capacity is further diminished by intercostal muscle paralysis; however, arm function is normal.
- C5–C8 are tetraplegic. Those with C8 lesions have voluntary control of the shoulder, elbow, and wrist but decreased hand function; whereas those with C5 lesions rely on the biceps brachii and shoulder muscles for self-care and mobility.
- C4 require artificial support for breathing.

EXERCISE TESTING

When exercise testing individuals with SCI, consider the following issues.

- Initially, a functional assessment should be taken including trunk ROM, wheelchair mobility, transfer ability, and upper and lower extremity involvement. This assessment will facilitate the choice of exercise testing equipment, protocols, and adaptations.
- Consider the purposes of the exercise test, the level of SCI, and the physical fitness level of the participant to optimize equipment and protocol selection.
- Voluntary arm ergometry is the easiest to perform and is norm referenced for the assessment of CRF (96). This form of exercise testing, however, is not wheelchair propulsion sport specific, and the equipment may not be accurate in the lower work rate ranges needed for quadriplegics (*i.e.*, 0–25 W).
- If available, a stationary wheelchair roller system and motor-driven treadmill should be used with the participant's properly adjusted wheelchair. Motor-driven treadmill protocols allow for realistic simulation of external conditions such as slope and speed alterations (257).
- Incremental exercise tests for the assessment of CRF in the laboratory should begin at 0 W with incremental increases of 5–10 W per stage among tetraplegics. Depending on function and fitness, individuals with paraplegia can begin at 20–40 W with incremental increases of 10–25 W per stage.
- For sport-specific indoor CRF assessments in the field, an incremental test adapted from the Léger and Boucher shuttle test around a predetermined rectangular court is recommended. Floor surface characteristics and wheelchair user interface should be standardized (138,257).
- After maximal effort exercise in individuals with tetraplegia, it may be necessary to treat postexercise hypotension and exhaustion with rest, recumbency, leg elevation, and fluid ingestion.
- There are no special considerations for the assessment of muscular strength regarding the exercise testing mode beyond those for the general population

with the exception of the lesion level, which will determine residual motor function, need for stabilization, and accessibility of testing equipment.
- Individuals with SCI requiring a wheelchair for mobility may develop joint contractures because of muscle spasticity and their position in the wheelchair (*i.e.*, tight hip flexors, hip adductors, and knee flexors) and excessive wheelchair pushing and manual transfers (*i.e.*, anterior chest and shoulder). Therefore, intensive sport-specific training must be complemented with an upper extremity stretching (*e.g.*, the prime movers) and strengthening (*e.g.*, the antagonists) program to promote muscular balance around the joints.

EXERCISE PRESCRIPTION/SPECIAL CONSIDERATIONS

The FITT principle of Ex R_x recommendations for the general population should be applied (see *Chapter 7*) (88,102). For this reason and because of the impact of SCI on neuromotor, cardiorespiratory, and metabolic function, the following FITT principle of Ex R_x recommendations and special considerations are combined in this section:

- Participants should empty their bowels and bladder or urinary bag before exercising because autonomic dysreflexia can be triggered by a full bladder or bowel distension.
- Skin pressure sores should be avoided at all times and potential risk areas should be checked on a regular basis.
- Decreased cardiovascular performance may be found in individuals with complete SCIs above T6, particularly among those with complete tetraplegia who have no cardiac sympathetic innervation with HR_{peak} limited to ~115–130 beats · min^{-1}. Individuals with high spinal lesions may reach their peak HR, cardiac output ($\dot{Q}$), and $\dot{V}O_2$ at lower exercise levels than those with paraplegia with lesion levels below T5 to T6 (110).
- During exercise, autonomic dysreflexia results in an increased release of catecholamines that increases HR, $\dot{V}O_2$, BP, and exercise capacity (220). BP may be elevated to excessively high levels (*i.e.*, SBP 250–300 mm Hg and/or DBP 200–220 mm Hg). In these situations, immediate emergency responses is needed (*i.e.*, stopping exercise, sitting upright to decrease BP, and identifying and removing the irritating stimulus such as a catheter, leg bag, tight clothing, or braces). If the symptoms (*i.e.*, headache, piloerection, flushing, gooseflesh, shivering, sweating above the lesion level, nasal congestion, and bradycardia) persist, medical attention should be sought. In competition, athletes with a resting SBP $\geq$180 mm Hg should not be allowed to start the event.
- Novice unfit but healthy participants with SCI will probably experience muscular fatigue before achieving substantial central cardiovascular stimulus. Initially, the exercise sessions should consist of short bouts of 5–10 min of moderate intensity (*i.e.*, 40%–<60% $\dot{V}O_2R$) alternated with active recovery periods of 5 min.

As a starting point and on the basis of proven efficacy and specificity to daily activity patterns, Rimaud et al. (203) has recommended interval wheelchair ergometry training at ≥70% HR_{peak} for 30 min · $session^{-1}$, 3 sessions · wk^{-1}.

- Individuals with tetraplegia who have a very small active musculature will also experience muscular fatigue before exhausting central cardiorespiratory capacity. Aerobic exercise programs should start with 5–10 min bouts of moderate intensity (*i.e.*, 40%–<60% $\dot{V}O_2R$), alternated with 5 min active recovery periods. As exercise tolerance improves, training can progress to 10–20 min bouts of vigorous intensity (*i.e.*, ≥60 $\dot{V}O_2R$) alternated with 5 min active recovery periods.
- Individuals with higher SCI levels, especially those with tetraplegia, may benefit from use of lower body positive pressure by applying compressive stockings, an elastic abdominal binder, or electrical stimulation to leg muscles. Beneficial hemodynamic effects may include maintenance of BP, lower HR, and higher stroke volume during arm work to compensate for blood pooling below the lesion. Electrical stimulation of paralyzed lower limb muscles can increase venous return and $\dot{Q}$. These responses usually occur only in individuals with spastic paralysis above T12 who have substantial sensory loss and respond to the stimulation with sustainable static or dynamic contractions.
- Muscular strength training sessions from a seated position in the wheelchair should be complemented with nonwheelchair exercise bouts to involve all trunk stabilizing muscles. However, transfers (*e.g.*, from wheelchair to the exercise apparatus) should be limited because they result in a significant hemodynamic load and increase the glenohumeral contact forces, and the risk of repetitive strain injuries such as shoulder impingement syndrome and rotator cuff strain/tear, especially in individuals with tetraplegia (256). Special attention should be given to shoulder muscle imbalance and the prevention of repetitive strain injuries. The prime movers of wheelchair propulsion should be lengthened (*i.e.*, muscles of the anterior shoulder and chest) and antagonists should be strengthened (*i.e.*, muscles of the posterior shoulder, scapula, and upper back [74]).
- *Tenodesis* (*i.e.*, active wrist extensor driven finger flexion) allows functional grasp in individuals with tetraplegia who do not have use of the hand muscles. To retain the tenodesis effect, these individuals should never stretch the finger flexor muscles (*i.e.*, maximal and simultaneous extension of wrist and fingers).
- Individuals with SCI tend to endure higher core temperatures during endurance exercise than their able-bodied counterparts. Despite this enhanced thermoregulatory drive, they generally have lower sweat rates. The following factors reduce heat tolerance and should be avoided: lack of acclimatization, dehydration, glycogen depletion, sleep loss, alcohol, and infectious disease. During training and competition, the use of light clothing, ice vests, protective sunscreen cream, and mist spray are recommended (7,9).

THE BOTTOM LINE

- Proper exercise and physical activity reduce the prevalence of secondary complications associated with SCI and improve quality of life. The level of the SCI lesion must be taken into account for exercise testing and the FITT principle of Ex R_x. Individuals with SCI have compromised thermoregulatory responses to exercise so caution must be taken, especially during endurance exercise.

Online Resources

National Spinal Cord Injury Association:
http://www.spinalcord.org

INDIVIDUALS WITH MULTIPLE CHRONIC DISEASES AND HEALTH CONDITIONS

The aging and increasing prevalence of overweight and obesity in the population make it increasingly likely health/fitness, clinical exercise, and health care professionals will be designing Ex R_x for clients and patients with multiple chronic diseases and health conditions. The focus of the *Guidelines* has traditionally been on Ex R_x for healthy and special populations with one chronic disease or health condition. This final section of this chapter presents guidelines for prescribing exercise for individuals with multiple comorbidities.

PREPARTICIPATION HEALTH SCREENING

Exercise training is generally safe for the majority of individuals with multiple diseases and chronic conditions wishing to participate in a light-to-moderate intensity exercise programs (see *Chapters 1* and *2*). For individuals with multiple comorbidities that fall into the high risk category as designated in *Table 2.3*, referral to a health care provider is recommended prior to participating in an exercise program (see *Figure 2.4*). Individuals with multiple CVD risk factors (see *Table 2.2* and *Figure 2.3*) that do not fall into the high risk category should be encouraged to consult with their physician prior to initiating a vigorous intensity exercise program as part of good medical care and should progress gradually with their exercise program of any exercise intensity.

EXERCISE TESTING

Exercise stress testing is recommended only for the highest risk individuals including those with diagnosed CVD, symptoms suggestive of new or changing CVD, DM and additional CVD risk factors (see *Table 2.2*), end-stage renal disease, and specified lung disease (see *Table 2.3*). Nonetheless, the information gathered from an exercise test may be useful in establishing a safe and effective Ex R_x for low- to moderate-risk individuals. Recommending an exercise test for low- to moderate-risk individuals should not be viewed as inappropriate if the purpose of the test is to design an effective Ex R_x. The *Guidelines* also recommends health/fitness, clinical exercise, and health care professionals consult with their medical colleagues when there are questions about clients and patients with known disease and health conditions that may limit their participation in exercise programs.

EXERCISE PRESCRIPTION

In general, the FITT principle of Ex R_x for individuals with multiple diseases and health conditions will follow the recommendations for healthy adults (see *Chapter 7*). *Table 10.11* summarizes the aerobic exercise FIT (*i.e.*, frequency, intensity, and time) principle of Ex R_x recommendations for special populations with one chronic disease, health condition, or CVD risk factor as discussed in this chapter. However, the challenge is determining the specifics of the FITT principle of Ex R_x that should be recommended for the client or patient that presents with multiple chronic diseases, health conditions, and/or CVD risk factors, especially when there is variability in the exercise dose that can most favorably impact a particular disease, health condition, or CVD risk factor (*e.g.*, BP requires lower doses of exercise to improve than does HDL, abdominal adiposity, or bone density).

SPECIAL CONSIDERATIONS

- A large body of scientific evidence supports the role of physical activity in delaying premature mortality and reducing the risks of many chronic diseases and health conditions. There is also clear evidence for a dose-response relationship between physical activity and health. Thus, any amount of physical activity should be encouraged.

TABLE 10.11. Summary of the Aerobic Exercise Frequency, Intensity, and Type Recommendations for a Single Disease, Health Condition, or Cardiovascular Disease (CVD) Risk Factor[a]

Condition	Frequency	Intensity	Time
Arthritis	3–5 d · wk^{-1}	40%–59% HRR or $\dot{V}O_2R$	20–30 min · d^{-1}
Cardiac disease	4–7 d · wk^{-1}	40%–80% HRR or $\dot{V}O_2R$	20–60 min · d^{-1}
Dyslipidemia	≥5 d · wk^{-1}	40%–75% HRR or $\dot{V}O_2R$	30–60 min · d^{-1}
Hypertension	≥5 d · wk^{-1}	40%–59% HRR or $\dot{V}O_2R$	30–60 min · d^{-1}
Obesity	≥5 d · wk^{-1}	40%–59% HRR or $\dot{V}O_2R$	30–60 min · d^{-1}
Osteoporosis	3–5 d · wk^{-1}	40%–59% HRR or $\dot{V}O_2R$	30–60 min · d^{-1}
Type 2 diabetes	3–7 d · wk^{-1}	50%–80% HRR or $\dot{V}O_2R$	20–60 min · d^{-1}

[a]Moderate intensity resistance exercise is generally recommended 2–3 d · wk^{-1} in addition to the amount of aerobic exercise specified previously for each chronic disease, health condition, and CVD risk factor (see *Chapter 7*).
HRR, heart rate reserve; $\dot{V}O_2R$, maximal oxygen consumption reserve.

- Begin with the FITT principle of Ex R_x for the single disease and health condition that confers the greatest risk and/or is the most limiting regarding ADL, quality of life, and/or starting or maintaining an exercise program. Also consider client and patient preference and goals.
- Alternatively, begin with the FITT that is the most conservative FITT prescribed for the multiple diseases, health conditions, and/or CVD risk factors the client and patient presents with as listed in *Table 10.11*.
- Know the magnitude and time course of response of the various health outcome(s) that can be expected as a result of the FITT principle of Ex R_x that is prescribed in order to progress the client and patient safely and appropriately.
- Frequently monitor signs and symptoms to ensure safety and proper adaptation and progression.

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