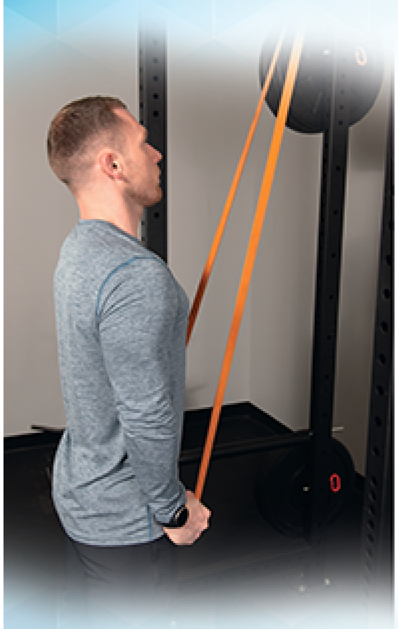
PART
V

Developing the Exercise Program

CHAPTER 13

Comprehensive Program Design



OBJECTIVES

Personal Trainers should be able to:

- Describe the physiological and psychological benefits of a comprehensive exercise program.
- Describe the components of a comprehensive exercise program.
- Consider advanced training options.
- Understand the anatomy of an exercise session.

INTRODUCTION

Personal Trainers have the opportunity to assist clients in creating exercise programs that not only help to prevent several hypokinetic diseases (*e.g.*, coronary heart disease, obesity, diabetes, low back pain) but also improve physical fitness and quality of life. As highlighted in this chapter, a comprehensive exercise program provides many physiological and psychological benefits. A well-rounded fitness plan follows a general format including a warm-up; the training stimulus, such as cardiorespiratory exercise and/or resistance exercise, a cool-down, and flexibility exercise; and, when indicated, neuromotor exercise training (Box 13.1) (1). For some clients, more advanced options with a greater focus on skill-related components of physical fitness may also be appropriate.

Box 13.1 Components of the Exercise Training Session (1,2)

- **Warm-up:** At least 5–10 min of low- to moderate-intensity cardiorespiratory and muscular endurance activities
- **Conditioning:** At least 20–60 min of aerobic, resistance, neuromotor, and/or sports activities. (Exercise bouts of 10 min are acceptable if the individual accumulates at least 20–60 min $\cdot$ d^{-1} of daily aerobic exercise.)
- **Cool-down:** At least 5–10 min of low- to moderate-intensity cardiorespiratory and muscular endurance activities
- **Flexibility:** At least 10 min of stretching exercises performed after the warm-up or cool-down phase

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In addition to health benefits of a fitness program, Personal Trainers should also be concerned with clients' sedentary behavior (*e.g.*, computer use, smartphone use, watching television). Sedentary behavior is associated with metabolic and cardiovascular risk factors promoting morbidity and mortality and reducing life expectancy and quality of life (1). Detrimental effects of sedentary activities are possible even among individuals who meet the *Physical Activity Guidelines*, and thus, including "physical activity breaks" or frequent short activity bouts on a daily basis to interrupt sedentary activities is recommended (3,4).

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Benefits of a Comprehensive Exercise Program

A comprehensive exercise program has many potential physiological as well as psychological benefits. This section provides Personal Trainers with insight into the range of physical and mental health benefits possible with a regular exercise program.

Physiological Benefits

Physiological changes as a result of a comprehensive exercise program provide many fitness and health benefits.

Improvement in Cardiovascular and Respiratory Function

Aerobic activities in which large muscle groups are used dynamically for extended periods of time place demand on the cardiovascular and respiratory systems in addition to the skeletal muscle system (5). By placing a stress on these systems, cardiorespiratory fitness can be improved. Increases in cardiorespiratory fitness are associated with a reduction in all-cause mortality. Conversely, low cardiorespiratory fitness is associated with increased risk of premature death, in particular cardiovascular disease mortality (5).

Reduction in Coronary Artery Disease Risk Factors

Prevention of risk factors (primordial prevention) and treatment of risk factors (primary prevention) are both important considerations considering the high prevalence of heart disease. Some primordial risk factors cannot be altered or prevented (*e.g.*, age, sex, or genetics), but others including physical inactivity can be addressed. Risk factors such as dyslipidemia, prediabetes, hypertension, and obesity are positively impacted with regular physical activity (3). Greater cardiorespiratory fitness in individuals with preexisting disease is associated with decreased risk of clinical events (1).

Decreased Morbidity and Mortality

Physical activity and exercise are known to prevent the development of several life-threatening diseases as well as premature death (6). Morbidity and mortality rates in a population can be directly affected by the quality and quantity of physical activity and exercise. Morbidity refers to the amount of disease in a given population, whereas mortality refers to the amount of death in a population. All-cause mortality is delayed with regular physical activity. Mortality is also delayed when individuals who were previously sedentary or insufficiently active increase their physical activity to meet the recommended levels of physical activity (1). The Centers for Disease Control and Prevention publishes a weekly report providing information on these rates in the United States, called the *Morbidity and Mortality Weekly Report*.

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Decreased Risk of Falls

According to the Centers for Disease Control and Prevention, each year, about 1 in 4 adults older than 65 years will experience a fall that leads to moderate or severe injury (7). Severe falls can cause injuries affecting mobility as well as brain trauma and can lead to other health conditions or disease. Falls may be linked to lack of muscular strength and endurance, balance, and coordination. Multicomponent physical activities (*i.e.*, aerobic, muscle strengthening, balance, gait, coordination, and functional training) can help reduce the risk of injury from falls and improve physical function. Moreover, recreational activities such as dancing, yoga, tai chi, gardening, or sports can also be considered multicomponent because they often incorporate multiple types of physical activity (2,3). Neuromotor exercise training (also called functional fitness training), which includes balance, coordination, gait, agility, and proprioceptive training, is a beneficial component of a comprehensive exercise program for older persons to reduce the risk of falls (1). Additionally, current research demonstrates the key role of resistance training in combating muscle strength and mass loss that is considered critical for several physiological indicators such as physical functioning, mobility, and independence, enhancing chronic disease management and life expectancy (8).

Increased Metabolic Rate

Metabolism is the rate at which bodily tissues break down and use energy consumed (calories). Unfortunately, metabolic rate declines steadily as a part of the aging process (2). If energy is not used, it is most often stored in fat cells. Typically, as individuals age, they become less and less physically active, losing muscle mass, thus contributing to this steady decline in metabolic rate (2). Older adults should do muscle-strengthening activities that involve all the major muscle groups at least 2 $d \cdot wk^{-1}$ performing two or three sets of 8–12 repetitions of each exercise in order to attenuate muscle loss or promote lean muscle gains, which can potentially maintain metabolic rate (3). More specifically, the effects of resistance training and especially the implementation of circuit training on energy expenditure is beneficial for weight control and cardiometabolic health in adults (9).

Improvement in Bone Health

Similarly with heart disease, bone health is affected by factors that cannot be modified (*e.g.*, age, sex, race, genetics) as well as those that can be changed (*e.g.*, diet, physical activity). Exercise training modalities for increasing bone mass or to slowing/preventing age-related bone loss require loading of the bone in a site-specific manner (10). Impact and weight-bearing activities (*e.g.*, plyometrics, jumping, resistance training) provide for a stress on the bone to promote positive adaptations in the bone (10).

Weight Loss and Reduced Obesity

Obesity is associated with several chronic diseases (*e.g.*, coronary heart disease, hypertension, stroke, Type 2 diabetes, dyslipidemia, some cancers) (5). Physical activity is recommended as part of an integrated weight management plan for prevention of excessive fat mass, for weight maintenance, to enhance weight loss strategies, and to reduce the risk of weight gain with age. In fact, evidence suggests a dose-response relationship between physical activity levels and the magnitude of weight loss. Although American College of Sports Medicine (ACSM) and the Physical Activity Guidelines for Americans recommend participation in at least 150 $\text{min} \cdot \text{wk}^{-1}$ of moderate-intensity activity for weight maintenance and reduction in chronic disease risk, 250–300 $\text{min} \cdot \text{wk}^{-1}$ of moderate-intensity activity may lead to greater weight loss (3,5).

Psychological

In addition to the many physiological benefits, regular exercisers may also experience a number of potential psychological benefits.

Decreased Anxiety and Depression

Depression is a common psychiatric disorder and a leading cause of disability that is marked by feelings of sadness and unhappiness along with being self-critical and having low self-esteem (11). In addition to impairing daily function and potentially creating difficulties in work and home life, depression is also associated with poor quality of life and health risks such as heart disease, diabetes, cancer, and osteoporosis (12). Exercise (both cardiovascular and resistance training) has been found to be helpful in treating mild to moderate depressive symptoms, to potentially reduce the risk of developing depression (13), and to work in conjunction with medication-based antidepressive therapy for those with diagnosed major depression (14).

Anxiety is an emotional state marked by excessive anticipatory worry, tension, and apprehensive expectation or fear and is considered a common psychiatric symptom. Anxiety is associated with poor health-related quality of life and increased risk for cardiovascular disease and is linked to all-cause mortality (15). Exercise has been linked to reduction in anxiety and is considered an effective, affordable, and convenient treatment option for individuals with anxiety while improving a variety of physical fitness components. Potential physiological explanations including regulation of the hypothalamic-pituitary-adrenal axis, increases in serotonergic and noradrenergic levels in the brain, and endogenous opioid release may play a key role (16).

Enhanced Feelings of Well-Being

Exercise provides enhancement of self-esteem, more restful sleep, and faster recovery from psychosocial stressors (17). Exercise also has the potential to enhance emotional well-being, to improve mood (18), and to enhance feelings of "energy" and quality of life (1).

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Positive Effect on Stress

High stress is when the perceived demands appear to exceed the resources available to handle those demands (15). Stress is associated with a number of health risks, including weakening of the immune system, overeating, and adverse shifts in blood lipid levels (19). People with depression, those suffering from stress and hostility, have the same risk of heart attack as those who smoke or have high blood pressure. However, exercise and physical activity have potentially positive effects on stress. For example, exercise training has been shown to reduce depression, overall stress, as well as hostility by 50%–70% (17).

Better Cognitive Function (Older Adults)

Regular physical activity (both cardiovascular and resistance training) is known to play a pivotal role in the enhancement of cognitive function reducing the risk for dementia or cognitive decline in older adults through processes of neuroplasticity (20). Importantly, cardiovascular exercise has been widely studied as an efficient and easily accessible training modality for remediation aiming to improve cognition. Multicomponent exercise programs promoting cardiorespiratory and muscular fitness, balance, and flexibility have been suggested as an effective training option to influence cognitive function and to be a part of a comprehensive approach for the prevention, management, and treatment of dementia in older adults (21). Exercise can also impact tasks that require complex mental processing, in particular, executive-control tasks such as coordination, inhibition, scheduling, planning, and working memory (2).

Components of a Comprehensive Exercise Program

The optimal exercise program should address the health-related physical fitness components of cardiorespiratory fitness, muscular strength and endurance, flexibility, body composition, and neuromotor fitness (5). In addition, skill-related physical fitness components can also be added, and they include agility, coordination, balance, power, reaction time, and speed (5). Including activities to improve aerobic fitness, muscular fitness, and flexibility is recommended for everyone. Neuromotor exercise, which includes skill-related physical fitness components, is advocated for those at higher risk for falling, in particular, older individuals, although there are likely benefits for younger adults as well (5). Additionally, some clients have goals related to sport or competitive activities in which the skill-related components need to be addressed.

The optimal exercise program should address the health-related physical fitness components of cardiorespiratory fitness, muscular strength and endurance, flexibility, body composition, and neuromotor fitness.

The FITT-VP principles of exercise prescription allow for complete design of the frequency (F), intensity (I), time (T) (or duration), and type (T) (or mode) of exercise plus the overall volume (V) or amount and progression (P) of the exercise (5). Within the FITT-VP framework, the Personal Trainer can develop individual exercise prescriptions (as discussed in more detail in the upcoming chapters in this part), which include cardiorespiratory and muscular fitness exercises as well as flexibility-promoting activities.

Cardiorespiratory Fitness

Cardiorespiratory endurance refers to the ability of the heart and blood vessels (circulatory system) and the lungs (respiratory system) to provide oxygen to the body during sustained physical activity (5). Another term commonly used is "aerobic" fitness because these activities require sufficient oxygen in order to be continued. Maximal oxygen consumption ($\dot{V}O_{2max}$) can be measured directly by analyzing expired gases or may be estimated from submaximal effort (see Chapter 12 for examples of submaximal exercise tests) or maximal effort. The higher the $\dot{V}O_{2max}$, the greater is the individual's aerobic capacity. Cardiorespiratory endurance training can be done in two different ways: continuously or in blocks (intervals), such as high-intensity interval training or HIIT. The first training option consists of rhythmic, aerobic-type endurance exercises. The latter is characterized by high-intensity efforts and recovery bouts performed intermittently (5). Both options demonstrate similar improvements in cardiorespiratory fitness, but interval training generally is more time-efficient compared to steady-state, continuous bouts of exercise.

Frequency

Although some activity is better than none, the recommended frequency for cardiovascular exercise is at least 3 $d \cdot wk^{-1}$ (5). When determining optimal frequency, intensity should be considered. As intensity levels increase, the number of days per week needed for health benefits decreases; the incidence of injury may also increase with vigorous intensity exercise done more than 5 $d \cdot wk^{-1}$ (5). In conclusion, a weekly combination of 3–5 $d \cdot wk^{-1}$ of moderate- and vigorous-intensity exercise options can be performed, which may be more suitable for most individuals (5).

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Intensity

Exercise intensity can be quantified using various methods, including heart rate reserve (HRR), percentage of age-predicted maximal heart rate, oxygen uptake reserve ($\dot{V}O_2R$), and rating of perceived exertion. The intensity recommended for a given individual depends on the person's habitual activity and fitness level (5). For individuals who are sedentary and very deconditioned, the recommended intensity is very low (*i.e.*, 30%–39% HRR or $\dot{V}O_2R$) but progressively increases with higher activity and fitness levels (*i.e.*, for habitually active individuals with high fitness, 60%–89% HRR or $\dot{V}O_2R$) (7). See Table 15.2 in Chapter 15 for specific ranges for various intensity levels. Typically, interval training can be classified as either HIIT or sprint interval training (SIT). HIIT, characterized by "near-maximal" efforts, is often performed at an intensity close to that which elicits ≥80%–100% peak heart rate; SIT is characterized by an all-out, supramaximal effort equal to or greater than the pace that elicits ≥100% peak heart rate (5).

Time (or Duration)

Exercise duration is the amount of time the exercise is performed, typically expressed as minutes per day or minutes per week. General baseline targets for time spent exercising depend on the intensity of the exercise. Thus, the recommendations link duration and intensity (5):

- Moderate-intensity exercise is recommended 30–60 $\text{min} \cdot \text{d}^{-1}$ on at least 3 $\text{d} \cdot \text{wk}^{-1}$ for a total of at least 150 $\text{min} \cdot \text{wk}^{-1}$, *or*
- Vigorous-intensity exercise is recommended 20–60 $\text{min} \cdot \text{d}^{-1}$ on at least 3 $\text{d} \cdot \text{wk}^{-1}$ for a total of at least 75 minutes, *or*
- A combination of moderate- and vigorous-intensity exercise at least 20–30 minutes on 3–5 $\text{d} \cdot \text{wk}^{-1}$
- Interval training typically consists of alternating bouts of vigorous- to supramaximal-intensity exercise (20–240 s) followed by equal or longer bouts of light- to moderate-intensity exercise (60–360 s). However, for detrained individuals, a moderate-intensity interval training approach is recommended. For example, brisk walking periods are alternated with a reduced pace.

> General baseline targets for time spent exercising depend intensity of the exercise.

A dose-response relationship exists between physical activity and health outcomes. Thus, benefits may begin at low levels for sedentary individuals (*e.g.*, <20 $\text{min} \cdot \text{d}^{-1}$), whereas extending the time or intensity may provide additional health benefits for those who are already regular exercisers (5). For example, one may gain even greater benefits with the following:

- Moderate-intensity exercise of 300 min · wk^{-1}, *or*
- Vigorous-intensity exercise of 150 min · wk^{-1}, *or*
- A combination of moderate- and vigorous-intensity exercise

Going above the baseline of 150 min · wk^{-1} of moderately intense exercise also is important to assist with weight loss or to help maintain weight loss. In these situations, the recommended duration of exercise is 50–60 min · d^{-1}, or 250–300 min · wk^{-1} (5). These recommendations provide a framework in which the Personal Trainer can develop a health-enhancing exercise program.

Type (or Mode)

Examples of continuous cardiovascular activities include walking, jogging, running, cycling, swimming, and using endurance-based machines (*e.g.*, stair climber, elliptical machines). Although most of these activities require low to moderate skills and can be used even by those with low fitness levels, others require considerable skill, fitness, and practice to master. Table 15.6 in Chapter 15 provides a classification system, which acknowledges the fitness and skill level required for optimal use of various aerobic exercises. Activities appropriate for everyone have minimal skill or fitness prerequisites (*e.g.*, walking). As fitness increases, more intense activities can be included (*e.g.*, jogging). Still, other activities have a major skill component (*e.g.*, swimming) that must be acquired before including in cardiovascular training or have a competitive nature (*e.g.*, team sports) that requires at least average physical fitness (5). On the other side, an interval training approach incorporates aerobic-based (*e.g.*, running, cycling, and rowing), resistance-based (*e.g.*, bodyweight exercises, plyometrics, traditional or adjunct resistance training equipment), or a hybrid of both aerobic- and resistance-based exercises depending on the goals of the training session and physical fitness level of the client (5).

Volume (Amount)

Exercise volume plays an important role for realizing health/fitness outcomes, particularly with respect to body composition and weight management. Exercise volume should be used to estimate the overall energy expenditure for an exercise prescription. Exercise volume is typically measured in metabolic equivalent (MET) · min · wk^{-1} and/or kcal · wk^{-1} (note that volume can also be tracked on a daily basis). Box 13.2 reflects the standard measures of exercise intensity (METs, MET-min, and kcal · min^{-1}) for different physical activities. These values can then be used to calculate volume of activity per week that is accumulated as part of the exercise program. The recommended volume that is consistently associated with lower rates of cardiovascular disease and premature mortality is greater than 500–1,000 MET · min · wk^{-1} (11). This is approximately equal to 1,000 kcal · wk^{-1} of moderate-intensity physical activity, ~150 min · wk^{-1} of moderate-intensity exercise, an intensity of 3–5.9 METs (for people weighing 68–91 kg or 150–200 lb), or 75 min · wk^{-1} of vigorous-intensity aerobic exercise, or an equivalent combination of moderate- and vigorous-intensity cardiovascular exercise per week to attain the volume of recommended physical activity. In deconditioned people, lower exercise volumes can have significant benefits, but even greater volumes may be needed for weight management.

Box 13.2 Calculation of METs, MET-min, and kcal · min^{-1} (2,3)

Metabolic equivalents (METs):
An index of energy expenditure. "[A MET is] the ratio of the rate of energy expended during an activity to the rate of energy expended at rest. . . . [One] MET is the rate of energy expenditure while sitting at rest . . . by convention, [1 MET is equal to] an oxygen uptake of 3.5 [mL · kg^{-1} · min^{-1}]" (21).

MET-min:
An index of energy expenditure that quantifies the total amount of physical activity performed in a standardized manner across individuals and types of activities (21). Calculated as the product of the number of METs associated with one or more physical activities and the number of minutes the activities were performed (*i.e.*, METs × min). It is usually standardized per week or per day as a measure of exercise volume.

Kilocalorie (kcal):
The energy needed to increase the temperature of 1 kg of water by 1° C. To convert METs to kcal · min^{-1}, it is necessary to know an individual's body weight. It is usually standardized as kilocalories per week or per day as a measure of exercise volume.

$$\text{kcal} \cdot \text{min}^{-1} = (\text{METs} \times 3.5\ \text{mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1} \times \text{body weight in kg}) \div 200$$

Example
Calculate weekly volume for a 70-kg male jogging (at ~7 METs) 3 days per week for 30 minutes.

$$7\ \text{METs} \times 30\ \text{min} \times 3\ \text{times per week} = 630\ \text{MET-min} \cdot \text{wk}^{-1}$$

or

$$(7\ \text{METs} \times 3.5\ \text{mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1} \times 70\ \text{kg}) \div 200 = 8.6\ \text{kcal} \cdot \text{min}^{-1}$$

$$8.6\ \text{kcal} \cdot \text{min}^{-1} \times 30\ \text{min} \times 3\ \text{times per week} = 774\ \text{kcal} \cdot \text{wk}^{-1}$$

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Progression Rate

Progression depends on an individual's health status, training response, fitness, and the exercise program goals. Progression allows for improvements in cardiorespiratory fitness while avoiding stagnation in training. The Personal Trainer may need to increase any or all of the FITT components to provide progression to the exercise program. Typically, only one variable is increased at a time. Initially, an increase in exercise time/duration per session of 5–10 minutes every 1–2 weeks over the first 4–6 weeks of an exercise training program is reasonable for the average adult. After about 1 month, the frequency, intensity, and time should be gradually increased over the next 4–8 months to meet the recommendations presented in *ACSM's Guidelines for Exercise Testing and Prescription* (5).

Progression depends on an individual's health status, training response, fitness, and the exercise program goals. Progression allows for improvements in cardiorespiratory fitness while avoiding stagnation in training.

A longer trajectory is recommended for those who are very deconditioned. Any progression should avoid making large increases in the FITT components to minimize risks of injury, muscular soreness, or overtraining.

Chapter 15 provides more detail on cardiorespiratory fitness training programs and incorporating the FITT-VP principle into a usable program for a client. A sample progression, including activity status and training focus, is provided in Table 13.1.

Table 13.1 Activity Status and Cardiovascular Training Focus

Activity Status	Cardiovascular Training Focus
Beginner: those who are inactive with no or minimal physical activity and thus are deconditioned	*No prior activity*: Focus is on light- to moderate-level activity for 20–30 min over the course of the day. Accumulating time in 10-min bouts is an option. Overall, the target is 60–150 min · wk^{-1}. *Minimal prior activity* (*i.e.*, once the previous target level is met): Focus is on light- to moderate-level activity for 30–60 min · d^{-1}. Accumulating time in 10-min bouts is an option. Overall, the target is 150–200 min · wk^{-1}.
Intermediate: those who are sporadically active but do not have an optimal exercise plan and thus are moderately deconditioned	*Fair to average fitness*: Focus is on moderate activity for 30–90 min · d^{-1}. Overall, the target is 200–300 min · wk^{-1}.
Established: those who are regularly engaging in moderate to vigorous exercise	*Regular exerciser* (moderate to vigorous): Focus is on moderate to vigorous activity for 30–90 min · d^{-1}. Overall, the target is 200–300 min · wk^{-1} of moderate-intensity activity or 100–150 min of vigorous-intensity activity or a combination of moderate- and vigorous-intensity activity.

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Resistance Training

Resistance training is used to optimize muscular fitness including both muscular strength and muscular endurance. Muscular strength refers to the ability of a muscle or muscle group to exert force (*e.g.*, one repetition maximum [1-RM]). Muscular endurance refers to the ability of a muscle or muscle group to continue to perform without fatigue (*i.e.*, repeated contractions or to sustain a contraction).

To improve muscular fitness, the muscles must be exposed to an overload (stress beyond the typical activity). This is done via resistance training. Over time, as the muscles adapt to a given overload, the training stimulus must be increased to continue to have gains. This is referred to as progressive overload. Details on resistance training programs are found in Chapter 14, and a sample progression is found in Table 13.2. As with cardiorespiratory training programs, the FITT-VP principle can be applied to resistance training.

Table 13.2 Sample Resistance Training Progression

Stage[a]	Exercises[b]	No. of Sets	No. of Repetitions	No. Days per Week[c]
Beginner: Moving through this level typically takes about 2–3 mo, although remaining at this level until the client feels comfortable enough to advance is appropriate.	Do a total of six exercises. Select *one* exercise from each of the following areas: hips and legs, chest, back, shoulders, low back, and abdominals.	1–2	8–12 (10–15 for older adults)	2–3
Intermediate to established: Moving through the intermediate to established level typically takes 3–12 mo depending on the client's level of consistency.	Do a total of 10 exercises. Select *one* exercise from each of the following areas: hips and legs, quadriceps, hamstrings, chest, back, shoulders, biceps, triceps,	2	8–12 (10–15 for older adults)	2–3

	low back, and abdominals.			
More advanced: Some clients may have higher level goals in the area of muscular fitness and thus will include an expanded training program.	Do a total of 10 exercises. Select *two* exercises from each of these larger muscle group areas: hips and legs, quadriceps, hamstrings, chest, and back.	2–3	8–12	2–3
	Do a total of five exercises. Select *one* exercise from each of these smaller muscle group and trunk areas: shoulders, biceps, triceps, low back, and abdominals.	2	8–12	2–3

[a]The time spent at each stage will depend on the client's muscular fitness level. Transition slowly between the stages (*e.g.*, over time, a beginner can add additional exercises or increase the number of sets to move toward the intermediate level of resistance training).

[b]Different exercises can be performed on different days.

[c]Schedule training days so that at least 48 h separate training sessions that target the same muscle group.

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Frequency

The frequency of resistance training varies depending on the goals of the client. For general muscular fitness, resistance training the major muscle groups (chest, shoulders, back, abdomen, hips, and legs) 2–3 $d \cdot wk^{-1}$ is recommended (5). At least 48 hours should separate workouts targeting any given muscle group to allow time for adaptations to occur (1,5). Depending on client schedules, Personal Trainers may incorporate whole-body sessions in which all the major muscle groups are exercised in one session (repeating this sequence a couple times per week) or may train a few selected muscle groups (split program) each session (multiple sessions) (5). In the latter scenario, more frequent resistance training will occur, but individual muscle groups will still only be targeted two to three times per week. In summary, a wide variation in program design options can be applied by adopting periods of both low- ($1\ d \cdot wk^{-1}$), medium- ($2\ d \cdot wk^{-1}$) or high-frequency training ($>3\ d \cdot wk^{-1}$) throughout an individualized training plan.

Intensity

Intensity of resistance training is inversely related to the number of repetitions; with higher resistance, the number of repetitions will be fewer. Depending on the muscular fitness goal (*i.e.*, strength, muscular endurance, etc.), the recommended range for intensity and repetitions can vary greatly. To improve muscular fitness, typically 8–12 repetitions per set are completed, at an intensity of between 60% and 80% of the client's 1-RM (*i.e.*, the greatest amount of resistance overcome in a single repetition) (5). For older and very deconditioned individuals, a lower intensity (40%–50% of 1-RM) with 10–20 repetitions is recommended initially (1). To lower the chance of injury or extreme muscle soreness after exercise, the number of repetitions selected should allow for muscle fatigue at the end of the set but not failure (5).

Intensity of resistance training is inversely related to the number of repetitions; with higher resistance, the number of repetitions will be fewer.

Time (or Duration)

The total time spent will vary with the program, in particular if a whole-body approach is used or if a split program targeting different muscles groups on separate days is applied. For adults, each muscle group should be trained with two to four sets with rest intervals of 2–3 minutes between sets (5). Four sets are more effective than two sets, but also realize that for novices, even a single set per exercise will improve muscular strength (5). When determining the number of sets, attention should be made to adherence and thus may be influenced by the individuals schedule, time availability, and level of commitment (5).

Type (or Mode)

Resistance training can be done using free weights, machines (stacked weights or pneumatic resistance), rubber bands/cords, body weight, and even alternative and nontraditional implements (kettle bells, medicine balls, battle ropes). For examples of different activities that can be used for the major body areas, see Table 13.3. In addition, Personal Trainers should include multijoint (*e.g.*, bench press, leg press) as well as potentially single-joint (*e.g.*, biceps curl, quadriceps extension) exercises (5). When selecting exercises, the Personal Trainer should ensure opposing muscle groups, agonists and antagonists, are included in order to prevent muscle imbalances. For example, including lower back extensions and abdominal crunches to strengthen both the lower back and the abdomen will provide for muscle balance.

Table 13.3 Examples of Resistance Training Exercises for Major Body Areas

Body Area	Exercises	
Hips and legs (gluteals, quadriceps, hamstrings)	Machine leg press Dumbbell squat	Ankle weight hip flexion and extension Band leg lunge
Legs (quadriceps)	Machine leg extension	Ankle weight knee extension
Legs (hamstrings)	Machine leg curl	Ankle weight knee flexion
Chest (pectoralis)	Machine chest press Band seated chest press	Dumbbell chest press Push-up and modified push-up
Back (latissimus dorsi)	Machine lat pull-down Dumbbell one-arm row	Machine seated row Band seated row
Shoulders (deltoid)	Machine overhead press	Dumbbell lateral raise

	Dumbbell or band upright row	
Arms (biceps)	Machine biceps curl	Dumbbell or band biceps curl
Arms (triceps)	Machine biceps press	Dumbbell lying triceps extension
Low back (erector spinae)	Machine back extension Prone plank	Kneeling hip extension
Abdominals	Curl-up Diagonal curl-up	Machine abdominal curl

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Volume

Muscular groups should be trained for a minimum of two to four sets. These may be the same exercise or from a combination of exercises affecting the same muscle group (1,5). For example, either four sets of bench presses or a combination of two sets of bench presses and two sets of dips may be used to train the pectoral muscles (5). For untrained individuals, lower volume per muscle group per session is needed, whereas for advanced trainees, a greater weekly volume is recommended to promoting hypertrophy and strength (5).

Progression

Progressive overload in resistance training is the gradual increase of stress placed on the body that can be done in many ways. One can increase the amount of resistance lifted, increase the number of repetitions, increase the number of sets done per muscle group, or increase the number of days per week the muscle groups are trained. However, if individuals seek to maintain a given level of muscular fitness, it is not necessary to continue to progressively increase the training stimulus. Muscular strength may be maintained by training muscle groups as little as 1 $d \cdot wk^{-1}$ as long as the training intensity or the resistance lifted is held constant (1,5).

Flexibility

Flexibility exercises have the potential to improve joint range of motion (ROM), physical function, postural stability, and balance (1). Although the Personal Trainer may not be able to point to benefits such as a reduction in cardiovascular disease risk, stretching is recommended as part of a comprehensive training program for adults (5).

Frequency

Stretching activities should be included a minimum of 2–3 days each week for most adults, although daily flexibility exercise is most effective (5).

Intensity

Describing the intensity of stretching to a client can be difficult because it is not a measurable entity like a treadmill speed. The Personal Trainer can use cues to help guide clients, such as moving within the ROM to point of mild tightness without discomfort (5). A stretch should not create discomfort; if so, the client should release slightly. A stretch should never be painful.

> A stretch should not create discomfort; if so, the client should release slightly. A stretch should never be painful.

Time (or Duration)

At least 10 minutes is recommended per session in order to allow all the major muscle–tendon groups to be targeted with at least four repetitions of each stretch (5).

Type (or Mode)

Flexibility can be improved using a wide variety of activities, including static stretching (active and passive), dynamic or slow movement stretching, and proprioceptive neuromuscular facilitation (5). Interestingly, when properly performed, even ballistic or "bouncing" stretches can be as effective as static stretches for increasing joint ROM in individuals engaging in activities that involve ballistic movements such as tennis or basketball (5).

Volume

Each flexibility exercise per joint should be held at the point of tightness for 10–30 seconds. Time/duration and repetitions of the flexibility exercises should be adjusted to accumulate a total of 60 seconds of stretching at each joint. Recommendations for using proprioceptive neuromuscular facilitation are to hold a 20%–75% maximum voluntary contraction for 3–6 seconds, followed by 10–30 seconds of assisted stretch. Performing flexibility exercises at least 2–3 $d \cdot wk^{-1}$ is recommended with daily flexibility exercise being most effective (1,5). Details on flexibility and various stretching program options are presented in Chapter 16.

Neuromotor Exercise

Neuromotor exercise involves motor skills including balance, coordination, agility, and proprioceptive training (1). Neuromotor-enhancing activities focus on the communication between feedback from the periphery (*e.g.*, arms and legs) and the interpretation by the central nervous system (*e.g.*, brain and spinal cord). As with any training, providing a challenge, or overload, will allow for improvements. This training is of particular importance for older adults who are at a higher fall risk or who have mobility impairments (5). In addition, all adults may gain benefits, especially if participation in recreation or occupational pursuits requires agility and balance (5).

Frequency

Neuromuscular exercise is recommended at least 2–3 $d \cdot wk^{-1}$ for 20–30 minutes of duration the previously mentioned populations (5). This recommendation is based on conventional use rather than evidence-based documentation of benefit as programs range from 1 to 7 $d \cdot wk^{-1}$.

Intensity

The intensity of balance-related training can be manipulated by the Personal Training through three aspects:

1. Base of support (narrowing the base of support will increase the challenge)
2. Center of mass (displacing the center of mass increases difficulty)
3. Peripheral cues (visual, vestibular, and proprioceptive pathways)

Some examples of how these three domains can be manipulated are included in Table 13.4 (5).

Table 13.4 Factors Affecting Intensity of Balance Training (5)

Domain	Less Difficult	Moderate	More Difficult
Base of support	Feet apart (with or without assistive device)	Feet together Semitandem stand	Heel-to-toe stand One-legged stand
Center of mass	Leaning forward and backward Leaning side to side	Turning in a circle Shifting weight from side to side Stepping over an obstacle	Crossover walking Balancing on a large ball or rocker platform
Peripheral feedback	These are more difficult and are recommended only after particular activity was done successfully with peripheral feedback.	Closing the eyes (seated position) while leaning forward, backward, and side to side Standing on a foam pad while shifting weight or bringing feet close together	Closing eyes (standing position) while leaning in various directions or reducing base of support Standing on a foam pad in a heel-to-toe stance or one-legged stance

Data from American College of Sports Medicine. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. *Med Sci Sports Exerc*. 2009;41(3):687–708.

Time (or Duration)

The minimum effective dose of balance training has yet to be defined (1). Improvements have been noted with 20–30 minutes or more per day for a total of 60 min · wk^{-1} (5). When activities like tai chi are incorporated, typically durations are 45–60 minutes, but the minimum effective time for neuromotor exercise training is not known (5).

Type (or Mode)

Various activities (see Table 13.5 for example of a progressive balance program), as well as tai chi, Pilates, and yoga, can be used (5).

Table 13.5 Sample Progressive Balance Program

	Level 1	**Level 2**	**Level 3**	**Challenge**
Seated balance activities	Seated chair lean	Add arm movements: ■ Raise one arm at a time to the front and then to the sides. ■ Raise both arms to the front and then to the sides. Add leg movements: ■ Raise one knee at a time. ■ Raise one leg (straightened) at a time.	Combine arm and leg movements.	■ Sit on a pillow. ■ Sit on a stability ball. ■ Close one eye. ■ Close both eyes. ■ Turn head to the right and then to the left.
Standing balance activities	Upright stance (variations including wide stance, narrow stance, semitandem, and tandem)	In all four variations, add the following: ■ Forward and backward sway	Add arm movements to sway: ■ Raise one arm at a time to the front	■ Close one eye. ■ Close both eyes. ■ Turn head to the right and

		■ Lateral sway (side to side)	and then to the sides. ■ Raise both arms to the front and then to the sides.	then to the left. ■ Hold an item, such as a book.
Movement balance activities	Walk forward and backward.	■ Wide-stance walk ■ Narrow-stance walk ■ Walk on heels. ■ Walk on toes.	■ Tandem walk forward and backward. ■ Walk while carrying an item. ■ Walk with head turns.	■ Barefoot ■ One eye closed ■ Surface change (mat, sand, etc.) ■ Obstacles
	Walk side to side.	■ Sidestep on heels. ■ Sidestep on toes. ■ Turn in a circle.	■ Sidestep while carrying an item. ■ Sidestep with head turns. ■ Crossover walk: Cross one foot over the other foot.	

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Advanced Training Options

Personal Trainers may want to consider advanced training options for new clients with an extensive background in fitness training (such as athletes) or for long-term clients who have made great progress since starting their beginner comprehensive fitness programs. Advanced training options can increase the challenge of an exercise program by manipulating current exercises through the FITT-VP principle (see Tables 13.6–13.8 for examples of how the FITT components can be manipulated for beginner, intermediate, and established exercisers).

Table 13.6	Sample Beginner Adult Exercise Program[a]			
Week	**Aerobic**	**Resistance**	**Stretching**[b]	**Comments**
1–2	3 d · wk^{-1}; 10–20 min · d^{-1}; light intensity (level 3 or 4)	2 d · wk^{-1}; one set, 8–12 reps of six exercises[c]	2 d · wk^{-1}; 10 min of stretching activities	An easy beginning aerobic activity is walking at a comfortable pace. For inactive clients, target 10 min at a time for aerobic activity. Include some stretching activities (see Chapter 16) after the walk. For resistance training, see Table 13.3 for details on what activities to include.
3–4	3 d · wk^{-1}; 20–30 min · d^{-1}; light to moderate intensity (level 4 or 5)	2 d · wk^{-1}; one or two sets, 8–12 reps of six exercises[c]	2 d · wk^{-1}; 10 min of stretching activities	The focus for the client over the next couple of weeks will be getting comfortable with at least 20 min of aerobic exercise at least 3 d · wk^{-1}. Continue with the resistance training program.
5–7	3 or 4 d · wk^{-1}; 30–40 min · d^{-1}; moderate intensity (level 5)	2 d · wk^{-1}; two sets, 8–12 reps of six exercises[c]	2 d · wk^{-1}; 10 min of stretching activities	For the next 3 wk, the client's focus is on getting comfortable with up to 40 min of aerobic exercise at least 3 d · wk^{-1} (for each week, add 5–10 min per session). Continue with the resistance training program, completing two sets per exercise and adding more weight if the 12 reps for a given exercise now feel easy.
8–10	3 or 4 d · wk^{-1}; 35–50 min · d^{-1}; moderate intensity (level 5 or 6)	2 d · wk^{-1}; two sets, 8–12 reps of six exercises[c]	2 d · wk^{-1}; 10 min of stretching activities	Over the past couple of months, the client will develop a good aerobic fitness base. For some variety, other activities such as biking or swimming can be included (for more ideas, see Chapter 15). If the client likes

				walking, that is also an option. For your resistance training program, consider adding some variety and trying some other exercises (see Table 13.3 for ideas).

[a] All activity sessions should be preceded and followed by a 5- to 10-min warm-up and cool-down.

[b] Include stretching activities after aerobic exercise to improve flexibility. For specific stretches to target the major muscle groups, see Chapter 16.

[c] Resistance training is more fully outlined in Chapter 14. Beginners should select one exercise for each of the following body areas (see Table 13.3): hips and legs, chest, back, shoulders, low back, and abdominals.
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Table 13.7 Sample Intermediate-Level Adult Exercise Program[a]

Week	Aerobic	Resistance	Stretching[b]	Comments
1–2	3 or 4 d · wk^{-1}; 35–50 min · d^{-1}; moderate intensity (level 5 or 6)	2 d · wk^{-1}; one or two sets, 8–12 reps of 8–10 different exercises[c]	2 or 3 d · wk^{-1}; 10 min of stretching activities	Aerobic activity is included for a total of 150–200 min · wk^{-1} (moderate-intensity activity). For resistance training, include exercises for biceps and triceps (in addition to the body areas previously targeted) and add exercises for the quadriceps and hamstrings in the second week, so by the end of this stage, the client will include a total of 10 exercises (see Table 13.3).
3–5	3–5 d · wk^{-1}; 30–60 min · d^{-1}; moderate intensity (levels 5–7)	2 d · wk^{-1}; one or two sets, 8–12 reps of 10 different exercises[c]	2 or 3 d · wk^{-1}, 10 min of stretching activities	The focus for the next 3 wk is to increase the time spent in aerobic exercise or to increase the intensity (don't do both at the same time). If the client feels more comfortable with moderate-intensity activity, 200 min · wk^{-1}

				is appropriate. If the client is ready to increase intensity (*e.g.*, jogging rather than walking), cut back on the time to 20–30 min · d^{-1} (note that the target for vigorous-intensity activity is 75–100 min · wk^{-1}). A mix of moderate- and vigorous-intensity activity is also an option (see Chapter 15 for more details). Continue with the resistance training program.
6–10	3–5 d · wk^{-1}; 30–50 min · d^{-1}; moderate intensity (level 6)	2 d · wk^{-1}; two sets, 8–12 reps of 10 exercises[c]	2 or 3 d · wk^{-1}, 10 min of stretching activities	For the client's aerobic activity, either increase the time spent per day or increase the number of days per week. Ultimately, the weekly total should be 200–300 min of moderate-intensity activity or 100–150 min of vigorous-intensity activity (recall that 2 min of moderate activity equals 1 min of vigorous activity) or a combination of moderate and vigorous activity. For resistance training, consider trying some different exercises this week while still targeting the same muscle groups (see Table 13.3 for details).

[a]All activity sessions should be preceded and followed by a 5- to 10-min warm-up and cool-down.

[b]Include stretching activities after aerobic exercise to improve flexibility. Target all the muscle groups, holding each for 15–60 s. For specific stretches to target the major muscle groups, see Chapter 16.

[c]Resistance training is more fully outlined in Chapter 14. Select one exercise for each of the following body areas: hips and legs, chest, back, shoulders, low back, and abdominals. In the progression, the number of body areas targeted is increased by adding quadriceps and hamstrings as well as biceps and triceps. This provides 10 body areas to target. Examples of exercises for each body area are found in Table 13.3.
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Table 13.8 Sample Established Adult Exercise Program[a]

Week	Aerobic	Resistance	Stretching[b]	Comments
1–2	■ 5 d · wk^{-1} for moderate exercise, or ■ 3 d · wk^{-1} for vigorous exercise, or ■ 3–5 d · wk^{-1} for a mix of moderate and vigorous exercise	2 d · wk^{-1}; two sets, 8–12 reps of 10 different exercises[c]	2 or 3 d · wk^{-1}, minimum; 10 min of stretching activities	Target for aerobic activity is 200–300 min of moderate-intensity activity or 100–150 min of vigorous-intensity activity (recall that 2 min of moderate activity equals 1 min of vigorous activity) or a combination of moderate and vigorous activity. Resistance training exercise examples are found in Table 13.3.
3–4	2 or 3 d · wk^{-1} of moderate activity and 1 or 2 d of vigorous activity	2 d · wk^{-1}; two sets, 8–12 reps of 10 different exercises[c]	3 d · wk^{-1}, minimum; 10 min of stretching activities	For the next couple of weeks, try mixing up the activities. Suggest a new aerobic activity or change the intensity of an activity already part of the client's exercise program. Continue with the resistance training program.
5–6	■ 5 d · wk^{-1} for moderate exercise, or ■ 3 d · wk^{-1} for vigorous exercise, or ■ 3–5 d · wk^{-1} for moderate and vigorous exercise	2 d · wk^{-1}; two sets 8–12 reps of 10 exercises[c]	3 d · wk^{-1}, minimum; 10 min of stretching activities	Continue with the aerobic training program. For resistance training, consider trying some different exercises (see Table 13.3 and Chapter 14). If the client typically uses machines, suggest a couple of new exercises using dumbbells to provide the muscles with a new challenge. Be sure to watch for good form when the client tries new activities.
7–8	■ 5 d · wk^{-1} for moderate exercise, or	2 d · wk^{-1}; three sets, 8–10 reps of	3 d · wk^{-1}, minimum; 10 min of	Continue with the aerobic training program. For resistance training, consider doing three sets rather than two (this may require the

■ 3 d · wk^{-1} for vigorous exercise, or ■ 3–5 d · wk^{-1} for moderate and vigorous exercise	10 exercises[c]	stretching activities	client to cut back on reps to add the additional set).

[a]All activity sessions should be preceded and followed by a 5- to 10-min warm-up and cool-down.

[b]Include stretching activities after aerobic exercise to improve flexibility. For specific stretches to target the major muscle groups, see Chapter 16.

[c]Resistance training is more fully outlined in Chapter 14. Select one exercise for each of the following body areas: hips and legs, chest, back, shoulders, low back, abdominals, quadriceps, hamstrings, biceps, and triceps.

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Advanced training options can increase the challenge of an exercise program by manipulating current exercises through the FITT-VP principle.

For some clients, development of the skill-related components of physical fitness is a training goal. The skill-related components of physical fitness include the following (5):

- Speed refers to the ability to perform a movement within a short about of time (*e.g.*, a 100-m sprinter moving quickly toward the finish line).
- Agility refers to the ability to change the position of the body in space with speed and accuracy (*e.g.*, cutting in a new direction to successfully execute a play in basketball).
- Coordination refers to the ability to use the senses, such as sight and hearing, together with body parts in performing tasks smoothly and accurately (*e.g.*, returning a serve in racquet sports).

- Balance refers to the maintenance of equilibrium while stationary or moving (*e.g.*, performing gymnastic moves on top of a balance beam).
- Power refers to the rate at which one can perform work (*e.g.*, a defensive back runs through the offensive line to sack the quarterback before the ball is thrown).
- Reaction time refers to the time elapsed between stimulation and the beginning of the response (*e.g.*, a soccer ball kicked toward a goal and the goalie's reaction to block it).

These skill-related components can be achieved simultaneously through several types of advanced training options such as HIIT, high-velocity weight training, Olympic weightlifting, plyometric training, balance training, sport- and nonsport-specific agility, and coordination drills (see Table 13.9 for examples of activities involving the skill-related components of fitness).

Table 13.9 Activities/Exercises Involving Skill-Related Components of Physical Fitness

Skill Component	Activity/Exercise Examples
Speed	Sprint drills Plyometric exercises (high-intensity jumps, bounds, and sprints) High-velocity resistance training Mixed martial arts (speed bag punching, sparring)
Power	Olympic weightlifting (clean and jerk, snatch) High-velocity resistance training Plyometric exercises (box jumps, push-up claps) Medicine ball exercises (ball slams, passing exercises)
Agility	Plyometric exercises (multidirectional jumps, bounds, and sprints) Sport-specific agility drills (shuttle drills, lateral shuffle drills)
Reaction time	Stimulus-response exercises (sprints initiated by whistle/start gun, quick response sport-specific ball handling) Mixed martial arts (blocking exercises, sparring)
Coordination	Multisensory integration exercises (sport-specific ball handling drills, racquet sports drills, batting exercises) Multimovement weightlifting (clean and snatch) Mixed martial arts (sparring)

	Yoga/Pilates
Balance	Stability exercises (traditional exercises performed on an uneven surface such as a foam pad or BOSU ball) Yoga/Pilates Static stretching

Power, Agility, and Speed

Personal Trainers can use several advanced training methods, such as plyometric exercises, to train their clients to improve power, agility, and speed. Plyometrics refer to exercises that link strength with speed of movement to produce power and were first known simply as "jump training." Plyometric exercises begin with a quick stretch of the muscle fibers (the eccentric phase) and then followed by a fast shortening of the same muscle fibers (the concentric phase) (1). This mode of training may improve a client's ability to increase speed of movement and power production as well as increase agility levels because plyometric exercises often change directions rapidly.

Another training method Personal Trainers can use to improve their clients' fitness levels is power resistance training. Muscular power production is used in various movements in sports, work, and daily living. Power can be increased through resistance training and by performing repetitions of lower loads at a high velocity (22). Some resistance training options Personal Trainers can use to develop more power in their clients are high-velocity resistance training and Olympic weight training. Both modes of resistance training yield increases in power production.

Reaction Time, Coordination, and Balance

Balance, coordination, and reaction time are not only needed for recreational purposes but also used in daily routines. There are many exercises and drills that Personal Trainers can use to condition their clients that require them to jump, run, slide, and bound in nontraditional movement patterns that will develop their coordination, reaction time, and balance skills. All three of these skills involve muscle activation along with sensory integration to perform exercise-related tasks in a more highly skilled way. Flexibility exercises have been shown to increase balance and reaction time (1).

Anatomy of an Exercise Session

The components of an exercise training session include the following: warm-up, conditioning exercise, cool-down, and stretching. Although the focus of exercise sessions can vary widely, this framework is appropriate for various conditioning stimuli.

Warm-Up

The warm-up is, at a minimum, 5–10 minutes of low to moderate activity intended to literally warm-up the muscles in preparation for the conditioning phase. This transitional phase provides opportunity for the body to adjust from resting status to the higher physiological, biomechanical, and bioenergetic demands of the conditioning phase (5). Warm-up activities include cardiovascular and muscular endurance activities.

Conditioning Phase

The conditioning phase is the main focus of the exercise session and may include one or more of the following: cardiorespiratory (aerobic) exercise, resistance training, neuromotor activities, and sport-specific activities. The conditioning phase will follow the FITT principles described previously in this chapter and as will be covered in greater detail in the upcoming chapters in this section.

Cool-Down

The cool-down involves similar cardiovascular and muscular endurance activities as found in the warm-up, but now, the transition is from the higher intensity of the conditioning phase back toward resting status. During this time of low- to moderate-intensity activity, the body will experience a decrease in heart rate and systolic blood pressure, and metabolic end products (*e.g.*, lactate) produced during more intense activity will be removed. Allowing for a gradual return toward baseline will help the client avoid postexercise hypotension (low blood pressure) and potential dizziness (due to blood pooling in the legs rather than flowing back to the heart and brain). The cool-down should be at least 5–10 minutes, longer for higher intensity conditioning phase sessions (5).

Stretching

The stretching phase is considered distinct from the warm-up and cool-down phases (5). For adults in a general fitness program and for athletes in sports in which flexibility is important, stretching after the warm-up is typically recommended (5). Stretching can also be included after the cool-down. For some sports (*e.g.*, those focused on muscular strength, power, and endurance), some research suggests stretching following the activity rather than following the warm-up (5). When properly performed, even ballistic or "bouncing" stretches can be as effective as static stretches for increasing joint ROM in individuals engaging in activities that involve ballistic movements such as tennis or basketball (5).

SUMMARY

A complete fitness program provides many physiological and psychological benefits. With an understanding of these benefits, a Personal Trainer can provide clients with the appropriate guidance regarding cardiorespiratory exercise, resistance training, and flexibility exercises as well as balance training or skill-related activities as needed to achieve individual client goals.

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CHAPTER 14

Resistance Training Programs

OBJECTIVES

Personal Trainers should be able to:

- Define resistance training principles.
- Review how and why resistance training should be performed.
- Design, evaluate, and implement resistance training programs.
- Evaluate clients' resistance training needs and progress.

INTRODUCTION

Resistance training, also known as strength training or weight training, is a standard part of a comprehensive Personal Training program. A resistance training program can affect almost every system in the body and is used in a wide variety of populations. The benefits of resistance training are numerous and include increases in strength, muscle mass, and bone density. Almost every population can benefit from resistance training, from children preparing for youth sports to individuals trying to counteract the effects of the aging process (1,2).

> A resistance training program can affect almost every system in the body and is used in a wide variety of populations, from children preparing for youth sports to individuals trying to counteract the effects of the aging process.

The History and Science behind Resistance Training

At the end of the Second World War, Captain Thomas DeLorme, MD, experimented with the use of progressive resistance exercise as a rehabilitation modality for injured soldiers (3). A few years later, DeLorme and A. L. Watkins published the first paper in a scientific journal on the topic of long-term resistance training (3). After the initial work by DeLorme and Watkins, the most influential personalities in resistance training were Mr. Bob Hoffman of York Barbell Club, who pioneered the interest in Olympic-style weightlifting and weight training with free weights through his publications and sales of barbells and dumbbells, and Mr. Joe Weider and his brother Ben, who promoted the bodybuilding industry.

The science of resistance training did not pick up again until two notable former weightlifters and future scientists, Dr. Patrick O'Shea from Oregon State University and Dr. Richard Berger from Temple University, fueled an explosion of scientific work in the 1960s and 1970s (4,5). Since then, published research on resistance training has grown exponentially with a gradual widening in research focus from enhancing athletic performance to also improving health and fitness (6). Although resistance training programs are critical for athletic and sports performance, they have now become a foundation of a variety of rehabilitation disciplines from orthopedic to cardiac to obesity management programs. Research on resistance training now appears in many medical and scientific journals such as the American College of Sports Medicine's (ACSM) *Medicine & Science in Sports & Exercise* and the National Strength and Conditioning Association's *Journal of Strength and Conditioning Research* (7,8). Thousands of scientific articles examining various aspects of resistance training with regard to designing optimal exercise prescriptions across the population spectrum are in print. However, in addition to these legitimate research articles, an abundance of resistance training mythology continues to be touted in popular books, magazines, and on the Internet. A demanding challenge has been placed on the Personal Trainer to sift through and carefully evaluate the scientific evidence from the marketing ploys. Resistance training programs and protocols should be guided by scientific evidence and not by dubious testimonials. Personal Trainers are advised to follow evidence-based practices to promote safety and effectiveness for clients.

General Resistance Training Principles

The terms *resistance exercise* and *resistance training* are often used interchangeably; however, there is an important distinction between the two terms. Resistance exercise refers to a single exercise session, whereas resistance training refers to the combination of many consecutive resistance exercise sessions over time. Thus, a resistance exercise protocol is an exercise prescription for a single session (most commonly called a “workout”), and a resistance training program is an overall plan guiding the specific exercise parameters chosen for each exercise protocol (or in other words, a series of planned “workouts” with a specific goal).

> Resistance exercise refers to a single exercise session, whereas resistance training refers to the combination of many consecutive resistance exercise sessions over time.

Designing a resistance training program is a very individualized process, and the needs and goals of the client are paramount to the selection of program characteristics (Fig. 14.1) (9). However, be aware that although a client may be training to maximize muscle hypertrophy, the client will also develop some muscular strength and endurance. Thus, the program will be at the same time both specific and general. The general principles of any effective resistance training program are as follows:

- Specificity of training: Only the muscles that are trained will adapt and change in response to a given program. For this reason, resistance programs must target all muscles for which a training effect is desired.
- Specific Adaptations to Imposed Demands (SAID) principle: SAID indicates that the adaptation will be specific to the demands that the exercise places on the individual. For example, if a high number of repetitions are used, the muscles will increase their ability to perform a high number of repetitions (muscular endurance).
- Progressive overload: As the body adapts to a given stimulus, an increase in the stimulus is required for further adaptations and improvements. Thus, if the load or volume is not increased over time, progress will be limited.

- Variation in training: No one program should be used without changing the exercise stimulus over time. An example of increasing variety in training is periodized training.
- Periodization: The phasic manipulation of the training variables (volume, intensity, frequency, and rest intervals) as a means of optimizing desired physiological outcomes while concurrently reducing the incidence of overtraining. Periodization allows for optimal training and recovery time in a resistance training program.
- Prioritization of training: It is difficult to train for all aspects of muscular fitness. Thus, within a periodized training program, one needs to focus or prioritize the training goals for each training cycle. This technique is often used in athletics paralleling competitive season schedules.

FIGURE 14.1. Exercise prescription in resistance training is an individualized process that requires a series of steps from a needs analysis and goal setting to evaluations and making changes in the workouts over time.

Program Design Process

The key to a great program design is to identify the specific variables that need to be controlled to best predict and/or ensure the desired training outcomes. The most challenging aspect of resistance training exercise prescription is deciding which changes in program design will best meet an individual's training goals. Appropriate changes in the resistance training program are required over time. This means that sound decisions must take into consideration the needs of the sport or activity, the individual training response, and available testing data. Therefore, the resistance training exercise prescription is a continual process of planning, assessing, and changing.

Planning a resistance training exercise prescription allows one to quantify the exercise stimulus. Planning ranges from the initial development of a single exercise session to the variation of the training program over time. A successful Personal Trainer needs the ability to quantify a client's workout and evaluate progress made to ensure the program is safe and effective and will lead to optimal physical development of the client.

Training Potential

The gains made in any variable related to muscular performance will ultimately be linked to an individual's genetic potential. A deconditioned individual will likely achieve large initial gains because of the great adaptive potential available. As training proceeds, the rate of adaptation slows, as an individual approaches genetic limits. Over time, the physiological adaptation as measured from baseline will continue to increase albeit at a much slower rate. At this point in the training process, because gains are less noticeable, other goals for the resistance training program must be targeted to prevent the client from losing interest because of a lack of progress (9–12). Appreciation of the process by which adaptations occur over time is critical in developing an optimal program.

Initial Assessments

When working with a new client, Personal Trainers should always devote adequate time to evaluate the clients' prior resistance exercise experience and discuss their training goals carefully before beginning any exercise sessions. The initial assessment should include the following:

- A needs analysis focusing on learning about the client's personal goals and needs
- The intended time frame for achieving these goals
- Targeted areas or muscle groups
- Health issues (*e.g.*, cardiovascular disease, asthma, diabetes, osteoporosis, osteoarthritis, immune system disorders, neurological disorders), musculoskeletal limitations, recent surgeries, chronic injuries, sites of pain, and so on

Personal Trainers should try to understand the motivation underlying their clients' goals. In addition, Personal Trainers should assess the level of support their clients feel they have, available from family or friends (see Chapter 8 for additional discussion of social support). Finally, Personal Trainers should discuss any prior resistance training experience their clients have had in order to uncover potential challenges or barriers to training and develop appropriate strategies for motivation. Personal Trainers work with clients to develop strategies to overcome potential barriers to resistance training. These initial assessments will help Personal Trainers determine which muscle groups, energy systems, and muscle actions need to be trained and how these and the other acute program variables should be manipulated to meet the specific needs of the training program.

Before developing a resistance training program, Personal Trainers should take the time to conduct a baseline fitness assessment, consisting of anthropometric measurements (height, weight, circumferences, skinfolds, etc.), resting hemodynamics (heart rate, blood pressure), body composition, and tests of muscular strength and endurance (see Chapter 12 for more information on assessment). Determination of initial fitness is necessary to the development of an effective training program.

Muscular strength assessments include the one repetition maximum (1-RM) testing on a variety of exercises, especially those exercises that involve the major muscle groups such as bench press and squat, but only if tolerable to the client (13). The 1-RM test allows the Personal Trainer to determine loading values for a particular exercise. There are specific procedures that should be followed when conducting a 1-RM test to help ensure safety, reliability, and validity of the test (14). Although 1-RM is a measure of maximal strength, muscular power can be tested by using the medicine ball "put" for the upper body power assessment and the vertical jump test or standing long jump for the lower body muscular power assessment (14–17). Muscular endurance testing might include curl-ups, push-ups, or maximal amount of repetitions that can be performed at a given percentage of the 1-RM load (16,17).

Follow-up Assessments

It is exciting and motivating for clients to see improvements toward reaching their goals. To see these improvements, it is important that Personal Trainers keep records of their clients' progress. Individualized training logs are a useful tool for monitoring progress. These logs should record specific exercises, resistance or load, number of sets, and number of repetitions. Another possible measure to consider on the training log is a rating of perceived exertion (RPE) similar to what was discussed in Chapter 15. However, there is a resistance training–specific RPE, termed the *OMNI-Resistance Exercise Scale* (OMNI-RES) (18,19). Clients rank the last repetition of each set using a 0–10 scale (0 being extremely easy and 10 being extremely hard). This has been shown to be a valid and reliable tool that can be used to track and evaluate intensity of exercise (18,20), which can be used to track progress as well as for adjusting exercise prescription. The training log provides a record of the resistance and knowledge of performance of previous exercise sessions, which is necessary for assigning the appropriate resistance for successive sessions. Kept over time, these logs provide the Personal Trainer with a means to examine and evaluate program effectiveness or to identify areas of weakness.

Formal reassessment of a client's progress should occur periodically for encouragement but not so often that there has not been adequate time for noticeable changes to develop. For example, in individuals with little to no resistance training experience, significant gains in muscular strength can be seen in as little as a few training sessions, whereas those with extensive experience (greater than 2 y of consistent resistance training) alterations in muscular adaptation may be limited (21). As such, more frequent testing may be necessary for untrained individuals (such as once per month or every other month); however, for trained individuals, this might be best to test only once per year (22). These follow-up assessments should include the same measures as administered at the baseline assessment, including anthropometrics and tests of muscular strength, power, and endurance.

Based on these assessments, the concepts of progression, variation, and overload can be applied to the resistance training program to achieve optimal physiological adaptations and to accommodate changing fitness levels and goals of clients (9,23–25). These assessments give Personal Trainers a basis for modifying the short-term acute program variables, including choice of exercise, order of exercises, intensity, number of sets, set structure, rest periods, load or resistance, and repetition speed (23,26–29). Variation can be incorporated by altering joint angles and positioning, primary exercises versus assistance exercises, or multijoint exercises versus single-joint exercises to stress the muscles and joints specified by the client's needs analysis (26,30). Progressive overload can be accomplished by increasing the intensity and/or volume by increasing the resistance, number of sets, number of repetitions, or number of exercises or by decreasing or increasing the rest intervals (10–12,24,25,31,32).

Individualization

Each Personal Training client is unique and should be treated as such when it comes to their resistance training programming. Similar training programs provided to different clients will result in varied training responses. Therefore, skilled and effective Personal Trainers do not give standard programs to multiple clients. Exercises need to be modified to best suit the anatomical characteristics, needs, and abilities of each client. Additionally, the Personal Trainer must make modifications in the progression of the program based on the training response of the specific client. For example, different levels of chronological age and/or maturation may lead to differing effects of the same resistance training program (33). Adjustments to programs should focus on optimizing the individual's physiological adaptations.

Client Feedback

To design an effective resistance training program, the Personal Trainer needs to pay special attention to feedback from the client. Clients may request favorite exercises or muscle groups, or they may complain of pain or fatigue requiring program modifications. Personal Trainer must be alert to this feedback and encourage further feedback to ensure that the program and strategy meet the expectations of the client. This can be accomplished by asking the client for feedback, for example, "How do you think the workout went?" "Did you feel that you worked out hard enough? Too hard? Just right?" "What did you find went especially well or easier? What was particularly challenging?" These are examples of simplistic questions that are meant to help the Personal Trainer establish a repertoire/buy-in with the client. With time and practice, these questions can become more discerning, and the ongoing relationship with each client will allow for greater depth to ensure answers are truthful and fully transparent. With such information, appropriate programming adjustments can be made. In addition, always pay attention to physical signs of overuse or exhaustion, such as dizziness, light-headedness, complexion changes, profuse sweating, facial expressions, and muscular exhaustion. Clearly, working a client to the point of vomiting or passing out is not safe and will not leave a good impression with clients or any spectators who are present when medical attention arrives.

Of special concern for Personal Trainers is the careful and proper progression in the resistance training program, especially for beginners or those coming back from an injury lay off. Too much exercise, too heavy of exercise, and/or accentuated eccentric exercise can lead to an excessive amount of muscle tissue damage and breakdown. This can result in delayed-onset muscle soreness (DOMS) or in extreme cases rhabdomyolysis (34–37).

Rhabdomyolysis is a clinical pathology that is characterized by the rapid breakdown of muscle tissue resulting in high amounts of intramuscular proteins (*e.g.*, myoglobin, myosin protein) entering into the blood stream that are potentially harmful to kidneys and can cause kidney failure and sometimes death (37–39).

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The most common manifestation of muscle injury is DOMS. DOMS symptoms are a first sign that the individual has done too much too soon. DOMS is a condition of heightened postexercise soreness that presents in the initial 24–48 hours after the exercise session and may last upward of 5–7 days (34,35,40,41). Although some swelling, pain, and soreness are common and classical signs of muscle tissue adaptation following a workout, DOMS should *not* be considered a goal of the training program (*i.e.*, no pain no gain). If these symptoms are extreme, tissue damage may be more serious, and DOMS is likely to reduce training potential as well as having a deleterious effect on performance (40,41).

To reduce the instances of DOMS and prevent rhabdomyolysis, Personal Trainers carefully progress the client to heavier loads with prudent volume changes, thus allowing for adequate recovery from each workout. A simple Likert-type (Box 14.1) scale can be used to gauge the level of soreness for the client. Individuals having a score of 3 or more should have the resistance intensity and/or volume reduced dramatically and should increase the amount of rest allowed in a periodized training program. Although some muscle soreness is a normal result of muscular adaptation, extreme soreness is a sign of physiological overshoot.

Box 14.1 Likert-Type Chart to Determine Muscle Soreness

0	
1	Minor soreness
2	
3	Moderate soreness
4	
5	Extreme soreness
6	

Symptoms of rhabdomyolysis include severe muscle aches, weakness, and extremely dark reddish-brown urine. Kidney shock and acute renal failure can develop in up to 2 days after major tissue trauma. If rhabdomyolysis is suspected, seek medical help immediately.

Personal Trainers should always explain the muscle group(s) that the exercise is intended to target, and clients should be taught how to differentiate between muscle fatigue and soreness, and extreme soreness, pain, or injury. Clients must be told that new exercises often feel uncomfortable or awkward, but that if pain is felt in any joint or nonsynergistic or stabilizer muscle, that exercise should be discontinued. The exercises should be stopped immediately if the client complains of pain or the Personal Trainer suspects that the client is in pain. The last thing a Personal Trainer wants to do is induce or aggravate an injury.

Feedback from the client can also come from paying close attention to the technique of the client during an exercise. Deterioration in technique often results from fatigue, insufficient flexibility in the range of motion (ROM), too heavy of a load, or even low technical ability of the client. It should also be noted that technique depends on the individual exercise. That stated, proper exercise technique should always be a priority. When technique is compromised during an exercise, the exercise should be either stopped or modified to reestablish correct technique to avoid injury.

In summary, it is important to properly assess workouts and prevent extreme muscle injury from occurring. The resistance load and volume of training need to be carefully progressed and monitored to limit muscle tissue damage and develop a physiological toleration to heavier resistance and volumes of exercise stress. Emphasizing proper technique and paying attention to the basic principle of progression are important to an effective and safe exercise prescription.

Setting and Evaluating Goals

Optimal program design needs to be individualized for each client's goals. Personal Trainers encounter an assortment of clients with a plethora of goals, including weight loss; weight gain; building strength; building muscle; improving overall health; improving speed, agility, power, balance, and coordination; decreasing blood pressure or cholesterol level; managing diabetes and other chronic diseases; injury rehabilitation; or sport-specific training. Often, the desired goals of clients are unrealistic. When improvements do not meet expectations, motivation can be lost, frustration may set in, and nonadherence to the program can occur. Therefore, it is crucial that the Personal Trainer help the client understand what realistic and obtainable goals are, considering the time course, the individual's training history and status, fitness level, and genetic potential. The expectations of the client must be realistic and measurable (see Chapter 8), considering the physiological time course of neural and cellular adaptations. Goal setting and time frame, as well as the individual's age, physical maturity, training history, and psychological and physical tolerance, should also be considered. Progression toward the goals must be gradual to minimize the risk of injury.

Common program goals in resistance training are related to improvements in function, such as increased muscular strength, power, and local muscular endurance, or decreased body fat (Fig. 14.2). Other functional gains such as increased coordination, agility, balance, and speed are also common goals of a program. Factors such as balance may have implications for injury prevention by limiting falls in older individuals. Other goals may relate to physiological changes related to increased body mass through muscle hypertrophy, improved blood pressure, decreased body fat, and increased metabolic rate for caloric expenditure.

FIGURE 14.2. Setting goals and evaluating progress in a resistance training program are vital to realistic progress and gains.

For the most part, training goals or objectives should be measurable variables (*e.g.*, 1-RM strength, vertical jump height, and fat mass loss) so that one can objectively judge whether or not gains were made or goals were achieved. Examination and evaluation of a workout log is invaluable in assessing the effects of various resistance training programs. Formal strength tests to determine functional changes in strength can be done on a variety of equipment, including isokinetic dynamometers, free weights, and machines. Using the results of these objective tests can help in modifying the exercise program to reach previous training goals or to develop new goals.

Athletic performance and good health are not always the same thing. A person being a competitive athlete does not mean that he or she makes healthy choices or has a healthy lifestyle. Many elite athletes train in ways that far exceed what is recommended for good health (*e.g.*, lifting 7 $d \cdot wk^{-1}$ or running 140 miles in a week or training 4–6 $h \cdot d^{-1}$). In fact, they may actually do exercises that would be considered contraindicated for the average healthy person. Thus, goals in resistance training have to be put in the context of the desired outcome not only for each individual but also within what is healthy.

Athletic performance and good health are not always the same thing.

Maintenance of Training Goals

A concept called "capping" may need to be applied to various training situations in which small gains will require very large amounts of time to achieve, and yet, in the long run, these small gains are not necessary for success. Capping a training goal is a tough decision that comes only after an adequate period of training time and observation of what the realistic potential for further change is for a particular variable. This may be related to a performance goal (*e.g.*, bench press 1-RM strength) or some form of physical development (*e.g.*, calf size). At some point, one must make a value judgment on how to best spend training time. By not adding any further training time to develop a particular muscle characteristic (*e.g.*, strength, size, and power), one decides that the current gains are "good enough," and it is time to go into a maintenance training program. Thus, more training time is available to address other training goals. Ultimately, this decision may result in greater total development of the individual.

Decisions such as capping are part of the many types of clinical decisions that must be made when monitoring the progress of resistance training programs. Are the training goals realistic in relation to the sport or health enhancement for which the client is being trained? Is the attainment of a particular training goal vital to the program's success? These difficult questions need to be continually asked in the goal development phase of each training cycle for any program.

Unrealistic Goals

Too often, goals are open-ended and unrealistic. Careful attention must be paid to the magnitude of the performance goal and the amount of training time needed to achieve it. Although scientific studies may last up to 6 months, most real-life training programs are developed as a part of a lifestyle for an individual's sports career or whole life. Over time, clients' goals change, and thus, resistance training programs must also change to reflect these changing needs.

Goals may at times exceed the reality of genetic limitations. For example, some men desire near impossible and extreme muscle size (*e.g.*, 23-in biceps, 36-in thighs, 20-in neck, and 50-in chest) or strength (*e.g.*, 400-lb bench press), or in contrast, some women desire drastic decreases in body weight and limb size and/or shape. Genetic limits in anatomical structure or somatotype may make these changes unattainable (42,43). Ultimately, for both men and women, goals must be carefully and honestly examined to determine if the resistance training program can actually stimulate the changes desired.

> For both men and women, goals must be carefully and honestly examined to determine if the resistance training program can actually stimulate the changes desired.

Big marketing of the newest high-tech fitness equipment and training programs can also create unrealistic training expectations in clients. Airbrushed pictures of movie actors and models advertising a specific program or product project body images that are desired but totally unobtainable. Most people make mistakes in goal development by wanting too much too soon, with too little effort expended. Making progress in a resistance training program requires a long-term commitment to a total training program. Thus, resistance training is one aspect of an overall healthy lifestyle that includes cardiovascular conditioning and proper nutrition.

Resistance Training Modalities

Many different training tools (*e.g.*, free weights, machines, and medicine balls) can be used in resistance training programs. Each tool fits into a category of training, which has certain inherent strengths and weaknesses. The modality chosen should depend on the accessibility of equipment, needs, goals, experiences, and limitations of the client.

Variable-Resistance Devices

Variable-resistance equipment operates through a lever arm, cam, or pulley arrangement. Its purpose is to alter the resistance throughout the exercise's ROM in an attempt to match the increases and decreases in strength (*i.e.*, strength curve). Proponents of variable-resistance machines believe that by increasing and decreasing the resistance to match the exercise's strength curve, the muscle is forced to contract maximally throughout the ROM, resulting in maximal gains in strength.

There are three major types of strength curves: ascending, descending, and bellshaped (Fig. 14.3). In an exercise with an ascending strength curve, it is possible to lift more weight if only the top one-half or one-fourth of a repetition is performed rather than if the complete ROM of a repetition is performed. For example, an exercise with an ascending strength curve is the squat exercise. If an exercise has a descending strength curve, it is possible to lift more weight if only the bottom half of a repetition is performed. Such an exercise is upright rowing. A bell-shaped curve is an exercise in which it is possible to lift more resistance, if only the middle portion of the ROM is performed and not the beginning or end portions of the ROM. Elbow flexion has a bell-shaped strength curve. Because there are three major types of strength curves, variable-resistance machines have to be able to vary the resistance in three major patterns to match the strength curves of all exercises (44). To date, this has not been accomplished. Additionally, because of variations in limb length (point of attachment of a muscle's tendon to the bones) and body size, it is hard to conceive of one mechanical arrangement that would match the strength curve of all individuals for a particular exercise (44–46).

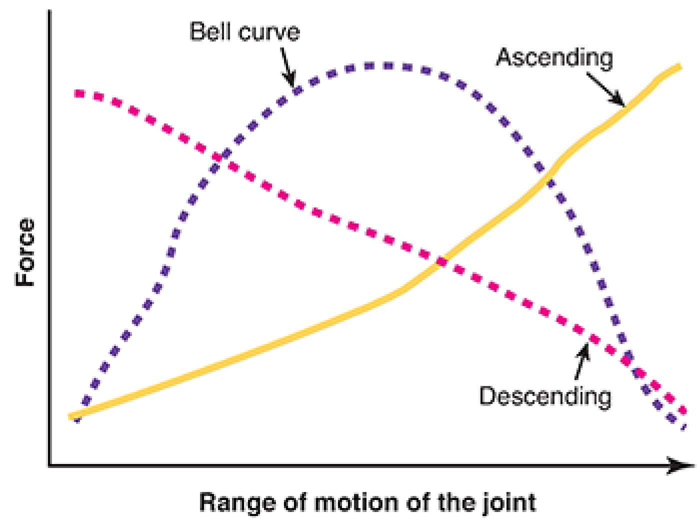


FIGURE 14.3. Three basic strength curves exist for every exercise, with hybrids of them for certain movements.

Biomechanical research indicates that certain types of cam-operated variable-resistance equipment do not match the strength curves of specific exercises such as the elbow curl, fly, knee extension, knee flexion, and pullover exercises (47–53). For example, one type of cam equipment was shown to match the strength curves of females fairly well (54), although not for all aspects of each exercise. For example, in women, the cam resulted in too much resistance near the end of the knee extension exercise and provided too much resistance during the first half and too little during the second half of elbow flexion and extension. The knee flexion machine matched the female's strength curve well throughout the ROM. This research indicates that not all machines are appropriate for all populations or for all exercises.

Elastic resistance bands have become popular within the fitness world because they are relatively easy to work with and less intimidating to clients. Although very effective as a training modality (55) if the resistance can be heavy enough (56), care must be taken when using elastic bands with certain types of exercises that do not match the ascending strength curve. A possible drawback to elastic bands is that the constantly increasing resistance offered as the band is stretched. In other words, elastic bands have a resistance pattern that only matches an ascending strength curve. At the beginning of a muscle flexion, the resistance is low, and at the end of the flexion, the resistance is very high. If the setup is not correct, only part of the muscle involved in the latter part of the flexion may be optimally stimulated. Thus, proper starting angle, band fit, and stretch are essential for optimal training outcome. Also, because of the physics of elastic bands, the resistance during the extension phase will be lower than that during the flexion phase, again reducing the training stimulus. In addition, elastic bands give minimal feedback to clients or trainers in that the resistance cannot be quantified.

Dynamic Constant External Resistance Devices

Isotonic is traditionally defined as a muscular contraction in which the muscle exerts a constant tension. The execution of free-weight exercises and exercises on various weight training machines, although usually considered isotonic, is not by nature isotonic. The force exerted by a muscle in the performance of such exercises is not constant but varies with the mechanical advantage of the joint involved in the movement and the length of the muscle at a particular point in the movement. A more workable definition of isotonic is a resistance training exercise in which the external resistance or weight does not change and both a lifting (concentric) phase and a lowering (eccentric) phase occur during each repetition. Thus, free-weight exercises and exercise machines that do not vary the resistance are isotonic in nature. Because there is confusion concerning the term *isotonic*, the term *dynamic constant external resistance training* has been adopted.

The types of devices used for dynamic constant external resistance include dumbbells, barbells, kettle bells, weight machines, sandbags, and medicine balls. These are generally devices that do not use pulleys or levers. The major disadvantage to this type of device is that it does not stimulate the neuromuscular systems involved maximally throughout the entire ROM. The changes in the musculoskeletal leverage occurring during a movement also change the force requirement and thus the exercise stimulus. However, these types of devices require recruitment of muscles, other than the primary movers of an exercise, to act as stabilizers. This increases the total amount of physiological work the body must do to perform the exercise as well as providing exercise stimuli to the stabilizing muscles that are very important in a real-world setting or for athletic performance. These types of modalities are referred to as “free form” exercises because they operate in multiple dimensions of space (frontal, sagittal, and transverse planes). Other benefits to most constant external resistance devices include little or no limitation in the ROM allowed and easy adaptation of the exercise to accommodate individual differences such as the clients’ body size or physical capabilities. Equipment fit is also not a limiting factor for large and small body sizes and limb lengths.

Static Resistance Devices

Specialized static or isometric contraction devices, in which a person pulls or pushes against an immovable resistance, are not as commonly used in Personal Training. That state, pushing an overloaded barbell against the safety racks, or using a wall or partner for an isometric contraction, can be used for an individual to overcome a sticking point, and this form of resistance exercise is called “functional isometrics.” Meaning that isometric training can be effective for superior joint angle specific strength (57). Isometrics or static resistance training refers to a muscular action in which no change in the length of the muscle takes place. This type of resistance training is normally performed against an immovable object such as a wall, barbell, or weight machine loaded beyond the maximal concentric strength of an individual.

Isometrics can also be performed by having a weak muscle group contract against a strong muscle group (*e.g.*, trying to bend the left elbow by contracting the left elbow flexors maximally while resisting the movement by pushing down on the left hand with the right hand with just enough force to prevent any movement at the left elbow). If the left elbow flexors are weaker than the right elbow extensors, the left elbow flexors would be performing an isometric action at 100% of a maximal voluntary contraction (MVC).

Increases in strength resulting from isometric training are related to the number of muscle actions performed, the duration of the muscle actions, whether the muscle action is maximal or submaximal, the angle at which the exercise is performed, and the frequency of training. Recommendations for muscular hypertrophy include isometric contractions at 70%–75% of MVC for 3–30 seconds per contraction with a total duration of 80–150 seconds per session. For maximal strength gains, isometric contractions should be performed at 80%–100% MVC for 1–5 seconds with a total contraction time of 30–90 seconds per session (57). Isometric exercises are thought to strengthen muscle fibers within 15° of the position being held isometrically, and therefore, clients should perform multiple positions with isometric contraction to ensure full ROM strengthening. Also, isometric training is good for individuals with joint disorders in which pain is elicited by motion (*i.e.*, rheumatoid arthritis).

Other Resistance Devices

Isokinetic devices allow one to maintain a maximum resistance throughout the whole ROM by controlling the speed of the movement. These devices use friction, compressed air, or pneumatics, which often allow for both the concentric and the eccentric component of a repetition, or hydraulics for the concentric component of a repetition. Isokinetic exercises, although popular in the rehabilitation setting, have never caught on as a typical modality used in a weight room. The initial excitement for this training modality was related to the ability to train at fast velocities similar to the high-speed movements seen in sport and real life. Isokinetic refers to a muscular action performed at constant angular limb velocity. Unlike other types of resistance training, there is no set resistance to meet; rather, the velocity of movement is controlled. The resistance offered by the isokinetic machine cannot be accelerated; any force applied against the equipment results in an equal reaction force. The reaction force mirrors the force applied to the equipment by the user throughout the range of movement of an exercise, making it theoretically possible for the muscle(s) to exert a continual, maximal force through the movement's full ROM.

Pneumatic resistance (compressed air) exercise has become relatively popular because it allows both the concentric and eccentric portions of a repetition and can be adjusted during a repetition or a set of exercises with handheld buttons. In addition, with no deceleration, it can be used effectively to train power with joint exercises not possible with conventional machines. Power is as important for older adults to maintain function as it is for athletes' performance. Because of the fixed nature of the configuration for most pneumatic machines, they are unable to address key factors such as balance and control in a multidimensional environment.

Hydraulics equipment has also become more popular with many fitness clubs promoting it as a safe and nonintimidating form of resistance exercise. Although this modality has no deceleration in its repetition range and has been used as a type of power training modality, it also has no eccentric component, which limits its efficiency as twice the number of repetitions may be required to get the same effect as a typical concentric–eccentric repetition (58,59). Training the eccentric phase is important to protect the body from injury and also to enhance the ability to recover from injury. Furthermore, concentric-only training appears to be less resistant to detraining (60,61).

Machines versus Free-Weight Exercises

A topic of great debate, especially in the health and fitness world, is the use of free weights versus machine resistance exercises. These different exercise modalities were discussed previously in the sections on constant external resistance and variable-resistance devices. The following is a comparison of the two modalities.

A topic of great debate, especially in the health and fitness world, is the use of free weights versus machine resistance exercises.

1. Machines are not always designed to fit the proportions of all individuals. Clients who are obese; who have special physical considerations or disabilities; and who are shorter, taller, or wider than the norm may not be able to fit comfortably in the machines. In contrast, free-weight exercises can easily be adapted to fit most clients' physical size or special requirements.
2. Machines use a fixed ROM; thus, the individual must conform to the movement limitations of the machine. Often, these movements do not mimic functional or athletic movements. Free weights allow full ROM, and the transfer to the real-world movements is greater than that for machines.
3. Most machines isolate a muscle or muscle group, thus negating the need for other muscles to act as assistant movers and stabilizers. Free-weight exercises almost always involve assisting and stabilizing muscles. On the other hand, if the goal is to isolate a specific muscle or muscle group, as in some rehabilitation settings or because of physical disabilities, machine exercises may be preferred.
4. Although it is never advisable to perform resistance exercise alone, machines do allow greater independence because the need for a spotter or helper is usually diminished once the client has learned the technique of the exercise. However, there is a misconception of extra safety that may lead to a lack of attention being paid to the exercise. Injuries are still possible when using machines, specifically when there is a breakdown in lifting form or improper seat height, lifting form, and/or joint alignment.

5. Machine exercises may be more useful than free-weight exercises in some special populations. One reason for this is that machines are often perceived to be less intimidating to a beginner. As the resistance training skill and experience level increases, free-weight exercise can gradually be introduced, if desired. However, it is important to inform clients of the benefits that free weights have compared with machines (*e.g.*, increased musculoskeletal loading that reduces the risk of developing osteoporosis, improved balance).
6. Certain free-weight exercises (*e.g.*, Olympic-style lifts) and hydraulic and pneumatic machines allow training of power because no joint deceleration occurs. (It should be noted that a certain amount of deceleration does occur during the lockout of the catch phases for various Olympic lift and free-weight movements.)
7. Rotational resistance accommodates certain body movements (*e.g.*, shoulder adduction) that would be difficult to work through a full ROM with free weights.

From the comparison earlier, it seems that variable-resistance devices (machines) in general are at a comparative disadvantage to constant resistance devices (free weights). However, machine exercises are still recommended for certain populations and can be very useful when used appropriately. In fact, a safe and optimally effective resistance training program involves a combination of both free-weight and machine exercises, taking into consideration many aspects of the client's needs and the advantages of the different modalities. Both modalities can be used to add variation to the training program and are effective "tools" in a Personal Trainer's "tool box." To summarize, for the general population, a combination of free weights and variable-resistance machines are generally most effective. Machines and other variable-resistance devices are recommended as an adjunct to a free-weight training program in midlevel and advanced clients.

For the general population, a combination of free weights and variable-resistance machines are generally most effective.

The Needs Analysis

Before designing a training program, a needs analysis of the client should be performed to design the most effective program. Once the needs and goals of the client have been established, the Personal Trainer can address questions that will come up when designing the workout using the acute program variables.

A needs analysis for strength training involves answering some important initial questions that affect the program design components (13,62,63). The needs analysis requires that the following questions be considered:

1. What is the main goal of the resistance training program?
2. What muscle groups need to be trained?
3. What are the basic energy sources (*e.g.*, anaerobic, aerobic) that need to be trained?
4. What type of muscle action (*e.g.*, isometric, eccentric actions) should be used?
5. What are the primary sites of injury for the particular sport or prior injury history of the individual?

Resistance Training Goals

The first question to be asked of the client concerns the main goal for the resistance training program. A discussion with the client of what type of outcome (*i.e.*, general health, muscular strength, muscular endurance, muscular hypertrophy, and/or muscular power) he or she desires will help the Personal Trainer develop an appropriate program. Each of the aforementioned program goals will require a different program design to optimize the stated goals. Reviewing these with the client allows for discussion of realistic expectations and time commitments before continuing with more extensive program evaluation procedures.

Biomechanical Analysis to Determine Which Muscles Need to Be Trained

In determining the client's needs and goals, an examination of the muscles and the specific joint angles to be trained needs to be conducted. For any activity, including a sport, this involves a basic analysis of the movements performed and the most common sites of injury. With the proper equipment and a background in basic biomechanics, a more definitive approach to this question is possible. With the use of a slow-motion videotape, a Personal Trainer can better evaluate specific aspects of movements and can conduct a qualitative analysis of the muscles, angles, velocities, and forces involved. The decisions made at this stage help define one of the acute program variables — choice of exercise.

Specificity is a major tenet of resistance training and is based on the concept that the exercises and resistances used should result in training adaptations that will transfer to better performance in sport or daily activity. Resistance training is used because it is often difficult, if not impossible, to overload a sport skill or other physical movement without risk of injury or dramatically altering skill technique. Specificity assumes that muscles must be trained similarly to the sport or activity in terms of the following:

- The joint around which movement occurs
- The joint ROM
- The pattern of resistance throughout the ROM (ascending, descending, or bell-shaped)
- The pattern of limb velocity throughout the ROM
- The types of muscle contraction (*e.g.*, concentric, eccentric, or isometric)

Resistance training for any sport or activity of daily living should include full ROM exercises around all the major body joints. For example, for general fitness and muscular development, the major muscle groups of the hips and legs, chest, back, shoulders, low back, and abdominals should be the training focus. For those who are interested in enhancing sport performance, specific sport activity movements should be included in the workout to maximize the contribution of strength training to those movements. The best way to select appropriate exercises is to biomechanically analyze, in quantitative terms, the sport or physical activity (64). Unfortunately, such analyses of each sport or activity are not readily available to the Personal Trainer. Thus, the Personal Trainer must use biomechanical principles in a qualitative manner to intelligently select exercises. Ideally, this analysis should be followed up with appropriate resistance exercises in the weight room that train the specific muscles and joint angles involved.

Biomechanical principles can be used in a qualitative manner to intelligently select exercises.

Transfer Specificity

Each resistance exercise used in a program will have various amounts of transfer to another activity, referred to as "transfer specificity." When training for improved health and well-being, transfer is related to its effects on specific clinical outcomes (*e.g.*, bone mineral density). However, training for enhancing sport performance requires equally specific exercises. Every training activity has a percentage of carryover to other activities, but no conditioning activity has perfect carryover. Although some activities have a higher percentage of carryover than others, because of similarities in neuromuscular recruitment patterns, energy systems, and biomechanical characteristics, only by practicing the exact task (*e.g.*, lifting groceries or shoveling snow) or sport (*e.g.*, running or basketball) itself is the training 100% transferred.

Unfortunately, most of the time, one cannot use the specific sport or activity as the training stimulus because it is not possible or safe to gain the needed "overload" on the neuromuscular system. Thus, this is why resistance training is used in the conditioning process. The optimal training program needs to maximize carryover to the sport or activity.

Determining the Energy Sources Used in the Activity

Performance of every sport or activity uses a percentage of all three energy sources. The energy sources (see Chapter 5) to be trained have a major impact on the program design. Resistance training usually stresses the anaerobic energy sources (adenosine triphosphate–creatine phosphate [ATP–CP] energy source and glycolytic energy source) more than aerobic metabolism (65). Individuals who have gained initial cardiovascular fitness will have difficulty improving maximal oxygen consumption values using conventional resistance training alone (66). However, resistance training can be used to improve endurance performance by improving running/cycling efficiency and economy (67). In addition, systematic reviews of the literature have reported that concurrent resistance and endurance training has a positive effect on endurance performance among well-trained runners and cyclists (67–69).

Selecting a Resistance Modality

Decisions regarding the use of isometric, dynamic concentric, dynamic eccentric, and isokinetic modalities of exercise are important in planning *any type* of resistance training program. Not all equipment uses concentric and eccentric muscle actions, and this can impact training effectiveness (*e.g.*, hydraulics) (70). Whether for sport, fitness, or rehabilitation, basic biomechanical analysis is used to decide which muscles to train and to identify the type of muscle action is involved in the activity. Most resistance training programs use several types of muscle actions.

Injury Prevention Exercises

Personal Trainers need to know the prior injury profile of their client and the common sites of potential injury from the sport or recreational activity performed or other daily activities. The prescription of resistance training exercises will be directed at enhancing the strength and function of tissue to better resist injury, enhance recovery if injured, and minimize the extent of damage related to an injury. The term *prehabilitation* (the opposite of rehabilitation) has become popular. Prehabilitation refers to preventing initial injury by training the joints and muscles that are most susceptible to injury in an activity (such as a rotator cuff program for throwing athletes). The prevention of reinjury is also an important goal of a resistance training program. Thus, understanding the sport's or activity's typical injury profile (*e.g.*, knees in downhill skiing, elbows and shoulders in baseball pitching, extended hours sitting or standing for work) and the individual's prior history of injury can help in properly designing a resistance training program.

Acute Program Variables

Developed more than 20 years ago, the paradigm of acute program variables allows one to define every workout (63). Every resistance exercise protocol or workout is derived from five acute program variables. The classical acute program variables are (a) choice of exercises, (b) order of exercises, (c) amount of resistance and number of repetitions, (d) number of sets, and (e) duration of rest periods between sets and exercises. In turn, the choices made for each of these variables define the exercise stimuli and ultimately, with repeated exposure, the training adaptations. Essentially, the choices made for the specific combination of acute program variables create an exercise stimulus "fingerprint" that is specific and unique to that workout protocol. Thus, by making specific choices for the acute program variables that are related to the needs and goals of the client, the Personal Trainer is able to create many different types of workouts (6).

The classical acute program variables are (a) choice of exercises, (b) order of exercises, (c) amount of resistance and number of repetitions, (d) number of sets, and (e) duration of rest periods between sets and exercises.

Choice of Exercises

The choice of exercise will be related to the biomechanical characteristics of the goals targeted for improvement. The number of possible joint angles and exercises is almost as limitless as the body's functional movements. As muscle tissue that is not activated will not benefit from resistance training, the exercises should be selected, so they stress the muscles, joints, and joint angles specified by the client's needs analysis. To aid the Personal Trainer in making the correct choices, exercises can be divided into several different categories based on their function and/or muscle involvement.

Exercises can be designated as primary exercises or assistance exercises. Primary exercises train the prime movers in a particular movement and are typically major muscle group exercises (*e.g.*, leg press, bench press, hang pulls). Assistance exercises are exercises that train predominantly a single muscle group (*e.g.*, triceps press, biceps curls) that aids (synergists or stabilizers) in the movement produced by the prime movers.

Exercises can be classified as multijoint or single-joint exercises. Multijoint exercises require the coordinated action of two or more muscle groups and joints. Power cleans, power snatches, dead lifts, and squats are good examples of whole-body multijoint exercises. The bench press, which involves movement of both the elbow and shoulder joints, is also a multijoint, multimuscle group exercise, although it involves only movement in the upper body. Some examples of other multijoint exercises are the lat pull-down, military press, and squat. Exercises that attempt to isolate a particular muscle group's movement of a single joint are known as single-joint and/or single-muscle group exercises. Biceps curls, knee extensions, and knee curls are examples of isolated single-joint, single-muscle group exercises. Many assistance exercises may be classified as single-muscle group or single-joint exercises.

The inclusion of both bilateral (both limbs) and unilateral (single limb) exercises in a program will ensure proper balance in the development of the body. Bilateral differences in muscle force production can be developed with one limb working harder on every repetition than the other, leading to an obvious force production deficit and imbalances between limbs. Unilateral exercises (*e.g.*, dumbbell biceps curl) play an important role in helping maintain equal strength in both limbs.

Multijoint exercises require neural coordination among muscles and thus promote coordinated multijoint and multimuscle group movements. Although multijoint exercises require a longer initial learning or neural phase than single-joint exercises (71), including multijoint exercises in a resistance training program is crucial, especially when whole-body strength movements are required for a particular activity. Multijoint exercises activate several different muscle groups at the same time and thus are time-efficient. Therefore, they can be especially useful for an individual or a team with a limited amount of time for each training session. Other benefits of multijoint exercises include enhanced hormonal response and greater metabolic demands. Be aware that many multijoint exercises, especially those with an explosive component, require advanced lifting techniques (*e.g.*, power cleans, power snatches). These exercises need additional coaching, practice, and skill development beyond the basic movement patterns. Almost all sports and functional activities in everyday life (*e.g.*, climbing stairs) depend on structural multijoint movements. Whole-body strength/power movements are the basis for success in most sports. Clearly, all running, jumping, or striking activities, as well sport-specific movements such as tackling in American football, a takedown in wrestling, or hitting a baseball, depend on whole-body strength/power movements. Thus, incorporating multijoint exercises in a resistance training program is important for all competitive or recreational athletes.

Order of Exercises

The order in which exercises are performed is an important acute program variable that affects the quality and focus of the workout. ACSM recommends that by exercising the larger muscle groups first, a superior training stimulus is presented to all of the muscles involved (9). Exercising the larger muscles first is thought to stimulate optimal neural, metabolic, endocrine, and circulatory responses, which may augment the training response to subsequent exercises later in the workout. This concept also applies to the sequencing of multijoint and single-joint exercises. The more complex multijoint technique-intensive exercises (*e.g.*, power cleans, squats) should be performed initially followed by the less complex single-joint exercises (*e.g.*, leg extension, biceps curls).

The rationale for this exercise sequencing recommendation is that the exercises performed in the beginning of the workout require the greatest amount of muscle mass and energy for optimal performance. This has been observed (72) during resistance exercise, where multiple-set performance was affected by order of exercise, meaning volume was greater when the exercise was placed at the beginning of a workout. These sequencing strategies focus on attaining a greater training effect for the large muscle group exercises. If multijoint exercises are performed early in the workout, more resistance can be used because of less fatigue in the smaller muscle groups that assist the prime movers during the multijoint exercises. Also, alternating upper and lower body exercises and/or pushing and pulling exercises allows more time for the assisting muscles to recover between exercises.

If multijoint exercises are performed early in the workout, more resistance can be used because of less fatigue in the smaller muscle groups that assist the prime movers during the multijoint exercises.

Because the order of exercise affects the outcome of a training program, it is important to have the exercise order correspond to the specific training goals. In general, the sequence of exercises for both multiple and single muscle group exercise sessions should be as follows:

1. Large muscle group before small muscle group exercises
2. Multijoint before single-joint exercises
3. Alternate push/pull exercises for total body sessions
4. Alternate upper/lower body exercises for total body sessions
5. Explosive/power type lifts (*e.g.*, Olympic lifts) and plyometric exercises before basic strength and single-joint exercises
6. Exercises for priority weak areas before exercises for strong areas
7. Most intense to least intense (particularly when performing several exercises consecutively for the same muscle group)

Resistance and Repetitions

The amount of resistance used for a specific exercise is one of the key variables in any resistance training program. The resistance is the major stimulus related to changes observed in measures of strength, hypertrophy, and local muscular endurance. When designing a resistance training program, the resistance for each exercise must be chosen carefully. The use of either RMs (the maximal load that can be lifted, the specified number of repetitions) or the absolute resistance, which allows only a specific number of repetitions to be performed, is the easiest method for determining resistance. Typically, a single training RM target (*e.g.*, 10-RM) or an RM target range (*e.g.*, 3–5 RM) is used. The absolute resistance is then adjusted to match the changes in strength over the training program. Every set is done until failure (*e.g.*, momentary muscular fatigue) to ensure that the resistance used corresponds to the prescribed number of repetitions. This is because performing 3–5 repetitions with a resistance that allows for only 3–5 repetitions produces very different results than performing 13–15 repetitions using a resistance that would allow for only 13–15 repetitions.

When designing a resistance training program, the resistance for each exercise must be chosen carefully.

Another method of determining resistances for an exercise involves using a percentage of the 1-RM (*e.g.*, 70% or 85% of the 1-RM). If the client's 1-RM for an exercise is 200 lb (90.7 kg), a 70% resistance would be 140 lb (63.5 kg). This method requires that the maximal strength in all exercises used in the training program must be evaluated regularly. In some exercises, percentage of 1-RM needs to be used, as going to failure or near-failure is not practical (*e.g.*, power cleans, Olympic-style lifts). Without regular 1-RM testing (*e.g.*, each week), the percentage of 1-RM actually used during training, especially at the beginning of a program, will decrease, and the training intensity will be reduced. From a practical perspective, the use of percentages of 1-RM as the resistance for many exercises may not be administratively effective because of the amount of testing time required. In addition, for beginners, the reliability of a 1-RM test can be poor. Instead, by using the RM target or RM target range, the Personal Trainer has the ability to alter the resistance in response to changes in the number of repetitions that can be performed at a given absolute resistance.

As is the case for any of the acute program variables, the loading intensity should depend on the goal and training status of the client. The intensity of the loading (as a percentage of 1-RM) has an effect on the number of repetitions that can be performed and vice versa. The number of repetitions that can be performed at a given intensity ultimately determines the effects of training on strength development (73). If a given absolute resistance allows a specific number of repetitions (defined as the RM), then any reductions in the number of repetitions without an increase in the resistance will cause a change in the training stimulus. In this case, the change in the stimulus will lead to a change in the motor units recruited to perform the exercise and thus the neuromuscular adaptations. Differences exist between free weights and machines for percentage of RM used. For example, in a squat exercise, one may be able to perform only 8–10 repetitions, whereas in the leg press, 15–20 repetitions are possible. Differences exist related to the amount of balance and control that is needed in the exercise and the size of the muscle groups. For example, free-weight exercises require more neural control and activation of assistance muscles; also as the muscle group gets smaller, the magnitude of the response to a given percentage of the 1-RM is reduced.

The neuromuscular adaptations to resistance training depend on the amount and modality of resistance used. These adaptations follow the SAID principle presented earlier in this chapter. Compared with lower resistances, heavier resistances will allow lower numbers of repetitions (9,58,73) but will lead to greater improvements in maximal strength (9,10). Thus, if maximal strength development is desired, heavier loads should be used. Alternately, if muscular endurance is the goal, a lower load should be used, which will in turn allow a greater number of repetitions (12–15 RM) to be conveyed (68,73). Alternately, adaptations specific to muscular hypertrophy necessitate a differential training style. Recent systematic reviews and meta-analysis as well as reviews of the literature recommend a range of anywhere from 6–20 repetitions to optimize exercise-induced hypertrophic adaptations (9,28). Training at lower intensities (as low as 30% of 1-RM) to volitional fatigue as well as training across a wide spectrum of loads (6–20 repetitions range) can be used to induce alterations in muscular size (28,74). (See Tables 14.1–14.3 for more information relative to the guidelines set for by ACSM with regard to intensity of training.)

Table 14.1 ACSM Recommendations for Muscular Strength (9,14)

Novice Individuals	
Volume	1–3 sets per exercise
Intensity	Can range between 40% and 85% 1-RM Mean training intensity of 60% 1-RM 8–12 reps

Rest period	2–3 min between sets for core lifts 1–2 min for assistance exercises
Frequency	1–3 d · wk^{-1}
Trained Individuals	
Volume	Multiple set programs with systematic variations in volume and intensity
Intensity	Cycling load of 80%–100% 1-RM Progressing to heavy loads 1–6 reps
Rest period	2–3 min between sets for core lifts 1–2 min for assistance exercises Extended rest periods may be necessary
Frequency	4–6 d · wk^{-1}

Data from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2022. 548 p; and American College of Sports Medicine. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. *Med Sci Sports Exerc*. 2009;41(3):687–708.

Table 14.2 ACSM Recommendations for Muscular Hypertrophy (9,14,76)

Novice Individuals	
Volume	1–3 sets per exercise
Intensity	Lower load training 30% 1-RM+ to volitional fatigue or 70%–80% 1-RM 6–20 reps
Rest period	1–2 min
Frequency	Novice: 2–3 d · wk^{-1} Intermediate: up to 4 d · wk^{-1} for split routines
Trained Individuals	
Volume	3–6 sets per exercise in a periodized manner
Intensity	Lower load training 30% 1-RM+ to volitional fatigue Up to 20 reps or

	70%–100% 1-RM be used 1–12 reps per set 6–12 reps for the majority
Rest period	2–3 min for heavy loading 1–2 min moderate to moderate–high intensity
Frequency	4–6 d · wk^{-1}

Data from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2022. 548 p; and American College of Sports Medicine. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. *Med Sci Sports Exerc*. 2009;41(3):687–708.

Table 14.3 **ACSM Recommendations for Muscular Power (9,14)**

Novice Individuals	
Volume	1–3 sets per exercise
Intensity	Light to moderate load — moved at maximal velocity 30%–60% of 1-RM for upper body exercises 0%–60% of 1-RM for lower body exercises 3–6 repetitions not to failure
Rest period	2–3 min between sets for primary exercises when intensity is high 1–2 min for assistance exercises or lower intensity exercises
Frequency	Novice: 2–3 d · wk^{-1} Intermediate: 3–4 d · wk^{-1}
Trained Individuals	
Volume	3–6 sets per exercise
Intensity	Heavy loading 85%–100% of 1-RM (necessary for increasing force) Light to moderate loading 30%–60% of 1-RM for upper body exercises 0%–60% of 1-RM for lower body exercises Performed at an explosive velocity 1–6 reps in a periodized manner
Rest period	2–3 min between sets for primary exercises when intensity is high 1–2 min for assistance exercises or lower intensity exercises
Frequency	

$4–5\ d \cdot wk^{-1}$

Data from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2022. 548 p; and American College of Sports Medicine. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. *Med Sci Sports Exerc*. 2009;41(3):687–708.

Number of Days per Week of Training (Frequency)

Frequency of training (*i.e.*, number of days per week) is another program variable that needs to be determined when developing an optimal resistance exercise program. Factors such as desired outcome, training status, competition season (for athletes), and type of training session (full-body or split routine) are a few of the variables that should be considered when developing the frequency recommendations of a resistance training program.

When health-related benefits are the desired outcome for the program, ACSM has proposed that $2–3\ d \cdot wk^{-1}$ using a full-body resistance training program are sufficient. These recommendations are consistent with the *Physical Activity Guidelines for Americans*, second edition, which recommends 2 or more days per week of muscle strengthening activities. However, additional training days may be necessary for intermediate ($4–5\ d \cdot wk^{-1}$) and advanced trained individuals ($4–6\ d \cdot wk^{-1}$) for continued strength-related gains. These additional days may allow for greater volume of training, which appears to be a primary modulator in training adaptation. There are additional recommendations for frequency of training when hypertrophic, muscular endurance, power, or motor adaptations are the desired outcome (9). Tables 14.1–14.3 provide more information on the training frequency recommendations for differential program variables.

Number of Sets for Each Exercise

The number of sets does not have to be the same for all exercises in a workout program. For resistance-trained individuals, multiple-set programs have been found to be superior for strength, power, hypertrophy, and high-intensity endurance improvements (9,10,75). Additionally, recent meta-analytic research has shown a dose-response relationship between set number and muscular strength and hypertrophy (10,31,32). These findings have prompted support from ACSM for periodized multiple-set programs when long-term progression (not maintenance) is the goal (9). Both single- and multiple-set programs appear to be effective for increasing strength in untrained clients during short-term training periods (*i.e.*, 6–12 wk). However, multiple-set programs are superior for long-term progression. Single-set programs are effective for developing and maintaining a certain level of muscular strength and endurance. For some fitness enthusiasts, this level of muscular fitness may be adequate. Also, one-set programs sometimes result in greater compliance by those who are limited in their time for exercise and also need to perform cardiovascular exercise, flexibility exercise, and so on. Having a client do one set is better than no sets at all. However, no study has shown single-set training to be superior to multiple-set training in either trained or untrained individuals.

The number of sets is one of the critical variables in the exercise volume equation (*e.g.*, volume = sets × reps × resistance). The principle of variation in training or, more specifically, "periodized training" involves the number of sets and volume performed. Exercise volume is a vital concept in resistance training progression, especially for those who have already achieved a basic level of training or strength fitness. Some short-term studies (9,10) and most long-term studies (9,10) support the contention that the greater training stimulus associated with the higher volume from multiple sets is needed to create further improvement and progression in physical adaptation and performance. Meta-analytic research has shown that as experience in training increases, the need for greater volumes of training also increases (10,31,32). Use of a constant-volume program can lead to staleness and lack of adherence to training. Making variations in training volume (*i.e.*, both low- and high-volume exercise protocols) are critical during a long-term training program to continue to provide appropriate overload stimulus yet also to provide adequate rest and recovery periods. This concept is addressed later in this chapter under "Periodization of Exercise." See Tables 14.1–14.3 for more information on training recommendations from ACSM.

The number of sets performed for each exercise is one variable in what is referred to as the volume of exercise equation (*e.g.*, sets × reps × resistance) calculation.

Duration of Rest Period between Sets and Exercises

The rest periods play an important role in dictating the metabolic stress of the workout and influence the amount of resistance that can be used during each set or exercise. A major reason for this is that the primary energy system used during resistance exercise, the ATP–CP system, needs to be replenished, and this process takes time (see Chapter 5). Therefore, the duration of the rest period significantly influences the metabolic, hormonal, and cardiovascular responses to a short-term bout of resistance exercise as well as the performance of subsequent sets (76,77). For advanced training emphasizing absolute strength, rest periods of at least 2–3 minutes (with the possibility of extended rest periods as long as 3–5 min) are recommended for primary, large muscle mass multijoint exercises (such as squat or dead lift), whereas shorter rest may be sufficient for assistant, smaller muscle mass single-joint exercises (9). That stated, it appears that robust strength gains can be achieved with rest intervals of less than 1 minute. For novice resistance trained individuals, rest periods of 1–2 minutes may suffice for large muscle mass multijoint exercises because the lower absolute resistance used at this training level seems to be less stressful to the neuromuscular system (29). Performance of maximal resistance exercises requires maximal energy substrate availability at the onset of the exercise and thus requires relatively long rest periods between sets and exercises.

The duration of the rest period significantly influences the metabolic, hormonal, and cardiovascular responses to a short-term bout of resistance exercise as well as the performance of subsequent sets.

Based on an extensive review, a minimum of 3 minutes rest is recommended when training for muscular power (*e.g.*, plyometric jumps) due to the need to perform maximal effort movements (78). Similarly, when training for muscular strength, more than 2 minutes of rest is recommended between sets (29). Alternately, when training for muscular hypertrophy, shorter rest intervals of 30–60 seconds between sets is advocated. The shorter rest interval stimulates greater hormonal activity associated with a hypertrophic effect (78), but some research has noted similar hypertrophic adaptations with longer rest intervals (79).

Resistance training that stresses both the glycolytic and ATP–CP energy systems appears to be superior in enhancing muscle hypertrophy (*e.g.*, bodybuilding); thus, less rest between sets appears to be more effective in high levels of muscular definition. If the goal is to optimize both strength and muscle mass, both long rest with heavy loading and short rest with moderate loading types of workout protocols should be included. However, it should be kept in mind that short-rest resistance training programs can potentially cause greater psychological anxiety and fatigue because of the greater discomfort, muscle fatigue, and high metabolic demands of the program (80). Therefore, psychological ramifications of using short-rest workouts must be carefully considered and discussed with the client before the training program is designed. The increase in anxiety appears to be associated with the high metabolic demands found with short-rest exercise protocols (*i.e.*, 1 min or less). Despite the high psychological demands, the changes in mood states do not constitute abnormal psychological changes and may be a part of the normal arousal process before a demanding workout.

The key to determining optimal rest period lengths is to observe the client. Symptoms of loss of force production in the beginning of the workout and clinical symptoms of nausea, dizziness, and fainting are clear signs of the inability to tolerate the workout. When such symptoms occur, the workout should be stopped and longer rest periods used in subsequent workouts. With aging, rest periods need to be carefully heeded. Aging decreases the ability to tolerate changes in muscle and blood pH and underscores the need for gradual progression of cutting rest period lengths between sets and exercises (76). Typical rest periods are characterized as follows:

- Very short rest periods: 1 minute or shorter
- Short rest periods: 1–2 minutes
- Moderate rest periods: 2–3 minutes
- Long rest periods: 3–4 minutes
- Very long rest periods: 5 minutes or longer

The heavier the resistance, the more rest that should be allowed between sets and exercises. Also, more rest allows for a greater number of repetitions to be performed at a specific RM load (77,78,81). The gradual use of shorter rest periods stimulates improvements in the body's blood bicarbonate and intramuscular buffering systems (77,81). (See Tables 14.1–14.3 for the recommended rest period intervals set forth by ACSM.)

Variation of Acute Program Variables

As long as the demands placed on the neuromuscular system are similar, the acute program variables can be manipulated in various ways to develop different workouts for the single-exercise sessions used over time. The number of sets, number of repetitions, relative resistance used, and rest periods do not have to be the same for each exercise in a session. They can be varied either within an exercise or, more frequently, between different exercises in an exercise protocol. The use of light exercise levels can be used when it is necessary to rest higher threshold motor units (*i.e.*, motor neuron and associated muscle fibers). Motor recruitment follows a "size principle." Because not all motor units are recruited with each resistance loading or contraction of a muscle, different loadings can result in varying amounts and types of muscle tissue being used. Heavier loads with adequate volume recruit more muscle tissue than high repetitions of lower load levels (82). Understanding and using the size principle is vital for developing variation in resistance training and ultimately periodized training.

Muscle Actions

Muscles produce force while performing one of three different actions:

1. When sufficient force is produced to overcome the external load and shorten the muscle, the muscle action is termed a *concentric muscular action* or *contraction*.
2. When the muscle produces force but there is no change in the length of the muscle, the muscular action is termed an *isometric muscular action*.
3. When the production of force occurs while the muscle is lengthening (*i.e.*, resisting the movement), the muscular action is termed an *eccentric muscular action*.

In the past, the term *contraction* was used for each of the three muscle actions; however, only concentric muscle actions actually involve a classic muscle shortening or true contraction. Any exercise can include any combination of the three muscle actions; however, most exercises are performed using either isometric muscle action or both concentric and eccentric muscle actions. However, the most effective training programs appear to use concentric–eccentric repetitions (82). The skeletal muscle force–velocity relationship patterns encompass high- to low-speed eccentric muscle actions, maximal isometric muscle actions, and slow- to high-velocity concentric muscle actions, creating a descending hierarchy of force productions.

> The most effective training programs appear to use concentric–eccentric repetitions.

True Repetition and Range of Movement

Muscle actions involving movement of a joint are termed *dynamic*, and thus, exercises involving joint movements are called dynamic exercises. A full-range dynamic exercise usually contains both a concentric phase and an eccentric phase. The order of the phases depends on the choice of exercise.

A squat, for example, starts with the eccentric phase, whereas a pull-up normally starts with the concentric phase. It is important to perform the exercise so that the joints involved move through a full ROM. This is especially true for single-joint exercises. For example, in the arm curl, a full repetition should start with the elbow almost completely extended, progress until the elbow is maximally flexed, and finish with the elbow almost completely extended again. By using the whole ROM, the whole length of the muscle is stimulated, leading to adaptations throughout the whole muscle. However, ROM may need to be carefully monitored and perhaps restricted when working with clients who have orthopedic injuries or limitations or anatomical joint laxity such as in the knee, elbow, or shoulder.

Periodization of Exercise

Periodization is a concept that is applied in the design of workouts used in an exercise program (16,83). Periodization refers to systematic variation in acute program variables such as the prescribed volume and intensity during different phases of a resistance training program. A traditional linear periodization program contains four phases:

1. Hypertrophy phase, consisting of high volume and short rest periods
2. Strength/power phase, consisting of reduced volume but increased load and rest periods
3. Peaking phase, consisting of low volume but high load and longer rest periods
4. Recovery phase, consisting of low volume and load

Periodization refers to systematic variation in acute program variables such as the prescribed volume and intensity during different phases of a resistance training program.

There is no set formula for how a program should be periodized because it depends on the specific goals and needs of the client (84). Table 14.4 presents an example of a traditional four-phase periodized training program aimed at producing maximal strength.

Table 14.4 Traditional American-Style Periodization Schedule

Goal	Hypertrophy	Maximal Strength/Power	Peak	Recovery
Repetitions	High	Moderate–low	Low	Moderate
Sets	High	Moderate	Low	Moderate
Rest	Short	Moderate	Long	Moderate
Load	Low	Moderate	Very high	Low
Volume	High–moderate	Moderate	Low	Low

Periodization acts as a way to systematically vary the workout over time. Incorporating periodization into the training program systematically varies the acute program variables, which exposes muscles to different stimuli, leading to greater muscular adaptation and performance. In addition, rest is encouraged at different points in the training program, which allows for appropriate recovery and the prevention of both short- and long-term overtraining. Another important benefit to periodization is that it can reduce the potential boredom found with repeating the same resistance exercise program over and over again, which may improve program adherence. Many different models for periodization have been developed. Thus, the model to be used should be selected on the basis of the needs and desires of the client.

The terms *micro*-, *meso*-, and *macrocycle* refer to the time course of the different phases of periodization. The macrocycle is the largest training cycle time frame. A common example of a macrocycle is a calendar year, and all phases are included in this cycle. A mesocycle refers to the next smaller group of training cycles that make up the macrocycle, usually four to six in a year. Finally, the microcycle is the smallest component, which usually ranges in time from 1 to 4 weeks and is typically dedicated to one type of workout variable in that phase (*e.g.*, high-volume, low-intensity power).

The use of periodized resistance training has been shown to be superior to constant training methods (85). Periodized training involves the planned variation in the intensity of exercises and in the volume of a workout. Typically, one periodizes large muscle group exercises. However, periodization schemes can be created for smaller muscle groups as well. Although opinions among trainers differ regarding the number and time course of the cycles that are most effective, a primary theory suggests that a greater variation in the training stimulus will produce greater overall adaptations in the body. This idea has led to different variations in the classic periodization model. In general, there are two basic types that have been developed for maximal strength development: linear and nonlinear periodized protocols.

Linear Periodization

Classic periodization methods use a progressive increase in the intensity with small variations in each 1- to 4-week microcycle. An example of a classic 16-week, four-cycle linear periodized program is presented in Table 14.5.

Table 14.5 An Example of a Classic Linear Periodized Program Using 4-Week Microcycles

Microcycle 1 (4 wk)	Microcycle 2 (4 wk)	Microcycle 3 (4 wk)	Microcycle 4 (4 wk)	Microcycle 5 (2 wk)
3–5 sets of 12–15 RM	4–5 sets of 8–10 RM	3–4 sets of 4–6 RM	3–5 sets of 1–3 RM	Active rest/recovery

Classic periodization methods use a progressive increase in the intensity with small variations in each 1- to 4-week microcycle.

Although there are some variations within each microcycle, the general trend for the 16-week program is a steady linear increase in the intensity of the training program. Microcycle 5 is a 2-week active rest period in which no lifting is done or only a very light, low-volume training is used prior to the next mesocycle. Because of the straight-line increase in the intensity of the program, it has been termed “linear” periodized training. Linear periodization originally evolved from training for single-peak performance events (*e.g.*, track and field, weightlifting). Thus, consecutive or linear buildup in the training intensity to the peak was used.

The volume of the training program in the classic periodization program will gradually decrease in concert with an increase in intensity. The volume–intensity trade-off can be lessened as an individual improves training status. In other words, advanced athletes can tolerate higher volumes of exercise during heavy and very heavy microcycles. A meta-analysis of the research has shown that progressing to an average of eight sets per muscle group is the optimal dose needed to stimulate muscular strength adaptations in muscular strength in advanced lifters as compared to an average of three sets per muscle group for beginners and four sets for intermediate lifters (10).

One must be very careful not to train with high volumes and heavy weights too quickly; monitor the stress of the workouts and the total conditioning program. Pushing too hard has the potential for creating a serious overtraining syndrome. Overtraining can compromise progress for weeks or even months. Although it takes a great deal of excessive work to produce this type of overtraining effect, highly motivated individuals can easily make these mistakes out of sheer desire to make gains and see rapid progress in their training.

The idea of high-volume exercise in the early microcycles is that it may promote the muscle hypertrophy needed to eventually enhance strength in the later phases of training. Thus, the later cycles of training are dependent on the early cycles of training. Programs that attempt to gain strength without developing the needed hypertrophy of muscle tissue are limited in their potential.

The increases in the intensity of the periodized program allows for development of the needed nervous system adaptations for enhanced motor unit recruitment. As the program progresses, the heavier weights require that higher threshold motor units become involved in the force production process. The subsequent increase in muscle protein from the early cycle training enhances force production from the motor units. Thus, it is clear to see how the different parts of the 16-week training program are integrated.

One mesocycle is the completion of all of the cycles in this 16-week program. A year training program (macrocycle) is made up of several mesocycles. Multiple and short mesocycles allow for delineating different trainable features of muscle. In theory, each mesocycle can progress the body's musculature upward toward one's genetic limitations. Thus, the theoretical basis for a linear method of periodization consists of developing the body with a sequential loading from light to heavy and from high volume to low volume, thereby addressing the goals of the program for that training cycle while providing active rest at the completion of the mesocycle. This is repeated again and again with each mesocycle, and progress is made in the training program over an entire macrocycle.

Reverse Linear Programs

A twist on traditional linear periodization is termed *reverse linear periodization*. As the name states, it is a technique that follows the tenants of linear periodization for volume and strength; however, it is in the reverse order. One study has shown that this type of periodization is beneficial when muscular endurance is the primary program outcome (86).

Nonlinear Periodized Programs

More recently, the concept of nonlinear periodized training programs (also called daily undulating periodization or DUP) has been developed to maintain variation in the training stimulus (86–89). Nonlinear periodized training enhances program implementation because it is flexible and can accommodate schedule, business, or competitive demands placed on the individual. The nonlinear program allows variation in the intensity and volume within each week over the course of the training program (*e.g.*, 12 wk). Active rest is then taken after the 12-week mesocycle. The change in the intensity and volume of training will vary within the cycle, which could be 7–14 days. An example of a nonlinear periodized training program over a 12-week mesocycle is shown in Table 14.6.

Table 14.6 An Example of a Nonlinear Periodized Training Protocol[a]

Monday	Wednesday	Friday	Monday
1 set 12–15 RM	3 sets of 8–10 RM	4 sets of 4–6 RM	Power day 6 sets of 3 at 30%–45% of 1-RM using power exercises (*e.g.*, hang pulls) or plyometrics

[a]This protocol uses a 4-d rotation with 1-d rest between workouts.

> The nonlinear program allows variation in the intensity and volume within each week over the course of the training program (*e.g.*, 12 wk).

Recent research has shown that nonlinear periodized training can have similar or greater beneficial effects on resistance training outcomes when compared with traditional linear periodization. Rhea and colleagues (86) showed the nonlinear periodization training elicited a greater percentage of strength gains as compared with linear training. Additionally, Prestes and colleagues (90) found that undulating periodization induces greater increases in maximal strength as compared with linear periodization. These studies suggest that daily variations in the undulation training had a superior effect on maximizing strength as compared with weekly or monthly variation.

One of the theorized reasons for the success of nonlinear periodization is that unlike linear programs, the different components of muscle size, strength, and power are trained with the goal of attempting to train different features of muscle within the same time frame (*e.g.*, hypertrophy and power and strength). Thus, an individual stimulates multiple physiological adaptations within the same 7- to 10-day period of the 12-week mesocycle.

Often, busy travel, school, or competition schedules conflict with time requirements of traditional training program. A DUP program is highly adaptable to variations in a client's schedule. This type of training model may enhance adherence as it may "fit" the client's schedule better than the traditional linear method. Additionally, constantly altering program variables keeps the program interesting and challenging for clients, thereby reducing the boredom of repeating the same program. Theoretically, a DUP program can be different with each and every training session. Because the workouts are not linear, the different workouts change with different training sessions. If the Monday workout is missed, the rotation is just changed. For example, if a client misses a workout scheduled for Monday, with DUP, that workout is performed on the next training day and the sequence is continued. In this way, no workout stimulus is missed in the training program. With a DUP-type program, any mesocycle will be completed when a certain number of workouts are completed (*e.g.*, 48) rather than counting the completion of a set number of weeks (86,88–90).

> With a DUP type program, any mesocycle will be completed when a certain number of workouts are completed (*e.g.*, 48) rather than counting the completion of a set number of weeks.

Unplanned/Flexible Nonlinear Periodized Programs

One of the new advances in periodization is called “unplanned nonlinear periodization.” The name is somewhat of a misnomer because an overall plan is developed for a 12-week mesocycle, but the actual day that a given workout will be performed is based on the readiness to train. Thus, it is also termed “flexible nonlinear periodization.” In unplanned or flexible nonlinear periodization, a workout plan is set for the mesocycle, but deciding what workout is to be done on what day is left to the Personal Trainer, who will base it on the client’s fatigue level, psychological state, or fitness, to use only the most optimal workout that can be performed on a given day. In this model, the training session category (*e.g.*, light, moderate, power, or heavy) is prescribed on the basis of the physiological ability or state of the client at the time of the session. Thus, if the client is very fatigued before a particular exercise session, some workouts would not be prescribed. For example, a power training or plyometrics training day or a high-volume, low-rest training day would not be a good choice because fatigue would reduce the workout quality. After a specific workout is completed, it is checked off in the major planning matrix for the 12-week mesocycle. Again, the goal for any mesocycle in this type of nonlinear periodization program is to complete each planned workout rather than “x” number of weeks.

In any periodization model, it is the primary exercises that are typically periodized, but one can also use a two-cycle periodization program to vary the small muscle group exercises. For example, in the “triceps push-down,” one could rotate between the moderate (8–10 RM) and the heavy (4–6 RM) cycle intensities. This would provide not only the hypertrophy needed for such isolated muscles of a joint but also the strength needed to support heavier workouts of the large muscle groups.

In summary, different approaches can be used to periodize a resistance training program. Programs can be linear, reverse linear, nonlinear “daily undulating,” or unplanned/flexible nonlinear schedules. Periodized programs are more effective than constant-intensity training programs for increasing strength. Effective periodization is accomplished by melding specific program goals (strength, hypertrophy, muscular endurance, or some combination) with appropriate variations in volume–intensity and frequency of training. The key to workout success is variation, and different periodization approaches can be used to accomplish this training need.

> Effective periodization is accomplished by melding specific program goals (strength, hypertrophy, muscular endurance, or some combination) with appropriate variations in volume–intensity and frequency of training.

Progression from Beginner to Advanced

The level of fitness and resistance training experience of the client is perhaps the most important factor to be considered when designing a resistance training program. Resistance exercise can place a large stress on the body, and certain exercises require high levels of skill to avoid injury. Thus, exercise technique is the most important aspect of resistance training for beginners. At the beginning of the training program, correct technique should be significantly emphasized, and the resistance and volume should be kept low.

> Resistance exercise can place a large stress on the body, and certain exercises require high levels of skill to avoid injury.

From a short-term performance-enhancement point of view, a single set per exercise may be enough for beginners to achieve the stimulus needed from an exercise. However, depending on the individual, multiple sets, even for beginners may be beneficial (9,10,32,75). Some studies have found that multiple sets even for beginners create larger improvements than single sets, whereas no study has found that single sets are superior (10,31). One reason for this is that more repetitions can lead to faster improvements in exercise technique, especially for multijoint exercises. The squat exercise is an example of an exercise that requires a great deal of technique to be performed correctly. Thus, only doing one set of a few squats does not allow the client many practice trials of this complex movement.

There is a dose-response relationship with progressive resistance training. As a person becomes accustomed to a given stimulus or dose of exercise, additional stress is needed to elicit the given response or increase in strength, muscular endurance, hypertrophy, power, or all four.

As the client progresses past the initial few months of training, multiple sets should be used for each exercise session. As the skill and experience level of the client improves, more technical exercises can be taught. Advanced resistance training can include highly technical exercises such as the clean or the snatch as well as advanced modalities such as plyometric exercises. The progression will differ among individuals, and the Personal Trainer must evaluate each client extensively and continuously before including more advanced exercises to ensure that the exercises match the client's skill and experience level.

Client Interactions

As a Personal Trainer working with clients, it is important to encourage and motivate them as well as to provide innovative, optimal, individualized resistance training programs. Clients hire Personal Trainers for a variety of reasons. Many clients hire Personal Trainers because they feel they need constant guidance. In addition, Personal Trainers provide them with a support system. Most importantly, clients desire to hire professionals with training and knowledge in conditioning science. They want a professional to help them perform exercises properly and who understands exercise prescription to allow them to achieve their personal goals and objectives. For some clients, it is an important part of their sports conditioning program. Ultimately, the Personal Trainer must form a special relationship with each and every client that is based on professionalism, trust, and openness (Fig. 14.4).

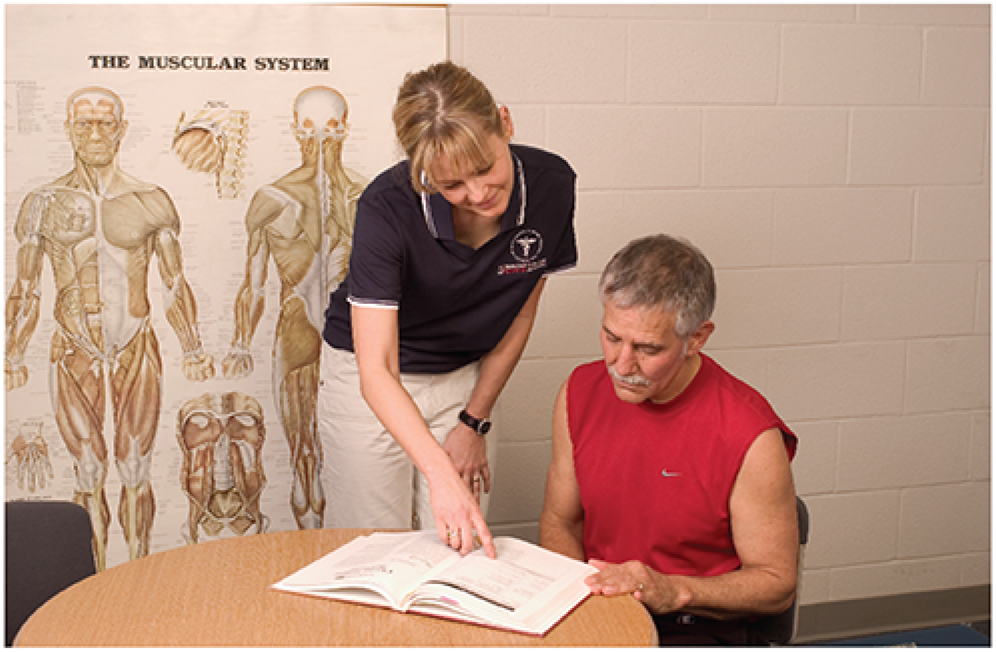


FIGURE 14.4. Having education and being a credible source of knowledge as a fitness expert is part of what Personal Trainers must provide to their clients. This takes continual study and preparation to stay current and up-to-date on basic topics and hot topics of the day.

Clients should feel that their Personal Trainer genuinely cares about them and is personally vested in helping them achieve their goals. Clients expect their Personal Trainer to be a source of knowledge and an educator. Clients expect their Personal Trainer to be able to explain things or answer the question "why?" Thus, clients appreciate having their Personal Trainer explain the reason they are doing a particular exercise or combination of sets and reps in their program. Personal Training has been found to be superior to unsupervised training, even for people who understand resistance training (91,92).

Personal Trainers should convey the specific benefits of resistance training, including increases in strength, muscle mass, and bone mass, particularly to clients who may be skeptical about why resistance training is important. Some uneducated clients may have false impressions of the outcomes from resistance training or on how to go about attaining optimal gains. Some men may do too much of one exercise (*e.g.*, biceps curls) trying to get huge, thereby creating muscular imbalance or women may hold back from performing any heavy loading because of the "fear of getting big muscles." These mistakes may at best diminish the gains that could be realized with resistance training and at worse result in serious overtraining or acute injury.

> Personal Trainers should convey the specific benefits of resistance training, including increases in strength, muscle mass, and bone mass, particularly to clients who may be skeptical about why resistance training is important.

Clients consider Personal Trainers experts and will often want to hear their opinion on fads facing the fitness industry. Often, clients' knowledge of resistance training comes from infomercials or magazine advertisements. Personal Trainers need to stay up-to-date with the scientific literature in order to provide accurate information and current research to their clients. Additionally, Personal Trainers should develop a network of experts who can act as resources for when clients ask questions that the Personal Trainer does not know the answer. It is always best to admit you do not know the answer than to convey potentially incorrect information. Furthermore, because Personal Trainers are required to obtain continuing education credits to maintain their certifications, staying current is critical to success.

Demonstration of Proper Lifting Technique

A key aspect in Personal Training is the ability to demonstrate a given lift or technique. Providing the client with a good visual representation of the lift will allow the client to then replicate the movement pattern. The Personal Trainer should demonstrate each lift with proper form with a verbal explanation of the lift or technique and then actually physically demonstrate proper form of the given lift.

Spotting in Resistance Exercise

Resistance training often requires that the Personal Trainer have physical contact with the client to ensure correct positioning, fit and setup of a machine, and proper technique in both machine and free-weight exercises. Personal Trainers should take time to explain to clients the spotting procedures in resistance training and the level of physical interaction required. Always ask your clients before physically touching them to ensure that they are comfortable with it. For example, when performing elbow extension exercises, it is sometimes helpful for the Personal Trainer to place his or her hands on the client's elbows as a reminder to keep the elbow from pointing outward. In these cases, explain to the client, "I am going to put my hands on your elbows to remind you to keep them from pointing outward. Is this okay with you?" In most cases, clients will have no problem with this physical contact, but it is always better to ask than to assume.

> Always ask your clients before physically touching them to ensure that they are comfortable with it.

Know Proper Spotting Technique

Good spotting technique is vital for a safe resistance training program. Personal Trainers must understand the movement technique of every exercise and how to position clients to get the proper anatomical positioning throughout the exercises. In addition, Personal Trainers need to know where to position themselves to spot appropriately for each exercise. The goal of correct spotting is to prevent injury. A lifter should always have an exercise spotted, and the Personal Trainer must mediate this process, alone or with additional help. A checklist for the Personal Trainer is the following:

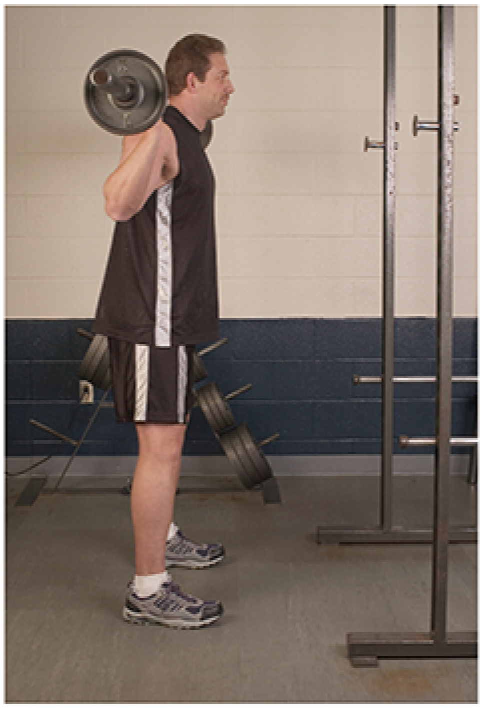
1. Know proper exercise technique.
2. Know proper spotting technique.
3. Be sure you are strong enough to assist the lifter with the resistance being used or get help.
4. Know how many repetitions the lifter intends to do.

5. Be attentive to the lifter at all times.
6. Stop lifters if exercise technique is incorrect or they break form.
7. Know the plan of action if a serious injury occurs.

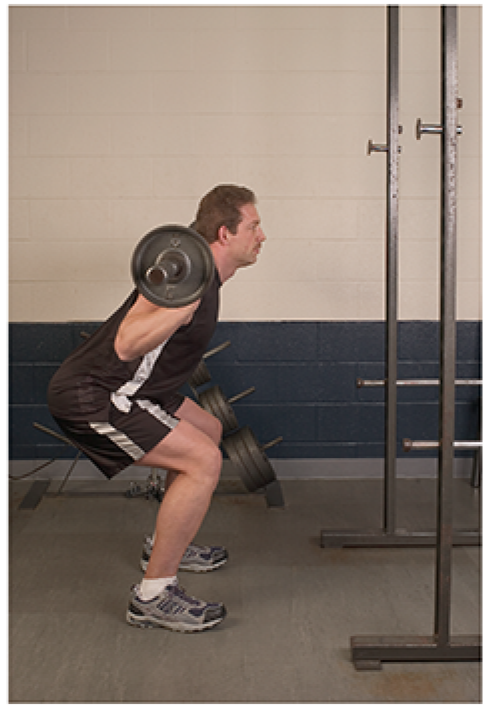
Resistance Exercises

A large number of resistance exercises can be used in a program. It is beyond the scope of this chapter to go through each and every exercise. The reader is referred to a comprehensive list of more than 125 exercise descriptions of both machine and free-weight exercises along with spotting techniques by Kraemer and Fleck (93). Each program should be designed on the basis of the principles outlined in this chapter. Periodization is very important, and many Personal Trainers are now using nonlinear methods to keep the clients interested and the programs effective (93). Free weights and machines can be used for each exercise as well as bilateral and unilateral exercises. See Figure 14.5 for examples of 15 basic exercises: (A) squat, (B) supine leg press, (C) 45° leg press, (D) lunge, (E) leg extensions, (F) leg curls, (G) machine vertical bench press, (H) smith supine bench press, (I) free-weight supine bench press, (J) dumbbell bench press, (K) machine seated rows, (L) front lat pull-down, (M) dumbbell arm curls, (N) barbell arm curls, and (O) triceps push-down.

A



Start



Finish

B

Start

Finish

C

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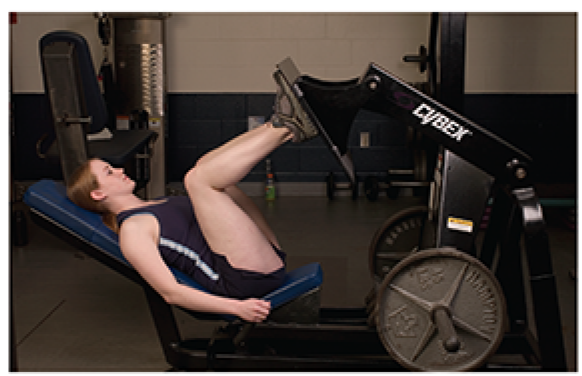
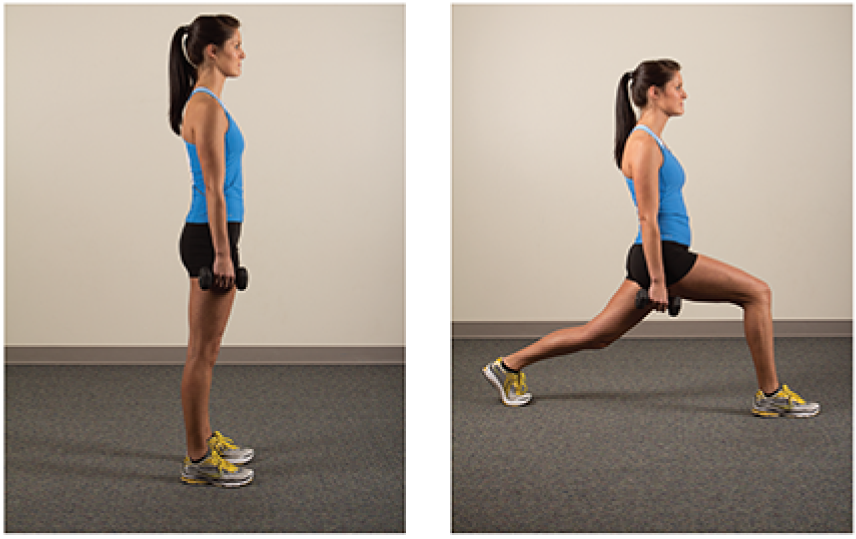


Finish

D

Start Finish

E

Start Finish Center of Rotation

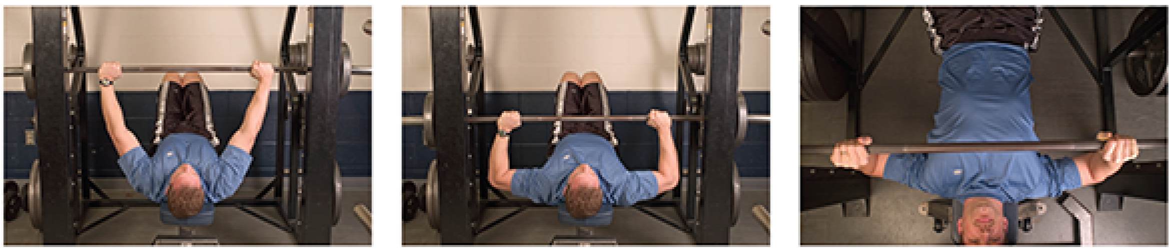
F

Start Finish

G

Start Finish

H

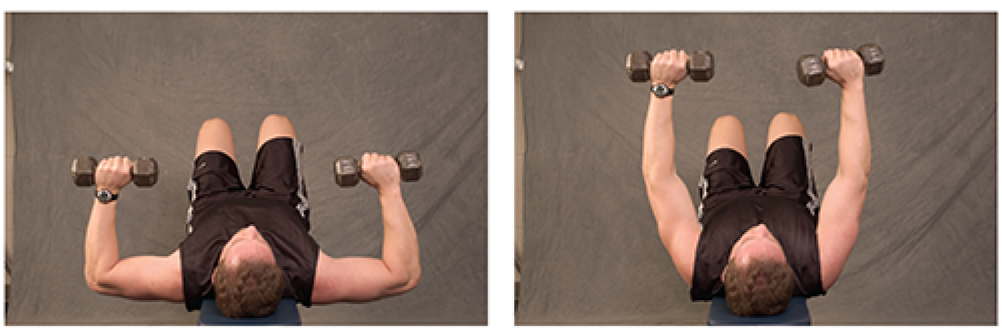


Start Finish Bar Position Over Chest

I

Start Finish

J



Start Finish

K

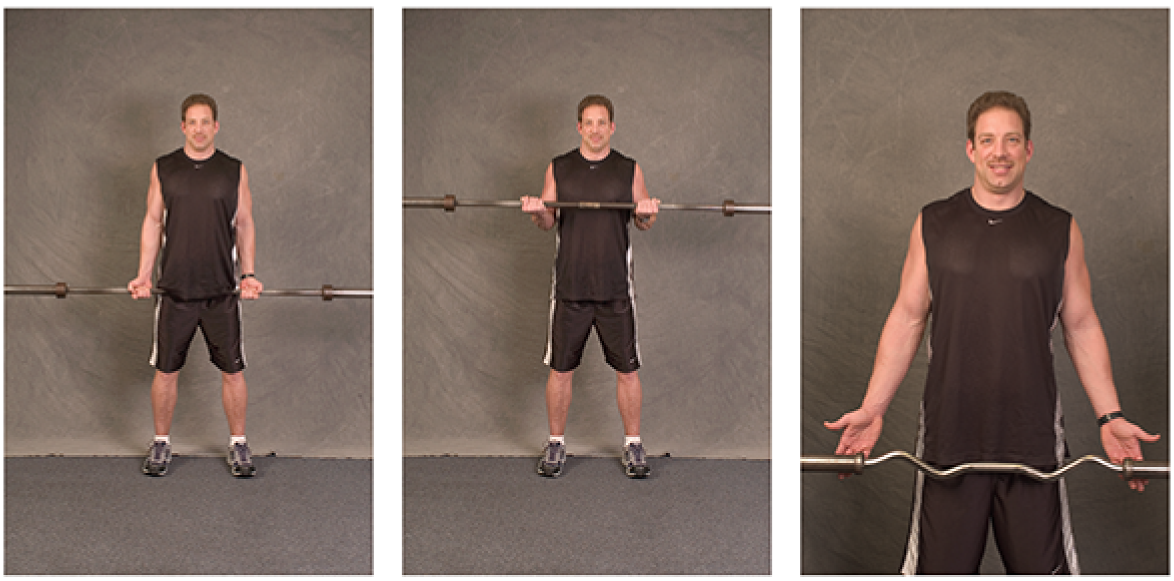
Start Finish Arm Position

L

Start Finish

M

Start Finish



N

Start Finish E-Z Bar

O

Start Finish

FIGURE 14.5. **A.** Back squat (thighs and glutes). Place the barbell on the back of the shoulders and grasp the barbell at the sides, with feet shoulder-width apart and toes slightly out. Dismount bar from rack. Descend until thighs are parallel to the floor and then extend the knees and hips until legs are straight, returning you to the starting position. Repeat for the appropriate number of repetitions. Keep the head forward with the chin level, back straight, and feet flat on the floor; keep equal distribution of weight throughout forefoot and heel and either squat within the power rack or have spotter(s). **B.** Supine leg press (thighs). Lie flat on the sled with shoulders against the pad. Place the feet on the platform, making sure that they are securely on the base plate. Extend the hips and knees. Flex the hips and knees until the knees are just short of complete flexion and return to the starting position to complete the repetition. Keep the feet flat on the platform and do not lock the knees. A full ROM should be used; keep the knees in the same direction as the feet. **C.** The 45° leg press (thighs). Lie down on the machine with the back on the padded supports. Place the feet on the platform. Grasp the handles on the side and release the weight. Lower the weight by flexing the hips and knees until the hips are completely flexed and then extend the knees to complete the repetition. Make sure that the feet are flat on the platform and the knees track over the feet. **D.** Lunge (thighs, unilateral). Standing straight up with feet shoulder-width apart, stand holding the dumbbells at the sides. Lunge forward with one leg at a time, keeping the hips in the middle of the two legs, with the trailing knee just above the ground. Return to the standing position to complete the repetition and then repeat with the opposite leg. Keep the back straight and chin level with the ground. **E.** Leg extensions (thighs, bilateral or unilateral). Sit on the machine with the back straight against the back pad or seat and grasp the handles on the side of the machine. Place the legs under the padded lever, making sure that they are positioned just above the ankles. Most machines will allow adjusting the length of the lever. Lift the lever until the legs are almost straight and return to the starting position to complete the repetition. It is important not to "rip" the plates off the stack because this can add stress to the knees. This exercise can be done with a single leg (unilateral) or with both legs (bilateral). Make sure that the knees are aligned with the machine's center

of rotation. **F.** Leg curls (hamstrings, bilateral or unilateral). Lying face down, grab the support handles in the front of the machine with the heels just beyond the edge of the lever pads. Lift the lever arm by flexing the knees until they are straight. Return to the starting position to complete the repetition. Keep the body on the bench and focus on moving only the legs. Many machines are angled so that the user is in a better position for the exercise movement to reduce stress on the lower back. Other forms of leg curls are standing and seated forms. This exercise can be done with a single leg (unilateral) or with both legs (bilateral). **G.** Vertical machine bench press (chest–triceps, bilateral). Sit on the seat, making sure that the line of the grips is just below the chest. The bar line should be an inch above the chest. Grasp the handles with an overhand grip and make sure that the feet are flat on the ground. Push the lever arm straight out until the elbows are straight. Return to the starting position to complete one repetition. **H.** Smith supine bench press (chest–triceps, bilateral). Lie flat on the bench with the upper chest under the bar, as shown in the bar position figure above. Place the feet flat on the floor unless the bench is too high, in which case put them flat on the bench. Keep the shoulders and hips on the bench at all times during the lift. Grasp the bar with elbows at 45° angles. Disengage the bar hooks from the smith machine. Lower the weight to the chest and then press the bar up until arms are extended to complete the repetition. When completed, rehook the bar to the machine. **I.** Free-weight supine bench press (chest–triceps, bilateral). Lie flat on the bench with the upper chest under the bar, as shown in the bar position figure above. Place the feet flat on the floor unless the bench is too high, in which case put them flat on the bench. Keep the shoulders and hips on the bench at all times during the lift. Grasp the bar with elbows at 45° angles. Lower the weight to the chest and then press the bar up until the arms are extended to complete the repetition. When completed, rerack the bar with a spotter's help. **J.** Dumbbell bench press (chest–upper arms–triceps, unilateral). Start in a seated position on the bench with a dumbbell in each hand resting on the lower thigh. Lift the weights to the shoulder and lie back on the bench or have the spotter give you the dumbbells once you are in a position. Position the dumbbells to the side of the upper chest. Press the dumbbells up until the arms are extended and then return to complete a repetition. When completed, return to the seated position with the dumbbells on your thighs or have the spotter take the dumbbells. If heavy weights are used, two spotters may be necessary. **K.** Machine seated rows (upper back, bilateral). Take a seated position with the chest against the pad. Grasp the lever vertical handles with a vertical or horizontal overhand grip. Pull the lever back until the elbows are in line with the upper body and return to complete the repetition. Check the seat height so that the chest is directly in front of the lever handles and check whether the client is pulling in a straight line parallel to the ground. The client can use an overhand grip as a variation to the movement, using the other horizontal handles. **L.** Front lat pull-down (upper back, bilateral). Use a locked grip (thumb around the bar) and grasp the cable bar with a wide grip. Sit with thighs under machine support. Proceed to pull down the bar to the upper chest. Return to the starting position to complete the repetition. **M.** Dumbbell arm curls (upper arm–biceps, unilateral). Take a seated position with two dumbbells held at the sides, with the palms facing in and the arms hanging straight down. Raise the dumbbells and rotate the forearm so that the palms face the shoulder. Lower to the original position to complete one repetition. One can also alternate one arm at a time. **N.** Barbell arm curls (upper arm–biceps, bilateral). In the standing position with the feet shoulder-width apart, grasp the straight barbell with an underhand grip and palms facing up. Raise the bar until the forearms are vertical and then lower the bar to the starting position to complete a repetition. One can also perform this exercise with an e-z bar with the palms facing inward. **O.** Triceps push-down (upper arm–triceps, bilateral). Stand in front of the lat pull station or high pulley station and take an overhand grasp on the bar with your elbows at the sides. Start at chest level and extend the arms down until straight and return to the starting position to complete the repetition. Position the hands above the bar prior to the push-down phase of the repetition. Other types of attachments also can be used (*e.g.*, rope, v-bar).

Visit thePoint to watch videos 14.1, 14.2, and 14.3, which demonstrate a body weight squat, lunges, and a dumbbell bench press.

SUMMARY

Development of a resistance training program is a systematic process in which science and art come together to allow the Personal Trainer to specifically address a client's needs for neuromuscular fitness. A sequence of events in the exercise prescription process consists of getting a client's medical clearance, Personal Training history, goal generation, a needs analysis, and a general preparation phase of initial training and testing before putting together workouts based on the acute program variables that will be used in a resistance training program. This program is then updated and revised with the same process over time. Education, client interactions, and motivation are vital components of successful resistance training programs that meet each client's goals and objectives.

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CHAPTER

15

Cardiorespiratory Training Programs

OBJECTIVES

Personal Trainers should be able to:

- Understand the current recommendations to improve cardiovascular fitness.
- Understand the physiological basis of the warm-up and cool-down.
- Apply the FITT-VP principles of exercise prescription to cardiovascular exercise training based on the client's preparticipation screening results, cardiovascular assessments, and goals.

INTRODUCTION

According to the most recent American College of Sports Medicine (ACSM) position stand (1), "The scientific evidence demonstrating the beneficial effects of exercise is indisputable, and the benefits of exercise far outweigh the risks in most adults." Regular cardiorespiratory, resistance, flexibility, and neuromotor exercise training is considered "essential for most adults" (1). This chapter focuses on one of the primary components of a balanced exercise program: cardiorespiratory training. The other major components, resistance and flexibility training, are described in Chapters 14 and 16, respectively.

History of Physical Activity Recommendations

In 1953, more than 55% of U.S. children failed to meet a minimum standard of muscular fitness and health compared with about 8% for European children (2). These troubling findings became a primary impetus for policy makers to focus on developing and improving fitness standards and recommendations. Expert panel meetings were held in the 1960s and 1970s to summarize all the research that was conducted by that time. Most of the research at this point was primarily focused on describing and comparing the benefits of different exercise training regimens in order to improve cardiovascular fitness. In 1973, an article by Michael Pollock (3) served as the basis of the first ACSM position statement entitled "Quantity and Quality of Exercise for Developing and Maintaining Fitness in Healthy Adults" (4). This statement provided the first guidelines for improving cardiorespiratory fitness (CRF), including performing moderate to vigorous cardiorespiratory exercise using large muscle groups 15–60 minutes for 3–5 $d \cdot wk^{-1}$.

As time continued and research expanded, it became apparent that significant health-related benefits could be achieved at lower levels of physical activity. In 1990, a distinction was made between physical activity recommendations for *health* and physical activity recommendations for *fitness*. Later recommendations by the Centers for Disease Control and Prevention (CDC) and the ACSM (5) were combined with the 1996 Surgeon General's guidelines (6) that clearly highlighted the health benefits of physical activity. These documents were based on evidence that significant health benefits could be achieved with the accumulation of at least 30 minutes of moderate-intensity physical activity on most days of the week (5). A unique characteristic of these CDC/ACSM recommendations is the option for "accumulating" physical activity across the day. The concept of accumulating activity was a large deviation from previous guidelines, which had recommended continuous exercise of at least 20 minutes in duration. In 1998, ACSM updated its position stand and included a more balanced approach by adding muscular fitness and flexibility components to the cardiorespiratory recommendations (7). These recommendations are supported by the current *2018 Physical Activity Guidelines for Americans*, second edition (8), which underscores the importance of physical activity in stating that "adults should move more and sit less throughout the day. Some physical activity is better than none. Adults who sit less and do any amount of moderate-to-vigorous physical activity gain some health benefits" (8, p. 8). The guidelines also recommend performing moderate- to vigorous-intensity exercise throughout the week and that additional health benefits can be gained by performing at least 300 minutes of moderate-intensity exercise.

> "Adults should move more and sit less throughout the day. Some physical activity is better than none. Adults who sit less and do any amount of moderate-to-vigorous physical activity gain some health benefits."

The recently updated *Physical Activity Guidelines for Americans*, second edition, published in 2018 (8) expanded on previous guidelines to include preschool-aged children, children and adolescents, adults, older adults, women during pregnancy and postpartum, adults with disabilities, and people with chronic medical conditions. This report emphasized that for activity to have substantial health benefits, adults need to accumulate at least 150 minutes (2 h and 30 min) per week of moderate-intensity physical activity (with additional benefits noted for more physical activity) or 75 minutes (1 h and 15 min) per week of vigorous-intensity physical activity (8). Personal Trainers should use the most recent ACSM position stand (1) and the current physical activity recommendations (9) to determine the most effective method to improve a client's CRF. The ACSM position stand includes over 400 references providing an extensive summary of the scientific evidence and most up-to-date recommendations for professionals concerning individualized exercise prescription (1). Table 15.1 provides an excerpt of the recommendations for cardiorespiratory exercise as presented in the 2011 ACSM Position Stand (1). This chapter is based on the most recent ACSM Position Stand and the *2018 Physical Activity Guidelines for Americans*, second edition.

Table 15.1 Evidence Statements and Summary of Recommendations for the Individualized Exercise Prescription of Cardiorespiratory Exercise

Component	Evidence-Based Recommendation	Evidence Category[a]
Frequency	≥5 d · wk^{-1} of moderate exercise, ≥3 d · wk^{-1} of vigorous exercise, or a combination of moderate and vigorous exercise on ≥3–5 d · wk^{-1}	A
Intensity	Moderate- and/or vigorous-intensity exercise for most adults	A
	Light- to moderate-intensity exercise may be beneficial in deconditioned persons.	B
Time	30–60 min · d^{-1} (150 min · wk^{-1}) of purposeful moderate exercise, 20–60 min · d^{-1} (75 min · wk^{-1}) of vigorous exercise, or a combination of moderate and vigorous exercise per day for most adults	A
	<20 min · d^{-1} (<150 min · wk^{-1}) of exercise can be beneficial in previously sedentary persons	B
Type	Regular, purposeful exercise that involves major muscle groups and is continuous and rhythmic in nature	A
Volume	≥500–1,000 MET · min · wk^{-1}	C
Pattern	One continuous session per day or in multiple ≥10-min sessions to accumulate the desired duration and volume of exercise per day	A
	<10 min per session may yield favorable adaptation in very deconditioned individuals	B
Progression	Gradual progression of exercise volume by adjusting exercise duration, frequency, and/or intensity until desired exercise goal (maintenance) is attained	B

[a]Table evidence categories: A, randomized controlled trials (rich body of data); B, randomized controlled trials (limited body of data); C, nonrandomized trials, observational studies; D, panel consensus judgment.

Adapted with permission from Garber CE, Blissmer B, Deschenes MR, et al. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. *Med Sci Sports Exerc*. 2011;43(7):1334–59.

General Training Principles

CRF refers to the ability of an individual to perform large muscle, rhythmic, repetitive, and continuous moderate- to vigorous-intensity exercise for an extended period of time. The goal is to increase heart rate (HR) and respiration in order to place an appropriate physiological stress on the cardiorespiratory system. The increase in stress is often referred to as "overload." The term *overload* is commonly used when referring not only to resistance or strength training (*i.e.*, lifting a weight heavier than typically done in daily activity to stress the muscle, resulting in increases in strength and potential hypertrophy) but also applies to CRF. Overload of the cardiovascular and respiratory systems is required to create beneficial adaptations in CRF. CRF is a function of enhancing both the central oxygen delivery (*i.e.*, heart and circulatory) processes and the peripheral oxygen-uptake mechanisms of the working muscles. Enhancing the body's ability to deliver and use oxygen for metabolic processes allows one to do more work. Typical measurements used to determine improvements in CRF include increases in maximal volume of oxygen consumed per unit time ($\dot{V}O_{2max}$) and decreases in HR or $\dot{V}O_2$ in response to a given submaximal workload.

> Overload of the cardiovascular and respiratory systems is required to create beneficial adaptations in CRF.

Major benefits of increased cardiorespiratory training and physical activity include the following (10):

- Overall decrease in morbidity and mortality
- Decreased risk of premature death from coronary artery disease
- Decrease in incidence of cardiovascular disease, stroke, Type 2 diabetes mellitus, metabolic syndrome, osteoporotic fractures, and gallbladder disease
- Lower risks of developing cancers of the bladder, colon, endometrium, esophagus, kidney, lung, and stomach
- Decreased risk of dementia (including Alzheimer disease), anxiety, and depression
- Increased likelihood of increased habitual activity levels that are also associated with health benefits

Additional benefits from regular physical activity and/or exercise are listed in Box 15.1 (10). Clearly, including CRF in an exercise program has many benefits and is instrumental in designing a balanced health-related program.

Box 15.1 Benefits of Regular Physical Activity/Exercise

Improvement in Cardiovascular and Respiratory Function

- Increased maximal oxygen uptake resulting from both central and peripheral adaptations
- Decreased minute ventilation at a given absolute submaximal intensity
- Decreased myocardial oxygen cost for a given absolute submaximal intensity
- Decreased heart rate and blood pressure at a given submaximal intensity
- Increased capillary density in skeletal muscle
- Increased exercise threshold for the accumulation of lactate in the blood
- Increased exercise threshold for the onset of disease signs or symptoms (*e.g.*, angina pectoris, ischemic ST-segment depression, claudication)

Reduction in Coronary Artery Disease Risk Factors

- Reduced resting systolic/diastolic pressures
- Increased serum high-density lipoprotein cholesterol and decreased serum triglycerides
- Reduced total body fat and reduced intraabdominal fat
- Reduced insulin needs and improved glucose tolerance
- Reduced blood platelet adhesiveness and aggregation

Decreased Morbidity and Mortality

- Primary prevention (*i.e.*, interventions to prevent the initial occurrence)
- Higher activity and/or fitness levels are associated with lower death rates from coronary artery disease
- Higher activity and/or fitness levels are associated with lower incidence rates for combined cardiovascular diseases, coronary artery disease, stroke, Type 2 diabetes, osteoporotic fractures, and gallbladder disease
- Lower risks of cancers of the bladder, breast, colon, endometrium, esophagus, kidney, lung and stomach
- Regular physical activity/exercise interventions act as secondary prevention (*i.e.*, interventions after a cardiac event help prevent another)
- Based on meta-analyses (pooled data across studies), cardiovascular and all-cause mortality are reduced in postmyocardial infarction patients who

participate in cardiac rehabilitation exercise training, especially as a component of multifactorial risk factor reduction
- Randomized controlled trials of cardiac rehabilitation exercise training involving postmyocardial infarction patients do not support a reduction in the rate of nonfatal reinfarction

Other Benefits

- Decreased anxiety and depression
- Decreased risk of dementia (including Alzheimer disease)
- Enhanced physical function and independent living in older persons
- Enhanced feelings of well-being
- Enhanced performance of work, recreational, and sport activities
- Reduced risk of falls and injuries from falls in older persons
- Prevention or mitigation of functional limitations in older adults
- Effective therapy for many chronic diseases in older adults

Reprinted from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2022. 480 p. Data from Chodzko-Zajko WJ, Proctor DN, Fiatarone Singh MA, et al. American College of Sports Medicine position stand. Exercise and physical activity for older adults. *Med Sci Sports Exerc*. 2009;41(7):1510–30. Data from U.S. Department of Health and Human Services. *Physical Activity and Health: A Report of the Surgeon General*. Atlanta (GA): U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion; 1996. 278 p.

The training guidelines presented in this chapter can be followed to bring about the appropriate overload for cardiorespiratory adaptations. However, the training methods used to overload the cardiorespiratory system can be quite varied. When the cardiorespiratory system is challenged (or overloaded) by endurance training (*i.e.*, exercise of a certain intensity for a certain period of time), then adaptation occurs. Over time, functional (*i.e.*, fitness or performance) changes or improvements follow. There is no single or best "one-size-fits-all" exercise program to apply universally. Determining how to stress the system appropriately for a given individual is one of the roles of a Personal Trainer. One must be aware that the presented guidelines are just that, guidelines. They give the Personal Trainer the *science* behind exercise prescription. A Personal Trainer must understand that each client comes with unique characteristics (*i.e.*, health risk factors, fitness levels, exercise goals, and personal preferences) that must be considered when designing a client's optimal fitness program. This is where the *art* of exercise prescription comes into play.

Performing activities that increase HR and respiration are required to overload or challenge the cardiorespiratory system. Altering the mode or type of exercise brings about specific adaptations as well as more generalized CRF gains. The minimal amount of overload needed to bring about the desired adaptation is referred to as the "threshold" for change. If the training level exceeds the threshold, then characteristic physiological adaptations occur. However, exceeding the threshold that is required for physiological adaptations to occur can result in diminished performance. This diminished performance is often termed *overtraining syndrome*. Here, the chronic accumulation of too much training (*i.e.*, overreaching) leads to long-term diminished performance and can take weeks to overcome. Conversely, the *principle of diminishing returns* is a general training principle that can be used to describe the theoretical "genetic ceiling" that each individual has in regard to his or her ability to continually improve his or her fitness with training. As an individual reaches his or her genetic ceiling, the amount and rate of improvement that occurs slows and eventually plateaus. Conversely, if a client is injured or decreases his or her exercise below the threshold of change, the *principle of reversibility* will apply, where physiological effects and health benefits will decrease with the reduction in exercise. The Personal Trainer must carefully balance the FITT principles of exercise prescription:

- Frequency (F; number of days per week)
- Intensity (I; how hard the workout is for the client)
- Time (T; duration or minutes per workout)
- Type (T; mode or what kind of activity)

The Personal Trainer should also consider the volume (V; total amount of energy expenditure achieved per week) and progression (P; gradual increase in the overload) when designing exercise programs to ensure that one properly overloads the cardiorespiratory system without overwhelming the client beyond an appropriate amount of overload (1).

The Personal Trainer must carefully balance frequency, intensity, duration, volume, and progression of the workouts to avoid overchallenging the client beyond an appropriate amount of overload.

Design of a Cardiorespiratory Training Session

A well-planned CRF session should include a warm-up, a conditioning phase, and a cool-down. The warm-up prepares the person for the conditioning phase, where a target intensity is to be achieved allowing for appropriate overload. The cool-down allows the person to transition back toward resting levels. Development of the structure of the entire exercise program sequence is presented in Chapter 13.

> A well-planned CRF session should include a warm-up, a conditioning phase, and a cool-down.

Warm-Up

A properly constructed exercise program will include a transition period from rest to the target exercise intensity. This transition period is called the warm-up. The duration, intensity, and type of exercises performed during the warm-up will vary depending on the individual and purpose of the warm-up. During the warm-up, the client should perform low-level activities similar to what will be done during the conditioning phase. For example, an appropriate warm-up for a brisk walking exercise program would include slow walking. The muscle groups used are similar in the two activities — slow walking being a low-intensity activity, which naturally leads to the brisk walking of the exercise program. The warm-up may also include gentle dynamic stretching activities, although stretching should not be done with cold muscles. The specific activities included in a warm-up will vary depending on the target activity to be included in the endurance phase. In general, the warm-up should include 5–10 minutes of low-intensity large muscle activity that progresses to an intensity at the lower end of the target exercise range for the endurance phase (10).

The intent of a warm-up is to prepare the muscles and cardiorespiratory system for the upcoming workout. It is a time of transition and should provide a gradual (rather than an abrupt) increase in HR, respiration, and body temperature. Taking sufficient time to prepare the body for physical activity increases the safety and enjoyment of the target exercise during the endurance phase. The benefits of completing a warm-up include the following (10):

- May reduce the susceptibility of injury to muscles or joints by increasing the extensibility of connective tissue
- May improve joint range of motion and function
- May improve muscle performance
- May help prevent ischemia (lack of oxygen) of the heart muscle, which may occur in clients with sudden strenuous exertion

Conditioning Phase

The warm-up allows a transition from rest to the conditioning phase, which is at a higher level of intensity. The object of the conditioning phase is to provide the appropriate overload to promote beneficial cardiorespiratory adaptations. Thus, the Personal Trainer must consider and balance the exercise prescription principles (FITT-VP). Each of these factors, as they pertain to cardiorespiratory endurance, is discussed in more detail later in this chapter.

Cool-Down

The cool-down is a transition from the higher intensity of the conditioning phase back toward resting levels. The cool-down reduces the risk of cardiovascular complications by allowing HR, blood pressure, and respiration rate to gradually decrease toward resting levels. By allowing a gradual progression toward resting rather than abruptly stopping exercise, the client will avoid an acute, excessive drop in blood pressure that could result in dizziness (this differs from the positive adaptation that exercise can provide to lower blood pressure chronically). A gradual decrease in intensity also helps remove metabolic end products (*e.g.*, lactate) from muscles used more intensely during the conditioning phase (10). Furthermore, 5–10 minutes of static stretching that incorporates all the major muscle groups should be incorporated following the aerobic cool-down. Stretching may help reduce the potential risks of muscle cramping.

The cool-down reduces the risk of cardiovascular complications by allowing HR, blood pressure, and respiration rate to gradually decrease toward resting levels.

Approximately 10 minutes of diminishing intensity activities are appropriate for a typical cool-down (10). For exercise done at higher intensity during the conditioning phase, a longer cool-down may be warranted. However, for the client who uses brisk walking as an exercise mode for the endurance phase, an appropriate cool-down could be a bit shorter and could include slow walking for 5 minutes followed by 5 minutes of dynamic body stretches.

Exercise Prescription for Cardiorespiratory Fitness

Frequency

According to the ACSM guidelines (1,10), the optimal frequency of aerobic exercise appears to be 3–5 $d \cdot wk^{-1}$ for most adults, with the frequency varying with the intensity. The *2018 Physical Activity Guidelines for Americans* suggest that adults should accumulate 150 $min \cdot wk^{-1}$ of moderate-intensity exercise. In addition, these guidelines recommend that adults should do any amount of moderate to vigorous physical activity at least 3 $d \cdot wk^{-1}$. Although additional benefits may be achieved beyond 5 $d \cdot wk^{-1}$, improvements can be attenuated as the frequency increases such that a plateau in benefits is often seen with exercise done greater than 5 $d \cdot wk^{-1}$ (1,10). Additionally, training at high intensity or vigorous activity for greater than 5 $d \cdot wk^{-1}$ might increase the incidence of injury and is not recommended for most adults (10). Admittedly, individuals focused on competition or high-level performance will likely train 6 or more days a week for specific physiological adaptations. Clearly, different goals will require altering the exercise program and thus involve different associated risks.

There is an inverse relationship between the recommendations for frequency and intensity such that if the exercise intensity is held at the lower end of the target range, then the frequency can be increased and vice versa (10). Current evidence suggests that multiple combinations of frequency and duration can be used to meet current physical activity recommendations. For example, 5 $d \cdot wk^{-1}$ of moderate-intensity exercise for 30 minutes may not be any different than performing 3 $d \cdot wk^{-1}$ of moderate-intensity exercise for 50 minutes. In addition, performing aerobic exercise only once or twice a week at a moderate- to vigorous-intensity can still confer health benefits for a client (10).

Intensity

A client's initial level of fitness is one variable to consider when determining the appropriate exercise intensity needed to achieve the required overload. The *principle of initial values* suggests that intensity levels are necessarily higher in fit than in unfit individuals because the threshold for cardiorespiratory benefits is higher. The Personal Trainer must understand that the minimum intensity threshold for improvement varies based on initial fitness level, age, health status, physiological differences, genetics, habitual physical activity, and social and psychological factors (1,10). For individuals with lower fitness, intensity levels as low as 45% oxygen uptake reserve ($\dot{V}O_2R$) and heart rate reserve (HRR) may provide a sufficient challenge to increase $\dot{V}O_{2max}$. In contrast, highly trained athletes may train at 95%–100% $\dot{V}O_{2max}$. Moderately trained individuals may find that 70%–80% $\dot{V}O_{2max}$ provides a sufficient training stimulus (10). Recent evidence suggests (11,12) that performing vigorous-intensity exercise (>6 metabolic equivalents [METs], 60%–84% HRR) is more effective at increasing $\dot{V}O_{2max}$ than moderate-intensity (3.0–5.9 METs, 40%–59% HRR) exercise, but moderate- to vigorous-intensity exercise is best used to meet current physical activity recommendations. Intensity can be determined using various methods. Table 15.2 provides an overview of the intensity classifications for CRF (10). Details on these various methods will be outlined in this section.

Table 15.2 Methods of Estimating Intensity for Cardiorespiratory Endurance Exercise

Cardiorespiratory Endurance Exercise					
	Relative Intensity				Absolute Intensity
Intensity	**%HRR or %$\dot{V}O_2R$**	**%HR_{max}**	**%$\dot{V}O_{2max}$**	**Perceived Exertion (Rating on 6–20 RPE Scale)**	**METs**
Very light	<30	<57	<37	Very light (RPE <9)	<2.0
Light	30–39	57–63	37–45	Very light to fairly light (RPE 9–11)	2.0–2.9
Moderate	40–59	64–76	46–63	Fairly light to somewhat hard (RPE	3.0–5.9

				12–13)	
Vigorous	60–89	77–95	64–90	Somewhat hard to very hard (RPE 14–17)	6.0–8.7
Near maximal to maximal	≥90	≥96	≥91	≥Very hard (RPE ≥18)	≥8.8

Adapted from Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee IM, et al. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. *Med Sci Sports Exerc*. 2011;43(7):1334–59.

Traditionally, moderate- to vigorous-continuous aerobic exercise has been the focus for improving CRF and decreasing the risk of developing hypokinetic diseases (*i.e.*, diseases caused by lack of movement). Interval training, broadly defined as performing intermittent bouts of vigorous- to supramaximal-intensity bouts of exercise (20–240 s) separated by equal or longer bouts of light- to moderate-intensity exercise (60–340 s), has emerged as a method of exercise prescription. There are two main classifications of interval training: high-intensity interval training (HIIT) or sprint-interval training (13). It is of vital importance that the Personal Trainer ensures his or her client can safely perform exercises at this intensity based on his or her preparticipation evaluation as outlined in Chapter 11 of this book. Because HIIT training is so popular, the 2018 Physical Activity Guidelines Advisory Committee examined the available scientific evidence regarding the use of HIIT for cardiometabolic health benefits (14). The results indicate that HIIT can improve CRF in adults with varied weight and health status and improve insulin sensitivity and blood pressure to a greater extent in adults that were overweight or obese.

Interval training can be composed of aerobic-based, resistance-based, or a combination of the two. Ultimately, the type of programming chosen, the intensity of exercise, the exercise interval duration, recovery intervals, and total number of intervals performed will be based on the goals of the training session and the physical readiness of the client (15,16).

Methods of Estimating Intensity for Cardiorespiratory Endurance Exercise

There are many ways to determine exercise intensity. Table 15.2 shows the different methods commonly used to determine exercise intensity. Some methods require knowledge of measured $\dot{V}O_{2max}$, maximal heart rate (HR_{max}), and/or resting heart rate (HR_{rest}). Others rely on estimations of HR_{max} based on age. Personal Trainers must use the information available to determine the most appropriate exercise prescription, realizing the shortcomings of the various methods. A good Personal Trainer has the willingness and ability to modify the exercise program to provide the appropriate overload and prescription to the client.

Maximal Heart Rate and Heart Rate Reserve

Using HR in prescribing intensity can be helpful because it represents a client's physiological response, but it too has shortcomings. Accuracy can be compromised when estimations of HR_{max} are used or with the use of medications known to influence HR (*i.e.*, β-blockers, a medication that suppresses HR at rest and during exercise). Medication use can be identified from the initial health history and should be updated as needed when changes in medications occur. When a measured HR_{max}, obtained during a graded exercise test, is unavailable, the Personal Trainer commonly uses an age-predicted estimate (220 − age). Be aware that there is controversy over using this method to estimate HR_{max}. Most notably, it can underestimate or overestimate measured HR_{max} and has a variability of ± 10–12 bpm (*i.e.*, 1 *standard deviation*). Thus, a 20-year-old may not have an HR_{max} of 200 as predicted by this formula, but instead, his or her estimate could be as low as 188 or as high as 212. Some population-specific equations for estimating HR_{max} are available. These may be superior to the "220 − age" equation, at least in some individuals, although they are not currently recommended for universal application (10). Table 15.3 provides the commonly used equations for estimating HR_{max} for various populations. Although directly measured HR_{max} is preferred to estimated methods, when this is not feasible, an estimation using one of these methods is acceptable. When estimating HR_{max}, choose an equation that most represents the client population.

Table 15.3 Commonly Used Equations for Estimating Maximal Heart Rate

Author	Equation	Population
Astrand	$HR_{max} = 216.6 - (0.84 \times age)$	Men and women age 4–34 yr
Tanaka et al.	$HR_{max} = 208 - (0.7 \times age)$	Healthy men and women
Gellish et al.	$HR_{max} = 207 - (0.7 \times age)$	Men and women participants in an adult fitness program with broad range of age and fitness levels
Gulati et al.	$HR_{max} = 206 - (0.88 \times age)$	Asymptomatic middle-aged women referred for stress testing

Adapted from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2022. 548 p.

Often, a Personal Trainer will not have access to information on oxygen consumption from an exercise test. We do know that as exercise intensity increases, HR and oxygen consumption have a linear relationship. Therefore, in the absence of oxygen consumption information, HR can be used. Whether using measured or predicted HR_{max} to determine intensity, ACSM recommends a percentage of HR_{max} for moderate-intensity exercise between 64% and 76% and a vigorous intensity from 77% to 95% of HR_{max} (10). The following calculation can be used to determine the exercise target HR based on a percentage of HR_{max} for moderate intensity:

$$\text{Percentage of target HR (lower end of range)} = (HR_{max}) \times 0.64$$

$$\text{Percentage of target HR (lower end of range)} = (HR_{max}) \times 0.76$$

For example, a 20-year-old with an estimated HR_{max} of 200 (220 − 20 = 200 bpm), the range moderate-intensity rage will be 128–152 bpm. However, based on the client's goals, health history, and current fitness level, this intensity range may be too limiting for the exercise session. The Personal Trainer must therefore decide if increasing the intensity range to include vigorous exercise (77%–95% HR_{max}) is appropriate and beneficial (10). Therefore, for the 20-year-old, moderately active client, the target HR range could be 128–190 bpm. Conversely, if a client is very deconditioned or unfit, then a lower percentage should be used (light intensity 57%–63% HR_{max}). Ultimately, it is up to the Personal Trainer to decide at what intensity the client should exercise. When picking the initial exercise intensity, it is important not to overestimate the client's ability and start at too high of an intensity and subsequently have to reduce it for the client because this can negatively impact the client's confidence. Often, it is more effective to start with a conservative intensity with the ability to increase it as needed.

Another HR method to determine intensity is HRR. HRR is a measure of *relative* intensity because this method uses information relative to the client's peak or HR_{max} and HR_{rest}. As discussed in previous chapters, a lower HR_{rest} can be an indicator of greater CRF. HRR, often referred to as the Karvonen method or formula, is based on the difference between HR_{max} and HR_{rest}. Exercise intensity can be determined from HRR in a similar manner as $\dot{V}O_2R$. For moderate- to vigorous-intensity exercise the intensity range is 40%–89% HRR (10).

$$\text{Percentage of target HRR (lower end of moderate range)} = [(HR_{max} - HR_{rest}) \times 0.40] + HR_{rest}$$

$$\text{Percentage of target HRR (upper end of vigorous range)} = [(HR_{max} - HR_{rest}) \times 0.89] + HR_{rest}$$

For example, when using this method for a 20-year-old client who has an HR_{rest} of 75, the range will be 125–186 bpm. This range is too wide to be a useful intensity for exercise prescription. Thus, changes must be made based on the client's fitness, goals, and health history. Additional examples are listed in Box 15.2.

Box 15.2 Example HR_{max} and HRR Calculations

Client name: Amy
Client demographics:
Age: 29 yr
Weight: 136 lb (61.8 kg)
Height: 5 ft 4 in (64 in; 1.63 m)
HR_{rest}: 62 bpm

$\dot{V}O_{2max}$ ($mL\ O_2 \cdot kg^{-1} \cdot min^{-1}$): 36.4 $mL\ O_2 \cdot kg^{-1} \cdot min^{-1}$ (fair category)

Amy is a healthy female adult who has been doing moderate-intensity cardiovascular exercise on her own for the last year and a half. She would like to continue exercise but at a vigorous intensity.

Step 1: Calculate her estimated HR_{max}.
Equation: 220 – age
220 – 29 = 191 bpm
Step 2: Determine appropriate HR_{max} and HRR intensities.
HR_{max} vigorous range: 77%–95%
HR_{max} intensity equation: HR_{max} × % intensity desired

191 × 0.77 = 147 bpm   191 × 0.95 = 181 bpm

HRR vigorous range: 60%–89%
HRR intensity equation: [(HR_{max} – HR_{rest}) × % intensity desired] + HR_{rest}

[(191 – 62) × 0.60] + 62   [(191 – 62) × 0.89] + 62

[129 × 0.60] + 62   [129 × 0.89] + 62

77 + 62 = 139 bpm   115 + 62 = 177 bpm

So, for Amy to exercise at a vigorous intensity, she should try to achieve an HR between 147 181 bpm (%HR_{max}) and 139 177 bpm (%HRR).

Selection of the intensity range must be made with the client's fitness, health status, and fitness goals in mind.

Rating of Perceived Exertion

Rating of perceived exertion (RPE) is used to subjectively rate overall feelings of exertion during exercise and can be helpful in guiding exercise intensity (10,17). Commonly used is the Borg 6–20 scale and the Borg Category Ratio 10 (CR10) scale (10). Table 15.4 lists and compares the two Borg RPE scales. The threshold level for cardiorespiratory benefits appears to be an RPE of 12–13, which represents moderate intensity. When using the Borg 6–20 scale, it is important for the Personal Trainer to explain how to use the scale and to "anchor" certain numbers on the scale so the client has a point of reference. When explaining how to use the scale, the Personal Trainer should remind the client that the number he or she is giving represent overall body fatigue and is not localized to a specific area of the body. When anchoring the scale numbers, a 9 represents "very light" activity and can equate to a healthy individual walking slowly at his or her own pace. A 13 represents an intensity that is "somewhat hard" and means that the exercise is hard, but he or she can still continue (17). When using RPE, the Personal Trainer should keep in mind the variability between individuals (*e.g.*, the RPE value will not necessarily correspond directly with a particular percentage of HR_{max} or percentage of HRR) and then make adjustments as needed (10).

Table 15.4 Borg Rating of Perceived Exertion Scale and Borg Category-Ratio 10 Scale

Number Rating	Level of Exertion	Number Rating	Level of Exertion
6	No exertion at all	0	Nothing at all
7	Extremely light	0.3	
8		0.5	Extremely week
9	Very light	1	Very weak
10		1.5	
11	Light	2	Weak
12		2.5	
13	Somewhat hard	3	Moderate
14		4	
15	Hard (heavy)	5	Strong
16		6	

17	Very hard	7	Very strong
18		8	
19	Extremely hard	9	
20	Maximal exertion	10	Extremely strong
		11	
		•	Absolute maximum

Adapted from Borg G. *Borg's Perceived Exertion and Pain Scales*. Champaign (IL): Human Kinetics; 1998. 104 p.

RPE is often recommended for determining exercise intensity in older adults and is helpful for individuals having difficulty assessing their HR or who are taking medications, which influence HR. Although older adults are encouraged to attain similar amounts of physical activity related to days per week and time per session as younger people (18), given the wide range of fitness levels in older adults, using a perceived exertion scale (*i.e.*, a moderate or 12–13 rating on the 6–20 scale or a 3–4 level rating of exertion on a CR10 scale) to gauge intensity is often preferable to standard activity descriptions. For example, for some older adults, moderate-intensity activity may be a slow walk, whereas for others, it may be a brisk walk or jog.

Talk Test

A very simple, yet effective, way to determine intensity is with the "talk test." The talk test is a reliable method to estimate exercise intensity and is associated with the transition from aerobic to anaerobic energy systems via lactate threshold, ventilatory threshold, and the respiratory compensation point (10). Simply put, how well a client is able to speak or carry on a conversation relates well to his or her relative intensity. Table 15.5 represents current exercise intensity ranges and their relationship with the talk test. In practice, the Personal Trainer should first estimate the client's moderate- to vigorous-intensity HR range using the HRR method. Next, have the client perform a 5- to 10-minute warm-up and then gradually increase the intensity to a walking or jogging speed. When the client reaches a steady-state HR at the new intensity, have them recite a standard phrase aloud (*e.g.*, the 31-word United States Pledge of Allegiance). After saying the phrase, have the client subjectively assess his or her level of speech difficulty based on Table 15.5 (19).

Table 15.5 Physical Activity Intensity and the Talk Test

Relative Intensity			
Intensity	**%HRR**	**RPE**	**Speech Difficulty**[a]
Very light	<20	<10	Speech is unaffected from rest.
Light	20–29	10–11	Comfortable speech is possible.
Moderate	40–59	12–13	Speech is possible with some difficulty.
Vigorous	60–89	14–16	Speech is limited to short phrases.
Maximal to near maximal	≥90	17–19	Speech is very difficult.

[a]Individual must speak aloud.

Adapted from Webster AL, Azanar-Laín S. Intensity of physical activity and the "talk test" — a brief review and practical application. *ACSMs Health Fit J*. 2008;12(3):13–7.

Time or Exercise Session Duration

Exercise duration and intensity are typically inversely related. As one increases, the other decreases. Thus, the intensity of the exercise must be considered when determining the duration. ACSM recommends 30 min · d^{-1} (150 min · wk^{-1}) of moderate-intensity exercise, 20 min · d^{-1} (75 min · wk^{-1}) of vigorous exercise, or a combination of both to improve CRF (10). This duration can be in one exercise session or could be accomplished intermittently through multiple exercise bouts. If fitness gains are a primary goal and the exercise is done intermittently, then each exercise bout should be ≥10 minutes for each bout. However, current evidence suggests that accumulating physical activity in bouts that are <10 minutes in duration are also associated with favorable health benefits, including a reduction in all-cause mortality (20). Sedentary individuals may need to begin with very short bouts (*i.e.*, 5–10 min · d^{-1}) of low-intensity exercise. Time and intensity should then be gradually increased while always being mindful of the client's fatigue level. The rate of progression will vary depending on the health status and age of the individual. Longer durations of exercise (≥30–60 min · d^{-1} or more; 250–300 min · wk^{-1}) are recommended for weight control especially for those who are otherwise sedentary (7). This time frame does not include warm-up and cool-down, both of which should be completed in addition to the time spent at the target exercise program (21).

Exercise Type or Mode

The type of exercise selected should be based on the client's fitness, health, skill, and interests. During the initial consultation with a client, it is best to discuss what activities are most enjoyed as well as those that are accessible. Enjoyability and access may seem obvious but are important to consider when selecting an exercise mode for best possible adherence, particularly outside of the sessions with the Personal Trainer.

Typically, cardiorespiratory exercises are those that involve the use of large muscle groups in a repetitive, rhythmic fashion. Some activities are weight bearing, meaning that body weight is moved during the exercise (*e.g.*, walking, running). In other activities, body weight is not a factor because the body is supported (*e.g.*, cycling, swimming) and are referred to as non–weight-bearing exercises. Use of non–weight-bearing exercises may be useful in avoiding injuries of the lower limbs due to overuse or in populations where weight-bearing exercise can create potential issues (*i.e.*, obese clients). ACSM has classified a number of cardiorespiratory endurance activities into four groups (Table 15.6) (10). The groups do not necessarily represent the recommended or optimal progression of activity but rather present the Personal Trainer with a structure of the characteristics of different exercise modes that should be considered when selecting activities.

Table 15.6 Grouping of Cardiorespiratory Exercise and Activities

Exercise Group	Exercise Description	Recommended For	Examples
A	Endurance activities requiring minimal skill or physical fitness to perform	All adults	Walking, leisurely cycling, aqua-aerobics, slow dancing
B	Vigorous-intensity endurance activities requiring minimal skill	Adults (per the preparticipation screening guidelines; see Chapter 11) who are habitually physically active and/or at least average physical fitness	Jogging, running, rowing, aerobics, spinning, elliptical exercise, stepping exercise, fast dancing
C	Endurance activities requiring skill to perform	Adults with acquired skill and/or at least average physical fitness levels	Swimming, cross-country skiing, skating
D	Recreational sports	Adults with a regular exercise	Racquet sports, basketball,

	program and at least average physical fitness	soccer, downhill skiing, hiking

Adapted with permission from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2022. 548 p.

Group A includes endurance activities that require minimal skill or fitness to perform, such as walking. These activities easily accommodate individual fitness levels and thus are recommended for all adults. Group B activities are those that require minimal skill but, in contrast to Group A activities, are typically performed at a more vigorous intensity. Jogging and running are examples. These activities are appropriate for those who exercise regularly and who have at least an average level of fitness. Examples of Group C exercises are swimming and cross-country skiing. This group reflects activities that have a high relationship between skill and energy expenditure. For example, an experienced swimmer may be able to easily swim at a constant intensity, whereas a person with poor swimming skill would be very inefficient and would struggle to swim at an appropriate and constant intensity to achieve cardiorespiratory benefits.

Recreational sports such as basketball, soccer, tennis, and other racquet sports are classified as Group D activities. These activities are typically vigorous and intermittent. The nature of these activities does not lend themselves to constant, controlled intensity levels. This is even more true when competition is involved. As a result, Group D activities should be used with caution for clients with low fitness or who are at high risk or symptomatic for disease unless modifications to rules are implemented. Group D activities are generally recommended as ancillary activities that are added to a regular fitness program (10).

The Personal Trainer can use these activity groupings to guide his or her selection of an appropriate exercise mode for his or her client. As noted previously, Group A activities are appropriate to use with any client but are particularly appropriate for clients beginning an exercise program. Group B activities are recommended for most regular exercisers with at least an average fitness level. Group C activities may be included but will require discussion with the client regarding his or her skill levels for the activities in question. Group D activities may best be included as additional activity after a fairly good level of fitness is achieved. The Personal Trainer and the client must maintain open lines of communication regarding the selection of exercise modes. In some situations, individuals will be satisfied with continuing with various Group A activities. Other clients may have goals to move to Group B, have the skills or desire to learn new skills to include Group C activities, or enjoy the variety and challenge of Group D activities.

The Personal Trainer should also always instruct clients about proper posture and body alignment during cardiorespiratory training. Having a client perform these exercises in a proper biomechanical position is just as important with cardiorespiratory exercise as when clients are performing resistance training exercises, as discussed in Chapter 14. Typical concerns with treadmill exercise include leaning forward, uneven or unnatural gait, and excessive gripping on the handrails. Proper upright posture, body alignment, and normal gait with the use of handrails only for balance should be encouraged. Similarly, with stair steppers or other cross-training machines, upright posture should be maintained rather than allowing forward head protrusion, rounded shoulders, or poor alignment. The biggest challenge with cycle ergometry is determination of appropriate seat height. Seat height should be adjusted to allow for 5°–10° of knee flexion at the bottom of the pedal stroke. Figures 15.1–15.4 show examples of proper exercise postures.

FIGURE 15.1. Personal Trainers should instruct clients to adjust seat heights to maintain a 5°–10° bend in the knee before reaching full extension to reduce compression on the joint structure. Full extension of knee while pedaling on the stationary bike is not recommended.

FIGURE 15.2. Stair climber activity.

FIGURE 15.3. Walking activity.

FIGURE 15.4. Rowing activity.

The Personal Trainer should also always instruct clients about proper posture and body alignment during cardiorespiratory training.

Volume (Quantity)

Exercise volume is the product of FITT of exercise. Exercise volume is used to estimate the gross energy expenditure of an individual's exercise program. Determining exercise volume is important in realizing health/fitness outcomes, particularly with respect to body composition and weight management. Exercise volume is typically expressed in kcal · day^{-1}, kcal · wk^{-1}, or MET-min · wk^{-1}. Box 15.3 provides definitions and calculations for MET, MET-min, and kcal · min^{-1}. These then can be used to calculate volume in MET-min · wk^{-1} and kcal · wk^{-1} to evaluate whether the exercise program is at the appropriate overload volume. In addition, volume can be approximated based on steps per day (10). Pedometers and other wearable technology have increased the accuracy of tracking physical activity. The Personal Trainer should be aware that the often-stated goal of 10,000 steps $\cdot$ d^{-1} is an appropriate target but that a daily step count of 7,000–8,000 steps $\cdot$ d^{-1}, with at least 3,000 steps $\cdot$ d^{-1} at a brisk pace, will meet the threshold for health benefits (12).

Box 15.3 Calculation of MET, MET-min, and kcal · min^{-1}

A shortcoming of caloric expenditure estimates includes the influence of coordination and skill. An experienced swimmer, for example, will expend less energy to swim the same pace as someone with an inefficient stroke patterns. Even though they are at the same pace and theoretically doing a similar amount of work, the inexperienced swimmer will expend more calories than those expended by the experienced swimmer. Thus, the Personal Trainer needs to understand that interindividual differences limit the precision of this estimation.

ACSM recommends expending 150–400 kcal in physical activity each day (10). Sedentary individuals need to begin on the lower end of the range and progress upward. Expenditures of approximately 1,000 kcal · wk^{-1} are associated with decreases in the risk of all-cause mortality (10) and values of ≥500–1,000 MET-min · wk^{-1} are consistently associated with lower rates of cardiovascular disease and premature mortality (10). Therefore, a recommended exercise volume for decreasing risk of premature mortality is an exercise volume of ≥500–1,000 MET-min · wk^{-1}.

> Selection of frequency, intensity, and duration determines the calories expended during the activity.

The following equation can be used to approximate the number of calories expended per minute of a given activity (10):

$$\text{Calories per min} = (\text{MET} \times 3.5 \times \text{body weight in kilograms}) / 200$$

The attraction of using this approach is it includes both time and intensity of the prescribed exercise mode. For example, if a client runs on the treadmill at 0% grade at 7 mph for 45 min, the Personal Trainer can “summarize” the caloric expenditure of the workout by using this formula and the MET level for 7 mph, which is 11.7 MET. If the client weighs 150 lb (68.2 kg), then the number of calories expended for the total workout can be determined as follows:

$$(11.7 \times 3.5 \times 68.2) / 200 = 14 \text{ kcal} \cdot \text{min}^{-1}$$

$$14 \text{ kcal} \cdot \text{min}^{-1} \times 45 \text{ min} = 630 \text{ kcal for the workout}$$

ACSM recommends a minimum goal of ≥500–1,000 MET-min · wk^{-1} (10). To determine if a person who walks 3 mph (about 3.3 METs) for 30 min on 5 d of the week is getting a sufficient volume of exercise, use the following calculation:

$$30 \text{ min at this intensity} = 3.3 \text{ MET} \times 30 \text{ min} = 99 \text{ MET-min} \cdot d^{-1}$$
$$\text{Volume for 5 d of activity} = 99 \times 5 = 495 \text{ MET-min} \cdot wk^{-1}$$

Thus, this person is just under the recommended volume. The Personal Trainer should encourage that this person increase time, intensity, or frequency to meet the guidelines. Weekly volume for someone exercising at a higher intensity, for example, jogging 5 mph for 20 min 3 d · wk^{-1} would be

$$5 \text{ mph} = 8.6 \text{ MET}$$
$$20 \text{ min at this intensity} = 8.6 \times 20 = 172 \text{ MET-min} \cdot d^{-1}$$
$$\text{Volume for the 3 d of activity} = 172 \times 3 = 516 \text{ MET-min} \cdot wk^{-1}$$

Thus, this person is within the recommended weekly volume range. Calculating MET-min · wk^{-1} is especially useful when individuals combine activities of different intensity levels (*e.g.*, walking and jogging in the same week). For example, the MET-min · wk^{-1} for a person walking 2 d · wk^{-1} at 3 mph for 30 min and jogging at 5 mph for 2 d · wk^{-1} for 20 min would be determined as follows:

$$3 \text{ mph} = 3.3 \text{ MET and } 5 \text{ mph} = 8.6 \text{ MET}$$
$$30 \text{ min at 3 mph} = 3.3 \text{ MET} \times 30 \text{ min} = 99 \text{ MET-min} \cdot d^{-1}$$
$$\text{Volume for 2 d of activity} = 99 \times 2 = 198 \text{ MET-min} \cdot wk^{-1}$$
$$20 \text{ min at 5 mph} = 8.6 \times 20 = 172 \text{ MET-min} \cdot d^{-1}$$
$$\text{Volume for 2 d of activity} = 172 \times 2 = 344 \text{ MET-min} \cdot wk^{-1}$$
$$\text{Total volume for 4 d} = 198 + 344 = 542 \text{ MET-min} \cdot wk^{-1}$$

For a more extensive list of MET values, please see the updated *2011 Compendium of Physical Activities* (12) or http://sites.google.com/site/compendiumofphysicalactivities/home. Note that the MET values in various tables may differ slightly as these are approximations.

Progression

Progression, as a component of the exercise prescription, ensures that the overload is not applied in a manner that exceeds the cardiorespiratory system's ability to adapt. Any or all of the FITT components may be increased to continually overload and challenge the cardiorespiratory system. However, the Personal Trainer should not increase all of the components at the same time but rather adjust them individually to help the client attain his or her CRF goals. When and how much to increase each component will depend on the client's initial fitness level, his or her progress, health status, and goals. Often, the duration of the exercise bout is increased first, with an increase ranging from 5 to 10 minutes for a couple of weeks before intensity is increased. Frequency may be increased from 3 to 5 $d \cdot wk^{-1}$ depending on the exercise responses and goals of the client. The volume of exercise is therefore gradually progressed during the course of the exercise prescription until the client's goals are reached. The intensity, duration, and frequency of the conditioning phase are gradually increased, which results in a gradual progression of the volume of exercise performed. As noted previously, if there is a decrease in the overload such as an injury, travel, or unexpected work obligations, the system will regress, and fitness gains will be lost. Therefore, the Personal Trainer must work with the client to anticipate periods of decreased physical activity and plan for a safe "reentry" back into the exercise program. To avoid an overuse injury, clients should refrain from "jumping back" into the same level of activity after more than a few days off.

The intensity, duration, and frequency of the conditioning phase are gradually increased, which results in a gradual progression of the volume of exercise performed.

Sample Cardiorespiratory Endurance Training Programs

Tables 15.7 and 15.8 include examples of cardiorespiratory endurance programs for various types of activities (*e.g.*, walking/jogging program and a typical mix of activities, which may be available at a health club). For each, an overall scheme of a 6-month training progression is shown for an apparently healthy client. Use of the terms *beginner*, *intermediate*, and *established* to describe the fitness level of the client is somewhat subjective. For some individuals, even the beginner stage may present too much of a challenge. If so, starting out with only 5–10 minutes of exercise may be more appropriate. The progression should not be overly aggressive. Do not focus on achieving target goals quickly but rather to gradually increase the overall workload to establish compliance and promote adherence. Progression should be individualized on the basis of the client's initial fitness level, health status, age, and individual goals.

Table 15.7 Sample Walking and Jogging Program

Status	Time Point	Warm-Up	Workout[a]	Cool-Down
Beginner	First week	Slow, easy walking pace for a couple of minutes	Walk at a pace that gives a light level of exertion (level 3 or 4) for 10 min at least twice a day for a total of 20 min each day (3 d · wk^{-1}). Your weekly total should be 60 min.	Slow, easy walking pace for a couple of minutes
	Progression, part 1	Slow, easy walking pace for 5 min	Each week add 15 min to your weekly total until you reach 120 min of activity (*e.g.*, 30 min 4 d · wk^{-1}). Stay at this duration and increase your intensity over the next couple of weeks from light (level 3 or 4) to moderate (level 5 or 6). Once you are comfortable with this time and intensity for a couple of weeks, continue to add 10–15 min · wk^{-1} until you reach 150 min.	Slow, easy walking pace for 5 min
	Progression, part 2	Easy walking pace for 5–10 min	Walk at a pace that gives a moderate level of exertion (level 5 or 6); continue to add 10–15 min each week to progress from 150 min · wk^{-1} to a total of 200 min.	Easy walking pace for 5–10 min
	Final week	Easy walking pace for 5–10 min	Walk at a pace that gives a moderate level of exertion (level 5 or 6) for 30–60 min (3–5 d · wk^{-1}). Your weekly total should be 200 min.	Easy walking pace for 5–10 min

Intermediate	Initial week	Easy walking pace for 5–10 min	Walk at a pace that feels moderate (level 5 or 6) for 30–60 min (3–5 d · wk^{-1}). Your weekly total should be 200 min.	Easy walking pace for 5–10 min
	Progression	Easy walking pace for 5–10 min	Continue to increase exercise duration by 10–15 min · wk^{-1} to approach 300 min of moderate activity accumulated on a weekly basis. Another option is to introduce a more vigorous activity, such as jogging, realizing that the time needed will be less (typically 2 min of moderate activity equals 1 min of vigorous activity).	Easy walking pace for 5–10 min
	Final week	Easy walking pace for 5–10 min	Walk at a pace that feels moderate (level 5 or 6) for 45–90 min (3–5 d · wk^{-1}). Your weekly total should be 300 min (moderate intensity). OR Combine moderate and vigorous walking on alternate days. Your weekly total should be equivalent amounts of moderate and vigorous activity (*e.g.*, 200 min of moderate plus 50 min of vigorous).	Easy walking pace for 5–10 min
Established	Continue/maintain	Easy walking pace for 5–10 min	Walk at a pace that feels moderate (level 5 or 6). Your weekly total should be a minimum of 300 min (moderate intensity). OR Jog (at level 7 or 8). Your weekly total should be a minimum of 150 min (vigorous intensity). OR Combine moderate and vigorous walking on alternate days. Your weekly total should be equivalent amounts of moderate and vigorous activity (*e.g.*, 200 min of moderate plus 50 min of vigorous).	Easy walking pace for 5–10 min

[a]Level of exertion is on a scale of 0–10 (sitting at rest is 0 and your highest effort level is 10).

Adapted with permission from American College of Sports Medicine. *ACSM's Complete Guide to Fitness & Health*. Champaign (IL): Human Kinetics; 2011. 408 p.

Table 15.8 Sample Cross-Training Program at a Health Club

Status	Time Point	Warm-Up	Workout[a]	Cool-Down

Beginner	First week	Slow, easy walking pace for a couple of minutes	Pick one activity each day at a light level of exertion (level 3 or 4) for 10 min at least twice a day for a total of 20 min each day (3 $d \cdot wk^{-1}$). Select from walking on the treadmill or stationary biking. Your weekly total should be 60 min.	Slow, easy walking pace for a couple of minutes
	Progression, part 1	Slow, easy walking pace for 5 min	Each week add 15 min to your weekly total until you reach 120 min of activity (*e.g.*, 30 min 4 $d \cdot wk^{-1}$). Potential activities include treadmill walking, stationary biking, and using a stair climber. Stay at this duration and increase your intensity over the next couple of weeks from light (level 3 or 4) to moderate (level 5 or 6). Once you are comfortable with this time and intensity for a couple of weeks, continue to add 10–15 $min \cdot wk^{-1}$ until you reach 150 min.	Slow, easy walking pace for 5 min
	Progression, part 2	Easy walking pace for 5–10 min	Exercise at an intensity that gives a moderate level of exertion (level 5 or 6); continue to add 10–15 min each week to progress from 150 $min \cdot wk^{-1}$ to a total of 200 min.	Easy walking pace for 5–10 min
	Final week	Easy walking pace for 5–10 min	Exercise at an intensity that gives a moderate level of exertion (level 5 or 6) for 30–60 min (3–5 $d \cdot wk^{-1}$). Activities may include treadmill walking; stationary biking; or using a stair climber, elliptical trainer, rowing machine, or Nordic ski machine. Your weekly total should be 200 min.	Easy walking pace for 5–10 min
Intermediate	Initial week	Easy walking pace for 5–10 min	Exercise at a level that feels moderate (level 5 or 6) for 30–60 min (3–5 $d \cdot wk^{-1}$) using a treadmill, stationary bike, stair climber, elliptical trainer, or Nordic ski machine. Your weekly total should be 200 min.	Easy walking pace for 5–10 min
	Progression	Easy walking pace for 5–10 min	Continue to increase exercise duration by 10–15 $min \cdot wk^{-1}$ to approach 300 min of moderate activity accumulated on a weekly basis. Another option is to introduce more vigorous activity a couple of days per week, such as jogging on the treadmill, taking a spinning class, or taking a step aerobics class, realizing that the time needed will be less (typically, 2 min of moderate activity equals 1 min of vigorous activity).	Easy walking pace for 5–10 min
	Final week	Easy	Exercise at a level that feels moderate (level	Easy

		walking pace for 5–10 min	5 or 6) for 45–90 min (3–5 d · wk^{-1}). Your weekly total should be 300 min (moderate intensity). OR Combine moderate and vigorous walking on alternate days. Your weekly total should be equivalent amounts of moderate and vigorous activity (*e.g.*, 200 min of moderate plus 50 min of vigorous).	walking pace for 5–10 min
Established	Continue/maintain	Easy walking pace for 5–10 min	Exercise at an intensity that feels moderate (level 5 or 6). Your weekly total should be a minimum of 300 min (moderate intensity). OR Exercise at a higher intensity (level 7 or 8). Your weekly total should be a minimum of 150 min (vigorous intensity). OR Combine moderate and vigorous walking on alternate days. Your weekly total should be equivalent amounts of moderate and vigorous activity (*e.g.*, 200 min of moderate plus 50 min of vigorous).	Easy walking pace for 5–10 min

[a]Level of exertion is on a scale of 0–10 (sitting at rest is 0, and your highest effort level is 10).

Adapted with permission from American College of Sports Medicine. *ACSM's Complete Guide to Fitness and Health*. Champaign (IL): Human Kinetics; 2011. 408 p.

For each stage, a range rather than a single number is included for frequency, intensity, and duration. The role of a Personal Trainer is to assist the client with the appropriate balance based on individual responses. Frequency of exercise progresses gradually over the 6-month period outlined from 3 d · wk^{-1} up to a target of 3–5 d · wk^{-1}. Intensity increases from relatively low to a target of 70%–85% HRR. By slowly increasing the intensity, the client is able to adapt to the higher levels of exercise without becoming discouraged or experiencing retrogression (*i.e.*, a reversal of gains due to excessive overload). The duration of the exercise session also increases in small steps to allow for appropriate adaptations. Finally, the Personal Trainer can consider changing the mode of exercise to provide more variety in the program.

Progression should be individualized on the basis of the client's initial fitness level, health status, age, and individual goals.

Recall that the activities are classified by group. Walking is a Group A activity and is appropriate for anyone. The progression found in Table 15.7 could also be used with swimming or other aquatic exercises, which are Group C activities and require skill to maintain an appropriate intensity for a sufficient period of time. For each activity, the sequence in time, intensity, and frequency as well as progression of the different types of activities should be noted. When designing a program, occasionally including new modes of exercise can provide much-appreciated variety but should be introduced gradually so that appropriate adjustments can be made (*i.e.*, appropriate overload). Most importantly, remember that the overall training program must match the goals of the client.

Weight Loss

Many clients are interested in losing weight and often consult Personal Trainers. The ACSM position stand "Appropriate Physical Activity Intervention Strategies for Weight Loss and Prevention of Weight Regain for Adults" (11) indicates that increasing activity levels above the baseline of 150 min · wk^{-1} of moderately intense exercise is important to assist with weight loss or to help maintain weight loss. In these situations, the recommended duration of exercise is at least 30–60 min · d^{-1} (this can be divided into multiple shorter exercise sessions), or 250–300 min · wk^{-1} (11). More information about exercise and weight loss is provided in Chapter 20.

Implementing Cardiorespiratory Endurance Training Programs

Implementation of effective cardiorespiratory training programs requires the Personal Trainer to have knowledge of the current scientific basis of exercise (*e.g.*, exercise prescription guidelines). This chapter has reviewed current guidelines (1,10) regarding the FITT-VP components of cardiorespiratory exercise prescription (*i.e.*, frequency, intensity, time, type, volume, and progression). These guidelines provide a framework to structure the exercise program and give the Personal Trainer the ability to showcase the *art* of exercise prescription. The Personal Trainer must evaluate each client individually for health status and disease risks (see Chapter 11) and conduct individual fitness assessments (see Chapter 12), which are used to determine an appropriate initial level of exercise. Think of an artist painting a sunset. The artist uses a palate of colors to create the exact sunset he or she has envisioned. The color palate equates to the information gained from fitness assessments and health screening. To create a realistic sunset, the artist uses different techniques (brushes, mixing colors, brush stroke, and brush pressure) to create his or her painting. The Personal Trainer does the same thing by changing the FITT components to create the best exercise program he or she can for the client.

Implementation of effective cardiorespiratory training programs requires the Personal Trainer to have knowledge of the current scientific basis of exercise (*e.g.*, exercise prescription guidelines).

SUMMARY

Cardiorespiratory training is an essential component of a client's overall exercise program. Other important components include resistance and flexibility training, which are detailed in Chapters 14 and 16, respectively. Each cardiorespiratory training session includes three basic parts: warm-up, conditioning phase, and cool-down. A CRF program or prescription requires the FITT-VP components: frequency, intensity, time/duration, type, volume, and progression. The Personal Trainer must balance the FITT-VP components with the client's characteristics (*e.g.*, health status, initial fitness), life situations (*e.g.*, work schedule, availability of exercise time), goals (*e.g.*, general fitness, weight loss, competition), and preferences.

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CHAPTER 16

Guidelines for Designing Flexibility Programs

OBJECTIVES

Personal Trainers should be able to:

- Describe the factors influencing flexibility.
- Understand the benefits and risks of flexibility training.
- Determine how to evaluate flexibility.
- Understand various methods of stretching.
- Be aware of precautions for individuals with health concerns.
- Understand the relationships between stretching and performance.
- Develop a flexibility program based on the FITT-VP principles.

INTRODUCTION

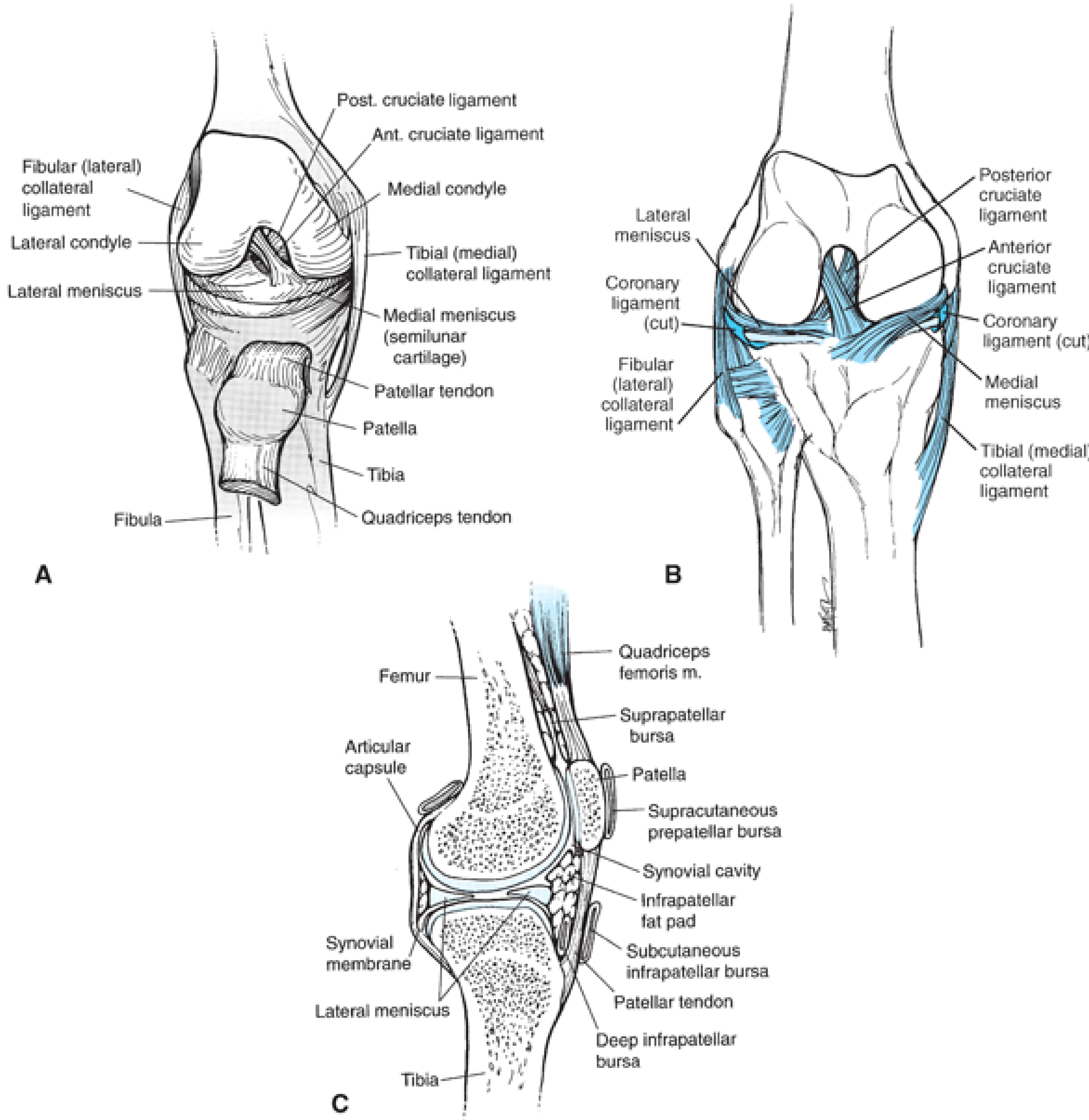
Flexibility refers to the degree to which a joint moves throughout a normal, pain-free range of motion (ROM). As most physical activities and sports consist of numerous multijoint movements, it is essential that musculoskeletal function not be compromised by inadequate flexibility. Stretching is the method used most commonly to increase joint ROM. The American College of Sports Medicine's (ACSM's) current position stand on exercises to develop and maintain fitness and flexibility in adults recommends the inclusion of general stretching exercises emphasizing the major skeletal muscle groups at least 2–3 $d \cdot wk^{-1}$ (1). Flexibility is classified as a health-related dimension of fitness (2), meaning that flexibility contributes to an overall improved quality of life in athletes and the general public.

The purpose of this chapter is to present flexibility as an essential component of health-related fitness and to provide Personal Trainers with a basic understanding of how to properly incorporate flexibility training into the exercise programs of apparently healthy individuals.

Determinants of Flexibility

Hamill et al. (3) suggest that several factors influence an individual's level of flexibility. These factors include joint structure, health of the soft tissue around the joint, length of antagonist muscles, and temperature of the tissues being stretched in addition to the viscoelastic ("rubber band–like") properties of the tissues surrounding the joint. For this reason, it is important that the Personal Trainer know which of these factors may be a hindrance to movement and develop training programs that address these restrictions.

Figure 16.1 depicts a typical human knee joint. To better understand the importance of the properties of the tissues surrounding this joint, study the anterior view (*panel A*) and the lateral view of (*panel C*) Figure 16.1. Notice that the knee is padded with fat and is secured into place by ligaments. These tissues influence knee ROM both at the joint itself and elsewhere in the lower extremity. For example, tightness of the ligaments as illustrated in Figure 16.1 or excessive fat surrounding the thigh could inhibit knee ROM during flexion. In fact, one belief about bodybuilders is that they are "muscle bound" and possess a more limited joint ROM as a result of the additional bulk. This may be true to a certain extent because possessing a large amount of skeletal muscle around a joint can certainly limit ROM. Thus, if the training demands of an athlete or the natural (healthy) body composition of a client predispose them toward greater muscle bulk rather than flexibility, there may be a trade-off such that a more limited joint ROM may be appropriate. However, regardless of the training goal, it is still a worthwhile endeavor to attain and maintain a healthy level of flexibility to mitigate the risk of potential injury associated with limited joint ROM (4).



Ligament	Insertion	Action
Anterior cruciate	Anterior intercondylar area of tibia to medial surface of lateral condyle	Prevents anterior tibial displacement; resists extension, internal rotation, flexion
Arcuate	Lateral condyle of femur to head of fibula	Reinforces back of capsule
Coronary	Meniscus to tibia	Holds menisci to tibia
Medial collateral	Medial epicondyle of femur to medial condyle of tibia and medial meniscus	Resists valgus forces; taunt in extension; resists internal, external rotation
Lateral collateral	Lateral epicondyle of femur to head of fibula	Resists varus forces; taut in extension
Patellar	Inferior patella to tibial tuberosity	Transfers force from quadriceps to tibia
Posterior cruciate	Posterior spine of tibia to inner condyle of femur	Resists posterior tibial movement; resists flexion and rotation
Posterior oblique	Expansion of semimembranosus muscle	Supports posterior, medial capsule
Transverse	Medial meniscus to lateral meniscus in front	Connects menisci to each other

FIGURE 16.1. Typical joint anatomy: anterior **(A)**, posterior **(B)**, and lateral **(C)**. (Reprinted with permission from Hamill J, Knutzen KM. *Biomechanical Basis of Human Movement*. 3rd ed. Philadelphia [PA]: Lippincott Williams & Wilkins; 2009. p. 212.)

As can be seen from Figure 16.1, contraction of the quadriceps femoris muscles will produce leg extension if the knee is bent at the start of the movement. However, tight quadriceps femoris muscles (perhaps as a result of soreness, poor recovery, or excessive conditioning) can restrict full leg extension and limit joint flexibility. Notice too from Figure 16.1 that the joint is restricted by the very architecture of the bones themselves. Leg extension is limited by what are termed "bony blocks," which consist of the ends of the femur and tibia resisting hyperextension during full leg extension. It is also possible that injury, disease, and poor soft tissue integrity can contribute to hypermobility or excessive ROM in a joint. The possibility of hypermobility can also be imagined when studying Figure 16.1.

It is also possible that injury, disease, and poor soft tissue integrity can contribute to hypermobility or excessive ROM in a joint.

Clearly, joints have inherent structural properties that determine ROM. Not surprisingly, these properties differ by joint and among individuals, which often explains the large variability in joint ROM values observed in certain instances such as during testing and athletic performance. Although the anatomical structure of the joint clearly influences ROM, there are other influences such as age, sex, and physical activity history that also play a role in determining ROM.

Age

With increasing age, the ability to move through a full ROM typically becomes compromised due to an overall loss of flexibility of approximately 25%–30% by age 70 years (5–8). This reduction in flexibility observed in older adults has been linked to disability and reduced functional ability (9). The decreases in flexibility that one may experience will depend on the joint itself. Brown and Miller (10) reported a 30% loss in hamstring flexibility from the age of 20–29 years to older than 70 years, whereas Germain and Blair (8) observed a 15% loss in shoulder flexion from the age of 20–30 years to older than 70 years. Therefore, it is important that flexibility, including any changes over time, is assessed and addressed at each joint.

Loss of ROM within a joint may have several causes. With age, changes occur in the framework of the connective tissue collagen fibers as demonstrated by increased rigidity of the tissue. This increased rigidity is attributed to tighter cross-linkage within and between collagen fibers, which makes the joint more resistant to movement (11,12). There is also a general reduction of elastin as well as a deterioration of the cartilage, ligaments, tendons, synovial fluid, and muscles with age, which may decrease joint ROM (9,13,14). However, physiological changes are not the only suspect in the age-related loss of flexibility. Decreased physical activity appears to accelerate the age-related loss of ROM (14,15). Fortunately, this means some loss in flexibility may be preventable with regular, whole-body flexibility exercises.

Sex

Numerous studies suggest that females are more flexible than males due to a different pattern of skeletal architecture and connective tissue morphology as well as hormonal differences (16,17). This difference in ROM between sexes may result from differences in joint and bone structures (18). For example, females typically have broader and shallower hips compared to males, which allows for the possibility of a greater ROM in the pelvic region (18). Females may also have greater potential for flexibility during trunk flexion after puberty because of a comparatively lower center of gravity and shorter leg length (19).

Physical Activity History

In addition to one's anatomy, an individual's history of physical activity can impact his or her joint ROM. Studies have shown that individuals who are physically active are more likely to have a greater ROM than a sedentary individual (8,20,21). Cornu et al. (21) demonstrated that volleyball players exhibited greater flexibility in wrist extension than sedentary individuals. In another sport-related study, Jaeger et al. (22) found that elite field hockey players had significantly greater hip ROM than sedentary individuals. Studies have not been limited to sport activity, though. In a study by Voorrips et al. (23) that examined different habitual physical activity of older women, it was found that the more active older women had significantly greater flexibility in the hip and spine than moderately active and sedentary older women.

Benefits and Risks of Flexibility Training

As with other forms of physical training, flexibility training has both benefits and risks. These benefits and risks are frequently described from the anecdotal and personal experiences of coaches, clinicians, and exercise leaders rather than from sound research or understanding of the science of human anatomy, physiology, and biomechanics. The following sections provide the Personal Trainer with a short review of the scientific evidence supporting the benefits and risks associated with flexibility training.

> The existing science on flexibility training often presents fitness professionals with more questions than answers regarding the benefits and risks of stretching.

Benefits

Improved Range of Motion in Selected Joints

Flexibility training has been shown to improve an individual's joint ROM (23–25). In a long-term study on the effects of flexibility training on shoulder and hip ROM by Misner et al. (25), it was found that the flexibility program used produced significant increases in shoulder extension (5.7%), shoulder transverse extension (10.4%), hip flexion (13.3%), and hip rotation (6.3%). A minor improvement (5.5%) was also observed in shoulder flexion. Improvements in flexibility could be seen in a relatively short time period. Kerrigan et al. (26) recorded improved ROM values in both static and dynamic hip extension when participants followed the program twice daily for 10 weeks. Kuukkanen and Mälkiä (24) also found improvements in spinal ROM and greater hamstring flexibility after subjects followed a 3-month program.

Improved Performance for Activities of Daily Living

The extent to which individuals can live independently depends on their ability to perform basic daily tasks such as self-care and essential household chores. These tasks are formally termed "activities of daily living" (ADL). Balancing ability and postural control are critical aspects of performing ADL (27). Consequently, the ability to perform ADL has been highly correlated with joint mobility (28). In other words, ADL are easier to perform when an individual possesses an adequate ROM within the working joints. In addition, flexibility training can significantly aid balance and postural stability, particularly when combined with resistance exercise (15,29). Indeed, when performed correctly, flexibility training can improve ADL functioning both directly through enhancing ROM and indirectly through its effect on postural control (30–32).

Risks

Joint Hypermobility

Hypermobility syndrome is known as "congenital laxity" of ligaments and joints. This condition is characterized by extreme ROM accompanied by mild- to moderate-intensity pain (33). Although it is suggested that certain individuals or athletes (*e.g.*, gymnasts) may possess extraordinary joint ROM, there is insufficient scientific evidence to link hypermobility to flexibility training. Regardless, the Personal Trainer should be aware that too much flexibility may be as detrimental as too little. Individuals with both hyper- and hypomobility may be at increased risk of injury. For this reason, the prudent professional should aim for assisting his or her clients in achieving "optimal" flexibility rather than continually striving to achieve greater ROM.

Effects of Stretching on Strength, Power, Speed, and Agility

A recent review article by Behm et al. (4) suggests that static stretching may result in an acute decrease in force production (*e.g.*, muscular strength/power). Nelson et al. (34) found that muscular strength and endurance performance decreased after short-term static stretching among a group of college students enrolled in physical education courses. Similarly, Fowles et al. (35) discovered that voluntary strength and muscular activation was negatively affected after prolonged stretching and muscle force was reduced up to 1 hour poststretching. Bacurau et al. (36) observed a reduction in one repetition maximum leg press strength following a bout of static stretching when compared to ballistic stretching. Furthermore, Miyahara et al. (37) observed a 6.9% and 7.1% decrease in strength following both static and proprioceptive neuromuscular facilitation (PNF) stretching, respectively, although PNF stretching increased ROM approximately 8% more than static stretching. These findings suggest that static stretching might be detrimental to subsequent activities that require high force production (36). Overall, in the systematic review by Behm et al. (4), strength, power, and speed was negatively influenced by static stretching, suggesting that other stretching methods (*i.e.*, dynamic stretching) should be prioritized prior to activities requiring maximal strength and power production.

Strength may not be the only performance variables affected by different stretching protocols. Several literature reviews have reported the effects of different stretching methods (*i.e.*, dynamic, ballistic, static, and PNF) on power-speed-agility performance (4,38,39). Research provides support for the assertion static stretching may impair power (4,40–42), speed (40,43,44), and agility (45,46) performance when compared to other stretching modalities. Research also suggests that dynamic stretching may not be detrimental and/or lead to improvements in lower body power production (41–43), jumping (44,47), sprinting (43,47,48), and agility (45,46) performance compared to other stretching methods (*i.e.*, PNF and static stretching [SS]) (49). Additionally, dynamic stretches performed at a faster velocity throughout a similar, sport-specific movement pattern have been linked to improved strength and power performance (42,49). In fact, in activities such as gymnastics that require large ROM movements, it is necessary to perform preparticipation activity to achieve the required ROM for the performance (50). It is important to note that incorporating different stretching protocols (*i.e.*, static, dynamic, PNF) in a warm-up accompanying other movements may not necessarily impact performance (38). Thus, although these studies suggest that maximal strength or performance may be compromised following an acute stretching bout, it is possible that if preperformance stretching is accompanied by other warm-up movements, performance is not negatively impacted (38,51,52). In fact, research by Blazevich et al. (52) found that individuals were more confident about how their performance following a warm-up that included both static and dynamic stretching protocols. Therefore, based on the current literature, it is recommended that engaging in one, specific stretching protocol (*i.e.*, static stretching) to elicit improvements in ROM for a long duration should be completed following activity (38). However, when different stretching methods (*i.e.*, static, dynamic, or ballistic) are performed for a short duration (*i.e.*, ≤60 s) and included in a full dynamic warm-up prior to activity, subsequent performance may not be significantly affected (51–53).

Ineffective for Preventing Injury

Flexibility training is often promoted as a means of reducing injury risk. However, the research does not show a consistent link between performing regular flexibility training and a reduction in musculotendinous injuries (1,50,54,55). Reviews published regarding injury prevention and flexibility have generally been unable to conclude whether or not stretching before or after exercise contributed to injury prevention among competitive or recreational athletes (55). McHugh and Cosgrave (50) suggested that there is some evidence that preparticipation stretching may reduce the incidence of muscle strains but that it does not prevent overuse injuries. Finally, Witvrouw et al. (54) concluded that the type of sport activity in which an individual participates is critical when determining the value of flexibility training to reduce injury. They found that the more explosive the skills involved in an activity, the more likely stretching may be needed to decrease injury.

The more explosive the skills involved in an activity, the more likely stretching may be needed to decrease injury.

Temporary Effects

Interestingly, the duration of time that increased flexibility lasts after stretching may not be as long as what Personal Trainers may think. Increased flexibility following acute stretching is extremely short-lived. Depino et al. (56) recruited 30 male subjects and found that the improvements in knee ROM following static stretching of the hamstrings lasted less than 3 minutes. These authors further suggest that athletes who statically stretch and then wait longer than 3 minutes before activity can expect to lose any ROM gained as a result of the preceding bout of stretching. Spernoga et al. (57) similarly found that ROM improvements in the hamstring following PNF stretching lasted only 6 minutes after the stretching protocol ended. However, although the acute effects appear to diminish quickly, a consistent stretching program over 12 weeks has been found to result in significant improvements in flexibility of the hip flexors (58), indicating the effectiveness of ACSM flexibility training recommendations at long-term improvements of flexibility.

Evaluating Flexibility

Assessment of clients' ROM is an essential component of developing their exercise program. Goniometry assessment provides the fitness professional with several important pieces of information. These include the following:

- Initial ROM prior to the start of the exercise program
- Baseline measurements from which plans can be made for future exercise goals
- Immediate ROM feedback
- Identification of muscular imbalances

> Assessment of clients' ROM is an essential component of developing their exercise program.

Chapter 12 provides a more comprehensive discussion on evaluating flexibility.

Types of Stretching

Several methods exist to improve flexibility and increase joint ROM, and nearly all of them involve some form of stretching (examples of most of the types of stretching are presented in Figs. 16.2–16.40). Stretches can be performed by the clients (active stretching) themselves or with the help of the Personal Trainer (passive stretching). Although passive stretching can be very helpful for improving flexibility, it should only be performed by a Personal Trainer with adequate knowledge and experience to prevent injury to the client. There are generally three types of stretching that can be performed using active or passive techniques to improve flexibility: static, dynamic, and PNF. Table 16.1 provides an overview of various types of stretching and their appropriate use.

There are generally three types of stretching that can be performed using active or passive techniques to improve flexibility: static, dynamic, and proprioceptive neural facilitation or PNF.

FIGURE 16.2. Forward flexion and extension. **A.** Facing forward, move head forward to tuck chin into chest and hold. Then, move slowly from this flexion position to extension. **B.** Extension should involve looking up to ceiling until a 45° angle is reached and hold. Avoid dropping head back onto the upper back.

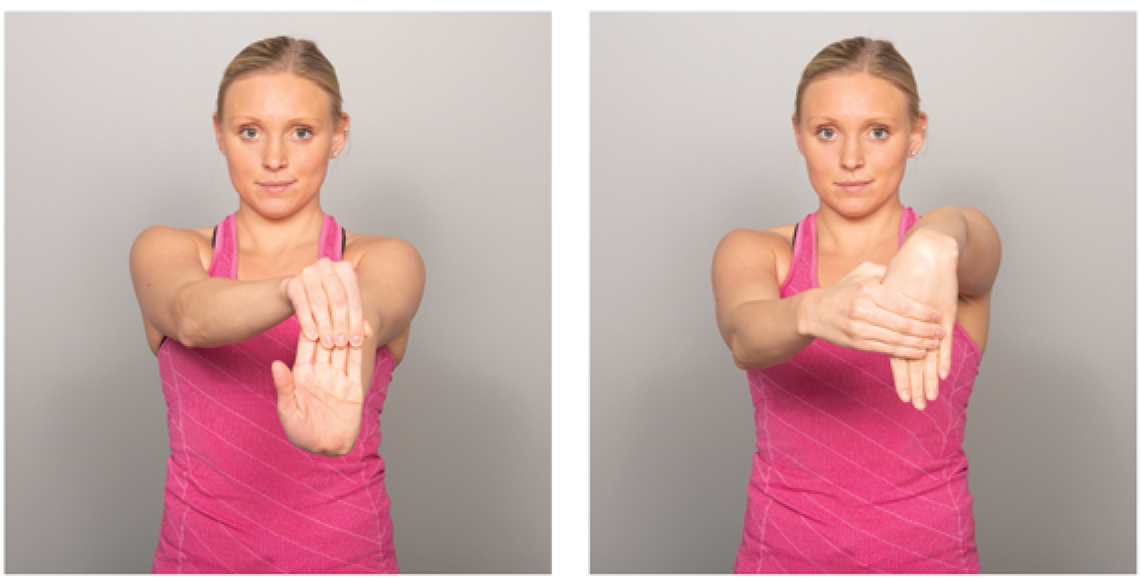
FIGURE 16.3. Chest stretch: Shoulders should be relaxed, not elevated. Move extended arms to the back and keep arms at or a little below shoulder height. A good cue for this stretch is “open arms wide.”

FIGURE 16.4. Arm across the chest: Facing forward, extend the right arm and draw across the chest. Arm should be as straight as possible, with gentle tension developed on the right shoulder. Grasp right elbow with the left hand. Apply gentle pressure with the left hand to increase tension on the right shoulder and repeat with the other arm/other side.

A B

FIGURE 16.5. Chest stretch (progression). **A.** Place the palms of the hand on the back of the head and bring elbows back. **B.** Place extended arm against an open doorway and lean forward, feeling gentle tension develop across the chest.

FIGURE 16.6. Elbow behind the head: Facing forward, bring left arm up, bend from the elbow, and drop the hand behind the head. Try to reach right shoulder with left hand. Repeat with other arm/other side. Bring right hand to left shoulder and gently pull left elbow rightward to increase tension on left arm (triceps brachii).



A B

FIGURE 16.7. Palm up/palm down. **A.** This exercise can be performed while standing or seated. Extend right arm perpendicular to the body. Extend wrist, so the palm faces away from the body. Gently pull right hand (fingertips) toward body until tension develops in the forearm flexors. Repeat with other arm/other side. **B.** This exercise can be performed while standing or seated. Extend right arm

perpendicular to the body. Flex wrist, so the palm faces the body. Gently pull right hand with left hand until tension develops in the forearm extension.

FIGURE 16.8. Arm hug: Cross the arms around the body, elbows pointing forward. Let the upper body round.

A

B

FIGURE 16.9. **A.** Kneeling cat: Kneel in quadruped position. Draw in abdominals and contract the gluteals, round throughout the entire spine. **B.** Kneeling cow: From kneeling cat, lift the head, contract the hip flexors and arch the back. Keep the abdominals drawn in towards the spine.

Visit thePoint to watch video 16.1, which demonstrates the kneeling cat.

FIGURE 16.10. Pillar/overhead reach: Facing forward, stand erect and extend arms above head, keeping shoulders in neutral position. Place hands together and use the palms to press upward. Stretch can also involve the trunk muscles (torso) by moving in frontal plane to one side of the body and back. Hold when tension is developed in the torso on the side opposite reach.

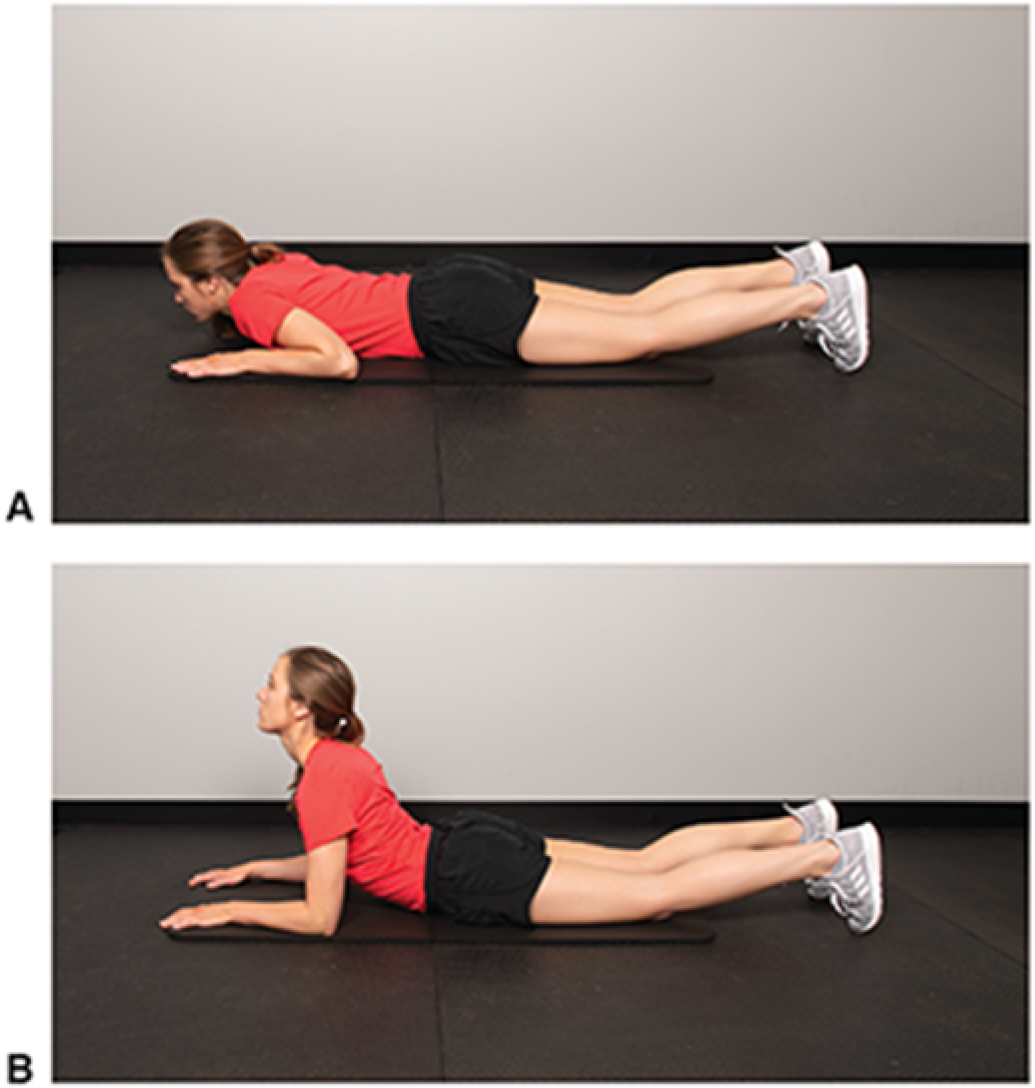


FIGURE 16.11. Modified cobra. **A.** Lie prone on the floor with the head resting on the forearms and the legs extended. Place the elbows directly under the shoulders with the hands facing forward. **B.** Press into the forearms and raise the upper body, keeping the hips on the floor.


A

B

FIGURE 16.12. Supine rotational stretch. **A.** Lie face up on the floor. Bend knees so that the feet are flat on the floor. Then, extend arms across the floor to stabilize upper body with movement. **B.** Slowly move both legs with the knees bent to the left side of the body. Maintain upper back against the floor and the abdomen oriented toward the ceiling. Repeat by moving the legs to the right side.

Visit thePoint to watch video 16.2, which demonstrates the modified cobra.

FIGURE 16.13. Seated hip rotator stretch level I: Sit upright on a sturdy, nonmovable chair. Cross right ankle onto bent left knee. Gently press down on right knee until tension develops in the outer portion of the right thigh. Repeat with the opposite side.

FIGURE 16.14. Seated hip rotator stretch level II: Sit upright on the floor, with left leg extended and right knee bent. Place the right foot over the left leg. Hug the knee toward the chest. Repeat on other side.

FIGURE 16.15. Supine hip rotator stretch (progression from seated): Lie face up on floor with knees bent, so feet are flat on the floor. Cross right ankle onto bent left knee. Lift left foot off the floor. Wrap hands around the left leg and draw into the body. Focus on opening up the right knee until tension develops in the outer portion of the right thigh. Repeat on the opposite side.

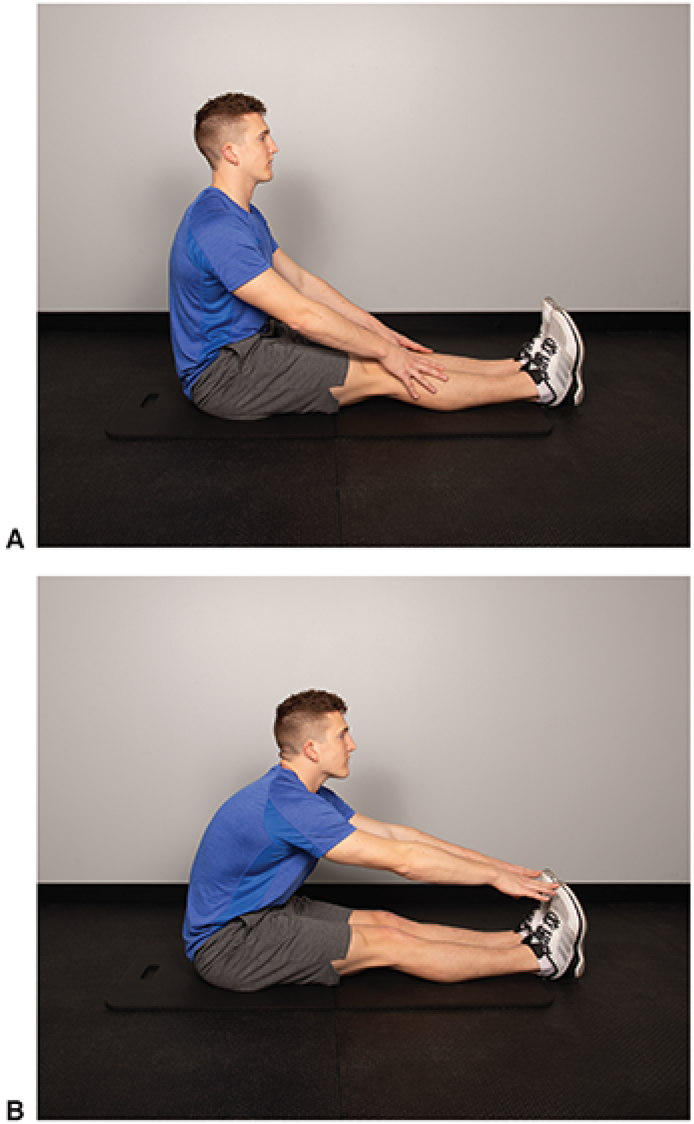
FIGURE 16.16. Kneeling hip flexors stretch: Kneel on knees with upper body lifted. Plant the left foot on the floor until a 90° angle is reached with both the front and back legs. Shift the weight forward while keeping the upper body lifted.

FIGURE 16.17. Standing hip flexor stretch: Stand erect and keep hands on the hips. Step forward with left foot into a lunge position; right heel may be elevated to facilitate this movement. Shift the hips forward. Maintain this position, feeling tension develop in hips, quadriceps, and buttocks. Repeat with the opposite side.

FIGURE 16.18. Prone quadriceps stretch: Lie prone on the floor with legs extended and draw right heel back toward the gluteals.

FIGURE 16.19. Side-lying quadriceps stretch (progression): Lie on floor with left side of the body; the trunk should be perpendicular to the floor. Bend right knee, keeping knees and hips stacked. Reach with the right hand across the front of the right foot. Gently pull thigh back slightly using the right arm. Allow the left arm to stabilize the torso. Repeat with the left thigh by positioning the body with the right side against the floor.

FIGURE 16.20. Standing quadriceps stretch (progression): While in a standing position (a chair may be used to hold onto for support), bend the right knee toward the gluteals. Grasp the right ankle with the right hand and gently pull thigh back slightly using the right arm.



A

B

FIGURE 16.21. Seated hamstring stretch. **A.** Sit upright on the floor with both legs extended and hands resting on the quadriceps. **B.** Slowly walk the hands forward toward the feet, keeping the chest lifted.

FIGURE 16.22. Standing hamstring stretch (progression): Standing upright, bring the right foot slightly ahead of the left foot. Slowly draw the hips back while slightly bending the left knee and extending the right knee. Bring the toes of the right foot off the floor and toward the body, hold, and then return to the starting position. Repeat with the opposite leg.

FIGURE 16.23. Supine knees to chest: Lie supine on the floor and hug the knees to the chest. This can be done with one leg or two legs.

FIGURE 16.24. Child's pose: Kneel in a quadruped position and sit back onto heels with arms extended.

FIGURE 16.25. Butterfly stretch: Sit upright on the floor with the soles of the feet together. Draw the knees to the floor and lean forward from the hips.

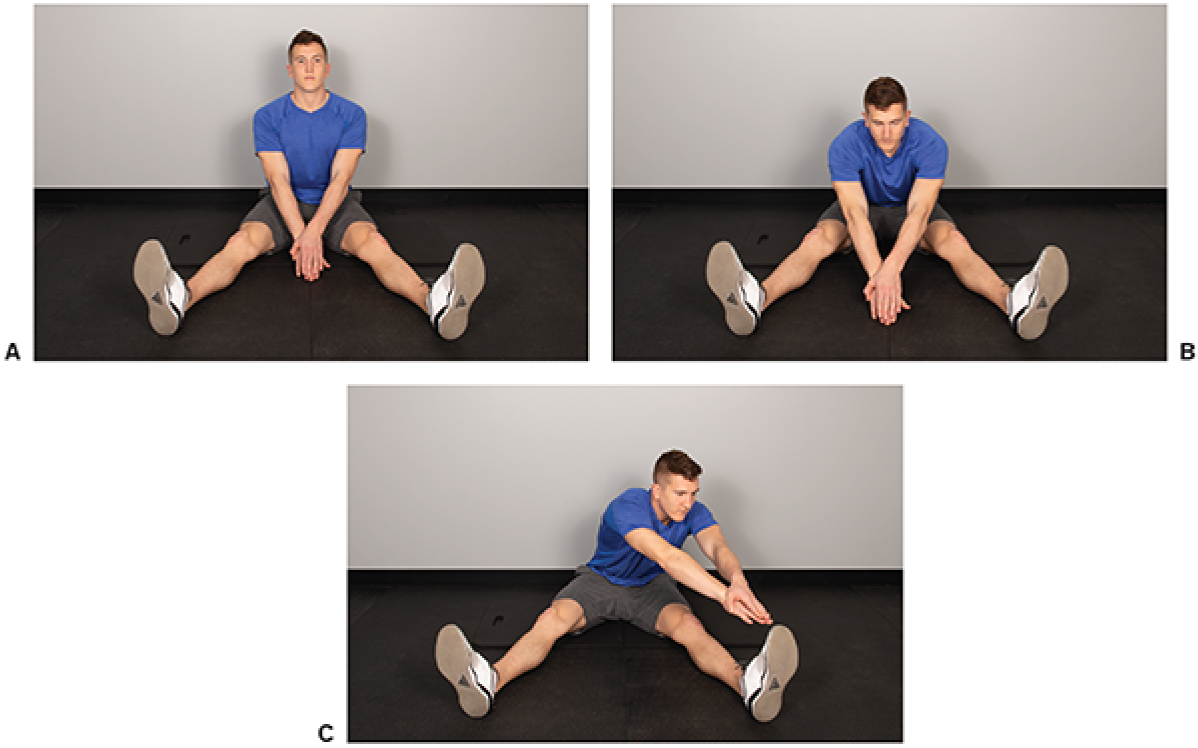


FIGURE 16.26. Straddle: Sit upright on floor with both legs extended **(A)**. Slowly spread legs apart so that feet are as far from each other as possible and gently reach toward center **(B)** or alternate reach from right to left **(C)**.

FIGURE 16.27. Seated calf stretch: Sit upright with both legs extended. Turn the toes toward the ceiling and draw the tops of the toes toward the upper body.

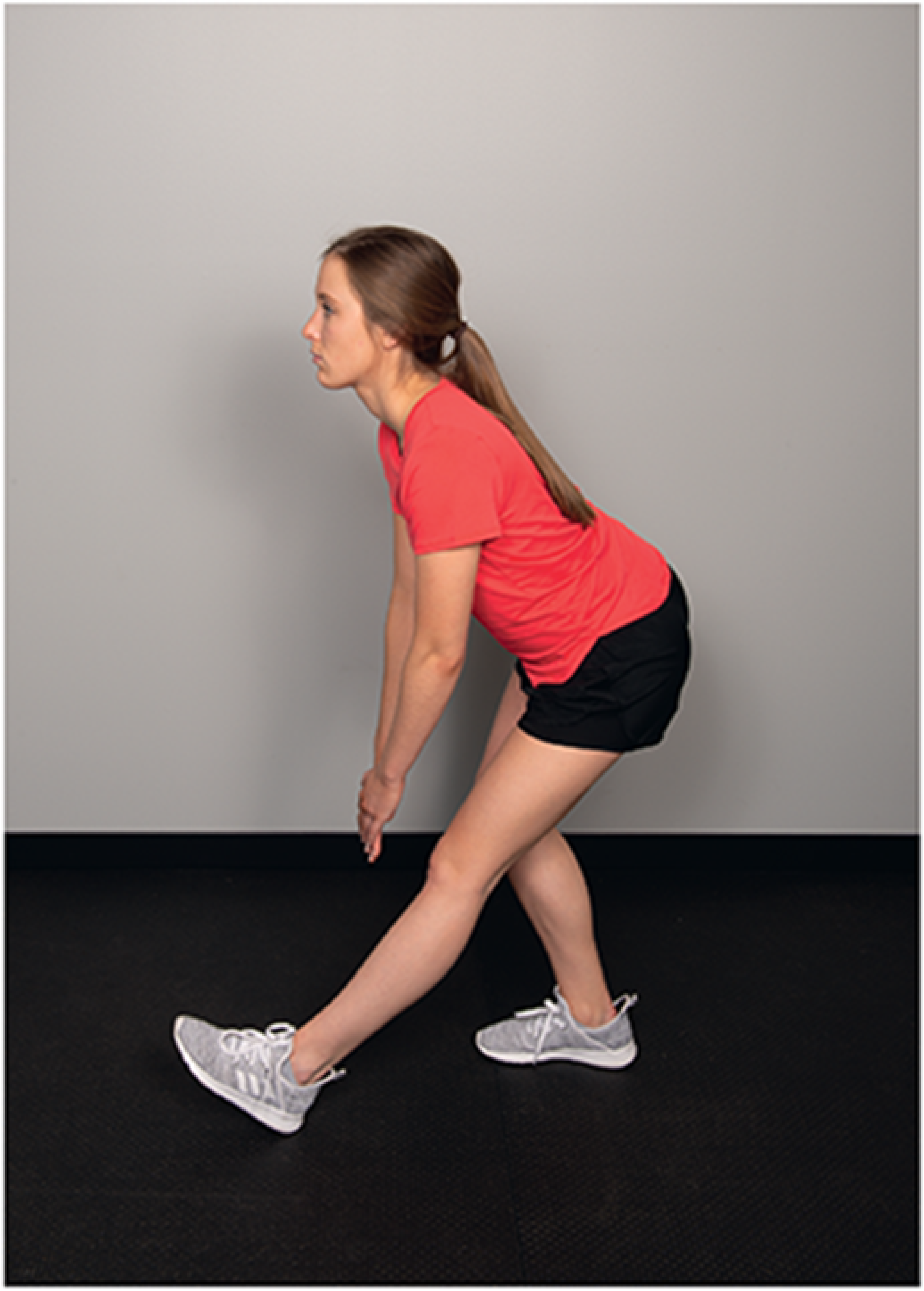


FIGURE 16.28. Standing calf stretch: Place body weight on the left leg, with the right leg forward and heel on the ground. Grasp banister or handrail for support if necessary. Bring the toes of the right foot toward the body and sit back slightly onto the left leg. Feel the stretch develop in the right calf and slowly return to the starting position and repeat with the opposite side.

FIGURE 16.29. Dynamic arm circles: Stand with feet shoulder-width apart and knees slightly bent. Raise both arms to the side at shoulder height, with palms facing down, and make small circles with the arms extended, gradually increasing the size of the circles.

Visit thePoint to watch video 16.3, which demonstrates dynamic arm circles.

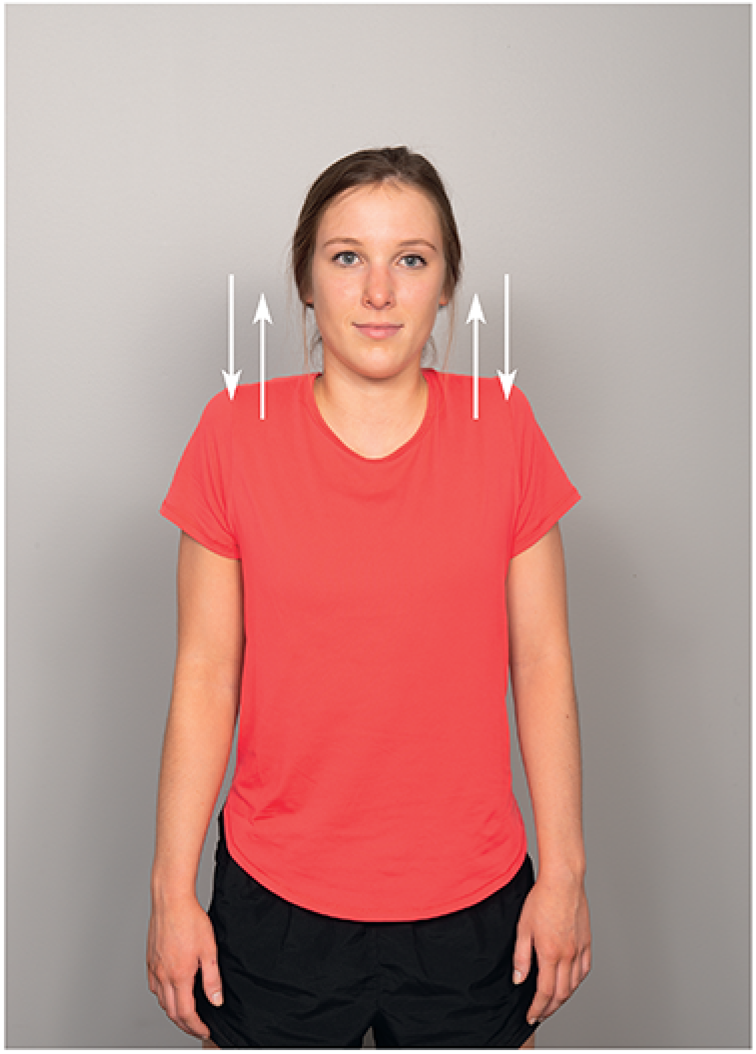


FIGURE 16.30. Shoulder shrugs: Lift both shoulders toward the ears and then lower away from the ears.

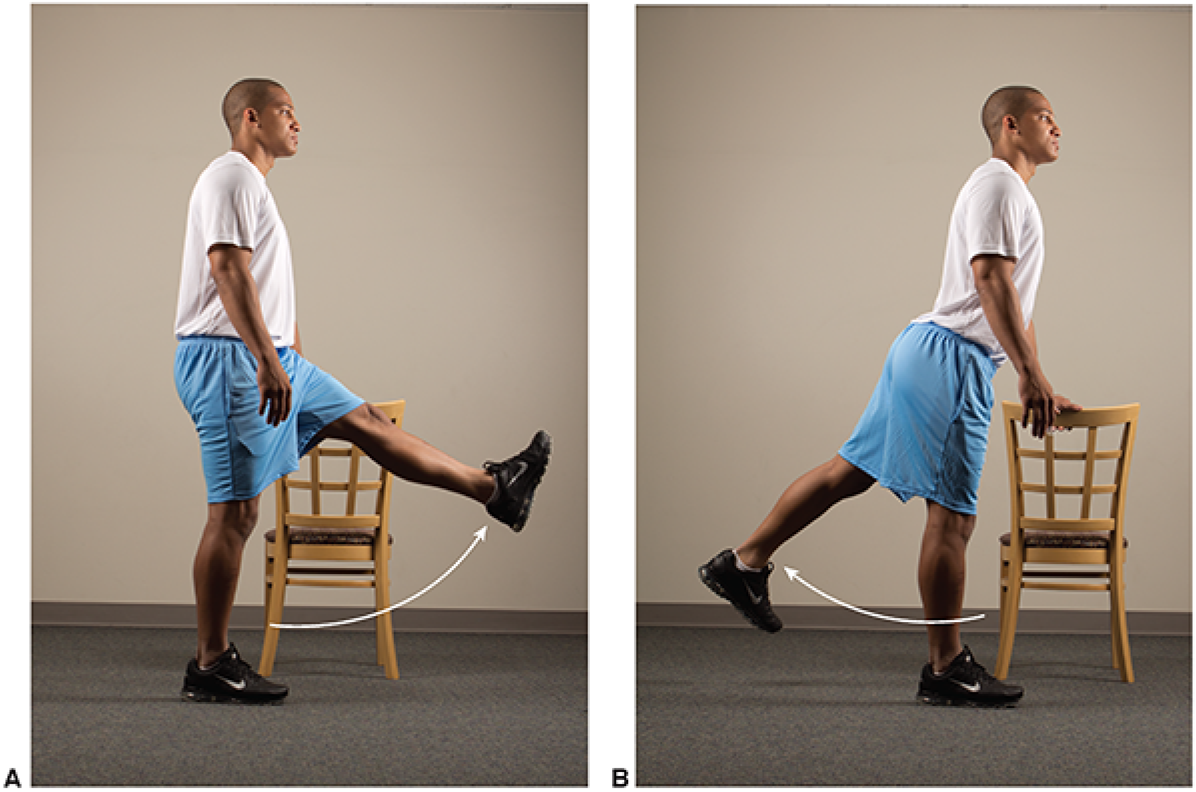


FIGURE 16.31. Pendulum leg swings (front to back): Place a hand on the back of a chair for balance. Lift the left leg and swing the leg forward (in front of the body) and backward (behind the body). Begin with small swings and progress to larger swings. Switch to the opposite leg.

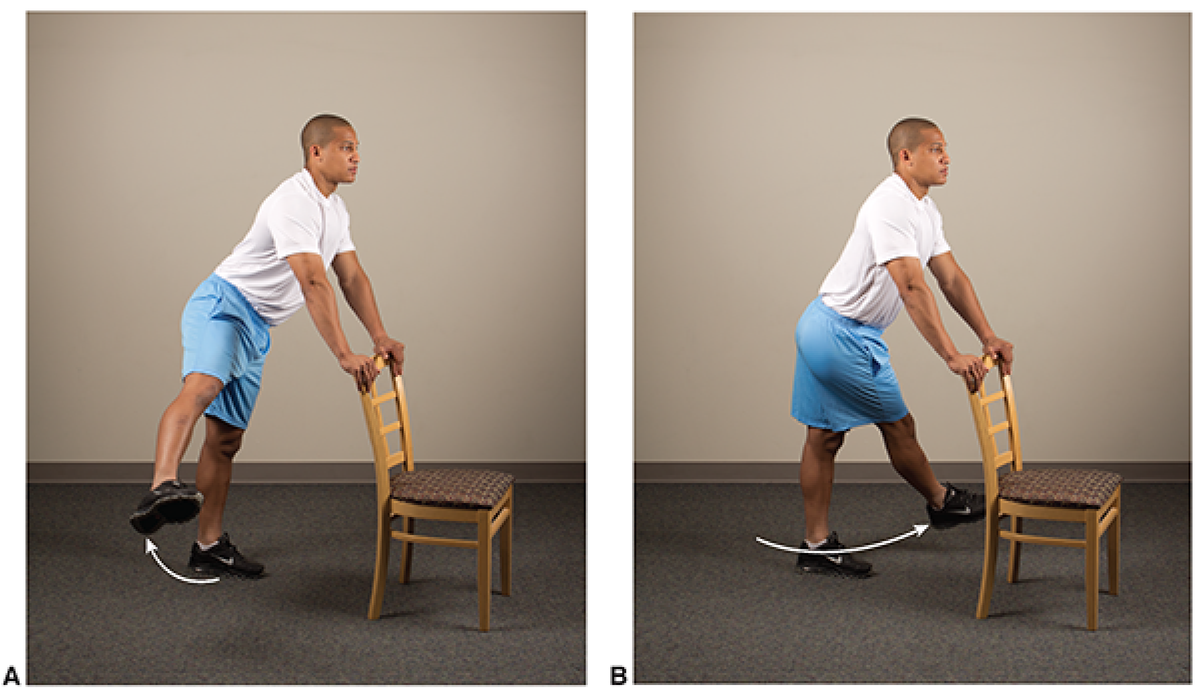


FIGURE 16.32. Pendulum leg swings (side to side): Place both hands on the back of a chair for balance. Swing the right leg out to the right and back across the body to the left. Begin with small swings and progress to larger swings. Switch to the opposite leg.

Visit thePoint to watch video 16.4, which demonstrates front to back and side-to-side leg swings.

FIGURE 16.33. Dynamic external hip rotation: Stand upright with feet shoulder-width apart. Raise the left foot in front of the body and allow the knee to rotate outward. Tap the inside of the left heel with the right hand. Switch and raise the right foot and rotate knee outward. Tap the inside of the right heel with the left hand. Alternate tapping each foot and progress to walking forward while alternating feet.

FIGURE 16.34. Dynamic internal hip rotation: Stand upright with feet shoulder-width apart. Raise the right foot toward the side of the body and tap the outside of the right heel with the right hand, allowing the knee to rotate inward. Switch and tap the outside of the left heel with the left hand. Alternate tapping each foot and progress to walking forward while alternating feet tapping.

Visit thePoint to watch video 16.5, which demonstrates dynamic internal and external hip rotation.

FIGURE 16.35. Side shuffle: Stand with feet shoulder-width apart and knees slightly bent. Take one step to the right with the right foot and then bring the left foot in to meet the right foot. Begin with small steps, progress to larger steps, and then progress to a shuffle. Switch to the opposite direction.

FIGURE 16.36. Butt kicks: Begin marching in place. Pull the heel in closer toward the buttocks with each step and progress to moving forward (walking or jogging) while kicking the buttocks.

FIGURE 16.37. High knees: Begin marching in place. Raise the knees higher and higher with each step and progress to moving forward (walking or jogging) with high knees (keep posture upright).

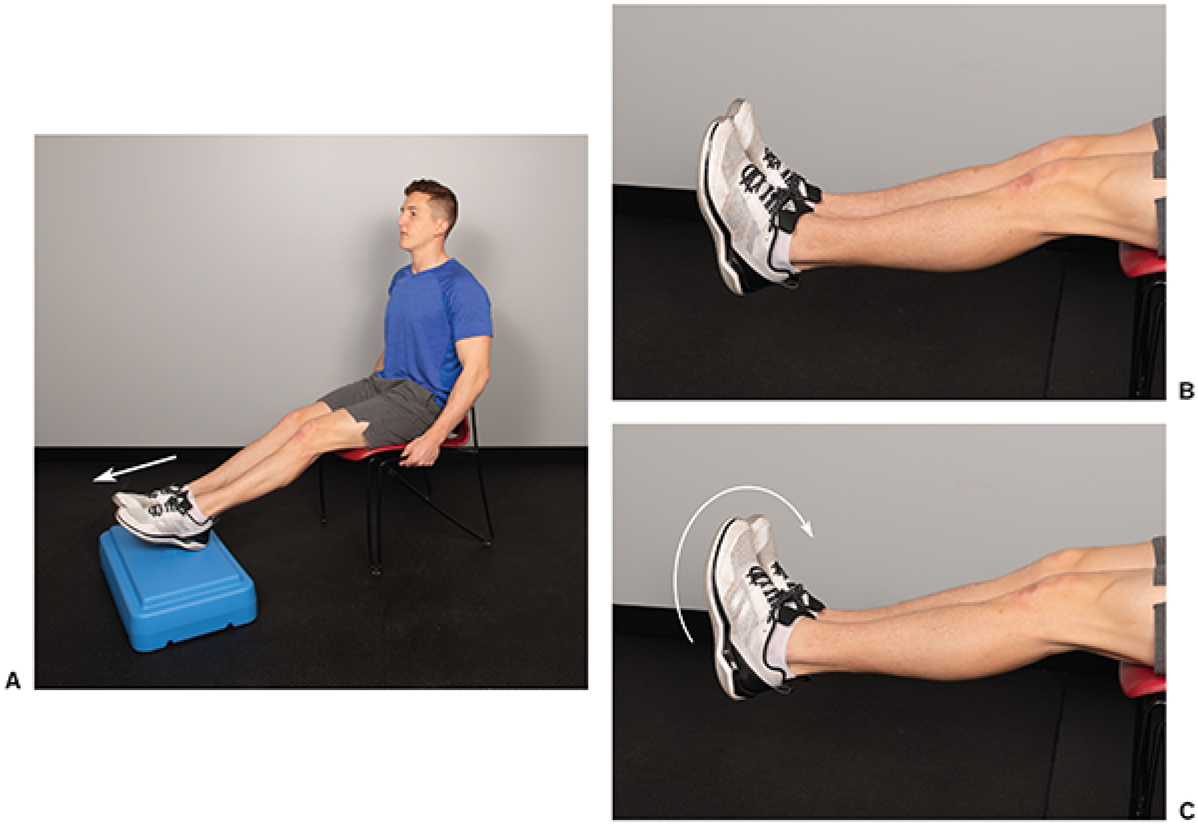


FIGURE 16.38. **A–C.** Dynamic foot ROM: Sit upright in a chair with both legs extended together. Pull toes toward the body and then point toes away from the body and pull toes toward the body. Rotate feet clockwise and counterclockwise. This stretching can be done one foot at a time.

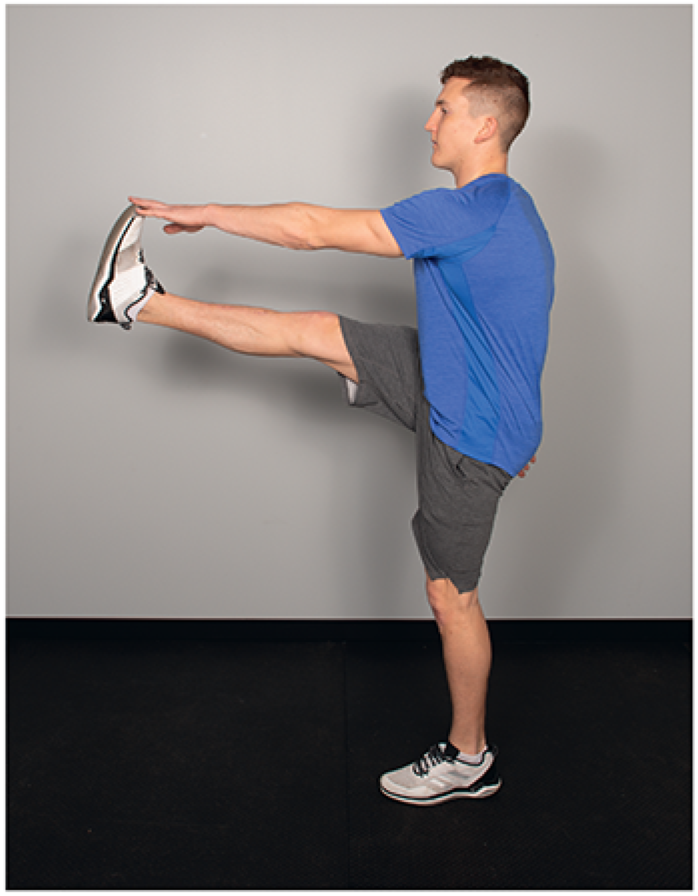


FIGURE 16.39. Soldier walk: Simultaneously rotate the right arm forward and raise the left leg (straight). Reach the right hand toward the left lower leg and toes and switch to the opposite side. Alternate to the opposite side. Progress to walking while alternating sides (keep posture upright).

Visit thePoint to watch video 16.6, which demonstrates the soldier walk.

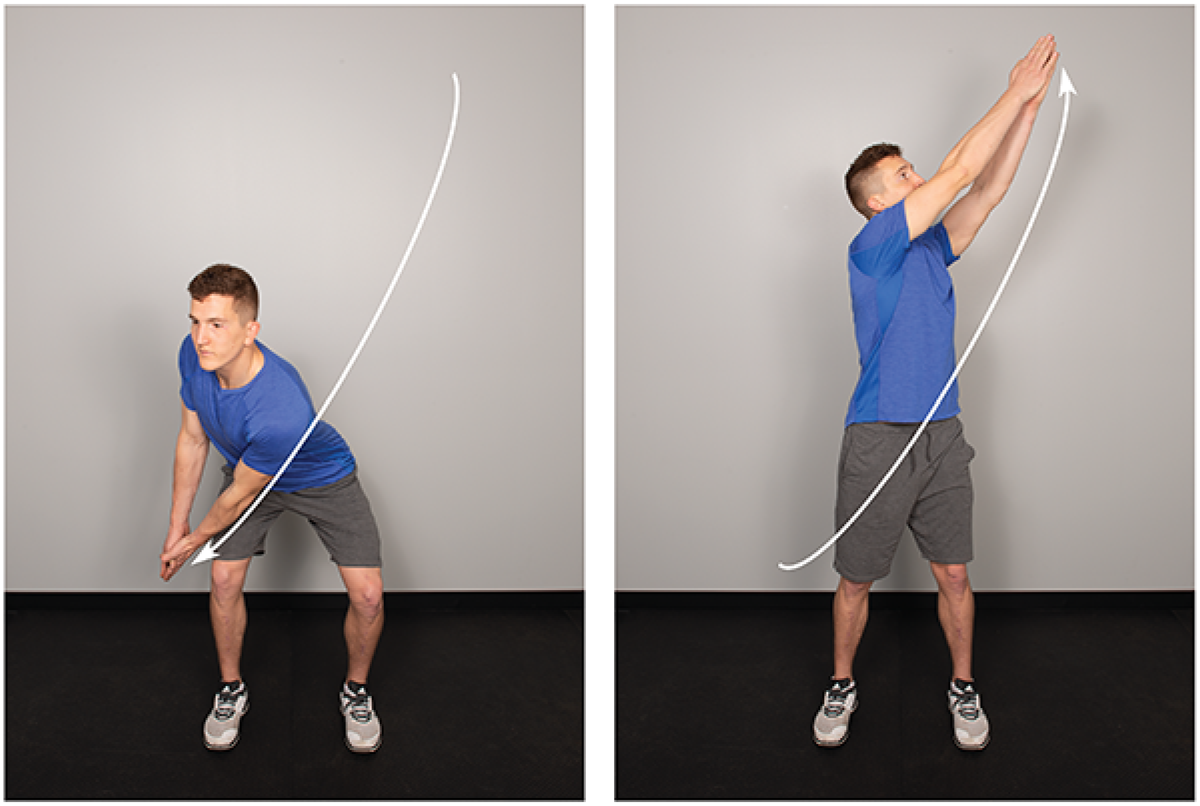


FIGURE 16.40. Wood chop: Stand with feet wider than shoulder width. Reach both arms down toward the outside of the left foot while bending the knees slightly. Move the arms diagonally across the body and end reaching above the right shoulder. Switch to the opposite side.

Visit thePoint to watch video 16.7, which demonstrates the wood chop.

Table 16.1 Overview of Stretching Technique and Appropriate Use

Technique	Definition	Exercise Design	Appropriate Use
Static stretching	This is the most common method used to improve flexibility. Static stretching consists of slowly moving to minor	All major muscle groups should be targeted at least 2–3 d $\cdot$ wk^{-1}. Hold each static stretch for 10–30 s, 30–60 s for older	Appropriate for use following a thorough warm-up (a thorough warm-up consists of 5–10 min of light to moderate multijoint,

	discomfort and then holding that stretch.	adults. ACSM recommends stretches be repeated 2–4 times to accumulate a total of 60 s for each flexibility exercise.	large muscle group movements) or during the cool-down period
Dynamic stretching	Dynamic stretching involves moving parts of your body through a full ROM while gradually increasing the reach and/or speed of movement in a controlled manner. These exercises are very rhythmic in nature. Dynamic stretching is often incorporated in the "active" phase of the group exercise warm-up due to its similarity to the movements or patterns that will be used during the conditioning period.	Begin gradually with a small ROM progressing to larger ROM, repeating each activity 5–12 times.	Appropriate for use during the warm-up or as part of the cool-down
PNF	PNF stretching involves both the stretching and contraction of the targeted muscle group. Although there are several ways to employ PNF, the most common technique is termed *contract-relax*. Following the preliminary passive stretch, the muscle is isometrically contracted for 6 s, relaxed for 2–3 s, and then passively moved into the final stretch,	All major muscle groups should be targeted at least 2–3 $d \cdot wk^{-1}$. A 3- to 6-s muscle contraction at 20%–75% maximum intensity is followed by 10–30 s of assisted stretching. A total of 60 s of stretching time should be achieved per targeted muscle group.	Appropriate for use following a thorough warm-up or during the cool-down period; appropriate for certified fitness professionals to use with clients if properly educated on the technique

	which is held for 10–30 s. This method is most effective with the use of a trainer to assist the client through the stretch.		
Passive stretching	The client is not actively involved in this type of stretching. The client assumes a position and then either holds it with some other part of the body (*i.e.*, arm) or with the assistance of a partner or some other apparatus (*i.e.*, stretching strap). The goal is to slowly move the client into the stretch in order to prevent a forceful action and possible injury.	Exercise design would follow the static stretching protocol.	Appropriate for use following a thorough warm-up or during the cool-down period; appropriate for certified fitness professionals to use with clients if properly educated on the technique
Ballistic stretching	This approach involves a bouncing or jerky type movement to reach the muscle's ROM limits. This bouncing motion may produce a powerful stretch reflex that counteracts the muscle lengthening and could possibly lead to tissue injury. Although ballistic stretch is not common practice for the general population, its use in training and rehabilitation of athletes who utilize explosive movements	Exercise design would be determined by activity-specific needs on an individual basis.	Not appropriate for the general population; may be suitable for athletes involved in ballistic sport skills

regularly may have a justifiable role.

Static

Static stretching is undoubtedly the most commonly used method to improve flexibility. Static stretching can be performed actively or passively and consists of moving slowly into position and then holding the position for a few seconds at peak tension. For example, to actively stretch the sternocleidomastoid (neck) muscles, the client would perform a lateral flexion of the neck as depicted in Figure 16.41. This position would be held at peak tension for 10–30 seconds before returning the head upright. Static stretches can be modified too, as depicted in Figure 16.41, so that the client can better hold at peak tension or truly achieve peak tension via self-assistance and support. Similarly, a Personal Trainer can also assist in moving into the correct position and holding stretches at peak tension—thus achieving a passive, static stretch for the client. However, this should be done with significant care and communication between the client and Personal Trainer, so as not to overextend the joints, particularly in sensitive areas such as the head and neck.

A B C

FIGURE 16.41. Progression of a static stretch. **A.** Facing forward, tilt head to the left, moving only in the frontal plane. Hold and then return to the starting position. **B.** Repeat with the other side. A good cue for this exercise is "right ear to right shoulder." **C.** Reach with one arm in opposite direction from head tilt. With or without a partner, pull from top of head toward the direction of stretch, applying gentle pressure only.

Despite the popularity of static stretching, little agreement has been reached among experts with respect to how long the static stretch should be held at peak tension. The ACSM suggests a hold range of 10–30 seconds (59). Data from Nelson and Bandy (60) supports this recommendation when they concluded that static stretches of 30 seconds, 3 d · wk^{-1}, for 6 weeks, significantly improved hamstring flexibility in high school–aged males versus unstretched controls. Interestingly, Sainz de Baranda and Ayala (58) reported that no particular single duration (15, 30, or 45 s) of static stretching was better with regard to its effect on ROM. Thus, the Personal Trainer should advise his or her clients to hold static stretches for 10–30 seconds. ACSM recommends stretches be repeated two to four times to accumulate a total of 60 seconds for each flexibility exercise (*e.g.*, if each stretch is held for 15 s, each would be repeated four times) (59). Box 16.1 provides an example of static flexibility stretches and training.

Box 16.1 Sample Static Flexibility Training Program

Client: A 40-yr-old woman who has been medically cleared to begin a consistent exercise program

Height = 168 cm (5 ft 6 in)

Weight = 68 kg (150 lb)

No history of orthopedic problems; mild chronic back pain

Objective: Improve flexibility as measured by goniometry

Session: 15-min warm-up using a NordicTrack CX 1055 elliptical trainer (average heart rate: 108 bpm)

Body Region	Exercise	Comments
Neck	Lateral flexion	Begin as an active stretch; move head slowly to prevent dizziness.
Shoulders	Arms across chest	Avoid bending the elbow as the arm is brought across the chest.
Chest	Chest stretch	Maintain relaxed shoulders.
Arms	Elbow extension	
Back	Kneeling cat	Discontinue stretch if it produces immediate back pain.
Torso	Modified cobra	Discontinue stretch if it produces immediate back pain.
Hips	Seated hip rotator, level I	Progress to level II exercise when level I was performed for 30 s without pain.
Thigh (anterior)	Prone quadriceps	Maintain upright posture and natural spinal curves.
Thigh (posterior)	Seated hamstring	Maintain upright posture and natural spinal curves.
Calves	Standing calf stretch	Maintain upright posture and natural spinal curves.

Trainer's Notes: Be sure to follow the FITT-VP guidelines for flexibility training suggested in this chapter, keeping in mind that they can be adapted to the individual needs of the client. If one or more of the recommended parameters do not seem to be effective, adapt as needed. This program can and should be progressed as the client achieves greater low back ROM.

Remeasure with the goniometer every 4–6 wk. By following the stretches listed in this chapter, this client will be able to progress from these basic stretches to more complex ones. The order of exercises performed during a session is not important.

Dynamic

Dynamic stretching is a form of stretching that incorporates movement along with muscle tension development. Dynamic stretches should be performed only as active stretches. In the broadest sense, dynamic stretches are built into every mode of exercise and physical activity. Dynamic stretching has been characterized as being very similar to a sport- or function-specific warm-up (61). The goal is to move the specific joint in a controlled manner within a normal ROM in order to minimize the risk of injury. It is important to progressively introduce dynamic stretches into the stretching program, particularly if the client is not accustomed to this type of stretching. Dynamic stretches should begin gradually with a small ROM progressing to larger ROM, repeating each activity 5–12 times (62,63). An example of this is arm circles; begin with small, slow circles and gradually progress into larger and faster circles until a full ROM is reached for the shoulder joint. It is difficult to depict examples of dynamic stretching on paper. Consider the movements of a boxer in the ring prior to a fight. Jabs he makes with the upper extremities and quick turns of the torso all serve as good examples of dynamic stretch. Tae Bo movements and stereotypical medicine ball exercises provide further examples of dynamic stretching. Ideally, dynamic stretches incorporate movements that are specific to sport movements of interest, but excellent dynamic stretches can also be developed on the basis of the flexibility needs of the medically cleared population at large. Box 16.2 provides an example of dynamic flexibility stretches and training.

Box 16.2 Sample Dynamic Range of Motion Training Program

Client: A 25-yr-old male, medically cleared to begin consistent exercise program

Height = 191 cm (6 ft 3 in)

Weight = 95 kg (215 lb)

No history of injury or orthopedic problems

Objective: Improve sports performance and prevent injury through increasing joint ROM and warming up prior to conditioning phase of activity

Session: 5-min warm-up using a treadmill (average heart rate, 110 bpm)

Body Region	Exercise	Comments
Shoulders	Arm circles	Start with small circles and progress to a larger ROM.
	Shoulder shrugs	
Hips and buttocks	Pendulum leg swings (front/back, side/side)	Begin with small swings and progress to larger swings.
	Hip internal/external rotation	Progress to walking forward while alternating feet.
	Side shuffle	This exercise can start in a stationary position and then progress to a walk or light jog.
Quadriceps	Butt kicks	This exercise can start in a stationary position and then progress to a walk or light jog.
Hamstrings	High knees	Progress to walking while alternating sides.
Ankles	Dynamic foot ROM	
Full body	Soldier walk	
	Wood chop	

Trainer's Notes: Full-body dynamic ROM exercises should be performed after the completion of exercises of individual muscle groups. Many dynamic ROM exercises can be progressed by adding forward or lateral movement in the phases of walking, jogging, and then running (*e.g.*, butt kicks and high knees). Progressions should be given to clients only when they have demonstrated control of movement in a stationary position.

Sometimes, dynamic stretching is confused with another form of movement termed "ballistic stretching." Ballistic stretching refers to the use of the momentum of the moving body segment to produce a bouncing movement at the end of the ROM that is done to obtain a peak muscle tension or stretch (64). For example, a ballistic stretch procedure would consist of a client reaching his or her maximal ROM and continuing to perform a "bouncing" movement at the muscle's maximal length (64,65). For example, a client seated upright on the floor could extend his or her arms forward in an effort to reach the toes. By moving slowly into that position and holding for a few seconds at peak tension, the client would be performing an active static stretch. However, if in an attempt to touch the toes, the client pushed forward repeatedly with short, successive, bouncing flexions at the hip, he or she would be performing a ballistic stretch. Ballistic stretching is controversial. It has often been considered a "contraindicated" movement, but in fact, when properly performed, ballistic stretching may be done safely in adults, particularly in individuals who perform ballistic movements such as those found in basketball. Ballistic stretching can be equally effective as static stretching in increasing joint ROM (1). Box 16.3 provides a discussion on the controversy regarding the use of ballistic stretching.

Box 16.3 Ballistic Stretching — Understanding the Controversy

Some flexibility experts fail to distinguish dynamic stretching from another form of movement termed *ballistic stretching*. Unfortunately, this misunderstanding has resulted in a great deal of confusion by fitness professionals, so much, so Personal Trainers often discourage clients from performing dynamic stretches. Almost all physical movements impose some type of dynamic stretch on the soft tissues that bring about these movements. In contrast, ballistic stretching refers to the bouncing or jerky stretching action or movement that is done to obtain a peak muscle tension. For example, a client seated upright on the floor could extend his or her arms forward in an effort to reach the toes. By moving slowly into that position and holding for a few seconds at peak tension, the client would be performing an active static stretch. However, if in an attempt to touch the toes, the client pushed forward repeatedly with short, successive, bouncing flexions at the hip, he or she would be performing a ballistic stretch.

The claim is often made that ballistic stretching is unsafe or at least ineffective for improving flexibility. It is thought that each successive "bounce" movement in ballistic stretching may impose too rapid a stretch on muscles while they are in the process of contracting making them susceptible to muscle injury. In fact, Smith et al. (66) found that similar bouts of static and ballistic stretching induced increases in delayed-onset muscle soreness (DOMS) in 20 male subjects unaccustomed to such exercise. Importantly, though, these researchers concluded that the static stretching actually induced significantly more DOMS than did ballistic stretching. In terms of performance, Kokkonen et al. (67) concluded that acute ballistic muscle stretching inhibited maximal strength performance, but Unick et al. (68) found no statistically significant difference in vertical jump performance as a result of static or ballistic stretching among actively trained women.

No attempt is being made here to settle the controversy surrounding ballistic stretching. Personal Trainers should recognize that both dynamic and ballistic stretching movements are normal components of sport activity and may have legitimate roles in the training and rehabilitation of athletes.

Proprioceptive Neuromuscular Facilitation

PNF involves both active and passive techniques designed to improve joint ROM. Several muscle groups can be trained when PNF techniques are properly used. This form of stretching requires an experienced Personal Trainer and a cooperative client. PNF stretching should be performed only by competent and trained practitioners because overstretching is possible if the technique is not fully understood. PNF techniques involve two dual process methods where an (a) isometric contraction is followed by a static stretch in the same muscle/tendon group (known as the contract-relax) and (b) an additional contraction of the agonist muscle group during the stretch, known as the contract-relax-agonist-contract method (69). PNF stretching is commonly believed to elicit a relaxation response from the neuromuscular system altering the stretch tolerance, allowing the musculature to continue to stretch (70). This response can occur in the prime mover (agonist), synergist, and antagonist muscles across a particular joint. With a stretch-induced reduction in muscle tone, joint ROM increases during subsequent stretches and eventually during physical activity. However, a review by Chalmers (71) refutes this rationale and points to studies that suggest that PNF improves ROM mainly because of changes in the ability to tolerate stretching and/or changes in the viscoelastic properties of the stretched muscle. Although the mechanism for ROM change following PNF stretching is unknown (70), it is clear that PNF techniques have long been shown to increase joint ROM. PNF stretching has been shown to improve ROM, however, due to the intensity of this stretching method, there are some risks associated with this type of stretching. Overstretching may result in injury or reduction in athletic performance. Because of this, the athlete or trained professional should not elicit any pain while doing PNF stretching. If the athlete or client experiences any pain above the feeling of the stretch, then the stretch should be stopped immediately.

Visit thePoint to watch video 16.8, which demonstrates PNF stretching.

PNF stretching should be performed only by competent and trained practitioners because overstretching is possible if the technique is not fully understood.

Rationale for Flexibility Training

Despite the importance of full, pain-free joint ROM for sport and physical activity, the justification for certain flexibility training techniques is controversial. Moreover, little scientific evidence exists to support either continuing or discontinuing even the most common stretching habits designed for injury prevention among competitive or recreational athletes (55). Not surprisingly, the Personal Trainer is bound to be confused with respect to the inclusion or omission of flexibility exercises in the overall conditioning of clients.

One approach to this problem involves conducting a thorough fitness assessment of the client to determine the extent to which inflexibility limits sport and/or general physical performance. Should ROM deficiencies be evident in the client, then the Personal Trainer is justified in prescribing the basic stretching techniques described in this chapter. These stretches (static, dynamic, and PNF) are most commonly known to improve flexibility. It is reasonable to employ these techniques and continue to monitor the flexibility needs of the client. Although at least one early study (72) found significant improvements in flexibility with all three methods, Personal Trainers are encouraged to select an approach that best suits the needs, limitations, and abilities of the client while continuing to monitor joint ROM and its ultimate impact on sport and physical activity performance.

Designing a Flexibility Training Program

There are three preliminary training guidelines unique to the design of flexibility programs. These involve warm-up, breathing, and posture.

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Warm-Up

Although stretches can be performed at the start, in the middle, and/or at the finish of the workout, it is common to precede stretching with a brief, aerobic exercise warm-up. An active warm-up reduces the resistance to stretch (73). It has been established that increasing the temperature of a muscle increases the elastic properties or the ability to stretch (12,74,75). Warm muscle tissue responds less stiffly than cold muscle tissue. Little evidence suggests that the exercise warm-up should be altered to accommodate flexibility training exclusively. Typical warm-up exercises include stationary cycling, treadmill walking/running, or rowing. It is often recommended that stretching be done at the end of the workout after the muscles are warm.

Breathing

Proper breathing techniques are often helpful in relaxing the client and allowing movement into position more comfortably. Flexibility training is no time to perform a Valsalva maneuver (air expiration against a closed glottis).

Purposeful and controlled breathing that accompanies relaxing exercise may help reduce stress levels and decrease voluntary muscle tension. Remind exercisers to exhale slowly as they move toward the endpoint of a stretch and inhale as they return to the starting position.

Posture

In the design of a flexibility training program, Personal Trainers should understand the proper positioning of the stretch to target the appropriate muscle group. Focus on maintaining proper body alignment during the execution of the exercises. For example, consider the stretch depicted in Figure 16.20. Posture can be greatly improved by using the "free hand" (the hand *not* grasping the ankle) to hold a railing or the back of a chair to maintain balance. The Personal Trainer should emphasize that one should avoid pressing the elevated foot to the gluteals (*i.e.*, hyperflexion at the knee) or leaning into the stretch for additional force development. Some reminders for correct postural alignment are listed in the following text:

- Maintain neutral position of the spine (characterized by having a slight inward curve at the cervical and lumbar spines and a slight outward curve of the thoracic spine).
- Shoulders should remain back and away from the ears.
- Hips should be in a neutral and level position (see Figs. 16.22 and 16.28 for examples of proper hip placement).

Precautions for Individuals with Health Concerns

There is little reason to avoid flexibility training in the apparently healthy individual. However, there are several common health conditions that require special attention and may present challenges to the Personal Trainer in regard to flexibility training. Four of these conditions are arthritis, muscular imbalance, osteoporosis, and hip fracture/replacement. Although Chapter 20 provides specific guidelines about exercise programming for these special populations, this section presents information to consider when designing flexibility training programs for individuals who may have these conditions.

> There is little reason to avoid flexibility training in the apparently healthy individual.

Arthritis

Over 50 million Americans suffer from arthritis or other joint pain and inflammation, with a higher prevalence found in women compared to men. Arthritis is believed to limit physical activity in both normal weight and obese adults (76). Arthritis is defined as an inflammation of a joint resulting in damage to the joint structure. There are more than 100 different types of arthritis, with the two most common types being osteoarthritis and rheumatoid arthritis (68). Osteoarthritis is a chronic degenerative condition that develops over time and is believed to result from either abnormal or excessive wear on "normal" cartilage or normal wear on "abnormal" cartilage. Rheumatoid arthritis is classified as an autoimmune disease in which the body attacks and destroys the joint surface. In either case, individuals with arthritis tend to limit movement because of pain and stiffness, which may result in an increased loss of flexibility and joint motion. Fortunately, flexibility and joint range can be improved in an individual with arthritis through training (77). In addition, training may assist in pain reduction, fatigue, and inflammation (59). Consider the following guidelines when flexibility training an individual with arthritis (59,68):

- Avoid strenuous exercises during acute flare-ups and periods of inflammation. However, it is appropriate to gently move joints through their full ROM during these periods.
- Encourage individuals with arthritis to stretch during the time of day when pain is typically least severe and/or in conjunction with peak activity of pain medications.

- If the client experiences greater joint pain following a training session, the session may have been too intense and may need to be modified.
- Avoid overworking individuals who have taken anti-inflammatory medications (*e.g.*, aspirin, ibuprofen, and naproxen sodium); these drugs can temporarily lessen musculoskeletal pain and make it possible for a client to do too much.
- Discuss with clients the importance of wearing shoes that have good shock absorption and stability.
- Functional activities such as sit-to-stand, step-ups, and stair climbing are good exercises that assist in ADL.

Muscular Imbalance

Many people have muscular imbalances of the body, which may create postural alignment issues and injury. Repetitive movements, poor posture, and weak or tight muscles can cause these muscular imbalances. Consider a baseball or tennis player who consistently trains and plays with joint dominance. When the body experiences an imbalance in muscular forces on opposite sides of a joint, ROM of that joint may be affected (18). The obvious goal to correct the muscular imbalance would be to strengthen the weak muscles and stretch the shorter muscle if ROM is compromised.

Osteoporosis

Osteoporosis is a disease in which bone mineral density (BMD) is reduced, bone microarchitecture deteriorates, and the bone becomes fragile and very susceptible to fracture. The prevalence of osteoporosis in all adults aged 50 years or older is approximately 11.0%, whereas prevalence of low bone mass in all adults aged 50 years or older is approximately 44.5% (78). In women 50 years and older, the prevalence for osteoporosis and low bone mass are 16.5% and 52.6%, respectively (78). In men, the estimates are 5.1% and 35.6% for osteoporosis and low bone mass, respectively (78). Both men and women lose bone steadily after about age 35 years; however, at menopause, women often have an accelerated loss of bone due to hormone changes. The most common sites for bone loss include spine, hips, and wrists. Flexibility exercises for those with osteopenia (low bone mass) or diagnosed osteoporosis should be designed to minimize the chance for fracture. When possible, it may be helpful to have the client use a chair or handrail for support when needed. Examples of exercises to avoid include those that involve twisting, bending, or compression of the spine or those that stress the wrists or hips. Specifically avoid the following:

- Bending forward (*e.g.*, forward fold pose)
- Supine spinal rotation or twists
- Plough pose
- Back extension (*e.g.*, cobra pose)

Hip Fracture or Replacement

For individuals who have recently had a hip fracture or hip replacement, it is recommended to avoid flexibility exercises that involve excessive

- Internal rotation of the hip (turning the foot inward)
- Hip adduction (crossing the legs beyond the midline)
- Hip flexion (thigh more than parallel to floor)

Flexibility Program Development

The ACSM recognizes that joint ROM is important and can be improved by engaging in flexibility training (1). Flexibility programs should follow the same FITT-VP principles (*i.e.*, frequency, intensity, type, time, volume, and progression) of exercise prescription as resistance training (see Chapter 14) or cardiorespiratory endurance (see Chapter 15). In this section, the ACSM FITT-VP guidelines are outlined. Unless otherwise indicated, the guidelines apply to all three of the stretching examples presented in Figures 16.2–16.40. Also as noted previously, flexibility exercises are most effective when the muscles are warm; thus, low- to moderate-intensity warm-up activities should be done preceding all stretching.

Frequency

It is currently recommended that stretches be performed at least 2–3 $d \cdot wk^{-1}$, but stretching exercises are most effective when performed daily, including two to four stretch repetitions per muscle group. There does not appear to be added benefit to stretching multiple times per day as found in a study by Bandy et al. (79), which found no increased in hamstring flexibility in 93 female and male subjects when the frequency of stretching was increased from one to three times per day. Little research exists to refute the practice of stretching daily whether followed by other physical activity or not.

Intensity

Intensity is commonly thought to be an important variable for successful stretching leading to improvements in flexibility (80). Moving into position of tightness or mild discomfort before holding a stretch is the current recommendation on static flexibility training intensity. This subjective feeling of discomfort will vary from client to client. Individual effort can be standardized in the laboratory using maximal voluntary isometric contractions. Feland and Marin (81) found that a submaximal form of PNF produced comparable gains in hamstring flexibility to those produced by maximal voluntary isometric contractions in 72 male subjects aged 18–27 years. These authors concluded that PNF stretching using submaximal contractions might reduce injury risk associated with PNF stretching. Because most Personal Trainers will not have access to isokinetic equipment, it is recommended that fitness professionals employ a Borg Rating of Perceived Exertion scale (82) and suggest that clients position themselves for (static) stretching at an intensity that corresponds to a 13–15 (*somewhat hard* to *hard*) range.

Time

Current recommendations involve stretch hold times of 10–30 seconds for active static stretches. Times of 10–30 seconds are also recommended for

PNF techniques when preceded by a 3- to 6-second active contraction. However, with older adults, an increase to 30–60 seconds for the stretch hold time is recommended. There seems to be little additional flexibility benefit to static stretch hold times that exceed 30 seconds in the younger adult (83).

Type

It is recommended that a general stretching routine be used to best improve flexibility. This means that stretches should involve the major muscle and tendon groups of the body. Some of the more commonly performed static stretches and dynamic stretches are presented in this chapter. For an example of how these parameters can be incorporated into a flexibility training program, see Box 16.2. Because PNF techniques require advanced skill and experience, only Personal Trainers who have advanced training and practice should attempt employing these stretches. For more information about PNF techniques, readers are referred to Houglum (20).

Volume

A total of 60 seconds of flexibility exercises per joint is recommended. This goal may be accomplished by repeating each exercise two to four times (*e.g.*, two 30-s stretches or three 20-s stretches or four 15-s stretches) of the same joint.

Progression

Recommendations for optimal progression are unknown. However, it is essential for continual stretching to maintain a "normal" level of flexibility. It is recommended to stretch before or after activity. Stretching along with dynamic movement should be performed prior to activity, and static stretching should be completed following activity. Flexibility exercises may acutely reduce power and strength, so it is recommended that flexibility exercises be performed after any exercise or sport where strength and power are important for performance.

SUMMARY

The purpose of this chapter is to present flexibility as an essential ingredient of health-related fitness and to provide Personal Trainers with a basic understanding of how to properly incorporate flexibility training into the exercise programs of healthy individuals. Although the science of flexibility training may seem confusing and at times conflicting, Personal Trainers are urged to continue to keep pace with the changes in the scientific literature as it develops.

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CHAPTER 17

Personal Training Session Components

OBJECTIVES

Personal Trainer should be able to:

- Understand how to organize training sessions.
- Apply basic customer service skills as they are applied in a fitness facility and during a Personal Training session.
- Understand communication skills necessary to promote client adherence and motivation.
- Use goal-setting techniques and client accountability to promote adherence.
- Understand criteria for an optimal Personal Training session.
- Develop a checklist for professional behavior.

INTRODUCTION

Developing a Personal Training session takes planning and critical thinking for short- and long-term goals. This requires the trainer to be aware not only of what will take place in a single session but also of what will take place in subsequent sessions in the future. Ensuring a well-organized session while taking notes of what was successful (or unsuccessful) during that time is crucial for the prosperity for the Personal Trainer and client. We address in detail how to plan for prosperous training session in this chapter as well as address the needs and typical activities of Personal Trainers.

In most facilities, Personal Trainers will encounter a diverse clientele, including older adults, middle-aged professionals, and adolescents. Furthermore, Personal Trainers assist clients who may be unfit, have injuries and disabilities, and lack sincere motivation to be active outside of training sessions. Nonetheless, a skilled Personal Trainer is able to communicate effectively with all types of people, provide motivation, and move clients toward their goals through implementation of individualized exercise programs.

Optimal Client Care and Customer Service

Before sequencing and motivational information is presented, a discussion of optimal customer service is in order. This is because effective customer service is the primary responsibility of every Personal Trainer.

Personal Trainers should keep in mind that every person they come in contact with throughout their workday, who is not on staff, is considered a "customer." This includes all training clients, facility members, and guests (prospective clients). This section presents basic customer service skills that every Personal Trainer should strive to perfect.

Personal Trainers should keep in mind that every person they come in contact with throughout their workday, who is not on staff, is considered a "customer."

Client Safety

Personal Trainers are responsible for client safety. For example, all Personal Trainers should understand mechanisms of injury for the major joints of the body. Knees, shoulders, and spines are more likely to get hurt in certain positions and during certain moves, so a competent Personal Trainer will avoid these positions and moves whenever possible (for additional information, see Chapters 3 and 4 as well as the activity-specific Chapters 14, 15, and 16). In addition, it is extremely important that Personal Trainers provide individualized exercises and training programs for each client. A hallmark of a skilled Personal Trainer is the ability to provide a personalized approach; in other words, no one client's program should look exactly the same as any other client's program. Knowledgeable Personal Trainers need to know hundreds, if not thousands, of exercises, progressions, and modifications. In this way, the Personal Trainer is always able to provide the right exercise at the right time for the right client. For example, not every client has the ability to complete a barbell-loaded back squat. If a client is unable to maintain proper exercise form, such as tracking knees with toes, keeping heels on the ground, or maintaining proper spinal alignment, the Personal Trainer must consider ways to modify this exercise. Using a different, simpler exercise that targets the same muscle groups is ideal for progressing to a back squat (*i.e.*, leg press, sit-to-stand, etc.). If pain occurs during the exercise, the Personal Trainer should cease implementation of exercises that require similar joint actions and potentially direct the client to the appropriate health professional. A primary duty of a Personal Trainer is to listen to and observe the client in order to find the safest, most effective exercise or variation at that point in time.

It is imperative that the Personal Trainer know the client's physical limitations as established from the medical history and fitness assessment prior to designing a program. However, the reality is that a client's needs can change from day to day, making it critical to modify and adjust the program or a specific exercise on the spot.

Providing an Exercise Program Road Map

Using information obtained from the client and an understanding of appropriate goal setting based on assessment results, the Personal Trainer should provide a general overview of a well-thought-out training program. Because most training sessions are purchased in packages, it is beneficial to develop a schedule (week by week) of what is expected from the client and what the client can expect from the Personal Trainer during their time together. Although this schedule will be more of a guide than a hard timeline, it is beneficial to provide a road map for success.

Plan Each Workout

Prior to each session, the Personal Trainer should review the client's exercise program road map, short- and long-term goals, any health issues or injuries, and the details of the last few sessions. In this way, the Personal Trainer can plan the most appropriate workout for each client, always keeping in mind the recommendations specified by current American College of Sports Medicine (ACSM) guidelines (1). How will overload be created? Changing the frequency, intensity, duration, and type of exercise are all proven strategies. Rest time, speed of movement, balance, core challenge, coordination, agility, and more can all be manipulated by changing the specific exercise, equipment used, sequencing of exercises, and order/format the program is executed. However, the Personal Trainer should always be ready to alter and adapt the plan, depending on the client's needs and current status. Checking with a client regarding his or her physical and mental readiness to begin the exercise session is crucial.

Use Proper Charting

Proper charting is a "must-have" — both from a customer service perspective as well as an ethical, safety, and liability standpoint. Documenting all activities and events will help the Personal Trainer provide optimal service while limiting liability risk. All workout specifics should be recorded, such as weight/repetitions/sets used, training heart rate (HR) and/or rating of perceived exertion (RPE), and blood pressure (BP) responses or changes (if BP cuff is available). Furthermore, the Personal Trainer should highlight any signs and/or symptoms that may have occurred during a session, including any pain with exercise and actions to address this pain/symptom. Relevant subjective comments made by the client should also be noted. The Personal Trainer should chart ideas and goals for the next workout. If another staff member will be training that client next, any exercise accommodation or program should be carefully detailed in order to prevent confusion. The purpose of keeping good notes is to

- Keep track of exercise programs to verify effectiveness following intermediate and summative assessments.
- Share program information if more than one Personal Trainer will be working with a client.
- Reinforce long- and short-term objectives.
- Keep track of the client's workout over time so that progression can be appropriately applied.
- Provide evidence of professionalism in the event of a lawsuit.

A Personal Trainer should be sure to update the fitness program chart as soon as any change in medical or structural condition (*e.g.*, musculoskeletal injury) presents itself. In addition, the Personal Trainer should take the appropriate steps, speak to the client regarding those conditions that affect the program, and ask the client's permission to contact his or her physician if warranted.

Be Attentive

Attentiveness begins the moment the client walks onto the exercise floor and finishes with the Personal Trainer saying goodbye to the client. Attention to every detail within the workout is important. Pertinent details include the following:

- Monitor all signs and symptoms of cardiovascular disease.
- Provide water and a towel, if appropriate.
- Modify or progress exercises based on the client's ability/feedback.
- Make certain the client trains within the desired target training zone.
- Ensure proper breathing, alignment, and technique during all exercises.
- Adhere to fitness program–specific recommendations.
- Listen to the client and ask for feedback.

> Attention to every detail within the workout is important.

Maintain Professional Conduct in the Training Facility

A Personal Trainer who is training a client must focus on that client alone (Fig. 17.1). Watching TV monitors, chatting with staff or other members, looking at oneself in the mirror, and talking or texting on a cell phone all show disrespect for the client. Aside from the safety factor, if a client perceives that his or her Personal Trainer is disinterested and uncaring, the quality of the workout will be compromised. Body language is important; a Personal Trainer should always face the client and, whenever possible, physically be on the same level. For example, if the client is lying supine on the floor performing abdominal crunches, the Personal Trainer should also be nearby on the floor, either in a sitting or in a kneeling position. Standing above a supine client and talking down to him or her may be intimidating and is impersonal. Finally, Personal Trainers should maintain professionalism even during potentially challenging work environments (*e.g.*, competition for clients among other Personal Trainers).

FIGURE 17.1. Proper body language is critical to success in the Personal Trainer.

Maintain a Professional Appearance

The Personal Trainer's appearance must be neat and professional. Personal Trainers who are not required to wear a uniform might consider developing their own to create a consistently professional image. Like effective branding does for any product on the shelf, a consistently professional appearance will speak volumes about a Personal Trainer. First impressions are important, and it is up to the Personal Trainer to portray a professional appearance that will produce the desired impression for every client and prospective client.

First impressions are important, and it is up to the Personal Trainer to portray a professional appearance that will produce the desired impression for every client and prospective client.

Work on Self-Improvement

Personal Trainers should set short- and long-term career goals for themselves and make a concerted effort to reach those goals. Reading related literature; attending clinics, workshops, and conferences; and sharing information with other Personal Trainers will enhance knowledge, skills, and abilities. Networking with other trainers and allied exercise and health care professionals, such as dietitians, physical therapists, and exercise physiologists, allows Personal Trainers to refer when necessary, increases likelihood of receiving clients through referral, and helps promote the profession from within. It is highly recommended that Personal Trainers work to attain a college degree in a fitness- or health-related field; this may be critical if and when state licensure is mandated, although the potential degree requirements are not known. Additionally, acquiring certifications in specialty areas, such as martial arts, yoga, Pilates, older adults, pregnancy, and diabetes, will increase a Personal Trainer's knowledge and enhance his or her ability to attract a wide variety of clients (for more information on ACSM specialty certifications, see Chapter 1).

Help Keep the Facility Clean

During nontraining time, check the facility to make sure that all is in order, the weights are put back, and the facility looks presentable. Personal Trainers should make periodic checks of the changing rooms and locker room facilities, going out of their way to make sure the areas are inviting and comfortable to clients.

Personal Training Session Criteria for Appropriate Sequencing

Session Components

A Personal Trainer must include appropriate workout components in the Personal Training session (Table 17.1). A typical hour spent with a client should include some or all of the following components (note these components are not listed in a specific order):

- Greeting
- Appropriate warm-up
- Cardiorespiratory aerobic or anaerobic interval work
- Cool-down phase
- Muscular strength/endurance component: traditional exercises and functional exercises
- Core work for stability
- Condition-specific exercises (*e.g.*, orthopedic protocols, pregnancy protocol)
- Neuromotor training (promotion of balance, agility, and coordination)
- Flexibility component
- Goal setting and farewell
- Charting

Table 17.1 Personal Training Session Evaluation Criteria/Checklist

Greeting	■ Personal Trainer's appearance is neat and professional. ■ Provide appropriate greeting and reception. ■ Pick up client on time. ■ Display good client rapport. ■ Ask how the client feels and on what he or she would like to focus.
Warm-up phase	■ Use appropriate cardiorespiratory equipment. ■ Consider any musculoskeletal or metabolic limitations. *Relevant to goals and/or structure of workout* ■ A minimum of 5 min in length ■ Appropriate intensity (*i.e.*, at low end of training zone)
Cardiorespiratory phase	Monitor and document intensity responses (HR, RPE). Follow ACSM guidelines. ■ Monitor HR, RPE, TT, and/or breathlessness at the various stages of the workout. ■ Use RPE for any *hypertensive clients* on medication that affects HR. RPE is to be monitored throughout workout with *pregnant clients*. Perceptual signs/signals (such as ataxia [unsteadiness of gait] or other

	physical signs of fatigue) should be monitored in conjunction with HR, BP, and RPE, and exercise is modified accordingly. This is especially important in clients who have a tendency to work hard and underestimate their RPE.
Cool-down phase	■ A slow decrease in exercise intensity occurs at the end of the CV bout, any hard bout of exercise, or at any point within the workout, prior to final flexibility and abdominal work. ■ The postexercise cool-down activity should be 5–10 min in length; it is dependent on the exercise intensity, exercising time, and client-specific conditions (*e.g.*, provide hypertensive client and less fit clients a longer cool-down period to allow for HR and BP to return toward preexercise levels without blood pooling or orthostatic hypotensive responses).
Muscular strength and endurance component	Follow ACSM guidelines. *Exercise selection takes the following into account:* ■ Client's goals (long term and short term) ■ Overall training program and program components ■ Client's skill and fitness levels ■ Any musculoskeletal or metabolic conditions and subsequent health care provider recommendations ■ Any day-to-day considerations (*i.e.*, client is tired, sore, had recent illness, inconsistent attendance, hasn't trained in over 1 mo) ■ Availability of equipment and other activities occurring within fitness center ■ The client's need for foundational training, traditional resistance exercise, and/or functional training ■ Previous exercise sessions *Spotting and cueing:* ■ Always ask permission before hands-on spotting. ■ The hands-on interaction is based on the client, the exercises used, the appropriate feedback needed, and their overall program. ■ Properly monitor the range of motion on resistance training exercises; give feedback on speed of movement; ensure client safety. ■ Free weights: Appropriate spotting occurs *at all times* with all clients. Personal Trainer is in a position to assist the clients with the weights if they are not able to maintain good form or are unable to complete the activity. Personal Trainer positions his or her body in such a way that the client is comfortable, safe, and experiences an improved workout. ■ Teaching cues are safe, accurate, and appropriate for the client. Provide a variety of cues: alignment, safety, educational, and motivational. Use a positive style of cueing. ■ Incorporate a "setup" phase, when needed, to help the client achieve proper alignment and technique. *Equipment use:* ■ Use a variety of equipment during the workout. ■ Return all equipment and maintain them in a neat, orderly condition.

Core work for stability	■ Focus on appropriate core stability exercises for the neck, scapulae, spine, and pelvis.
Condition-specific protocols	■ Do not exceed scope of practice and follow the licensed health care provider's recommendations. ■ Know what *not* to do as well as what to do. ■ Seek medical clearance for all pregnant women.
Neuromotor training	■ Include exercises for balance, agility, and enhanced proprioception.
Flexibility component	■ Occurs after client is thoroughly warmed up ■ Static stretches are held for 30–60 s, proprioceptive neuromuscular facilitation stretches can be held for 6–7 s. ■ Include stretches for the major muscle groups, any specific areas highlighted within the fitness assessment, or muscle groups emphasized during the workout. ■ Incorporate relaxation and/or stress-management techniques, if appropriate.
Goal setting and farewell	■ Help client set a short-term goal and/or give "homework" at end of session, if appropriate. ■ Thank client for a good workout. ■ Farewell should be friendly, positive, and affirmative.
Charting	*The client's session should include specific information regarding* ■ New exercises/machines used, how the client felt and performed the exercises ■ Client's subjective comments ■ Any particular changes in the client's fitness level as noted on a specific machine (*e.g.*, "ran 0.3 m farther than usual today;" "wasn't able to complete usual distance due to hard workout") ■ Relevant observations made by Personal Trainer ■ Any pain or discomfort that occurred during the session ■ Any notes for the next workout
Innovation and problem-solving skills	*Ability to improvise and modify any aspect of client's workout based on* ■ Other activities occurring within the fitness center ■ Specific injuries, limitations, or complaints of pain/discomfort ■ Equipment availability

Adapted from American College of Sports Medicine. American College of Sports Medicine position stand. Progression models in resistance training for healthy adults. *Med Sci Sports Exerc*. 2009;41(3):687–708.

Continuity and Planning

The “flow” of the Personal Training session should proceed in a continuous, uninterrupted manner. Making efficient use of floor space and choice of exercise modality when the training floor is crowded is also important. It is up to the Personal Trainer to be creative and make alternative choices of exercises when necessary, particularly if the preferred equipment is already in use by other members of the facility. Additionally, prior to the session, the Personal Trainer should prepare the client’s program for the day, set up equipment if possible, review the client’s short- and long-term goals, any health issues or injuries, and the details of the last few sessions.

Greeting and Punctuality

The Personal Trainer should greet the client in an appropriate manner. A friendly, professional greeting with a handshake and a smile goes a long way to setting the tone and building rapport with the client. Rapport is developed over time through empathetic listening, being trustworthy, and establishing repeated positive interactions with a client (for more information on listening and communication, see Chapter 9). Personal Trainers should make every effort to improve communication skills; ability to listen and communicate well is essential for the development of client rapport and motivation. Inappropriate language (*i.e.*, demeaning comments; racial, ethnic, or sexist epithets; or “locker-room talk”) has no place in a Personal Training session and can damage rapport. The relationship between a Personal Trainer and a client is a professional one, and thus, personal conversation should generally be kept to a minimum. A Personal Trainer should focus completely on the client’s needs from the moment of greeting the client to the farewell at the end of the session. At the beginning of the session, an inquiry should be made about the client’s status and include any of the following: how he or she feels, any aches or pains, how the client felt after the last session, and what the client would like to work on that day.

In addition, the Personal Trainer should always start the session on time. Starting a session late is unprofessional and indicates to the client that the Personal Trainer does not value the client’s time.

Warm-Up Phase

The Personal Trainer must help the client select an appropriate warm-up modality that

- Considers any musculoskeletal or metabolic limitations
- Is relevant to the goals and/or structure of the workout
- Is a minimum of 5 minutes in length
- Is an appropriate intensity (*i.e.*, low intensity, increasing toward the low end of training zone)
- Includes monitoring of RPE and/or HR

In many cases, when a client is experienced and has worked with the Personal Trainer for an extended period of time, the client arrives early and completes a preplanned warm-up prior to the actual training session. Similarly to the workout phase, the warm-up should rely on feedback from the client to ensure its effectiveness and follow principles of progressive overload.

Cardiorespiratory Phase

The Personal Trainer is responsible for helping design an appropriate cardiorespiratory and/or anaerobic interval program for each client; ACSM guidelines for the development of cardiorespiratory fitness should be followed (1). The Personal Trainer should also monitor HR, respiration, or RPE throughout the various stages of the entire workout.

The client's HR may be monitored by palpating the pulse, either at the radial or carotid arteries, or by using an HR monitor (for information on measuring HR, see Chapter 12). If the Personal Trainer chooses to use HR to monitor exercise intensity, he or she should be well aware of its potential inaccuracy. For example, do not assume that one maximal HR formula fits all clients. Also, several extraneous factors, such as heat, humidity, illness, cigarette smoking, and stress, may affect HR. While using HR to monitor exercise intensity, the Personal Trainer should also monitor the client for ataxia (unsteadiness of gait) or other physical signs of fatigue or stress (1).

RPE is frequently recommended as another way to assess exercise intensity (1). The Borg 6–20 RPE scale (see Table 15.4) or a simple 0–10 scale may be used (see Chapter 15). With new clients, it is helpful to have an actual RPE chart visible while explaining proper intensity, but eventually, most clients can understand and apply the RPE scale effectively without a visible chart. For more information on monitoring exercise intensity, see Chapter 15.

Ventilatory symptomatology is a recommended way to assess exercise intensity when a client's HR response is not a reliable means (*i.e.*, client's taking medications, such as β-blockers) or to more closely relate to ventilatory thresholds for apparently healthy clients and athletes (2). Popularly referred to as a talk test (TT), this requires a client to determine if he or she can talk "comfortably" during cardiorespiratory exercise. It is useful to familiarize a client with this procedure during a pretest using "The Pledge of Allegiance", or something similar, as the paragraph he or she is reciting to determine if he or she is comfortable talking or not.

In practice, many Personal Trainers design cardiorespiratory programs for their clients but eventually encourage clients to perform this part of the workout on their own. In this way, for many clients, the actual session is reserved for the more various and complicated muscle-conditioning exercises. If the Personal Trainer is not actually supervising the cardiorespiratory workout, the Personal Trainer should nevertheless always ask the client about his or her adherence to the workout and about program variables such as duration, frequency, intensity, and mode.

Cool-Down Phase after Cardiorespiratory Exercise

The cool-down portion of the workout should be 5–10 minutes in length, depending on the intensity and duration of the workout and client-specific conditions (*i.e.*, less-fit clients should be allowed a longer cool-down period to allow HR and BP to decrease). Ideally, HR and/or RPE should be monitored during the cool-down.

Muscular Strength/Endurance Component

Many clients seek a Personal Trainer's advice because they are unsure of what exercises to do in the resistance training area; they want a program that generates results. Additionally, they often want a Personal Trainer to help make certain they are exercising correctly with safe and effective form and technique. Therefore, in addition to following ACSM guidelines for resistance training, Personal Trainers should be familiar with a large variety of exercises and know how to properly teach, spot, and cue each exercise in such a way that clients understand and follow through with correct performance.

Exercise Selection and Programming

The Personal Trainer must take several factors into account when deciding which exercises to give a client. These factors include the following:

- Client's goals and attitude
- Client's fitness and skill level
- Any musculoskeletal issues or injuries
- Any recommendations from the client's health care providers
- Considerations on the particular training day (*e.g.*, client is tired, sore, has been ill, has not trained regularly, has not trained in over a month)
- Availability of equipment and other activities occurring within the fitness center

A skilled Personal Trainer should know a large number of traditional exercises for each muscle group, including single-joint and multijoint exercises using machines as well as free weights and other equipment. It may be useful to organize the vast number of possible exercises along a continuum from easiest to hardest (Fig. 17.2); such a continuum provides a practical way to think about exercise selection (3).

FIGURE 17.2. Exercise session continuum. (Adapted from Ratamess N. *ACSM's Foundations of Strength Training and Conditioning*. Philadelphia [PA]: Lippincott Williams and Wilkins; 2012. 319 p.)

To be even more specific, the left, easy, or foundational side can provide a starting point for new clients. At the beginning of a program, it is wise to select basic exercises that promote core stability and mobility, thus helping to create a strong and safe foundation for harder and more complex exercises. Examples might include supine abdominal hollowing, supine heel slides, quadrupeds (bird dogs), hip hinging, and scapular depression and retraction exercises. These foundational exercises help prepare the client for more challenging work and can be used to educate him or her about safety, proper alignment, and injury prevention. As a client progresses, exercises may be selected from the traditional weight room repertoire and include the use of variable resistance machines, cable column setups, and free weights. Progression often moves from single-joint exercises to multijoint exercises and from open kinetic chain to closed kinetic chain movements.

Eventually, many clients may progress to less traditional exercises — now often labeled under the heading of functional training — such as woodchoppers; reverse woodchoppers; lunges with a pickup; and other moves that incorporate balance, core, and coordination challenges. Compared with traditional weight training, these moves often use a lighter weight held farther from the trunk and help to improve biomechanical efficiency and neuromuscular control (4). On the far-right side of the exercise continuum are sport-specific moves that prepare an athlete for performance (see Chapter 18 for more specifics on advanced program options). Because functional exercises and, especially, sport-specific moves require a high degree of fitness, skill, balance, coordination, and core stability, Personal Trainers should not select these exercises until the client is able to perform them safely and correctly. In fact, many clients have no desire to progress all the way to the sport-specific/performance end of the continuum. It's important to realize that many people want to exercise for health, fitness, and wellness benefits and that this does not necessarily include sports performance or aggressive, very difficult moves or routines. The Personal Trainer should emphasize the muscle groups and movements that are specific to the client's individual goals and objectives. Finally, the Personal Trainer should attempt to select exercises according to the initial or follow-up fitness evaluations and interviews.

Spotting: Hands-On Interaction

The Personal Trainer should provide appropriate spotting during all aspects of the exercise session. Legally, it is a Personal Trainer's job to ensure client safety. The Personal Trainer should monitor ranges of motion and prevent the client from moving into extreme and unsafe positions, such as extreme shoulder horizontal abduction in a supine dumbbell fly. As a general rule, when a client lifts a heavy weight, the Personal Trainer needs to spot the weight for safety (keeping hands on or near the weight). If the client is a novice, or is performing an exercise for the first time, or is lifting a light weight, the Personal Trainer may need to spot specific joints or actions instead of the weight. For example, if a client is performing a squat for the first time (in which case the weight would be either light or nonexistent), the Personal Trainer may need to kneel and spot the client's knees, helping the client to find and feel the correct knee position while moving. During core, balance, and agility work, the Personal Trainer should assist the client and help ensure proper alignment and technique. Personal Trainers should properly position themselves to prevent the client from falling and should provide adequate support for the client during balance-training drills. Furthermore, Personal Trainers should also position themselves in a way that does not impede the client's movement and maintains comfortable spatial interaction between both the client and Personal Trainer. During stretching, the Personal Trainer may spot the client as needed to help ensure proper form and alignment.

The hands-on interaction that occurs during the workout should be based on the client, exercises used, appropriate feedback needed, and overall program. Always consider the client's safety, alignment, and comfort level with touch. Because not all clients are comfortable with hands-on techniques, the Personal Trainer must always ask permission before touching.

> The Personal Trainer must always ask permission before touching the client.

Do not touch a client if he or she says no, or seems uncomfortable in any way, and stay away from gender-specific areas of the body. Additionally, the Personal Trainers should be aware of their body position. It is usually best to be on the same level as the client. For example, if the client is on the floor performing supine abdominal work, the Personal Trainer should not be standing over them shouting down commands. Instead, kneel or sit near the client in order to facilitate hands-on spotting if necessary, increase client comfort, and maintain an appropriate speech volume.

A good technique for teaching clients proper form is to have a "setup" phase prior to the performance of each exercise. During the setup, the Personal Trainer carefully ensures that the client is focused and properly aligned and the core is stabilized. Only then does the client actually begin to move and perform the exercise.

Cueing

Proper cueing during a client's session is critical. It is the Personal Trainer's job to help the client perform each segment of the workout, and each exercise, correctly. This can be accomplished with skillful spotting and cueing. There are many different types of cues, including educational, safety, alignment, and motivational cues. In addition, cues may be delivered visually, orally, and through touch (tactile cues). The Personal Trainer needs to be adept at exercise demonstration as well as visual cueing. Another useful cueing technique is the right/wrong method. This method can be very effective for clients who are having difficulty with proper positioning. For example, if a client is having trouble maintaining a neutral pelvis, the Personal Trainer may demonstrate a misaligned pelvis versus a neutral pelvis. In other words, show the client the incorrect position and then the correct position. Many clients find this type of teaching technique very helpful. Remember to phrase all cues positively, as in "Make sure to always keep a slight bend in your knees" instead of "Don't lock your knees." Constant use of the word "don't" sounds negative and pejorative. In general, it's best to avoid monotonous counting; clients already know how to count! Instead, the Personal Trainer should make certain he or she is providing detailed information and cues that will ensure the safety and efficacy of each exercise.

Equipment Use

The Personal Trainer may use a variety of equipment during the workout. Any equipment used during the workout must be returned to a neat, orderly condition during the course of the workout to maintain safety and not interfere with any other workouts that are occurring within the same time frame. Personal Trainers have many equipment and exercise options, and as a client progresses and becomes more skilled, variety may become more and more important. Machines, free weights, cable columns, stability balls, BOSU balance trainers, TRX Suspension Trainers, kettle bells, medicine balls, foam rollers, and elastic tubing and bands are all common in many facilities. Personal Trainers should be familiar with safety precautions, proper progressions/modifications, and a wide variety of exercises on all types of equipment. Once the Personal Trainer has a satisfactory understanding of the equipment, then he or she can select the most appropriate exercise for each client depending on the client's level of fitness, skill, goals, musculoskeletal and/or metabolic issues, exercises performed in the previous session, and equipment availability.

> The Personal Trainer may use a variety of equipment during the workout.

Core Work for Stability

All clients, both novice and experienced, need to be able to maintain neck, scapular, spinal, and pelvic stability in order to perform exercises with good alignment and to minimize the risk of injury. The Personal Trainer should therefore make time in the session to focus on core exercises such as abdominal hollowing, pelvic tilts, and scapular depression and retraction; these may be performed supine or standing against a wall. Scapular awareness can also be promoted in the prone "prop" position (up on the elbows) because gravity pulls the torso downward and the scapulae tend to elevate. Many clients find it challenging to maintain the prone prop position for even 30–60 seconds while keeping the scapulae depressed. The quadruped/all fours/bird-dog position is another excellent way to teach core stability of the neck, scapulae, spine, and pelvis; many movement variations exist, such as holding the opposite arm and leg parallel to the floor or slowly lifting arm and leg up and down without moving the core. The plank, and all its variations, is yet another way to challenge core stability and, depending on the variation (*e.g.*, a side plank), can be quite advanced.

Condition-Specific Protocols

Most Personal Trainers will occasionally work with clients with special conditions; these conditions can include pregnancy as well as a large number of musculoskeletal issues such as low back pain, tennis elbow, rotator cuff tendonitis, hip bursitis, lateral knee pain, and more. Although a Personal Trainer must never exceed his or her scope of practice and should always refer a client with active musculoskeletal pain to the appropriate medical practitioner, the reality is that many clients want to stay active and will continue working with their trainer, even with an injury. If the Personal Trainer agrees to continue training a client with a history of musculoskeletal pain, it is incumbent on the Personal Trainer to adhere to the recommendations of the client's licensed health care provider. In other words, the Personal Trainer must know what not to do as well as what to do. For example, a client who has finished a regimen of physical therapy sessions for tennis elbow may have a specific exercise protocol that he or she need to continue postrehabilitation (provided by the physical therapist), which may then be incorporated into the Personal Training session. Likewise, when training pregnant women, it is recommended that a woman past her first trimester of pregnancy avoid exercising in the supine position, particularly if she is symptomatic. The Personal Trainer should make certain to include alternate abdominal exercises that are not in the supine position and should also seek a medical clearance for all pregnant women (1,5). Such condition-specific protocols will need to be sequenced into the Personal Training session.

> The Personal Trainer must follow the recommendations of the client's licensed health care provider.

Neuromotor Training

Neuromotor training includes training for balance, coordination, gait, agility, and enhanced proprioception. Neuromotor training is recommended as part of a comprehensive exercise program, particularly for older adults who are at an increased risk of falling (1,6). Younger and middle-aged adults involved in physical activities that involve agility, balance, and other motor skills may also benefit, although research in this area is still limited (1). Balance exercises may be either static (such as standing on one leg while incorporating upper body movements) or dynamic. A dynamic balance exercise involves transferring body weight from one foot to the other; for example, pretending to walk along a "tightrope," or a line on the floor, with one foot directly in front of the other can be challenging for some clients. Personal Trainers should make an effort to include both types of balance exercises in the exercise session whenever possible.

Flexibility Component

A flexibility component can be included anytime the muscles have been warmed up. Flexibility exercises can be included at the end of the Personal Training session. The Personal Trainer should teach his or her client a basic stretching routine that addresses all active muscles and all joints with a decreased range of motion. Muscles that have been vigorously challenged or repetitively used during the workout should be stretched. This final segment can also be a good time to incorporate relaxation techniques such as deep breathing, progressive muscle relaxation, and positive imagery. Many clients are unfamiliar with stress management "quick fixes" and will be grateful for any tips and strategies from the Personal Trainer. Details on stretching and developing flexibility are found in Chapter 16.

Goal Setting and Farewell

Goal setting is critical for success (Fig. 17.3). The Personal Trainer can ask his or her client to set a short-term goal at the end of each session. The goal should ideally be relatively easy to attain, positive, and doable for the client. Some sample short-term goals include the following: "Take a 10-minute walk after lunch every day for the next 3 days," "Go for a 1-hour walk in the park on Saturday with the kids," and "Stand up and pace during every phone call on Friday." Another suggestion is for the Personal Trainer to assign "homework" for the client. Examples of homework include the following: "Every night at dinner, sit on the edge of the chair and maintain a perfectly neutral spine for 60 seconds," "Twice a day, stand against a wall and make certain the spine and neck are in neutral," "While making coffee every morning, stand on one foot and balance for 20 seconds," and so on. Goals should always be set by the client, whereas "homework" may be assigned by the Personal Trainer. In either case, let clients know that they will be asked about the goal or the homework at the next session. Small steps help promote long-term behavior change. Upon completion of the session, thank the client for a good workout. Always end the session with a positive and affirmative farewell, with plans for the next meeting.

FIGURE 17.3. Personal Trainer reviewing goal setting with a client.

Charting

Proper charting was discussed earlier in the chapter. The Personal Trainer needs to allow enough time after the session to record all workout details, client goals, and ideas for the next session.

Education and Motivation

Client Education

Most clients have a specific area of concern. In order to make the session more meaningful, Personal Trainers can gear the workout to address these concerns. Some clients, for example, want to “tone up” their hips and thighs. The Personal Trainer can take this opportunity to educate the client about the meaning of “toning up” and include information about muscle-specific exercises such as hip extensions and hip abduction and adduction movements. The effectiveness of multi-muscle exercises such as squats and lunges should be discussed. Additionally, the Personal Trainer might educate the client about the importance of increasing lean body mass while also promoting cardiorespiratory exercise as a way to burn large numbers of calories and reduce excessive body fat.

The Personal Trainer should talk to each client about how the routine he or she has designed relates to the client’s goals and training objectives. When prudent, appropriate postrehabilitation protocols should be implemented and explained as to how they will be integrated into the client’s program to improve or prevent further injury.

Another important area for client education is proper breathing technique. The client should never hold his or her breath during any contraction. This increases intrathoracic pressure and as a result increases BP, which may or may not be dangerous for a specific client but is certainly unnecessary. As a general rule, the client should inhale before starting the lift, exhale when performing the concentric contraction, and inhale during the eccentric phase.

Many clients hire trainers primarily for guidance in the weight room. However, the Personal Trainer should educate the client about all the components of fitness and should also provide a suitable program for cardiorespiratory conditioning. Typically, many clients will perform their cardiorespiratory workout before or after the actual supervised session. This will depend on the client’s overall physical condition, daily schedule, and specific training goals and objectives. The Personal Trainer should make sure that clients understand how to operate their preferred aerobic equipment and that they can either take their own HR or gauge RPE effectively, before they exercise without supervision. It is important to ask clients what additional activities they are performing outside of the facility. This will assist the Personal Trainer in designing training sessions and can provide additional opportunities for education. The Personal Trainer should teach each client the physiological basis of the RPE scale and explain how this will assist in monitoring exercise intensity and how it will make the sessions more efficient (Fig. 17.4).

FIGURE 17.4. Personal Trainer explaining the use of the RPE chart to a client.

In light of the current obesity epidemic, Personal Trainers need to provide most clients with strategies for increasing their physical activity throughout the day, and the risks of constant sitting should be discussed. Help clients with tips for incorporating more nonexercise movement into their day. Encourage them to stand more and sit less, to take movement breaks during TV commercials, and to be “inefficient” when doing household chores — making more trips than necessary in order to burn more calories and keep the body active.

Another important area for client education involves low back care and the maintenance of proper posture throughout the day. Personal Trainers can help reduce the incidence of back pain by teaching clients how to adjust their chairs and sit correctly, how to bend and lift, and how to find ideal spinal alignment in activities of daily living.

Client Motivation

The ideal Personal Trainer is also a great motivator. What does this mean? A great motivator makes each workout as interesting and as varied as possible. Most clients are motivated by a trainer who is also a good role model, someone who practices what he or she preaches. Personal Trainers who are enthusiastic and passionate about fitness and wellness can be inspiring. Good motivators are genuine, empathetic, and caring and let clients know that they believe in the clients' ability to succeed at their goals. Many novice exercisers hire a Personal Trainer because they need extrinsic motivation. Extrinsic motivation is the type of motivation that comes from the outside; for example, a client who adheres to a program because he or she wants to win a reward, such as a free 6-month club membership, is extrinsically motivated. A client may be motivated to keep exercising because of positive feedback from the Personal Trainer — another example of extrinsic motivation, where the concern may be more about the outcome instead of the process.

However, people are more likely to adopt healthy lifestyles and fitness regimens for the long run if they are intrinsically motivated (7). Intrinsic motivation comes from within. Clients with intrinsic motivation continue to exercise simply because they enjoy it and they feel better when they do; exercise becomes its own reward. Personal Trainers can help clients become more intrinsically motivated by bringing attention to feelings of well-being after an exercise session and by helping clients discover the benefits of exercise for themselves. Exercise sessions should be productive yet fun and enjoyable.

A motivating Personal Trainer also helps clients achieve feelings of self-efficacy. Self-efficacy has been defined as the confidence a person has that they can perform a given task well (8). In the fitness setting, this means that a client eventually knows what to do and is comfortable doing it. A client with self-efficacy, for example, is able to walk into the cardiorespiratory training room and/or the weight room and feel a sense of mastery in terms of some or all of the equipment. Such a client knows how to adjust the machines for his or her own use and understands how to perform the chosen exercises properly. An important task of the Personal Trainer is to enable clients to have this type of mastery and competence in the exercise environment. Most clients find that having a sense of self-efficacy with regard to fitness and wellness is very motivating and helps ensure long-lasting adherence. Chapters 7, 8, and 9 can assist you in developing your client's self-efficacy regarding exercise.

> The Personal Trainer should help promote the client's self-efficacy, or sense of mastery and competence, in the exercise environment.

SUMMARY

The Personal Trainer must first and foremost ensure client safety and care while he or she strives to deliver the highest level of customer service. This includes focusing on proper exercise form, appropriate planning and charting the client's program and progress, being attentive to the client, and always behaving professionally. All components of a training session should be administered sequentially and closely observed, from warm-up through to the cool-down, and standard exercise guidelines should be followed. Personal Trainers should acknowledge that they are role models, educators, and motivators of clients and therefore continue to challenge themselves in these areas.

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CHAPTER 18

Advanced Program Options

OBJECTIVES

Personal Trainers should be able to:

- Identify the roles and proficiencies of Personal Trainers whose clients consist mostly of competitive athletes and/or those with advanced training goals.
- Discuss how to maximize performance by improving one or more health- and skill-related fitness components.
- Identify American College of Sports Medicine recommendations for advanced resistance training.
- Identify various advanced resistance training techniques used to maximize muscle strength, hypertrophy, power, and endurance and how they may be used in a training program.
- Understand recommendations for plyometric, speed, agility, and anaerobic conditioning program design.

INTRODUCTION

The Personal Training profession has evolved rapidly, and practitioners accommodate numerous segments of the population. Not only have Personal Trainers rendered services to previously sedentary, novice, and moderately trained individuals but also a growing number of athletes and highly fit individuals have hired Personal Trainers in order to maximize performance. Although sports teams at the university and professional level typically have a full-time strength and conditioning coach on staff, some athletes at the elite and professional levels prefer to hire a Personal Trainer for individualized training. It is not unusual for athletes to work with their strength coaches during in-season and preseason training and to hire a Personal Trainer for off-season training. For example, athletes commonly attend off-season speed and agility training camps, and many college football players attend strength and conditioning camps prior to combine testing in preparation for the National Football League draft. As the Personal Training profession increases involvement of clientele with advanced fitness levels, the roles and proficiencies of the Personal Trainer will expand. Box 18.1 presents examples of educational foundations and proficiencies important to a Personal Trainer. The scope of this chapter is to provide Personal Trainers with advanced training recommendations particularly suited to more highly fit individuals.

Box 18.1 Professional Educational Foundations and Proficiencies of a Personal Trainer

Anatomy, physiology, and kinesiology
Bioenergetics
Exercise/sports biomechanics
Sports nutrition
Supplements and ergogenic aids
Overtraining and detraining
Periodization and recovery
Weight loss/body fat reduction
CPR administration and first aid
Injury prevention
Weight and implement training
Aerobic endurance training
Plyometric, speed, and agility training
Balance and functional training
Strength, power, and ballistic training
Flexibility training
Muscle endurance and hypertrophy training
Sport-specific demands and conditioning
Advanced program design
Skills assessment

CPR, cardiopulmonary resuscitation.

> Not only have Personal Trainers rendered services to previously sedentary, novice, and moderately trained individuals but also a growing number of athletes and highly fit individuals have hired Personal Trainers in order to maximize performance.

The motivation, coaching, instruction, and direct supervision provided by the Personal Trainer are instrumental for athletes and highly fit individuals. Not only does supervised training result in fewer injuries and better technique but also performance abilities may be enhanced. Personal Training poses several advantages to the athlete/client targeting further progression.

Research has shown supervision results in greater strength gains (1,2) and the self-selection of greater training loads (2). Although athletes are supervised to a large extent by the coaching staff, coaches must often monitor several athletes simultaneously. Personal Trainers offer the advantage of one-on-one instruction for an entire workout.

Advanced Training Status

Personal Trainers who work in the general health and fitness domain train clients primarily to improve health and overall fitness, whereas advanced clients train rigorously with the aim of improving (or maximizing) one or more fitness components. The *needs analysis* for advanced clientele reveals areas of focus for the training program to maximize performance as well as for injury prevention (3–5). Fitness components may be categorized as health related or skill related. Health-related components of fitness include muscle strength and endurance, cardiorespiratory endurance, flexibility, and body composition. Skill-related components of fitness include power, speed, agility, balance, reaction time, and coordination. Both of these component categories are critical to improving performance. Although athletic success is related to skill level, conditioning traits can differentiate athletes of different caliber (6). Elite athletes possess greater strength, power, speed, and jumping ability compared with athletes of lesser rank (6). For example, National Collegiate Athletic Association (NCAA) Division I football players have greater maximal strength, vertical jump height, fat-free mass, lower percentage of body fat, and faster 40-yard dash times than NCAA Division II players (7). Thus, health- and skill-related components of fitness appear to contribute to athletic success and are of value to anyone with advanced training goals.

Advanced training status is determined by fitness level and training experience. Individuals who are classified as advanced typically have demonstrated a substantial level of adaptation, which occurs at different rates depending on the training program. Training advanced to elite clients can pose a challenge to Personal Trainers. Some of the largest rates of fitness improvements take place in untrained individuals where the window of adaptation is high, whereas trained individuals may show a slower rate of progression (8). Therefore, the Personal Trainer must be creative and must design advanced training programs based on the scientific principles of progressive overload, variation, and specificity (discussed in Chapters 13 and 14). This chapter provides an introduction to a number of advanced training options; additional instruction and experience in implementing the various techniques should be gained prior to Personal Training any clients.

Advanced Program Design

Advanced training programs consist of systematic manipulation of the acute program variables. The manipulation of these variables becomes more critical because of the smaller window of adaptation shown in advanced or elite athletes. The level of variation needs to be greater than that seen in beginning and intermediate programs. A basic program may improve several components of fitness simultaneously in an untrained or moderately trained individual. However, this same program may only improve one or two fitness components in a trained individual. Advanced training is characterized by greater specificity and requires periodization in the program (see Chapter 14) (3,5,9). Training cycles are common, and each cycle may target a few components of fitness. Exercise selection is based on training and program goals along with enhanced motor coordination, where movement complexity increases over time. Advanced training also requires the optimal integration of training modalities. A strength/power athlete may simultaneously perform resistance, speed, agility, and plyometric training in a preseason training phase, and an endurance athlete may simultaneously perform aerobic endurance, interval, and some resistance training (RT). Although training basics have been discussed in previous chapters, this chapter focuses on the applied concepts of advanced program design of resistance, plyometric, speed, and agility training.

Resistance Training

The American College of Sports Medicine (ACSM) has been instrumental in providing Personal Trainers with guidelines and recommendations for RT. Early position stands focused mostly on untrained populations. However, in 2002 the ACSM first published RT guidelines targeting progression from novice to advanced training status for those individuals striving to increase muscle strength, power, endurance, and hypertrophy (8). In 2009, the ACSM extended these guidelines by publishing an evidenced-based position stand (10). The basic elements of ACSM RT guidelines were discussed in Chapter 14. ACSM recommendations for advanced RT are presented in Table 18.1. The Personal Trainer can use these recommendations when prescribing the client exercise selection, sequence, intensity, volume, muscle actions, rest intervals, frequency, and lifting velocity. There are many effective progression structures for multiple-set programs. These may include constant load/repetition (keeping load and repetition number the same for each set), heavy to light (decreasing weight each set while maintaining or increasing repetition number), light to heavy (increasing weight each set while maintaining or decreasing repetition number), and undulating (integrated) systems (5,11). Thus, it is up to the personal preference of the Personal Trainer and client as to which one or combination of systems will be used.

Table 18.1 American College of Sports Medicine Recommendations for Advanced Resistance Training (8,10)

	Muscle Strength	Hypertrophy	Muscle Endurance	Power
Muscle action	CON, ECC, and ISOM	CON, ECC, and ISOM	CON, ECC, and ISOM	CON, ECC, and ISOM
Intensity and repetitions	Cyclical rotation of loads of 80%–100% of 1-RM	A loading range of 70%–100% of 1-RM used for 1–12 repetitions	Various loading strategies (10–25 repetitions or more) in	Moderately heavy loading (75%–85% of 1-RM) for 1–3

		per set in periodized manner such that the majority of training is devoted to 6–12 RM and less training devoted to 1–6 RM loading.	periodized manner	repetitions per set in a periodized manner for ↑ force, light to moderate loading (30%–60% of 1-RM for upper body exercises, 0%–60% of 1-RM for lower body exercises) for 3–6 repetitions per set in a periodized manner for ↑ RFD; performed explosively
No. of sets per exercise	Multiple sets (3–6)	Multiple sets (3–6)	Multiple sets (3–6)	Multiple sets (3–6)
Exercises	Unilateral and bilateral single- and multiple-joint exercises should be included with emphasis on multiple-joint exercises. Emphasis should be placed on free-weight exercises with machine exercises used to compliment program needs.	Unilateral and bilateral single- and multiple-joint free-weight and machine exercises	Unilateral and bilateral multiple- and single-joint free-weights and machine exercises	Unilateral and bilateral multiple-joint free-weight exercises
Exercise order	Large muscle group exercises before small muscle group exercises, multiple-joint exercises before	Large muscle group exercises before small muscle group exercises, multiple-joint exercises before	Various sequencing combinations	Similar to strength training

	single-joint exercises, higher intensity exercises before lower intensity exercises, or rotation of upper and lower body or opposing exercises	single-joint exercises, higher intensity exercises before lower intensity exercises, or rotation of upper and lower body or opposing exercises		
Rest intervals	At least 3–4 min for structural exercises using heavier loads. For assistance exercises, a shorter rest period length of 2–3 min may suffice.	Correspond to goals of each exercise: 2–3 min may be used with heavy loading for structural exercises, and 1–2 min may be used for other exercises of moderate to moderately high intensity.	Short rest periods, for example, 1–2 min for high-repetition sets (15–20 repetitions or more), <1 min for moderate (10–15 repetitions) sets. For circuit training, rest periods should correspond to time needed to get from one exercise to another.	At least 2–3 min for structural exercises when intensity is high; shorter rest interval (1–2 min) for assistance exercises
Repetition velocity	A continuum of velocities from unintentionally slow to fast CON velocities; should correspond to the intensity	Slow, moderate, and fast repetition velocities depending on the load, repetition number, and goals of the exercise	Intentionally slow with moderate repetition number (10–15); moderate to faster with large number of repetitions (15–25 or more)	Fast
Frequency	4–6 $d \cdot wk^{-1}$	4–6 $d \cdot wk^{-1}$	4–6 $d \cdot wk^{-1}$	4–5 $d \cdot wk^{-1}$

↑, increased; RFD, rate of force development.

The Personal Trainer can use ACSM recommendations for advanced RT when prescribing the client exercise selection, sequence, intensity, volume, muscle actions, rest intervals, frequency, and lifting velocity.

Key elements of advanced RT involve the planning of training and potential use of advanced techniques. Advanced RT involves periodization of the acute program variables, primarily the volume, intensity, and exercise selection. Training phases target different fitness components and the volume and intensity, especially for the critical structural exercises, should be prescribed accordingly. The Personal Trainer may assess the client's RT progress periodically via one repetition maximum (1-RM) testing (see Chapter 12) or multiple repetition maximum (RM) testing. Multiple RM testing involves lifting a weight multiple times and then doing some mathematical calculations to estimate 1-RM (see ACSM [5] for a list of commonly used equations). Common exercises assessed include the bench press, squat, deadlift, and power clean, although any exercise can be assessed depending on program priorities. Multiple RMs can be assessed and used for testing high-intensity muscle endurance or can be used to predict 1-RM strength (5,12). Periodic strength testing (~3 mo or more) not only can be used to measure progress but also is instrumental for determining training loads for some structural exercises that are prescribed based on a percentage of 1-RM. In addition, advanced RT techniques provide additional overload and can assist advanced clients in overcoming training plateaus (5). Although intermediate clients can benefit from their use, they are best reserved for advanced trainees.

Advanced Resistance Training Techniques

Advanced RT techniques are based on program variables and exercise range of motion (ROM). Techniques discussed in this chapter include eccentric (ECC) emphasis training, functional isometrics (ISOM), partial repetitions, variable resistance, forced repetitions, breakdown sets, combining exercises, discontinuous sets, quality training, and spectrum repetition/contrast loading combinations.

> Techniques discussed in this chapter include ECC emphasis training, functional ISOM, partial repetitions, variable resistance, forced repetitions, breakdown sets, combining exercises, discontinuous sets, quality training, and spectrum repetition/contrast loading combinations.

Eccentric Emphasis Training

ECC emphasis training targets the ECC phase of movement. Tempo ECC training uses a slow cadence (>3–4 s) during the ECC phase with heavy to supramaximal loading in the presence of capable spotters or a power rack with the pins set at appropriate height for safety. The concentric (CON) phase is performed with assistance from spotters. Alternately, variations include performing a bilateral exercise with a moderate weight (CON phase) and then performing the ECC phase with only one limb and/or using a machine with multiple loading capacities that enable greater ECC loading. Repetitions during traditional sets can be enhanced with additional force applied during the ECC phase via the Personal Trainer or weight releasers that are removed from the bar (*e.g.*, during bench press or squat) just prior to the start of the CON phase (13). ECC emphasis training should be used with caution (no more than 4- to 6-wk training cycles, one or two times per year) to reduce muscle damage and the risk of overtraining and/or injury. To perform ECC emphasis training in a less focused manner so it can be spread throughout the training year, for example, in a workout, the client may perform three or four sets of the bench press and then perform one or two additional sets of heavy negatives for two or three repetitions (5). This is a technique used in advanced strength and hypertrophy training (3).

Functional Isometrics

Functional ISOM involve lifting a barbell in a power rack a few inches until it is pressed or pulled against the rack's pins (3). The client continues to push/pull maximally for ~2–6 seconds with a high rate of force development. The rack's pins are set in two places (when not beginning from the floor): at the starting position and at the targeted area of the ROM. Because skeletal muscles produce more force during ISOM actions, the rationale is to target specific areas of the ROM to increase dynamic strength to a greater extent. Although there is no strong evidence for improvements in overall dynamic strength with an ISOM training program, there is a body of evidence that indicates that static strength increases from ISOM training are joint-angle specific (3). However, functional ISOM can be performed in multiple areas of the ROM but are most effective when performed near the sticking region (or weak point) of the exercise (5,11). For example, the client may set the pins slightly above the parallel position for the barbell squat and perform three to five sets of three to five repetitions with a moderate load. Some commonly targeted exercises are the bench press, deadlift, squat, and clean pull, and this type of training can be easily integrated into an RT program.

Partial Repetitions

Partial repetitions are performed in a limited ROM with the intent to enhance ROM-specific strength and potentially full exercise ROM strength. Most often, the repetitions are performed in either the area of maximal strength or near the sticking point. Partial repetitions can be used in different ways. Some clients may use them for hypertrophy and muscle endurance enhancement by extending sets beyond exhaustion when a full ROM repetition can no longer be performed unassisted. Some athletes (mostly bodybuilders) have integrated partial repetitions into dynamic sets with full ROM repetitions. Often, partial repetitions are performed in the area of maximal strength with heavy to supramaximal loading. Strength expression varies throughout the ROM, yielding differently shaped curves depending on the biomechanical characteristics of the movement (see Fig. 14.3). For an exercise like the bench press, maximal force is produced near the lockout phase. Supramaximal loads may be lifted in this ROM (14). Strength athletes such as power lifters may benefit from including partial ROM lifts into strength peaking mesocycles. Often, one to three sets of partial repetitions are performed following completion of the full ROM exercise. For example, the client may perform four sets of traditional squats followed by one to three sets of partial squats. A power rack is recommended because the pins prevent bar movement below the inferior segment of the lift.

Variable Resistance Training

Variable resistance training (VRT) is performed by altering the loading throughout the ROM. Common ways for clients to perform VRT are through specific machines, elastic bands, or by altering free-weight exercises via bands and/or chains. The latter is more often seen in advanced RT of strength and power athletes. Variable resistance machines modify loading via cams that vary in length and change the mechanics based on the various types of strength curves. Bands and chains can be added to barbells to create free-weight VRT (5). Bands and chains come in different sizes and provide a variety of resistance levels, and exercises such as the bench press and squat are commonly used. Chains are applied to both ends of the bar while it is in the racked position with much of the chain links suspended in the air. Upon liftoff, the client supports the majority of chain weight. As the bar descends, more chain links are supported by the floor, thereby reducing the load. Upon ascent of the bar, progressively more loading is encountered as the chain links are lifted from the floor. Loading depends on the weight and size (5–7 ft) of the chain and the distance of the bar from the floor. Chains oscillate, which increases the stabilization requirement. A similar effect is gained through elastic bands attached to the floor (or rack) and bar (with less oscillation). The farther the band is stretched, the more resistance applied to the bar.

Forced Repetitions

Forced repetitions are those completed with the assistance of a spotter or via self-spotting (for exercises like the leg press or unilateral arm exercises) beyond one's normal capacity. The rationale is to extend a set beyond failure with hopes of providing greater increases in muscle strength, endurance, and hypertrophy (3,5). The Personal Trainer should apply minimal assistance allowing up to approximately one to four repetitions. Forced repetitions can be used exclusively as a set with heavy to supramaximal loading or can be used to extend a set when failure has occurred. As a result, forced repetitions elicit higher levels of fatigue than traditional repetitions. Although forced repetitions are used in novice and intermediate RT, they are best used for advanced training because they provide a potent neuromuscular stimulus and need to be used with caution.

Contrast Loading

Contrast loading involves inclusion of low, moderate, and high repetitions (with concomitant changes in loading) within a session. Heavy weights are usually lifted first followed by light/moderate weights, or are alternated. For example, a client may perform six sets of an exercise. The first two sets may be performed with heavy weights for five repetitions, the next two sets may be performed with moderate weights for 10 repetitions, and the last two sets may be performed with light weights for 20 repetitions. Multiple fitness components are stressed. The goal is to recruit as many muscle fibers as possible with heavy weights and then stimulate circulatory/metabolic growth factors with low to moderate weight and high repetitions (5). This technique is used mostly by bodybuilders to increase muscle hypertrophy.

Breakdown Sets

Breakdown (or descending) sets involve a rapid reduction in weight with minimal rest thereby allowing the client to extend a set by performing additional repetitions. The rationale is when failure occurs, there is still potential to perform more repetitions beyond fatigue with less weight. Single or multiple breakdowns may be used and are most effective when a spotter or the Personal Trainer is present to remove weights or change pins on machine weight stacks quickly (11). Breakdown sets are traditionally used to enhance muscle hypertrophy and endurance. However, breakdown sets can be used to target muscle strength if a heavy weight is lifted for a few repetitions, and then 5%–10% of the load is reduced, allowing one to two additional repetitions are performed until the targeted number of repetitions are completed.

Combining Exercises

Combining exercises involves performing two or more exercises consecutively or simultaneously with minimal rest and are primarily used for increasing muscular endurance and hypertrophy, especially if the client is attempting to minimize workout duration. Muscle strength can increase, but it is a secondary goal as the weight lifted for each exercise is less than what would typically be used if the exercise was performed alone (and dependent on the weakest of the exercises). The metabolic demands of a workout can be greater when combination exercises are used due to the longer duration of each set and the potential for greater workout continuity (5). For example, multiple exercises can be combined to form a single exercise (combination lifts). This is common when using Olympic lifts (*e.g.*, a clean from the floor, a front squat, and a push press to finish for a series of repetitions) and traditional exercises. Combination exercises such as the lunge with rotation, dumbbell squat with shoulder press, and the burpee with push-up, to name a few, have become popular in recent years especially when included in metabolic circuit programs that have increased in popularity. It is important for the Personal Trainer to select a weight that can be tolerated for the weakest of the exercises in sequence when nonbody weight exercises are performed.

Another strategy is to perform all repetitions for one exercise followed by consecutive performance of one or more exercises with minimal rest in between exercises. Because the client is performing exercises in succession, weights can be selected that match each exercise. These include (a) supersets (consecutive performance of two exercises either for the same or different muscle groups), (b) tri-sets (consecutive performance of three exercises), and giant sets (consecutive performance of four or more exercises separate from circuit training). Often, bodybuilders use supersets, tri-sets, and giant sets of exercises that stress similar muscle groups. Some strength athletes use supersets to increase muscle strength but do so using exercises that stress opposing or unrelated muscle groups in order to allow adequate recovery with use of heavier weights.

Quality Training

Quality training involves reducing rest interval lengths within specific loading/volume parameters as training progresses. Although mostly used to increase muscle endurance and hypertrophy, recent evidence shows it can be used for strength increases (15). For example, a client currently training the squat for four sets of 10 repetitions with a particular load with 2.5 minutes in between sets may gradually reduce rest intervals by 10–20 seconds on a weekly or biweekly basis until a targeted value (*e.g.*, 1.5 min) is reached and performance is maintained. Subsequently, the client may add weight, increase rest interval length, and begin the process once again.

Discontinuous Sets

Sets that include rest intervals in between repetitions are discontinuous sets. The goal is to increase the quality of effort for each repetition by maximizing acute force and power output. Peak force and velocity decrease because a continuous set is prolonged. Including an intra-set rest interval may limit fatigue and increase repetition quality. Inserting a rest interval in between repetitions (inter-repetition) results in more repetitions performed and higher force/power output (16). One variation, *rest-pause training*, allows more repetitions to be performed with maximal or near-maximal weights. For example, a client may target five repetitions with a 3-RM load. The client performs three repetitions without assistance, racks the weight, and rests for 10–15 seconds. The client then proceeds to perform one additional repetition with the same load, rests for 10–20 seconds, and performs one additional repetition totaling five altogether. The length of the rest interval, volume, and resistance can be altered depending on the goals of the set. A variation used by some elite power lifters is the *dynamic method*. The way this method has been commonly used is by having the individual perform 8–10 sets of a structural exercise for two or three explosive repetitions with moderate loading (~60% of 1-RM) with 45 seconds to 1 minute rest in between sets. Although the repetitions are performed consecutively, the large set number coupled with substantial rest illustrates a variation of rest-pause training. The use of multiple repetitions is advantageous for those lifters who attain peak force or power on the second or third repetition rather than the first. A variation used successfully by Olympic weightlifters is *cluster training*. Typically, 10–45 seconds rest intervals are used in between repetitions of the Olympic lifts and variations to maximize bar velocity and power. Cluster sets can be structured in different ways. The load can be kept constant for all repetitions, or can be increased, decreased, or undulated.

Motion-Specific Training

Motion-specific training, also known as functional training, involves the use of exercises that train specific movements. Motion-specific training involves adding resistance to movements, many of which stress the entire body or core musculature to a large extent. The intent is to improve athletic performance, balance, and coordination and to provide a link between strength gained through traditional RT and motion-specific strength. Exercises consist of multiplanar movements sometimes performed in unstable environments with various pieces of equipment such as bands, medicine balls, dumbbells, stability balls, kettle bells, ropes, TRX (for suspension training), and other devices. Exercises performed in unstable environments often require that the client use less loading. The goal is to increase primarily core (stabilizer) muscle strength and not the prime movers per se (although there could be a secondary strength-building effect). For example, a client will be able to use heavier dumbbells when performing the bench press on a flat bench (*e.g.*, stable environment) versus a stability ball (*e.g.*, unstable environment). The flat bench press will have a better strength-building effect for upper body musculature, whereas the stability ball bench press will have a stronger core component. Thus, unstable motion-specific training is best used when integrated into traditional RT programs. The combination can be used to optimize performance.

A staple of motion-specific training is the use of body weight exercises. Exercises such as body weight squats, lunges, push-ups, pull-ups, dips, reverse dips, sit-ups, crunches, leg raises, burpees, and hyperextensions all require the client to overcome one's body weight. In the absence of adding external weight, body weight exercises can be made more difficult by changing grip/stance width, leverage (moment arm of resistance), or cadence or by using unilateral versus bilateral contractions (one rather than two arms or legs). Basic knowledge of biomechanics is critical for the Personal Trainer to make exercises easier or more difficult in the absence of adding external resistance (5). Increasing the moment arm of resistance, size of the base support, amount of weight supported by musculature, and the center of gravity (COG) can change exercise difficulty dramatically (see Chapter 4 for more information on biomechanics). The push-up is a good example. It can be made easier by performing it on the knees (*modified push-up*) or more difficult by staggering hand spacing or by performing it with one leg in motion while suspended in the air (a *Spiderman push-up*). Performing a back extension or sit-up is more difficult with the hands overhead than crossed at chest level. Difficulty is increased by adding a rotation or unilateral (vs. central) loading. Some body weight exercises are extremely difficult and performed mostly by advanced clients. Exercises such as one-arm push-ups, single-leg squats, and single-arm pull-ups are difficult for many. An exercise such as the pull-up press requires a great deal of strength. The client presses the body outward from the top pull-up position (with a wide pronated grip). Athletes such as gymnasts who train against body weight possess high levels of muscle strength and power.

> Basic knowledge of biomechanics is critical for the Personal Trainer to make exercises easier or more difficult in the absence of adding external resistance.

Body weight training is aided by devices, which allow body weight to be manipulated. For example, the TRX Suspension Trainer consists of two straps with adjustable handles and foot attachments that can be suspended or anchored from the ceiling, a door, beams, or a power rack (Fig. 18.1). It is based on a pendulum system where manipulation of the client's body position (distance from anchor, body angle relative to floor, height of the starting position and COG, and size of base support) dictates the percentage of body weight that needs to be overcome. For example, the more upright the body (feet back), the easier the exercise is (less weight to support) for some upper body exercises. The closer to the ground (feet closer to anchor), the more difficult the exercise is because a larger percentage of body weight must be overcome. Advanced clients benefit greatly from body weight training as does a beginner.

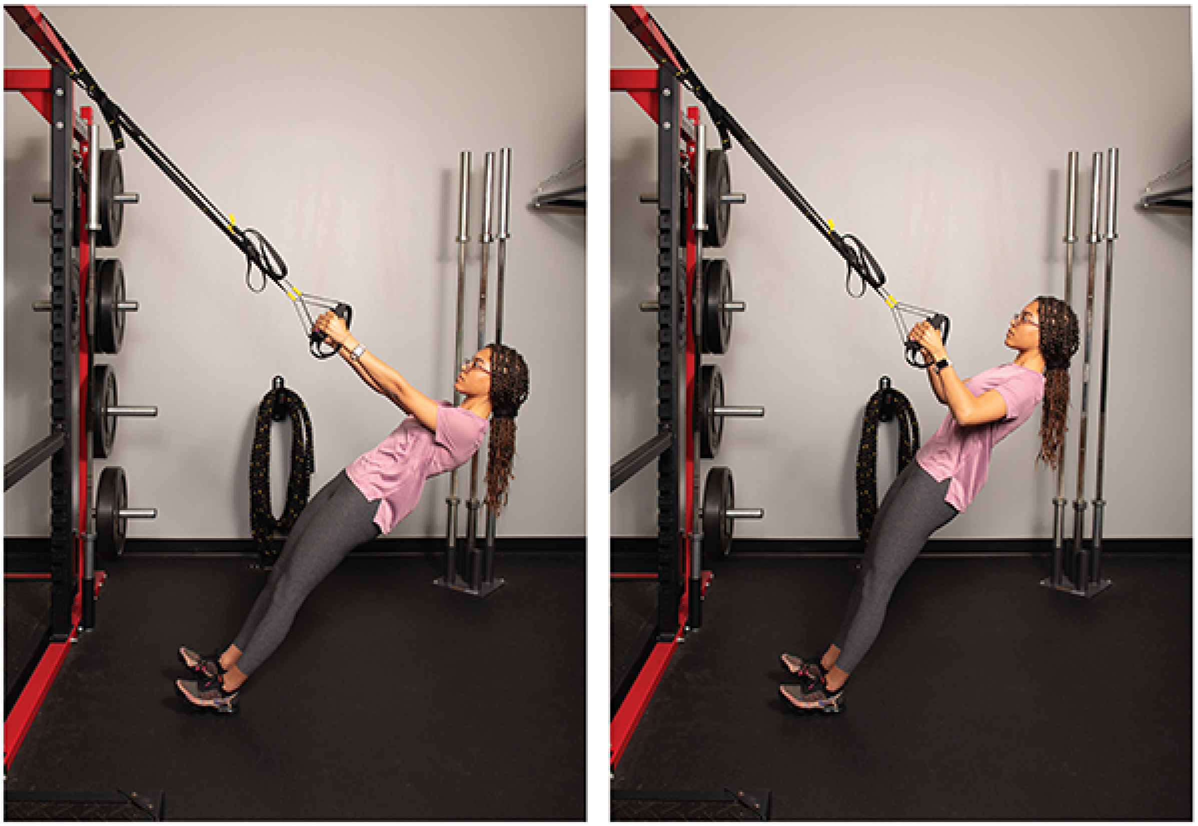

FIGURE 18.1. TRX inverted row.

Strength Implements

By definition, RT entails any method or form of exercise requiring the client to exert a force against a resistance. The source of the resistance may vary greatly. Although most advanced RT programs target free weights and machines, the use of other sources of resistance including body weight, medicine balls, movement-specific devices, bands/cables, and strength implements has increased in popularity among advanced trainees. Implements provide a different stress to the client than free weights because many implements provide unbalanced resistance and the gripping may be more difficult. Some exercises with implements cannot be replicated similarly with free weights. Table 18.2 presents some popular implements used in advanced strength and conditioning programs (see ACSM [5] for additional information).

Table 18.2 Examples of Strength Implements Used in Resistance Training

Implement	Characteristics
KB	Weights with superior handle location; enhance grip strength due to thicker handles and leverage changes as KB moves; handle allows KB to swing freely; grasped off of COG due to position of handle
Sleds	Resist linear movements; provide strong stimulus to all major muscle groups, ↑ metabolic challenge; can be loaded with weights for pushing or pulling (with a harness); some sleds have multiple handles, which allow pushing from low and high body positions; automobiles and trucks have been used in a similar manner.
Kegs	Fluid (or sand)-filled drums; great balance requirement as fluid moves when kegs are lifted; require strong grip to hold in stable positions during lifting
Log bars	Have a midrange grip support for lifting with a semipronated forearm position; some are filled with water to add resistance and balance requirements; vary in length based on strength level
Farmer's walk bars	Allows grasping of heavy weights and walk/run for a specified distance; great for grip strength/endurance training and total-body strength and conditioning
Thick bars	Bars with large diameters (2, 2¾, 3 in); used for grip strength training (17)
Super yoke	Device ~6 ft in length with a bar that is placed on rear shoulders supported by two beams that are loaded with weights; lifter must control yoke from swaying so ↑ balance requirement.
Sledge hammers	Used for striking drills on tires; can be made more difficult by grasping the hammer closer to end of handle or more explosive by grasping the hammer closer to the head for speed and power
Tires	From trucks and heavy equipment for flipping; involves triple extension of hips, knees, and ankles for total-body strength, power, and conditioning
Stones	Lifted from the ground to various heights for total-body strength, power, and endurance; adjustable stands may be used for loading stones
Sandbags	Bags of sand for lifting; some have handles making it easier to grasp and expands exercise selection; provides unbalanced resistance
Heavy bags	Punching bags used for exercises in addition to striking; can be thrown or lifted in multiple directions
Battling ropes	Ropes of various length and width used for various exercises during metabolic training
Chains	Added to BBs to provide variable resistance for multiple-joint exercises with ascending strength curves; oscillate during motion which increases stability requirement; can be used solely as a source of resistance

↑, increased; KB, kettle bell; BB, barbell.

Adapted with permission from 2018 Physical Activity Guidelines Advisory Committee. *2018 Physical Activity Guidelines Advisory Committee Scientific Report*. Washington (DC): U.S. Department of Health and Human Services; 2018. 779 p; American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2022. 548 p.

Olympic Lifts

The Olympic lifts (snatch, clean, and jerk) and several variations are total-body resistance exercises that recruit most major muscle groups. They are the most complex resistance exercises to perform and are considered the most effective exercises for increasing total-body power (3). Because of the complexity of these lifts, Personal Trainers should have advanced training and instruction before using with clients. Repetitions are performed with fast movements of the lower body and trunk (as the arms serve as guides and assist the client in preparation for catching the bar) and the kinetics closely resemble jumping and several motor skills comprising many anaerobic sports. The *clean and jerk* is a two-staged exercise where the lifter moves the bar from the floor to shoulder level and then to an overhead position. Although the clean and jerk is part of competition in the sport of weightlifting, the power clean is more commonly used with athletes in other sports and with more advanced clientele who wish to progress further in their training for strength and power (Fig. 18.2). The power clean is performed with less weight than the clean, so movement velocity is higher, and the jerk stage of the movement is not performed. This exercise results in larger amounts of weight lifted compared with the *snatch*, which involves lifting the weight directly from the floor to an overhead position (Fig. 18.3). The snatch is considered more complex because the bar must be lifted a greater distance directly from the floor. Variations (*e.g.*, overhead squat, hang clean/snatch, Romanian deadlift, high pull) are related exercises that enhance specific performance aspects of the complete lift and are used for strength and power enhancement because several require fast force production and teach proper kinesthetic awareness needed to apply maximal force to the ground. Often, these exercises are taught in progressions starting with the clean and later the snatch because they are similar in movement during some phases. Olympic lifts should be performed on a wooden platform with bumper plates. However, some facilities may not have platforms, so modifications can be made to create adequate space, and the use of a matted surface may suffice. It is important to teach the client how to properly drop the weights when learning the Olympic lifts. Poor technique in these movements can do more harm to the client if the movements are continued erroneously, so it is safer to drop the bar in a controlled manner. Lastly, the Olympic lifts are ideally performed using a *hook grip*. The hook grip involves wrapping the thumb around the bar and then wrapping the first three fingers around the thumb and bar for added support. A strong grip is necessary, and this configuration allows for greater support during fast pulling movements. Although effective for grip support, the hook grip is uncomfortable and may take some time for the client to adjust to the technique.

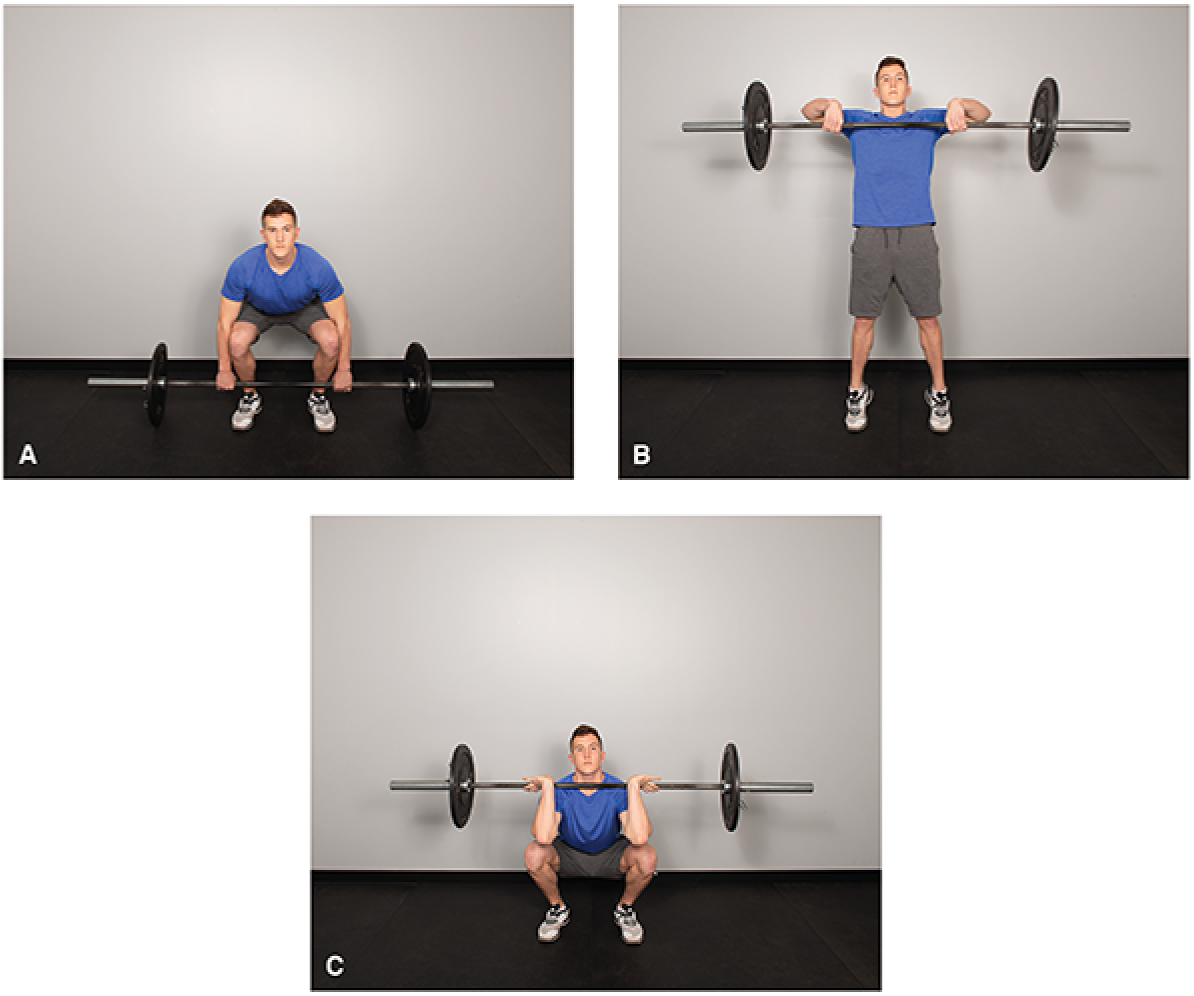

FIGURE 18.2. The power clean. **A.** The starting position. **B.** The second pull phase. **C.** The final position after catch when the client descends with the bar into the full front squat position.

FIGURE 18.3. The snatch. **A.** The starting position. **B.** The second pull phase. **C.** The catch position where the client descends into the full overhead squat position.

Because of the complexity of these lifts, Personal Trainers should have advanced training and instruction before using with clients.

Technical Aspects of Performing the Olympic Lifts

The Olympic lifts are technically challenging resistance exercises. Discussion of proper technique is best summarized by dissecting the lifts into phases. Because the clean and snatch have some similarities, they will be discussed together and their differences will be highlighted. The phases include the starting position, the first pull (barbell is pulled from the floor), a transition phase prior to the second pull, the second pull, the catch, and the finish. Boxes 18.2 and 18.3 discuss technical aspects of each of the phases of the clean and jerk and snatch exercises.

Box 18.2 Technical Aspects of Performing the Clean and Snatch

Phase	Correct Performance
Starting position	■ Feet are placed at hip width, toes pointed slightly outward, and bar is located on the floor near the shins. ■ Hips and trunk are flexed to an angle of 25°–50° with the ground, with the hips positioned close to or slightly above the knees. ■ Trunk is more upright and hips are higher during the clean because of the narrower grip width compared with the snatch. ■ Shoulders are positioned directly over or slightly in front of bar with the COG over the middle of the foot. ■ Low back is kept flat by hyperextending the lumbar spine and retracting the shoulder girdle. ■ Head is straight or slightly upward and arms grasp bar with elbows extended out and wrists flexed. ■ Wide grip width is used for snatch and shoulder width grip is used for clean. ■ Snatch grip width may be determined by having the individual stand and abduct one arm laterally (to where it is parallel to the ground) while making a fist and measuring the length of the opposite shoulder to the fist (the length represents the snatch width) — the bar should be ~4–6 in above the head during the overhead squat.
First pull	■ Bar is pulled toward the body (4–12 cm for the snatch; 3–10 cm for the clean) and is lifted off of ground to ~31% of height for the clean and ~35% for the snatch. ■ Mostly knee extension and plantarflexion with little change in trunk angle and COG shift toward heels

	(knee angle slightly greater for snatch than clean). ▪ Elbows remain extended, shoulders move in front of bar, and trunk angle may slightly increase by end of phase. ▪ Phase lasts ~0.50 s — bar is lifted ~1.5 m · s^{-1} for snatch and ~1.2 m · s^{-1} for clean.
Transition	▪ Adjustment phase characterized by unweighting ▪ Knee flexion (double knee bend) with an increase in trunk extension ▪ Bar reaches lower third of thigh for clean and middle of thigh for snatch. ▪ Postural realignment (vertical torso) occurs allowing a second pull to maximize force and power.
Second pull	▪ Bar is pulled upward and slightly away from body by extension of hips, knees, and ankles. ▪ Elbows remain extended throughout. ▪ Force applied to bar decreases at top as lifter prepares to pull under the bar for the catch. ▪ Most explosive phase takes ~0.1–0.25 s with snatch requiring more time than clean. ▪ Bar velocities for snatch are ~10%–20% higher than the clean. ▪ Optimal bar trajectory (S-shaped pattern): (a) bar is pulled toward body during first pull, (b) bar is pulled slightly away from body during second pull, and (c) bar moves closer to body in preparation for catch.
Catch	▪ Involves optimal positioning to catch the bar after second pull while bar is rising ▪ Lifter pulls bar to max height (68%–78% of height for snatch, 55%–65% of height for clean) and descends underneath simultaneously.

- For the snatch: Feet move out into a squatting position (wider than hip width).
- Arms pull body under bar while feet are moving.
- Elbows are wide, trunk is upright, wrists turnover, and bar rotates.
- Throughout descent lifter applies force to bar to support weight in full squat position.
- Lifter flexes shoulders, pushes head forward, and extends hips into an overhead squat finish.
- For the clean: Feet move out into squat position.
- Lifter pulls body down forcefully and receives bar at shoulder position.
- During foot landing, wrists rotate around bar, elbows push forward and upward creating a shelf to catch weight.
- Bar is caught on shoulders and chest — loading forces lifter down into a deeper front squat position.
- Upper arms are parallel to ground, knees are over feet, and lifter completes lift with a front squat.

Box 18.3 Technical Aspects of Performing the Jerk

Phase	Correct Performance
Starting position	■ Movement is initiated from the front squat position. ■ Hips and shoulders are aligned over the rear segment of the middle of the foot. ■ Feet are hip width with toes slightly pointed outward, head slightly back, and upper arms nearly parallel to floor, with elbows in front of the bar.
Descent	■ A countermovement is performed before the upward explosive thrust. ■ Knees flex and ankles dorsiflex in a vertical manner with COG shifting slightly forward. ■ Duration is ~0.20–0.25 s.
Braking	■ Transition between the end of final third of countermovement and beginning of thrust takes ~0.12 s. ■ With descent, horizontal bar displacement should be minimal (<2–4 cm).
Thrust	■ Explosive extension of hips, knees, and ankles drives the bar vertically upward with bar velocities of 1.2–1.8 $m \cdot s^{-1}$. ■ Final part of movement is brought about by forceful pushing of bar by arms to help with driving under the bar.
Split	■ Most common position, although some prefer the squat when driving under the bar. ■ One hip flexes (front) and other extends (back) to form a stable base; the back leg lands before the front leg as feet leave the ground (taking ~0.20–0.28 s).

	■ Back leg is nearly straight (~2-ft length from hip) and front knee flexes to >90° with shin perpendicular to floor (1-ft length in front of hip). ■ Bar is positioned slightly behind lifter’s head in line with shoulders and hips, head is forward, and back is hyperextended.
Finish	■ Weight is transferred to rear foot as front leg pushes backward.

Performance of the Olympic lifts can be augmented by inclusion of several skill transfer exercises and variations. Some multiple-joint basic strength exercises enhance one or more phases of the Olympic lifts. For example, the deadlift, back squat, behind-the-neck press, and good morning are exercises that strengthen large muscles (*e.g.*, ankle, knee, and hip extensors, shoulder and elbow extensors) involved in the Olympic lifts, emphasize proper body position, and improve kinetics in a manner that may transfer to Olympic lift performance. Exercises such as the front squat, overhead squat, and Romanian deadlift offer similar benefits and teach the client proper kinesthetic awareness and balance. Teaching the second pull during the clean and snatch may involve performing the high pull exercise (wide grip for snatch, shoulder width grip for clean) from above the knee, below the knee, and from the floor. This allows the client to perform the pull rapidly from various levels without having to adjust body position for the catch. Some coaches and Personal Trainers begin these variations from the hang position. Many Olympic weightlifters perform variations known as the stop clean or stop snatch where the bar is lowered to the proper depth from the standing position and then subsequently lifted with high power output. Progression may continue to the catch and finish phases. Exercises such as the pressing snatch balance and heaving snatch balance teach descent under the bar for the snatch. The top position can be taught by progressing from the behind-the-neck press (snatch grip) to the overhead squat to the snatch balance. The first exercise teaches proper overhead proprioception. The second teaches the lifter to descend/ascend (squat) with the bar overhead. The third requires the lifter to descend into the overhead squat position rather than begin with it.

The primary goal of performing the Olympic lifts is to increase muscle power, speed, and strength. Multiple sets of the Olympic lifts are performed at maximal velocity for usually one to three repetitions at the beginning of a training session. Intensity varies depending on the training phase. Heavy weights may be used during strength and power peaking phases and moderate to moderately heavy loads for other training phases. Peak power is produced at ~70% of 1-RM (18) so loading should encompass this intensity, in part, for advanced power training. Because of the need for high rate of force development and the exercise complexity, Olympic lifts should be performed early in a workout when fatigue is minimal. When multiple Olympic lifts and/or variations are performed, sequencing is based on complexity where the snatch takes precedence over the clean, both take precedence over the jerk, and variations are sequenced based on bar movement (*i.e.*, greater bar displacement means greater complexity and need for high velocity). For example, a hang clean would be performed before a high pull and a snatch below the knee would be performed before a snatch above the knee. Variations (skill transfer exercises) are performed after the full Olympic lifts in sequence. The frequency of Olympic lift inclusion in advanced training varies between 1 and 5 $d \cdot wk^{-1}$. Among Olympic weightlifters, frequencies as high as 18 $workouts \cdot wk^{-1}$ have been reported (19) with multiple short sessions per day. Box 18.4 depicts a sample program integrating multiple Olympic lifts focusing on the barbell snatch.

Box 18.4 Sample Workout Emphasizing the Olympic Lifts

Move	Repetitions	% of 1-RM	Rest Interval (min)
Full snatch	5 × 1–3	75–80	3
Snatch pull	5 × 3	85	3
Overhead squat	4 × 5	70	3
Good morning	3 × 5	85	3
Romanian deadlift (snatch grip)	3 × 5	75–80	3

This type of program may be performed by an Olympic weightlifter or strength/power athlete because it emphasizes total-body power and snatch kinetics and technique. This program consists of five exercises sequenced from most complex to least complex for the Olympic lifts followed by three skill transfer exercises (variations). Each repetition is performed at high velocity for the Olympic lifts. Rest intervals are 3 minutes to allow adequate recovery in between sets.

Plyometric Training

Plyometric training is a form of explosive exercise that targets power development. Historically, plyometric training was known as *shock training* and consisted mostly of depth jumps and variations where the intensity was ultra high (20), but current plyometric training includes lower intensity exercises as well. Plyometric actions encompass the stretch-shortening cycle (SSC) where the lengthening or prestretching of skeletal muscles under loading enables a more forceful CON muscle action. The brief period of time between ECC and CON actions (coupling time) is the *amortization phase*. Minimizing the length of the amortization phase maximizes the use of elastic energy making for a more powerful effort. Although plyometric exercises are classified based on intensity (impact loading and complexity), they are still performed with maximal effort.

Plyometric training increases athletic performance (*e.g.*, jump height and power, sprinting ability, agility, and muscle strength) (21–24). Vertical jump performance may increase an average of 5%–9% (22). Plyometric training is most effective when combined with RT for increasing performance (25,26). For example, plyometric training 2 d · wk^{-1} can easily be integrated with RT. Plyometric training can be performed on separate days from weight training or on the same day. If performed on the same day, plyometric training generally should be given priority and performed first. If only the upper body is resistance trained that day, then lower body plyometrics can be performed at any point in the workout. It is not recommended that high-intensity lower body RT and lower body plyometric training be performed on the same day because the modality trained second would occur in a semifatigued state. Plyometric drills can be incorporated into a weight training workout (*e.g.*, complex training).

Plyometric exercises such as the vertical jump, standing broad jump, and medicine ball pass can be used for maximal power assessment. The maximal vertical jump (performed near a wall or using a commercial device to measure vertical jump) is one of the most common power assessments used for athletes. The higher the jump, the greater the power the client possesses. The standing broad jump is another example of power assessment, testing power during horizontal locomotion. For upper body power, often the medicine ball chest pass (or put) is used. The client is seated (or standing) with his or her back against a support (or wall) and chest passes the ball as far as possible. The farther the ball travels, the greater the power output. The Personal Trainer can easily incorporate these exercises into an assessment battery. Minimal equipment is needed. If the Personal Trainer does not have a commercial device to measure vertical jump, a tape measure can be used for both vertical and standing broad jump drills. Chalk can be used on the finger tips to mark superior position during the highest segment of the vertical jump. A medicine ball, tape measure, chalk, and a bench with back support (for the seated chest pass) are needed for the chest pass. Chalk is placed on the ball and the location is marked (in the center) when the ball lands on the ground.

The distance is measured. Standards are available for the Personal Trainer (5,6) or the individual can develop their own data for comparison.

> The maximal vertical jump (performed near a wall or using a commercial device to measure vertical jump) is one of the most common power assessments used for athletes.

Safety Considerations

Plyometric training is safe for clients of all ages provided it is properly supervised (27). The most common causes of injuries are violation of training guidelines, inadequate warm-up, progressing too fast in volume and intensity, poor technique, poor surface selection, and undisclosed predisposition. Progressing too quickly in volume and intensity could result in overreaching and subsequent of overtraining. Overtrained clients are more susceptible to injury. Inadequate warm-ups fail to prepare the client for intense exercise. Poor technique may limit exercise selection as sufficient coordination, balance, and strength are needed for moderate- to high-intensity plyometric exercises. Improper landing can place the client at greater risk of injury. Caution must be used with large clients. A prior injury or predisposition to injury can place the client at greater risk. Careful monitoring of clients is necessary. An injury may necessitate altering or temporarily discontinuing plyometrics until medical clearance has been obtained.

Plyometric Program Design

Plyometric training variables include exercise selection, order, intensity, volume, frequency, and rest intervals. Designing a plyometric training program is multifactorial and should include planned progressive overload, specificity, and variation. Many factors need to be considered for plyometric training including the age/training status of the client, equipment availability, training surface, recovery in between workouts, nutrition, and the integration of plyometrics with other training modalities. Some critical factors include the following:

- Each repetition should be performed with maximal effort, minimal amortization, and maximal velocity.
- Exercise selection should be as specific to the demands of the sport/activity as possible, comprising unilateral and bilateral drills.
- Plyometric training should take place in an area with sufficient space; for example, a horizontal length of at least 30–40 yards and ceiling height (indoors) should be higher than maximal reach.
- Proper technique should always be instructed.
- Sufficient rest should be given when peak power is the goal.
- Gradual progression with increases in intensity via the addition of complex exercises and some external loading. Low- and moderate-intensity drills should be mastered before progressing to high-intensity drills.
- Volume can be increased with number of contacts and should be progressed gradually.
- High-intensity workouts require longer recovery period in between workouts.

Plyometric exercises consist of jumps-in-place, standing jumps, multiple hops/jumps, bounding, box drills, depth jumps, and throws, preferably on a grass or matted surface (28). The surface should be yielding to reduce joint stress but not too yielding to limit SSC activity. Jumps involve maximizing vertical or horizontal motion. Hops involve maximizing the repeated motion for a specific distance or pattern. Bounds are exaggerated horizontal drills with excessive stride length. Box drills involve jumping on or off boxes of different sizes. Depth jumps involve accentuating the ECC component by stepping off of a box prior to performing an explosive jump while spending minimal time on the ground. Intensity increases as drop height increases. Drop heights of 20–115 cm can be used (20–40 cm to begin with gradual progression) as the optimal depth jump height is debatable and individualized (5). Tosses and passes involve the upper torso and arms releasing the ball/object below or in front of the head. Throws involve the upper torso and arms releasing the ball or object above, over, or across the head. Some drills can be combined to form a more complex drill, that is, adding a sprint or multidirectional hop/jump to a depth jump.

To a certain extent, selection of plyometric exercises depends on equipment availability. Although plyometrics can be performed without equipment, some pieces of equipment are needed for some exercises. Common pieces of equipment include cones, boxes, jump ropes, mini-hurdles, bands, bags, weighted vests, medicine balls, slam balls, and core balls. Cones, bags, and hurdles are used as barriers for various hops and jumps. Boxes are used for box jumps, depth jumps, and variations. Jump ropes come in various forms and sizes with some designed for speed and some provide resistance. Bands provide resistance to jumping. Weighted vests can be used for additional resistance during plyometric drills. Medicine, core, and slam balls come in various sizes and are used for upper and lower body plyometrics.

Exercises are selected based on the client's training status and intensity. Plyometric programs begin with low- and moderate-intensity exercises for novice clients and progresses to high-intensity exercises over time. The intensity of plyometric exercises depends on several factors including complexity, loading (*e.g.*, body mass, external loading via vests, weights), velocity of impact, speed, and height and length of boxes or barriers used. Jumps-in-place are lowest in intensity, followed by standing jumps, multiple hops and jumps, bounding, box drills, and depth jumps (see Chu [28] for exercise explanations). Single-leg jumps are more intense than comparable double-leg jumps. Intensity is increased by using larger barriers or boxes or by setting cones/barriers farther apart (requiring the client to jump higher or farther). Exercises can be sequenced in numerous ways provided adequate recovery is given in between sets. Some strategies include the following:

- Low-intensity drills can be performed anywhere in the sequence (at the beginning following a warm-up or later in the workout after pertinent moderate- and high-intensity drills).

- Moderate- and high-intensity drills are performed near the beginning (following appropriate warm-up and low-intensity drills) while fatigue is minimal.
- When upper body plyometric drills are included, the client may choose to alternate between lower and upper body drills to maximize workout efficiency.

The volume (number of sets and repetitions) of plyometric training varies and depends on intensity and frequency as well as the impact of other modalities such as RT and sprint/agility training. Plyometric volume and intensity are inversely related. Chu (28) has recommended volume guidelines for plyometric training (refer to the reference for specifics). Plyometric training typically takes place 1–4 $d \cdot wk^{-1}$. High-intensity drills may necessitate a lower frequency when depth jumps are performed, and frequency may be lower when other modalities are included. Because of the intense nature of plyometric training, ~48–72 hours of recovery in between training sessions is recommended (28). Trained clients have greater tolerance and can perform high-intensity drills and a higher volume of exercise. Depth jump training requires fewer sets (two to four) of up to five to eight repetitions with long (2–10 min) rest intervals for 1–3 $d \cdot wk^{-1}$ (20). Lower plyometric volume and frequency is needed when training in-season athletes. Sports consist of plyometric actions, so practice and competition are training stimuli.

Adequate rest intervals are needed during plyometric training. Rest interval lengths are exercise specific and intensity dependent. More rest is needed in between sets of high-intensity exercises (*e.g.*, box jumps, depth jumps) than low- or moderate-intensity exercises (*e.g.*, ankle hops). Work-to-rest ratios of 1:5 (for low- and moderate-intensity exercises) to 1:10 (for high-intensity exercises) are recommended (28). Intra-set rest intervals are used for noncontinuous jumps (*e.g.*, depth jump) or throws. Shorter rest intervals minimize recovery and target power endurance. Box 18.5 depicts a sample plyometric program. This workout trains the entire body and alternates between upper and lower body drills to increase efficiency.

Box 18.5 Sample Plyometric Training Program

General warm-up	3- to 5-min jog
Dynamic ROM drills	1 × 5 drills
Linear sprints	3 × 20 yd (half speed)
Tuck jumps	3 × 10
Medicine ball side throws	3 × 8 (each side)
Barrier jumps	5 × 5
Medicine ball back throws	3 × 5
Single-leg push-off	3 × 6 (each leg)
Plyo push-up	3 × 10
Box jumps	3 × 8
Cool-down	Stretching

Ballistic Resistance Training

Ballistic RT is a plyometric modality aimed at increasing muscle power and strength. Traditional resistance exercises are performed in a full ROM where noticeable deceleration of the load occurs prior to completion of the CON phase. Deceleration is inevitable because the lifting action must then be reversed (*e.g.*, lowering the weight prior to lifting the weight for the next repetition). The length of the deceleration phase depends on the weight and velocity but may comprise more than 50% of the CON phase when lifting weights lower than about 85% of 1-RM (29). However, this deceleration phase limits power development throughout the full ROM. Ballistic RT is designed to minimize deceleration by having the client maximally accelerate the bar throughout the full ROM. Maximal acceleration results in releasing the load (throwing the object) or having the client leave the ground (jump) during a squat-type exercise. Some common ballistic exercises include jump squats, bench press throws, and shoulder press throws. If a linear position transducer is available and attached to the barbell, these exercises may be used to assess peak power in clients (5). Caution must be used because the external load and participant's body weight must be absorbed prior to the next repetition. In lieu of these safety concerns, equipment has been designed using various braking systems to catch or decelerate the weight upon descent. Peak power is produced at loads corresponding to 15%–60% of 1-RM for the jump squat and bench press throw (30), although body weight alone may maximize power output during jump squats (31). Personal Trainers may incorporate ballistic training in various ways. It may be integrated into RT and/or plyometric training workouts. Because of the power component, ballistic exercises are prescribed in a similar manner to Olympic lifts in that they receive priority in sequencing. Loading may vary but tends to be low to moderate to enable fast lifting velocities. Another programming alternative is to use potentiation to enhance ballistic exercise performance. For example, a Personal Trainer may have the client perform three heavy sets of squats followed by three sets of jump squats. The heavy squats can facilitate recruitment of fast-twitch motor units so that in the absence of fatigue, the jump squats could be performed with greater power output. In addition to power development, ballistic RT can increase maximal strength (32,33) and augment maximal strength development for some exercises (34).

> Ballistic RT is a plyometric modality aimed at increasing muscle power and strength.

Speed and Agility Training

Speed and agility are essential athletic components. Speed is the change in distance over time. Maximal speed attainment takes ~20–40 m, so acceleration ability (ability to increase velocity) is a critical training component especially following a change of direction, deceleration, or from a static position. Sprints of at least 60–80 m involve acceleration, maximum speed maintenance, and speed endurance (deceleration). Acceleration is related to the ability to react to a stimulus with a quick first response.

Obtaining and maintaining maximal speed are functions of conditioning. Agility comprises the ability to move rapidly while changing direction in response to a stimulus. Agility is complex and requires the optimal integration of several physiological systems and fitness components. The client must coordinate several movements including the ability to react and start quickly, accelerate, decelerate, move in the proper direction, and maintain the ability to change direction as rapidly as possible while maintaining balance and postural control. The rapid change of direction occurs in a variety of stable or unstable positions (*e.g.*, standing [unilateral or bilateral], lying [prone or supine], seated, and/or kneeling positions).

Speed and agility are essential athletic components.

Sprint speed is the product of stride length and frequency (rate). Stride length is determined by leg length, leg strength and power, and sprinting mechanics. Stride frequency refers to the number of foot contacts per period of time. Maximal sprint speed occurs only at the optimal combination of stride length and frequency, which varies based on a person's physical and biomechanical characteristics. Sprint, plyometric, strength, and ballistic training are the most effective ways to increase stride rate and frequency. An integrated approach is most effective where a combination of plyometric, sprint, flexibility, and RT is used. Sprint training increases acceleration and sprint speed and the combination of sprint and RT enhances maximal speed, speed endurance, power, and strength of the lower body.

Agility requires mobility, coordination, balance, power, SSC efficiency, stabilization, proper technique, strength, flexibility, body control, footwork, a rapid ability to accelerate and decelerate, anticipation, and scanning ability (35,36). Agility training includes multiple modalities including strength and power, sprint, specific agility, balance and coordination, and flexibility. Dynamic balance is needed to control the body when the COG is changing. Stability is greatest when the COG is low, the base support is large, and the line of gravity is centered within the base support. Force production is greatest in stable body positions. Performing an exercise unilaterally instead of bilaterally or narrowing the base support may improve balance. Proper posture, foot contact with the ground, and arm action are needed during agility movements. Agility drills involve multiple movements including linear sprints, backpedaling, side shuffling, drop stepping, cariocas, cutting, pivoting, jumps, and crossovers.

Sprint speed can be assessed using runs at top speed of varying distances (20–60 m). Norms are available for these (6), but the most commonly used test is the 40-yard dash. Most standardized tests of agility are only measuring change of direction over various configurations (T-test, pro-agility test, etc.) but have some usefulness in determining improvements to overall agility.

Sprint and Agility Training Program Design

Sprint and agility training consists of drills aimed at targeting linear speed and multicapacity movement development (35,36). Personal Trainers should constantly monitor correct sprinting technique, and be instructional to clients during agility drills. Clients should touch or run around cones in control, stay close to cones, have correct foot placement, lower the COG, decelerate and accelerate maximally, and have correct posture and approach angles. Cone lengths (and the number of cones) modulate the level of changing direction and pattern of acceleration/deceleration. Close distances force the client to change direction rapidly without large windows of acceleration, whereas large distances enable the client to accelerate over greater lengths, which also creates an opportunity for deceleration management upon changing direction. Drills may be integrated to increase complexity. Agility training can be performed with zero (a lined field) or minimal equipment. The Personal Trainer can expand the client's exercise repertoire by having cones of various sizes, agility ladders, rings and agility dots, reaction balls, bags, tires, mini-hurdles, reaction belts, ropes, and/or agility poles. Speed and agility drills include the following:

- **Form drills:** drills used to improve technique and serve as general warm-up/dynamic ROM exercises such as arm swings, "butt kickers," high knees, ankling, marching, and pawing. Drills are usually performed for one to three sets for 20–30 yards.

- **Linear sprints:** sprints of various length. Short sprints (10–20 yd) are used for improving acceleration, moderate sprints (40–60 yd) are used for improving acceleration and maximal speed, and longer sprints (>60 yd) are used for improving all facets of sprinting especially speed endurance. These sprints are performed with maximal effort. Other variations may be used. For example, a drill called *gears* can be used. The client may sprint for 100 yards and cones could be set every 25 yards. The client runs ~50% intensity the first 25 yards, accelerates and runs faster upon reaching the second and third 25-yard markers, and sprints maximally the last 25 yards. This helps improve acceleration ability from a running start and maximal speed. The drill *falling starts* can be used to improve acceleration from an unstable position. The client leans and falls forward (or can be pushed by a partner), braces, and subsequently sprints forward for the desired distance. Linear sprint drills are the most specific way to increase sprint speed.
- **Overspeed training:** allows the client to attain supramaximal speed (by increasing stride length and frequency) or an assisted speed that is greater than maximal effort. Supramaximal speed can be achieved with a tail wind, downhill running (~1°–7° for ~50 m), towing, and high-speed treadmill running. The supramaximal velocity attained should not exceed a value >10% greater than the client's own ability, or technical breakdowns could occur. Overspeed training is most effective when performed early in the workout where the client's energy levels are high and fatigue is minimal. For towing, elastic tubing (bungee cord, latex tubing) can be used and attached around the client's waist. The opposite end can be attached to another client or a stationary object. The force of the tubing (from stretching) propels the client forward thereby allowing an increase in stride length and frequency. If a stationary object is used, the client can attach the tubing in front, back up several yards, and begin running while being towed by the elastic tubing. The farther the distance, the greater the stretching of the tubing because more force will be applied

to the client. The client may connect the other end of the tubing to another client or the Personal Trainer. The client can attach the tubing in front while the other client doing the towing can attach the other end of the tubing to their rear. The lead client begins sprinting and tows the rear client. Towing can be used for other drills such as backpedaling and side-to-side movements as well.

- **Resisted sprint training:** The client sprints maximally against a resistance. Resistance may come in the form of wind (headwind), sleds, speed chutes, sand, weighted vests, harnesses, partner, stairs, and hills. Sleds are made of steel, have a handle and/or harness attachment, and have posts for plate loading. Loads of up to ~10% of body mass (for sprints of 10–50 yd) are typically used for speed training. A speed chute opens, thereby increasing resistance as the client accelerates. Chutes come in different sizes and provide various levels of resistance especially at higher speeds of motion. Weighted vests are light and durable and have the capacity for external loading (perhaps 10–20 lb or more). They are multipurpose and can be used for plyometric, agility, calisthenics, body weight, and sport-specific exercises. A harness can be used between two clients where the trailing client can provide resistance to the lead client. Enough resistance should be applied to allow the lead client to sprint to ~85%–90% of max speed. Some harnesses have a quick release mechanism, which allows the cord to disengage enabling the lead client to continue sprinting without resistance. These can be used for other modalities besides linear sprinting, for example, backpedaling and lateral movements.
- **Programmed agility drills:** those that are preplanned where the client is aware of the movements prior to beginning the drill. Some examples include the T-drill, square drill, 20-yard shuttle, figure-8 drill, and right triangle drill. There are numerous programmed drills that can be prescribed to a client. Drills should encompass the basic movements of linear sprints, accelerations/decelerations, backpedaling, side and diagonal shuffling, cariocas, cutting, and pivoting.

- **Reactive agility drills:** drills continued based on information from a Personal Trainer or object such as a ball. The client must react to a stimulus. Some examples include box jump with multidirection sprint, partner shadow or mirror drills, slap or tag drills, and drills that involve ball tosses and catching (*e.g.*, the blind partner toss).
- **Quickness agility drills**: drills designed to produce fast movements and quick feet. Some examples include agility ladder drills, pop-up drills (from the ground), down-and-up drills (sprawl in wrestling, burpee), and the resisted let-go. Numerous ladder drills can be prescribed to the client. Some common ladder drills include ins and outs, hopscotch, two-in lateral shuffle, and the side rocker.

Novice sprint and agility programs should focus on proper technique and footwork using basic drills. Basic drills have low levels of footwork complexity and change of directions. Complexity increases intensity. High-intensity agility drills include those with complex movement patterns, multiple directions, involve high rates of acceleration/deceleration, are reactive, and may incorporate some moderate to high plyometric drills in addition to basic agility movements. Similar to other modalities of training, variation of volume and intensity of sprint and agility is more conducive to progression rather than just increasing each over time. Box 18.6 depicts a sample combined sprint and agility workout that is an integrated approach, where both components are trained in a single workout. It is important to note that the Personal Trainer can prescribe and supervise independent sprint and agility workouts. In this case, the format may be similar except each workout comprises all speed or agility drills only.

Box 18.6 Sample Combined Sprint and Agility Workout

General warm-up	3- to 5-min jog
Dynamic ROM drills	1 × 5 drills
High knees	2 × 20 yd
Butt kickers	2 × 20 yd
Backpedals	2 × 20 yd
Side shuffles	2 × 20 yd
Cariocas	2 × 20 yd
Ladder ins and outs	3 repetitions
20-yd shuttle	3 repetitions
Sprints	6 × 40 yd
Flying sprints	3 × 40 yd
Cool-down	Stretching

Anaerobic Conditioning

Anaerobic conditioning is a term that refers to high-intensity muscle endurance capacity (5). It comprises the ability to perform near-maximal to maximal exercise for an extended period of time. Anaerobic conditioning consists of exercises targeting speed, power, and strength endurance. Speed and agility endurance enhancement enables the client to maintain maximal speed and agility performance over time. Speed endurance training is characterized by longer sprints (30–>300 yd for running and swimming but possibly longer distances for cycling) and reduced rest intervals in between sets and repetitions of exercise ranging between 75% and 100% of maximal speed (5). Drills consist of repeated sprints, interval sprints, and relays. Interval training allows the client to train at higher intensities while improving anaerobic and aerobic capacities. Low-intensity bouts of exercise interspersed in between high-intensity bouts allow the client to achieve higher net workout intensity. Intervals using a 1:1 ratio target aerobic capacity, whereas greater work-to-relief ratios (*e.g.*, 1:5 or 1:10) target anaerobic conditioning (adenosine triphosphate-phosphocreatine [ATP-PC] and glycolysis energy systems; for more information on energy systems, see Chapter 5). Agility and plyometric drills can be used in standard set format (high repetitions, moderate set duration with rest intervals) or in circuit training format. For speed endurance training involving low- to moderate-intensity drills for moderate distances, 8–20 repetitions have been recommended for advanced clients and 5–12 for novice clients (5). For speed endurance training involving high-intensity drills for short to moderate distances, 4–12 repetitions have been recommended for advanced clients and 4–8 for novice clients (5).

Anaerobic conditioning can also be improved by inclusion of weight training, body weight, or implement training. Circuits allow the client to perform several exercises in a short period of time yielding substantial metabolic and cardiovascular responses that could improve aerobic capacity as well. Circuit progression entails increasing the load, repetitions, duration or length of drill, and reducing the total time needed to complete the entire circuit (*e.g.*, *timed circuits*). Timed circuits are beneficial because they can enhance the power component. Fatigue results in slower repetitions and performance. Thus, a reduced time to complete a circuit indicates improved endurance because the client can maintain a better pace and movement velocity. Metabolic circuits have become popular among athletes and fitness enthusiasts to improve muscle endurance, aerobic capacity, and reduce percentage of body fat.

Circuits allow the client to perform several exercises in a short period of time yielding substantial metabolic and cardiovascular responses that could improve aerobic capacity as well.

Anaerobic capacity can be assessed in many ways. Two common assessments include the 300-yard shuttle and the line drill. The 300-yard shuttle requires two parallel lines 25-yard apart. The client sprints as fast as possible from one line to other line and immediately sprints back to the starting line for six continuous round trips. For the line drill, a basketball court is typically used. The client begins at the baseline, sprints to the foul line and back, sprints from the baseline to the half-court line and back, sprints from the baseline to the far foul line and back, and sprints from the baseline to the far baseline and back without rest, and total time is recorded. Multiple trials can be given for each test and the best time or average of each test can be recorded. These are fatiguing tests, so plenty of rest (at least 3–4 min) should be given in between trials.

SUMMARY

The Personal Training profession has evolved to accommodate athletes and those clients with advanced training status/goals. Personal Trainers have a unique niche in providing one-on-one individualized training services for advanced clients. Thus, Personal Trainers must have knowledge and proficiencies of advanced training concepts before implementing these techniques to maximize safety within client training programs. Advanced training encompasses the potential prescription and supervision of periodized resistance, plyometric, speed, agility, and anaerobic conditioning training programs to clients seeking to maximize several health- and skill-related components of fitness.

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CHAPTER 19

Populations across the Lifespan

OBJECTIVES

Personal Trainers should be able to:

- Describe exercise programming during pregnancy and postpartum.
- Understand the value of physical activity for children and create age-appropriate exercise programs.
- Understand physiological changes with aging and create age-appropriate exercise programs for older adults.

INTRODUCTION

According to the *2018 Physical Activity Guidelines*, only 26% of males, 19% of females, and 20% of adolescents report meeting the physical activity guidelines (1). Physical inactivity is associated with numerous unhealthy conditions, including obesity, hypertension, gestational and Type 2 diabetes, and atherosclerotic cardiovascular disease and contributes worldwide to 5 million deaths (2–4). Although pregnancy is generally considered a time when women are willing to make positive changes in lifestyle behaviors for the benefit of their children, only 23% of pregnant women meet the weekly recommended guidelines for physical activity (5). Furthermore, 21.6% of U.S. children ages 6–19 years meet the current recommendations for weekly physical activity (6). Children are more active than their adult counterparts; however, only the youngest children actually fulfill current physical activity guidelines. Older Americans are the least physically active. About 12% of individuals aged ≥65 years report meeting current physical activity guidelines and less than 5% of individuals aged ≥85 years and older meet these same guidelines (7). Additionally, 19.7% of people aged 45–64 years have difficulties in physical functioning with an increase to 44% in people aged 75 years and older (8). Currently, and over the next couple of decades, millions of baby boomers will continue to turn 65 years of age, and by 2030, 1 in every 5 Americans will be 65 years and older (9–11). This chapter discusses the special considerations and scope of practice of exercise program design for the following subpopulations: pregnancy, children, and older adults.

Programming during Pregnancy and Postpartum

Pregnancy is associated with multiple anatomical and physiological changes. Originally, the prevailing opinion was that physical activity should be discouraged during pregnancy because of the supposed increased maternal and fetal risk of untoward events (12). However, current research suggests that unless a specific obstetric or medical condition is present, the likelihood of adverse events or complications following acute exercise or chronic training in the mother and fetus is minimal (12). Thus, all women who have healthy, uncomplicated pregnancies should be physically active during pregnancy. Even women who were sedentary before pregnancy may begin an exercise regimen during pregnancy (13). The Personal Trainer should adjust the exercise regimen to the needs of each individual pregnant women keeping in mind her specific conditions and/or goals. Furthermore, he or she should recognize that similar to other populations, physical activities in people who are pregnant and those in the postpartum period confer numerous benefits and should be encouraged. Collectively, the Personal Trainer, client, and obstetric health care provider can establish the following exercise program goals: Avoid excessive weight gain, reduce the risk of gestational diabetes, lower the incidence of low back pain, and prevent excessive decreases in cardiorespiratory and muscular fitness (12). These benefits of exercise are targeted directly at the mother; however, there are also notable health benefits of maternal exercise for the developing fetus (14) and her child later in life (14). Thus, given the well-known benefits of exercise during pregnancy for mother and baby, the Personal Trainer should be aware of exercise guidelines and recommendations to enable safe exercise in the pregnant women. The Personal Trainer should also encourage the pregnant women to discuss with her physician potential medical or obstetric contraindications to exercise prior to starting an exercise program. The next section "Preparticipation Screening during Pregnancy and Postpartum" describes this in more detail.

Similar to other populations, physical activities in people who are pregnant and those in postpartum period confer numerous benefits and should be encouraged.

Preparticipation Screening Exercise during Pregnancy and Postpartum

Prior to participation in an exercise program, pregnant women, regardless of physical activity history or lifestyle, should be evaluated by their obstetric provider to determine whether exercise is contraindicated. Having pregnant clients review the Physical Activity Readiness Medical Examination for Pregnancy questionnaire (available at http://www.csep.ca) with their health care provider is recommended to help determine the appropriateness of participation in a fitness routine. This form can be signed by the obstetric provider to verify the safety of exercise and provide recommendations for cardiorespiratory and resistance training activities. Personal Trainers who work with pregnant clients must be knowledgeable of, and able to educate clients on, the potential signs that would warrant the termination of acute exercise listed in Table 19.1 (15–18). Furthermore, Personal Trainers should also be aware of the absolute and relative contraindications of exercise training as listed in Table 19.2. The following guidelines for exercise during pregnancy are for those women who are without contraindications for exercise.

Table 19.1	Warning Signs to Terminate Exercise during Pregnancy
Vaginal bleeding	
Regular painful uterine contractions	
Amniotic fluid leakage or other vaginal fluid loss including rupture of the membranes	
Dyspnea prior to exertion or that is persistent and excessive that does not resolve on rest	
Dizziness, syncope, or faintness that does not resolve on rest	
Muscle weakness or muscle weakness affecting balance	
Calf pain or swelling	
Headache	
Chest pain	

Table 19.2	Absolute and Relative Contraindications to Exercise during Pregnancy
Absolute Contraindications	**Relative Contraindications**
Ruptured membrane	Recurrent pregnancy loss
Unexplained persistent vaginal bleeding	A history of spontaneous preterm birth
Placenta previa after 28 weeks' gestation	Gestational hypertension
Preeclampsia	Symptomatic anemia
Incompetent cervix	Malnutrition
Intrauterine growth restriction	Eating disorder
High-order multiple pregnancy (*e.g.*, triplets)	Twin pregnancy after the 28th week
Uncontrolled Type 1 diabetes, uncontrolled hypertension, uncontrolled thyroid disease	Mild/moderate cardiovascular or respiratory disease
Other serious cardiovascular, respiratory, or systemic disorder	Other significant medical conditions

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General Exercise Considerations during Pregnancy and Postpartum

Fatigue, nausea, and vomiting may limit exercise, especially during the first trimester. Importantly, the Personal Trainer should recognize the increased nutritional requirements of pregnant clients. Personal Trainers are encouraged to use the metabolic calculations presented in Chapter 15 to estimate the total energy expenditure of the client's exercise program. Pregnancy requires an increase in energy intake to fulfill the metabolic demands of pregnancy. On average, women require an additional 300 kcal · d^{-1} while pregnant (19).

Pregnant women have diminished thermoregulatory control throughout pregnancy. Consequently, they need to be counseled to maintain adequate hydration; wear appropriate clothing that will facilitate heat dissipation; and avoid exercise in hot, humid conditions (12). Women should be encouraged to choose environmentally controlled indoor settings in these situations. Lastly, the Personal Trainer should remind clients that pregnancy is not a time to expect large improvements in fitness, and ultimately, throughout the gestational period, it is normal for numerous fitness parameters to decline (20).

Women who are pregnant should avoid contact sports or activities that have a higher risk of falling to avoid potential trauma to their developing baby. Such activities to avoid during pregnancy include, but are not limited to, nonstationary cycling, downhill or water skiing, gymnastics, and horseback riding (21).

The physiological changes associated with pregnancy persist for 4–6 weeks postpartum; however, women typically can gradually return to exercise provided the delivery was uncomplicated. The *2018 Physical Activity Guidelines* suggest the time needed for women to return to regular physical activity following birth should be discussed with her physician and based off of her own medical safety needs rather than giving a specific time period to resume physical activity (1). Women who are nursing may elect to feed their babies prior to exercise to alleviate the discomfort of engorged breasts and to reduce the likelihood of feeding problems postexercise due to acidity in the breast milk (22).

Aerobic Exercise Prescription during Pregnancy

The general cardiorespiratory training principles of exercise prescription detailed in Chapter 15 apply to pregnant and postpartum women, although the profound anatomical and physiological changes will require the Personal Trainer to make a number of special adaptations to the training program. Table 19.3 lists some of these exercise modifications for pregnancy. All women with healthy, uncomplicated pregnancies, even those who were previously inactive before pregnancy, are encouraged to exercise during pregnancy. Women with gestational diabetes or those who are overweight or obese may benefit greatly from the health benefits of physical activity during pregnancy. The current recommendations for aerobic physical activity during pregnancy according to the 2015 Committee Opinion by the American College of Obstetricians and Gynecologists (and reaffirmed in 2017) and others (1) are that women accumulate *at least* 150 minutes of moderate-intensity exercise each week with bouts of exercise lasting *at least* 20–30 $min \cdot d^{-1}$ (22,23). It is highly encouraged for pregnant women to be physically active every day (13,22). Due to the normal physiological changes that occur during pregnancy, perceived exertion may be a better determination of exercise intensity than heart rate. Pregnant women should aim for moderate-intensity exercise, which on a 0 (resting in the seated position) to 10 (maximal exertion) scale would be a 5 or 6 (1). The "talk test" may also be used to assess moderate exercise intensity during pregnancy. If a woman is participating in moderate-intensity exercise, then she should be able to carry on a conversation during exercise but not be able to sing (1,23,24). Recreational and competitive athletes may train safely at higher intensities and volumes throughout pregnancy with the understanding that they are undergoing close obstetric supervision (22).

Table 19.3 Aerobic Exercise Program Modifications for Pregnant Women

Program Component	Program Modification
Exercise mode	■ Walking and cycling may be easier to monitor for exercise intensity. ■ Activities that increase the risk of falls (*e.g.*, skiing and skating), abdominal trauma (*e.g.*, basketball and softball), and rapid changes in movement that impact balance (*e.g.*, tennis) should be avoided and generally are not recommended. ■ Activities at elevations >6,000 ft and scuba diving are contraindicated.
Exercise intensity	■ Target heart rate (*e.g.*, $\%HR_{max}$ or %HRR) should not be employed as a method to monitor exercise intensity due to the variability in maternal resting and maximal heart rate throughout pregnancy. Likewise, target $\dot{V}O_2$ (*e.g.*, $\%\dot{V}O_2R$) is not a valid tool to monitor intensity due to the progressive decrease in cardiorespiratory fitness over the course of the pregnancy.

	■ RPE values of 12–13 (light to somewhat hard) on the 6–20 scale can be used to accurately and safely monitor exercise intensity. ■ The talk test may also be used to monitor appropriate exercise intensity. Pregnant women should exercise at an intensity that permits conversation. Intensity should be decreased when conversation is not possible.
Exercise session duration	■ Accumulating 30 min of exercise in 20–30 min intermittent bouts and adjusted as needed to a total of 150 min · wk^{-1} of vigorous aerobic exercise.
Exercise frequency	■ Moderate-intensity exercise should be regular rather than sporadic in nature. Exercise should be performed 3–5 d · wk^{-1}.

HR_{max}, maximal heart rate; HRR, heart rate reserve; $\dot{V}O_2$, volume of oxygen consumed per unit time; $\dot{V}O_2R$, oxygen uptake reserve.

Adapted from American College of Obstetricians and Gynecologists. ACOG Committee Opinion No. 650. Physical activity and exercise during pregnancy and the postpartum period. *Obstet Gynecol*. 2015 (reaffirmed in 2017);126:e135–42; Artal R, O'Toole M. Guidelines of the American College of Obstetricians and Gynecologists for exercise during pregnancy and the postpartum period. *Br J Sports Med*. 2003;37:6–12; and American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2019.

Resistance Training, Flexibility, and Posture Prescription during Pregnancy

The general resistance and flexibility training principles of exercise prescription detailed in Chapters 14 and 16, with several adjustments that account for morphological and physiological changes, apply to pregnant and postpartum women. After the first trimester, resistance and flexibility training exercises in the supine position should be avoided because of the potential obstruction of venous return and subsequent risk of orthostatic hypotension (22). Instead, the Personal Trainer should modify these positions to a side lying, sitting, or standing position (24). Isometric or heavy resistance training may elicit a pressor response (sudden increase in heart rate and blood pressure) and is not recommended (20). Continuous breathing (inhale on the eccentric phase and exhale on the concentric phase of the lift) should be used during the exercise and the Valsalva maneuver should be avoided at all times (24). Joint range of motion (ROM) will be enhanced during pregnancy because of increased circulating levels of relaxin, and therefore, the potential exists for ligament and joint capsule damage with an overly aggressive flexibility program (20). Consequently, Personal Trainers are encouraged to focus on maintaining normal joint ROM with slow, static stretching throughout pregnancy. Abdominal exercises during pregnancy are not contraindicated, as long as at the abdominal exercise can be done in the side lying or standing position. However, some women develop diastasis recti during pregnancy, which is the separation of the abdominal muscles following rapid expansion of the abdominal region. In these women, abdominal exercises are not recommended (13,24). Lastly, due to the rapidly changing anatomy of a women's body during pregnancy, posture is impacted, which can lead to increased risk of lower back and leg pain. During resistance training, an emphasis should be placed on correct posture and pelvic alignment (25).

Programming for Children

Children and adolescents include individuals 6–17 years of age. *Physical Activity Guidelines* for Americans published in 2008 (26) and later updated in 2018 (1) advocate for children to participate in at least 60 min $\cdot$ d^{-1} of moderate- to vigorous-intensity physical activity and to include resistance exercise and bone-loading activity on at least 3 d $\cdot$ wk^{-1}. Unfortunately, after about age 10 years, most young people do not meet the physical activity guidelines. The guidelines for physical activity are not as clear for children younger than 6 years of age; however, in the past decade, there has been a substantial amount of research regarding this area, which was reviewed in the *2018 Physical Activity Guidelines.* These guidelines suggest that children 3 to 5 years of age experience greater health benefits, such as reduced risk of excessive body weight and adiposity and favorable indicators of bone health, from participating in higher levels of physical activity compared to lower levels of physical activity (1). Similarly, in a systematic review of 119 papers, physical activity interventions in children were found to be positively associated with psychological well-being (*i.e.*, happiness, self-image, satisfaction with life) and overall mental health and inversely associated with psychological ill-being (*i.e.*, stress, depression). In addition, this review found participation in team sports to be strongly associated with positive mental health and to buffer the effects of stressful life events (27). Therefore, decreasing sedentary behavior and encouraging youth to meet the physical activity guidelines not only supports muscle and bone growth and weight management but also mental health awareness. The *2018 Physical Activity Guidelines* recommend that children 3–5 years of age who are not meeting the median time spent in light-, moderate-, or vigorous-intensity physical activity ($3\ h \cdot d^{-1}$), as assessed by physical activity monitors, increase their physical activity levels to meet those recommendations. Furthermore, these young children should also participate in bone and muscle strengthening activities that emphasize jumping, leaping, and landing (1). Due to the lack of evidence for exercise guidelines in children younger than 6 years of age, the evidence provided in this chapter is for the Personal Trainer working with children ages 6–17 years of age unless otherwise also specified for younger children.

Physical Activity Guidelines updated in 2018 continue to advocate for children (6 yr of age and older) to participate in at least $60\ min \cdot d^{-1}$ of moderate- to vigorous-intensity physical activity and to include resistance exercise and bone-loading activity on at least $3\ d \cdot wk^{-1}$.

Most young people are healthy, and thus, it is safe for them to initiate moderate-intensity activities without medical screening (23). Medical exams and exercise testing prior to participation generally are unnecessary in this population unless clinically indicated by signs or symptoms representative of cardiopulmonary diseases. The physiological responses to acute exercise in children are comparable to their adult counterparts with expected quantitative differences attributable to lean body mass and height disparities between the two populations (23). Table 19.4 indicates some of the key comparisons between adults and children. Children have lower anaerobic capacities compared with adults, which limits their potential for higher intensity exercise performance. When designing an exercise program for children and adolescents, the American College of Sports Medicine (ACSM) recommends three target areas: aerobic endurance, muscular strengthening, and bone strengthening activities (23). Regular endurance, resistance, and bone-loading exercise will confer favorable training adaptations in children, resulting in benefits to cardiovascular, metabolic, and skeletal health.

Table 19.4 Physiological Responses to Acute Exercise in Children Compared to Adults

Variable	Difference
Absolute oxygen uptake ($\dot{V}O_2$ in $L \cdot min^{-1}$)	↓
Relative oxygen uptake ($\dot{V}O_2$ in $mL \cdot kg \cdot min^{-1}$)	↑
Cardiac output	↓
Heart rate	↑
Stroke volume	↓
Respiratory rate	↑
Minute ventilation ($\dot{V}E$)	↓
Respiratory exchange ratio	↓
Systolic blood pressure	↓
Diastolic blood pressure	↓

$\dot{V}O_2$, volume of oxygen consumed per unit time.

Adapted with permission from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2019.

Regular endurance, resistance, and bone-loading exercise will confer favorable training adaptations in children, resulting in benefits to cardiovascular, metabolic, and skeletal health.

Physical Activity for Children

As previously stated, many children do not meet current physical activity guidelines. Thus, a role of the Personal Trainer is to help identify a variety of age-appropriate activities for children that will safely and effectively develop aerobic, muscular, and bone strength. In addition, the Personal Trainer should work with parents/guardians to help develop and implement plans for their children to lessen the amount of time spent in sedentary activities (*e.g.*, watching television or movies, time on computer, or playing video games) while simultaneously increasing activities that encourages physical activity. Children who have been previously sedentary may be unable to initially achieve *at least* 60 min $\cdot$ d^{-1} of moderate- to vigorous-intensity aerobic, resistance, and bone-loading physical activities. In these instances, it is prudent for the Personal Trainer to gradually progress the volume of physical activity upward over several months to ultimately achieve the 60-minute-per-day goal. Table 19.5 describes the health benefits of physical activity in children ages 3 through 17 years.

Table 19.5 Health Benefits Associated with Regular Physical Activity in Children and Adolescents

Improved bone health (ages 3–17 yr)
Improved weight status (ages 3–17 yr)
Improved cardiorespiratory and muscular fitness (ages 6–17 yr)
Improved cardiometabolic health (ages 6–17 yr)
Improved cognition (ages 6–13 yr)
Reduced risk of depression (ages 6–13 yr)

From Physical Activity Guidelines for Americans, 2nd ed., https://health.gov/our-work/physical-activity/current-guidelines

A role of the Personal Trainer is to help identify a variety of age-appropriate activities for children that will safely and effectively develop aerobic, muscular, and bone strength.

In general, the exercise prescription for children should follow the frequency, intensity, time, type, volume, and progression (FITT-VP) framework. Table 19.6 summarizes the youth physical activity guidelines (1). Personal Trainers should design physical activity programs for children with two primary goals in mind (28):

1. The program should fulfill the minimal amount of physical activity needed to achieve the health benefits associated with regular physical activity.
2. Children aged 3–5 years should be encouraged to be physically active throughout the day participating in active play. School-aged children and adolescents (age 6–17 yr) should be encouraged to participate in a variety of physical activities that are enjoyable and age-appropriate. Keeping the activity fun and safe is important when working with children.

Table 19.6 Summary of Aerobic, Resistance, and Bone-Loading Activity Guidelines for Children

Parameter	Aerobic Activity	Resistance Activity	Bone-Loading Activity
Mode	Activities include running, hopping, swimming, dancing, and bicycling.	Can be unstructured (*e.g.*, playing on playground equipment, climbing trees, tug of war) or structured (*e.g.*, lifting weights, use of resistance bands)	Activities include running, jumping rope, basketball, tennis, and hopscotch.

Intensity	Moderate-intensity activity most days; corresponds to noticeable ↑ heart rate and breathing. Vigorous-intensity activity minimum of 3 $d \cdot wk^{-1}$; corresponds to substantial ↑ heart rate and quick breathing	Use body weight as resistance or 8–15 submaximal repetitions to moderate fatigue all performed with good technique.	No specific recommendation; however, avoid extreme intensity.
Duration	≥60 $min \cdot d^{-1}$	Included with the ≥60 $min \cdot d^{-1}$	Included with the ≥60 $min \cdot d^{-1}$
Frequency	Daily	≥3 $d \cdot wk^{-1}$	≥3 $d \cdot wk^{-1}$

Adapted with permission from U.S. Department of Health and Human Services. *2018 Physical Activity Guidelines for Americans* [Internet]. Washington (DC): U.S. Department of Health and Human Services; [cited 2019 May 15]. Available from: http://www.health.gov/PAGuidelines/guidelines/default.aspx; American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2021.

Other Considerations for Children

Traditionally, it was believed that resistance training during adolescence would be harmful to the developing skeleton. However, a plethora of scientific data exists that demonstrates that resistance training, when performed appropriately during childhood, is beneficial for bone formation and growth (29). Traditional resistance training activities for children are generally safe and appropriate provided they receive proper instruction and supervision (23). By age 7 or 8 years, children should be physically and mentally mature enough to initiate a resistance training program (30). The general resistance training principles detailed earlier for adults (see Chapter 14) can also be applied to children. In children who have little experience resistance training, the Personal Trainer should initially emphasize proper lifting form and other safety measures while using low volume (one to two sets) and low to moderate resistance (≤60% one repetition maximum [1-RM]) prior to gradually increasing the load (31). Children who have mastered basic resistance training exercises can then be progressed to exercises, which require more coordination, technical competency, and greater rates of force production (29). The Personal Trainer should have an overall goal of increasing skeletal muscle strength, function, and control in children rather than increasing skeletal muscle size (29). Generally speaking, the Personal Trainer can expect a 30%–40% increase in strength in an untrained youth (29). Modalities could include resistance machines, free weights (preferably dumbbells with younger ages), resistance bands, medicine balls, smaller kettle bells, cable machines, and body weight activities. If resistance machines are to be used, they should be designed to specifically fit children's body size to enhance the training response and decrease risk of injury. Therefore, employing adult-size machines in a child's resistance exercise program should be avoided. For younger children, unstructured muscle-strengthening activities (*e.g.*, playing on playground equipment) can also be included within the 60 min $\cdot$ d^{-1} of physical activity (23).

Children have underdeveloped thermoregulatory systems and subsequently are more prone to heat injuries than their adult counterparts (23). Personal Trainers should ensure that children remain properly hydrated and when possible encourage activity in thermoneutral environments.

Lastly, although most children are healthy, Personal Trainers may encounter children with health issues or disabilities such as asthma, Type 1 diabetes, or cerebral palsy. Furthermore, given that childhood obesity is on the rise, Personal Trainers are likely to encounter obese or overweight children or adolescent clients. Due to excess body fat, certain activities such as jogging or running may hinder performance. Furthermore, the Personal Trainer should be aware that this population is twice as likely to have a physical activity related injury as normal weight children or adolescents (29). In this situation, Personal Trainers should consult with the child's medical team and familiarize themselves with the specific exercise recommendations for the disease or disability present in that child. Then, the Personal Trainer should adapt the physical activity program for these individuals according to their condition, symptoms, and functional capacity (11,28).

Programming for Older Adults

Aging is a universal experience, although perception and experience alter ones late-life outcomes (32). Life expectancy in the United States has risen nearly 30 years since 1900 with those reaching the age of 65 years having an average additional life expectancy of 19.4 years (9,33). Older adults are defined as men and women 65 years and older and/or adults aged 50–64 years with clinically significant chronic conditions and/or functional limitations that impact movement ability, fitness, or physical activity (11). Limitations are defined as difficulty or inability in performing basic tasks of living, such as walking a quarter of a mile or lifting a 10-lb bag of groceries (34). Older adults over 65 years of age are at the highest risk for chronic diseases. Each system in the body responds to aging differently. Thus, one's chronological age cannot be assumed equivalent to one's physiological or functional age. Individuals of similar ages can differ remarkably in functional capacity, which in turn will affect how they respond to exercise.

Although it is inevitable that physiological function declines with age, the rate and magnitude of change are dependent on a complex mixture of genetics, individual health, presence of disease/injury, and exercise history. Safe and effective exercise programming for older adults requires that Personal Trainers have knowledge of these age-related changes on physiological function at rest and throughout the exercise-intensity spectrum. A list of key physiological aspects of aging is presented in Table 19.7.

Table 19.7 Physiological Aspects of Aging

System	Parameter	Change

Cardiovascular	Maximal heart rate and stroke volume	↓
	Maximal cardiac output	↓
	Resting and exercise blood pressure	↑
	Maximal oxygen consumption	↓
Environmental	Cold tolerance (heat production/blood redistribution)	↓
	Heat tolerance (sweat capacity/blood redistribution)	↓
Musculoskeletal	Lean body mass	↓
	Fat mass	↑
	Muscle strength	↓
	Bone mineral density	↓
	Flexibility	↓
Metabolic	Glucose tolerance	↓
	Insulin sensitivity	↓
Other	Balance	↓
	Reaction time	↑[a]

[a]Reaction time increases with age (*i.e.*, it will take longer to accomplish a task).

Adapted from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2021.

Individuals of similar ages can differ remarkably in functional capacity, which in turn will affect how they respond to exercise.

Physiological Changes with Aging

The prevalence of hypertension in Americans older than 50 years of age account for the majority of cases of uncontrolled hypertension (35). For example, those with "normal" blood pressure at age 55 and 65 years have a 90% risk of developing hypertension over the remainder of their life (36). Resting heart rate remains relatively unchanged with aging (37), maximum heart rate declines steadily with increasing age at a rate of almost 0.7 bpm ·

yr^{-1} (38,39). Maximum stroke volume (amount of blood pumped per heartbeat) and maximum cardiac output (blood flow out of the heart per minute) likewise decline with age. Maximum stroke volume and maximum heart rate decline by 10%, and maximum cardiac output declines by 20% in the three decades between age 30 and 60 years (40). These changes lead to reduced exercise capacity with declines in maximal volume of oxygen consumed per unit time of about 9% per decade in healthy sedentary adults, and this rate of decline progressively increases in old age (41). As a result, the functional capacity of the average sedentary person declines by 30% between the ages of 30 and 70 years (40,42).

The ability to recover from submaximal exercise is impaired in the aging population. Most notably, blood lactate levels remain higher in an aging population compared to young population postexercise (43). Total body water declines with increasing age contributing to decreased blood volume and impaired thirst sensation. In males, total body water decreases about 0.3 kg per year after age 30 years, and in females, by 0.7 kg per year after age 70 years (41). These changes predispose the older person to reduced exercise capacity, dehydration, and impaired exercise tolerance in hot and humid weather (44).

Between age 19 and 79 years, there is a progressive decline in brain blood flow (45) and a decrease in brain weight (46); this is likely due to loss of fluid and the slowing of nerve conduction velocity (47) resulting in slower reaction times and slower voluntary movements. These decrements in nerve conduction velocity are thought to contribute to some of the losses in muscular strength and power that occur with advancing age (48,49). However, the main culprit in decreased muscular strength with increasing age is a 30%–50% decrease in muscle mass between age 30 and 80 years due to decrease in the number of muscle fibers and greater atrophy of type II (fast-twitch) muscle fibers compared with type I fibers (41,50,51). As muscular power is a function of both strength and speed of movement, these muscle fiber changes mean that power output declines at a faster rate than strength alone. Lower body strength declines more rapidly than upper body strength (44). Muscular endurance also declines with age, although it does not decrease as quickly as power (44). It is not just the muscles that become weaker with advancing age. The connective tissue, ligaments, cartilage, tendons, and bones also weaken and become less flexible in old age (41,44). The weakening of bones (osteoporosis) occurs in both males and females; however, the problem is more prevalent in females, particularly after menopause. Females lose about 1% of bone density per year after 35 years of age, accelerating to 2%–3% per year for several years after menopause (41,44). Degeneration of the elastic components of connective tissue leads to a loss of mobility and stability in the joints.

Even though muscles and bones become weaker through atrophy, body weight actually increases in the 30s, 40s, and 50s through a progressive accumulation of body fat, particularly in the abdominal region. After age 70 years, body weight starts to decline (44).

Exercise Training Can Make a Difference

One might ask the question whether all these decrements are inevitably caused by biological aging or if exercise can counteract some of them. The answer is that only about 50% of the decrements noted earlier are due to actual aging, whereas the other 50% are due to sedentary living, poor nutrition, tobacco use, and alcohol consumption, which can be altered through exercise (41,44,52,53). Limiting time spent sitting and participation in physical activity reduces the risk of developing major chronic diseases common in older adults (1). Recent findings indicate multicomponent activity programs including aerobic, muscle-strengthening, and balance activities to be appropriate and encouraged for *all* older adults (1). Being regularly active throughout life not only significantly minimizes the normal age-related changes but can also increase aerobic capacity and muscular strength by 20%–30% in older adults (44,54). In older adults, aerobic capacity, muscular strength, body composition, and flexibility improvements are quite similar to those seen in young adults when compared based on relative change (relative to maximal capacity) and can occur at least into the 70s. Aerobic training may actually improve exercise efficiency to a greater extent in the elderly as compared with the young, although older adults are not able to increase their lower body strength to the same magnitude as young adults (55).

> Recent findings indicate multicomponent activity programs including aerobic, muscle-strengthening, and balance activities to be appropriate and encouraged for all older adults.

Successful Aging

Exercise not only improves health-related quality of life and psychological well-being but also increases the length of life. Physical inactivity is among the strongest predictors of physical disability in older adults (56). A meta-analysis of 38 studies found that regular physical activity at a mild to moderate intensity was strongly associated with a reduction in all-cause mortality in active compared with sedentary individuals (57). In everyday life, functional tasks such as getting up out of a chair, climbing stairs, bringing in the groceries, and keeping the house clean require at least minimal levels of cardiovascular endurance, muscular strength, endurance and power, flexibility, and balance. Approaching or falling below these threshold levels has the effect of limiting participation in life and reducing independence. Regular involvement in aerobic, anaerobic, resistance, flexibility, and functional training is a key element of successful aging (1).

> Regular involvement in aerobic, anaerobic, resistance, flexibility, and functional training is a key element of successful aging.

Exercise Testing in Older Adults

The likelihood is high that older adults will have clinically significant or underlying chronic disease. Thus, it is imperative that Personal Trainers complete a thorough preparticipation health screening and assessment (as detailed in Chapters 11 and 12) before beginning an exercise program with this population. A sedentary, asymptomatic older person can initiate low- to moderate-intensity exercise without medical evaluation (23). However, for sedentary older adults with known cardiovascular, metabolic, or renal disease and/or signs or symptoms suggestive of these diseases (see Chapter 11), a medical clearance is recommended before starting an exercise program. Exercise testing can determine functional capacity, help establish a safe exercise prescription, and can enable monitoring of progress in an exercise program. ACSM describes contraindications to exercise testing and participation in older individuals and provides detail on exercise testing (23). The main objective for working with older clients is to enhance and support "successful aging." Personal Trainers should design programs for older adults with three primary goals in mind:

1. Prevent or delay the progression of chronic diseases (and/or possibly "reverse" symptoms as in normalizing blood glucose).
2. Maintain or enhance cardiorespiratory fitness levels (*i.e.*, functional capacity).
3. Prevent functional limitations and disabilities.

Design Considerations for Developing Cardiorespiratory Fitness in Older Adults

Cardiorespiratory fitness is arguably the most important goal of an exercise program for older adults. Low cardiorespiratory fitness contributes to premature mortality in middle-aged and older adults (58,59). However, for every one metabolic equivalent (1-MET) improvement in cardiorespiratory fitness, one may expect a 25% reduction in overall mortality risk (60). Enhanced cardiorespiratory fitness improves insulin sensitivity, blood lipid profile, body composition, blood pressure, and autonomic nervous system function, leading to a decreased overall risk for developing cardiovascular disease (61). Moreover, decreased cardiorespiratory fitness contributes to a reduction in physiological functional capacity and eventually can result in loss of independence. Sometimes because of the natural decline in function associated with aging, the Personal Trainer may need to interpret "no change" or "maintenance of function" as a successful outcome when working with older adults. For example, a Personal Trainer who works with an older client for 2–3 years and observes "no change" in the client's cardiorespiratory fitness level over that time can conclude that the program was effective. Why? The inevitable decline in physiological function, in this case cardiorespiratory fitness, has been delayed. In summary, normal age-related changes are minimized by being regularly active throughout life; additionally, a restorative function may be seen in cases where a sedentary lifestyle has been replaced by regular physical activity.

> Being regularly active throughout life not only significantly minimizes the normal age-related changes but also restores functional capacity in previously sedentary adults.

An exercise program should be based on exercise testing results, consider the person's preferences and capabilities, be individualized with attainable goals, and provide regular and meaningful feedback as support for long-term adherence. When working with an older client, plan warm-up (minimum of 5–10 min) with gentle dynamic stretching to gradually ease the person from rest to the chosen exercise intensity. A deliberate cool-down (minimum of 5–10 min) should gradually bring the person back to resting levels after exercise. Time spent in warm-up and cool-down count toward meeting the ACSM physical activity guidelines, as long as the activity is at least moderate intensity (*i.e.*, brisk walking) (62). In general, physical activity programs for older adults should be designed to meet the current recommendations of at least 150–300 minutes of moderate-intensity physical activity a week, spread out across at least 5 days, with a target of 30 $\text{min} \cdot \text{d}^{-1}$ (even greater benefits are shown for up to 60 $\text{min} \cdot \text{d}^{-1}$). If completing vigorous exercise, then the recommendation is a target of 20–30 $\text{min} \cdot \text{d}^{-1}$ on 3 or more days per week accumulating 75–100 minutes of vigorous-intensity activity per week (23). The exercise does not need to be continuous but can be accumulated in smaller bouts across the day. An equivalent combination of moderate and vigorous activity can also be prescribed. Research has found that aerobic physical activity is most beneficial in reducing the risk of injury and preventing excess fatigue when spread throughout the week on *at least* 3 days (or more for greater benefit) (23). When not feasible for older adults to fulfill these guidelines due to debilitating chronic conditions, Personal Trainers should encourage these individuals to be as physically active as their condition permits. Exercise intensity for older adults is defined relative to individual fitness using a perceived physical exertion scale of 0–10 for which 0 is equivalent to sitting and 10 is maximal effort. Moderate-intensity activity is considered as a 5 or 6 and vigorous-intensity activity as a 7 or 8 (23). However, relative intensity individualized to the person should be used to prescribe aerobic training (1). Walking is the most common activity for older adults, although any activity that does not present excessive orthopedic stress can be included (62). Recent findings suggest multicomponent physical activities to be the most beneficial for specific physical function outcomes such as strength, gait speed, balance, and activities of daily living. Multicomponent activities include more than one type of physical activity including aerobic, muscle strengthening, and balance training (1). In summary, the cardiorespiratory training principles detailed in Chapter 15 apply to older adults, although depending on the disease and functional status of the individual, the Personal Trainer must also consider medications, risk factor profile, and behavioral issues to modify the program accordingly. Table 19.8 outlines some of the program modifications that could be considered when working with older adults with functional impairments.

Table 19.8 Aerobic Exercise Program Modifications for Older Adults

Program Component	Program Modification

Exercise mode	■ Walking is an excellent mode of exercise for many older adults. ■ Modality should not impose excessive orthopedic stress. ■ Aquatic, stationary cycle, and recumbent stepper exercise may be preferable for clients with a diminished ability to tolerate weight-bearing exercise. ■ Modality should be accessible, convenient, and enjoyable to promote adherence. ■ A group setting may provide social reinforcement to adherence.
Exercise intensity	■ To minimize complications and promote long-term compliance, intensity for inactive older adults should start low and progress according to client preference and tolerance. ■ Many adults have clinically diagnosed conditions or likely have underlying chronic diseases; thus, a conservative approach to increasing intensity may be required. ■ Exercise need not be vigorous and continuous to be beneficial ■ Measured peak heart rate is preferable to age-predicted peak heart rate because of the variability in peak heart rate in clients >65 yr and their greater risk for underlying CAD. ■ Activities performed at a given MET level represent greater relative intensities in older adults than in younger clients because of the decrease in peak METs with age (see Table 20.7). ■ Older adults are likely to be taking medications that can influence heart rate. ■ Intensity on a level of physical exertion should be 5–6 for moderate intensity and 7–8 for vigorous, on a scale from 0 to 10.
Exercise session duration	■ To prevent injury, ensure safety, and promote adherence, older adults should increase exercise duration prior to intensity. ■ Duration need not be continuous to produce benefits. Clients who have difficulty sustaining exercise for 30 min or who prefer shorter bouts of exercise can be advised to exercise for 10-min bouts throughout the day. ■ A daily accumulation of 30 min moderate-intensity physical activity can provide health benefits. ■ Even greater benefits are possible with up to 60 $\text{min} \cdot \text{d}^{-1}$ of moderate-intensity physical activity.
Exercise frequency	■ Moderate-intensity exercise should be performed on 5 or more days per week, vigorous-intensity activity on 3 or more days per week, or a combination of moderate and vigorous on 3–5 $\text{d} \cdot \text{wk}^{-1}$.

CAD, coronary artery disease.

From American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2021.

Design Considerations for Developing Muscular Strength in Older Adults

Aging is associated with a reduction in muscle mass, which in turn contributes to decreased muscle strength and a decline in functional capacity. Undeterred, the process can ultimately result in reduced balance ability, mobility problems, and lack of independence for the older adult (63). Furthermore, decreased muscle mass plays a role in the development of glucose intolerance and Type 2 diabetes.

The Personal Trainer should recognize the importance of implementing a resistance training program for older adult clients to attenuate the loss of muscle mass and protein (64). Muscle fiber size and performance, particularly the rate of force development, are consistently higher in older adults who are chronically exposed to strength training (65). Furthermore, some studies have suggested that resistance training can improve cognition, mood, self-confidence, and self-esteem (44,66).

When designing a resistance training program for older individuals, the general resistance training principles detailed earlier (see Chapter 14) can be applied. In fact, in certain elderly clients, even explosive-type, heavy resistance exercise has been shown to be safe and effective (67). However, it is critical that the Personal Trainer provide sufficient instruction on proper lifting technique and good posture. Initially, beginners may benefit from using weight training or resistance machines. Weight training machines leave less room for error in body position, and they safely enable larger absolute loads to be lifted. If weight-training machines are used with small-framed or frail clients, care must be taken that they fit the individual properly. Other modalities such as free weights (*e.g.*, dumbbells), elastic bands, and body weight activities can offer different benefits for those older participants who are experienced in their use. Some major advantages for these types of exercise modalities are that they are inexpensive, can be done at home, and take up minimal space. Additional benefits are that they can promote kinesthetic awareness and help improve balance (68). Power training, a nonconventional type of resistance training, may be beneficial in older adults who are at a greater risk of falls. Power training has been shown to be beneficial in reducing the risk of falls. To increase skeletal muscle power in older individuals, the Personal Trainer should have his or her client do high-velocity exercises including one to three sets of single and multijoint exercises at 30%–60% of 1-RM for 6–10 repetitions (23).

Older participants should move through the full ROM using proper form and avoid breath holding during the lifts. Intensity can be prescribed between moderate (5–6 on the 10-point exertion scale described previously) and vigorous (23). If the client's 1-RM is known, the target is 60%–70% 1-RM, although lower intensities (*e.g.*, 40%–50% 1-RM) are appropriate for beginners. Generally, one set of 10–15 repetitions is recommended when working with older adults (23). One set of 8 to 10 exercises including the major muscle groups should be part of the resistance training program, although two to three sets may be more beneficial (23). As with any resistance training prescription, load should be increased when the number of repetitions that can be completed with proper form exceeds the initially prescribed number (*e.g.*, original prescription is 10 repetitions of 30 lb, and now the client can lift 12 repetitions with proper form and with a rating of perceived exertion [RPE] of 7 on a 10-point scale — then, it is appropriate to increase the load and decrease the number of repetitions back to 10).

In summary, although the resistance training exercise prescription principles detailed in Chapter 14 are appropriate for many older individuals, they may need to be modified when working with those with functional limitations. Table 19.9 outlines modifications for resistance training programs that could be considered when working with older adults.

Table 19.9 Resistance Training Guidelines for Older Adults

Program Component	Program Modification
Exercise mode	■ Perform 8–10 exercises using the major muscle groups. ■ Dynamic muscle-strengthening activities include machine and free weights, weight-bearing calisthenics, resistance bands, and similar

	resistance exercises that use major muscle groups.
Exercise intensity	■ Perform each lift or movement with a resistance that allows for 10–15 repetitions per exercise. ■ Level of effort for muscle-strengthening activities should be light for beginners progressing to moderate to vigorous. On a 10-point scale, where no movement = 0, maximal effort = 10, moderate-intensity effort = 5 or 6, and high-intensity effort = 7 or 8.
Exercise session duration	■ Complete at least one set of each exercise. ■ Allow adequate rest between exercises to prevent carry over fatigue.
Exercise frequency	■ Resistance training should be performed on 2 or more nonconsecutive days per week.

Adapted from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2021.

Design Considerations for Developing Flexibility in Older Adults

Flexibility is an essential component of fitness and decreases with age and physical inactivity. As was discussed in Chapter 16 with increasing age, the ability to move through a full ROM becomes compromised. Aging causes connective tissue to become stiffer, which makes the joint more resistant to bending (41). Additionally, the joint cartilage, ligaments, tendons, synovial fluid, and muscles begin to deteriorate, which may decrease joint ROM (1). The loss of joint flexibility with aging has been reported to range from negligible to 57% with the majority of this loss occurring by age 65 years (41). Poor flexibility, coupled with decreased musculoskeletal strength, has been associated with a diminished ability to perform activities of daily living (1). Consequently, the beneficial effect of stretching on the achievement and maintenance of flexibility should not be overlooked. However, it is not known if flexibility by itself causes a reduction in the risk of exercise-related injuries (69).

> Poor flexibility, coupled with decreased musculoskeletal strength, has been associated with a diminished ability to perform activities of daily living.

Over the last decade, much scientific inquiry has considered the topic of stretching. Collectively, the findings indicate that static stretching should only be done when muscles and joints are warm. In other words, static stretching itself should not be considered the "warm-up" prior to cardiorespiratory or resistance exercise. Static stretching done immediately prior to exercise could have potentially detrimental effects in some instances (*i.e.*, decreased muscle strength and endurance, impaired balance, and diminished reaction time) (70). The Personal Trainer should be mindful of this evidence when designing programs for older adult clients and consider sequencing the workout so that stretching follows the cardiorespiratory and/or resistance training components. The exercise prescription principles for flexibility detailed in Chapter 16 are appropriate for older adults. To improve flexibility, older adults should gently increase the length of muscle beyond that used in everyday activities at least 2 $d \cdot wk^{-1}$. This can be done dynamically, statically, or both. Static held positions to stretch the muscles are to be held for 10–30 seconds and stretching should be employed for all the major muscle groups in the body. As noted in Chapter 16, guidelines for flexibility may need to be modified when working with those with functional limitations such as arthritis or osteoporosis.

Design Considerations for Developing Balance in Older Adults

Fall incidence rates currently pose a serious health problem for older adults with 1 in every 4 individuals aged 65 years and older experiencing one fall a year in the United States (71). Decreased balance with aging can be attributable to a series of declines in multiple physiological and psychological systems. These include decreases in joint and muscle flexibility (ROM), muscular strength, reduced central processing of sensory information, slowed motor responses, and declines in executive function (72). With aging, myelin sheaths sometimes exhibit degenerative change, and there is a loss of nerve fibers from the white matter in the brain (73). These changes contribute to a decline in sensory capability and cognitive function. Cognitive executive function is a key leader in the maintenance of independence in older years (74). Sensory capability is also affected by increasing age. Sight, hearing, taste, balance, vestibular function, and proprioception decline in old age leading to a greater risk of falling (41).

Physical activity programs reduce the risk of fall-related injuries in older adults (1). In addition, community-structured programs may be beneficial in long-term exercise participation to promote overall well-being, physical function, and reduce fall risk. It is recommended to incorporate multicomponent physical activity including gait, coordination, and physical function, as well as recreational activities of yoga, tai chi, gardening, and sports (23). Balance ability and postural control are critical factors for performing ADLs and participating in leisure-time activities (1). Balance and postural stability can be enhanced by combining flexibility with resistance exercise (75,76). Personal Trainers should therefore include balance exercises in older adults' exercise programs. Both static and dynamic balance activities should be employed at least twice a week. Progression should occur in a safe environment where a fall would not injure the participant (having spotters, having nearby secure objects to hang on to, and using mats). Progression can take place by steadily reducing the dynamic or static base of support (52). Although research has yet to identify the optimal frequency, duration, and type of balance exercises, balance training may be performed 2–3 d · wk^{-1} (11,23). Balance training can be integrated into various phases of the exercise session, including warm-up, main component, or cool-down. Sample balance exercises and training progression (from simple to complex) are presented in Table 19.10 and are shown in Figures 19.1–19.3.

Table 19.10 Balance Exercises and Training Progression for Older Adults

Position	Balance Exercise
Sitting	■ Sit upright and complete progressions listed below. ■ Perform leg activities (heel, toe, or single-leg raises, marching).
Standing	■ "Clock" — balance on one leg (other leg at 45° or 90° angle), Personal Trainer calls out time, client moves nonsupport leg to the time called out (*i.e.*, 5 o'clock, 9 o'clock), alternate legs. ■ Perform leg activities (heel, toe, or single-leg raises — 45° or 90° angle, marching). ■ "Spelling" — balance on one leg, Personal Trainer asks the client to spell word working with nonsupport leg (*i.e.*, client's name, day of week, favorite food), alternate legs.
In motion	■ Heel-to-toe walking along 15-ft line on floor (first with and then without partner) ■ "Excursion" — alternating legs, lunge over a space separated by two lines of tape. Progress to hopping or jumping (using single-leg or double-leg) back and forth across the space. ■ Dribble basketball around cones that require the client to change direction multiple times.
Training progression	■ Arm progressions: Use surface for support, hands on thigh, hands folded across chest. ■ Surface progressions: chair, balance discs, foam pad, physioball ■ Visual progressions: open eyes, sunglasses or dim room lighting, closed eyes ■ Tasking progressions: single tasking, multitasking (*i.e.*, balance exercise + pass/catch ball)

Number of repetitions per exercise and rest intervals will be dependent on client conditioning and functional status.

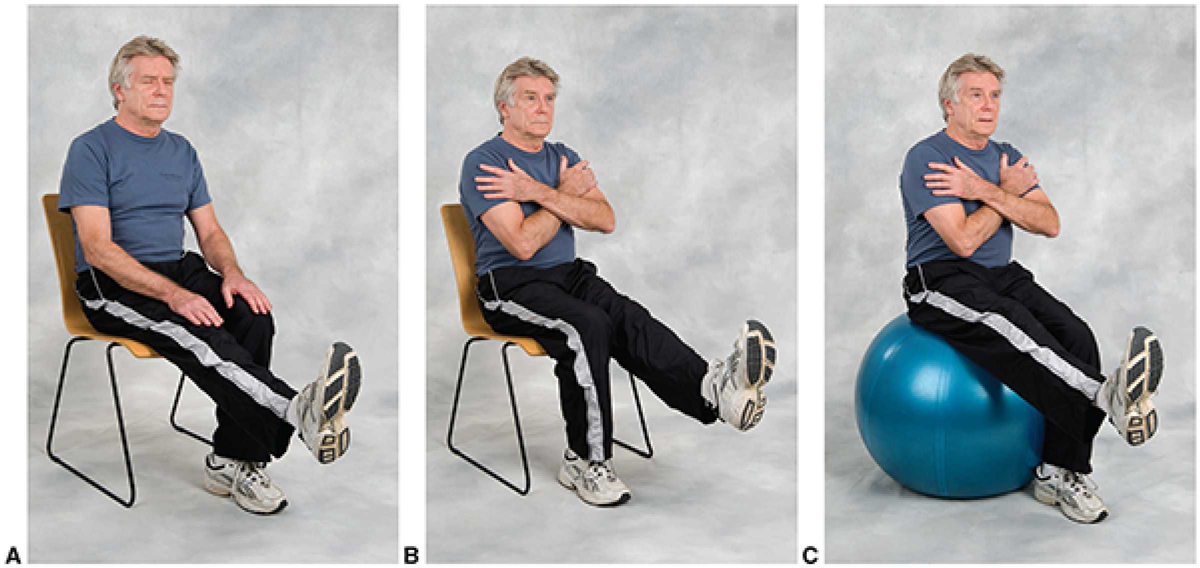

FIGURE 19.1. Sample progression of sitting balance exercises: closed eyes **(A)**, arms crossed **(B)**, and physio ball **(C)**.

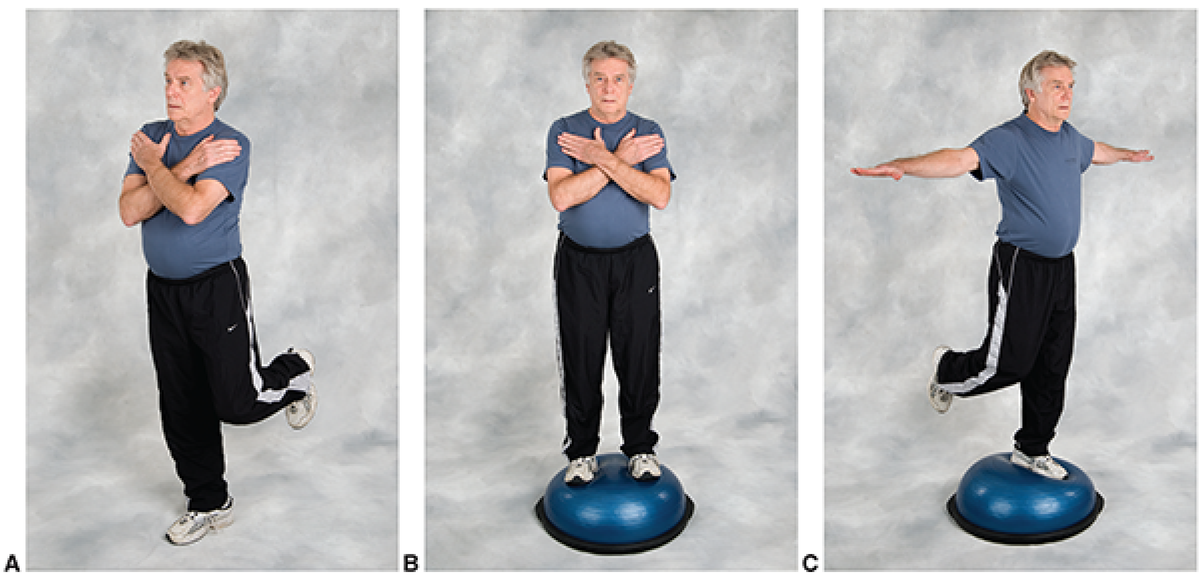

FIGURE 19.2. Sample progression of standing balance exercise, with arms crossed on floor **(A)** and with arms crossed **(B)** and open **(C)** on balance training equipment.

A B C

FIGURE 19.3. Sample progression of in-motion balance exercises: heel-to-toe **(A)**, excursion **(B)**, and multitasking **(C)**.

It is critical that Personal Trainers include balance exercises in older adults' exercise programs.

SUMMARY

This chapter examined exercise prescription throughout the lifespan, which encompassed pregnancy, children, and older adults. Personal Trainers should be aware of special considerations regarding exercise program design for special populations to create effective (and safe) exercise regimens for their clientele. By being aware of and using, the evidence-based guidelines noted in this chapter for pregnancy, children, and older adults, the Personal Trainer will minimize risk of injury during exercise and develop a more individualized exercise plan for his or her specific clientele population.

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CHAPTER 20

Metabolic Disease and Cardiovascular Disease Risk Factors

OBJECTIVES

Personal Trainers should be able to:

- Describe exercise programming for clients with cardiovascular disease, diabetes, dyslipidemia, and hypertension.
- Describe exercise programming for obese clients.
- Understand how to create exercise programs for individuals with comorbidities.

INTRODUCTION

According to physical activity data from the National Health and Nutrition Examination Survey, only 23.3% of Americans self-report meeting both the aerobic and muscle-strengthening physical activity guidelines (1). This value drops considerably (9.6%) when physical activity is characterized using physical activity monitoring devices (2). Physical inactivity is associated with numerous unhealthy conditions, including obesity, hypertension, gestational and Type 2 diabetes, and atherosclerotic cardiovascular disease (CVD) and contributes annually to over 5.3 million global deaths (3). In addition, current trends also show that although Americans are living longer, the number of individuals with chronic diseases continues to increase. Collectively, these factors make it increasingly likely that the Personal Trainer will be interacting with clientele who are other than apparently healthy adults. This chapter discusses the special considerations and scope of practice of exercise program design for the following subpopulations: CVD, diabetes mellitus, obesity, hypertension, and individuals with comorbidities.

Programming for Clients with Cardiovascular Disease

According to data from the National Health and Nutrition Examination Survey, 121.5 million American adults have one or more types of CVD (4). Although the prevalence of CVD-related deaths has declined since the 1980s, it remains the leading cause of death in the United States (4). In fact, the most recent statistics from the American Heart Association indicated that more than 360,000 Americans died of heart disease in 2016 (4). Patterns of nutrient intake and physical inactivity underlie the global epidemic of chronic diseases, including obesity, hypertension, dyslipidemia, and Type 2 diabetes, which all serve as risk factors that contribute to the process of coronary artery disease (CAD). Clearly, a main goal of the Personal Trainer is to help clients with the primary prevention of atherosclerotic risk factors. Personal Trainers should know that individuals who are able to reach the age of 50 years with no CVD risk factors have markedly higher survival rates than those with any combination of risk factors (5). However, even those individuals who have only one risk factor at middle age are at a much higher risk for CVD and CAD than middle-aged people with no risk factors (5). Fortunately, exercise programs that can effectively slow and even reverse the process of atherosclerosis can be designed even for individuals with known CAD.

Programming Goals for Cardiovascular Disease

Positive risk factor modification is the primary goal of an aerobic exercise program for clients with CVD. Scientific research has demonstrated that there is a dose-response relation between exercise and multiple health outcomes, including risk of CAD and all-cause mortality, obesity, dyslipidemia, Type 2 diabetes, and, perhaps most importantly, cardiorespiratory fitness (6,7). Maximal cardiorespiratory fitness, or the body's maximal ability to consume oxygen to produce energy, is an important marker for health outcomes and risk stratification (6). Studies have consistently demonstrated an inverse relation between maximal volume of oxygen consumed per unit time ($\dot{V}O_{2max}$) and CVD and total mortality in men and women across the lifespan (8,9). Moreover, it has been shown that risk for CVD is highest for individuals with low levels of cardiorespiratory fitness even when compared with those with traditional risk factors such as hypertension, dyslipidemia, or obesity (10). Each one metabolic equivalent increase ($3.5\ mL \cdot kg^{-1} \cdot min^{-1}$) in cardiorespiratory fitness can reduce the risk of CVD and all-cause mortality by 8%–25% (10,11). Based on the dose-response relation between exercise and health outcomes, both the American

College of Sports Medicine (ACSM) and U.S. Department of Health and Human Services have noted that the health benefits of a program are closely associated with total weekly energy expenditure (12,13). Studies have shown that exercise programs with energy expenditure of 14–23 kcal · kg^{-1} · wk^{-1} lead to significant improvements in cardiorespiratory fitness and other important risk factors for CAD, including dyslipidemia, body composition, and insulin sensitivity (14–19). In some patients with CVD, high-intensity interval training (HIIT) may have potential for improving $\dot{V}O_2$ peak as compared with standard continuous moderate-intensity exercises (20). Although HIIT is safe within this population when patients are on an optimized medication regimen, an in-depth clinical understanding of the patient's condition and the effects of acute and chronic exercise are needed to safely guide the patient through a training session and promote long-term compliance. Thus, when working with those with heart disease, the Personal Trainer should design an individualized aerobic exercise prescription conforming to the FITT-VP principles and parameters (frequency, intensity, time, type, volume, and progression) to fulfill total weekly volume of exercise that has been shown to elicit positive adaptations to CAD risk factors. Achievement of this objective can positively modify the process of atherosclerosis and subsequently reduce the likelihood of future cardiac events and increase survival (21,22).

Design Considerations for Aerobic Exercise Training for Clients with CVD

Exercise training is relatively safe for the majority of clients with CVD provided that appropriate assessment and screening is performed before beginning the program. The likelihood of an adverse event can be markedly reduced with baseline assessments, preparticipation screening, patient education, and client adherence to established exercise recommendations (12,23). All clients with CVD should have their cardiovascular risk assessed by their physician and gain physician clearance prior to participating in a formal exercise program. Additionally, many patients with CVD have a qualifying diagnosis (*i.e.*, myocardial infarction within the last year, percutaneous coronary interventions, coronary artery bypass graft surgery, heart valve repair or replacement, stable angina, heart failure with a reduced ejection fraction, or heart transplantation) to enroll in an outpatient cardiac rehabilitation program, which has received a class I (*i.e.*, highest recommendation provided by major health organizations based on evidence of efficacy) indication by the American Heart Association. Due to relatively low cardiac rehabilitation referral rates, the Personal Trainer is encouraged to promote these programs to clients that may not have been informed of their existence. A major recommendation for all cardiac rehabilitation participants is to perform "home" exercise on noncardiac rehabilitation session days. This can serve as a good opportunity to continue care with a Personal Trainer or wait until the client completes the cardiac rehabilitation program. In the case that a client has or is actively participating in a cardiac rehabilitation program, Personal Trainers should request information regarding the client's participation, including number of sessions of cardiac rehabilitation completed, types, durations, and intensities of exercise performed as well as any history of adverse events in response to exercise or any special considerations/precautions that should be taken during exercise. After establishing that it is safe for the client with CVD to begin, the specific details of an exercise program can be formulated. Most of the cardiorespiratory assessments described in Chapter 12 can be provided to clients with CVD after proper screening and clinical evaluations including a recent clinical exercise test. The overarching goal of an aerobic exercise intervention is to increase the client's cardiorespiratory fitness. To do so, the exercise stimulus must be at an intensity, duration, and frequency that presents a challenge to the cardiovascular, skeletal muscle, neural, and metabolic systems to initiate the adaptive process in the respective systems. Failure to meet minimal threshold values may result in lack of a training effect, whereas increasing intensity and/or volume too quickly may increase the risk of injuries and other adverse events.

An initial exercise prescription will be largely based on the client's physical capabilities, experience with exercise, and availability of peak or maximal exercise test data. Clients starting at a very low fitness level and/or are frail may need to perform intermittent exercise and gradually increase bout duration, decrease rest time, and progress to completing the desired duration of continuous exercise at moderate intensities, followed by a progressive increase in intensity. The frequency of exercise should start at 2–3 $d \cdot wk^{-1}$, with the ultimate goal of performing 4–5 $d \cdot wk^{-1}$ of aerobic exercise. The general principles of determining exercise intensity in patients with CVD closely follow prescription recommendations for apparently healthy adults, with the main caveat being that intensity is relative to the individual's peak cardiorespiratory fitness. When exercise testing data is available, moderate (40%–59% oxygen uptake reserve [$\dot{V}O_2R$] or heart rate reserve [HRR]) and vigorous (60%–80% $\dot{V}O_2R$ or HRR) intensity are recommended. However, details regarding the conditions in which the exercise test was performed must be considered to appropriately create the respective intensity parameters. In many clinical settings, maximal exercise testing is not employed to generate an exercise prescription but rather used as a diagnostic tool to identify underlying causes of CVD-related symptoms. This scenario commonly requires the patient to withhold any heart rate–limiting medications (*i.e.*, β-blockers) to sufficiently "stress" the heart. If heart rate–limiting medications are continued or added after the initial exercise test, heart rate data acquired during the test should not be used to develop a heart rate–based exercise prescription. Moreover, when an exercise test is not available or the condition in which the test was performed does not reflect the current state of the patient's medication regimen, it is appropriate and recommended to use subjective ratings of effort to prescribe light (rating of perceived exertion [RPE] <12 reflecting <40% HRR), moderate/"somewhat hard" (RPE 12–13 reflecting 40%–59% HRR) or vigorous/"hard" (RPE 14–16 reflecting 60%–80% HRR) (12). In cases when patients may have misinterpreted the RPE scale, the talk test (see Chapter 15) is recommended to verify effort. It is also important to note the limitations of using age-predicted maximal heart rate formulas to create a heart rate–based exercise prescription. Even if a formula derived from patient-specific populations (*i.e.*, β-blocked vs. non–β-blocked or men vs. women) is used, a significant level of variation (standard deviations of 10–15 bpm) (24) across age groups greatly reduces the applicability of these formulas in exercise training settings.

For most previously sedentary clients with CVD, the threshold intensity for improving cardiorespiratory fitness can occur at as little as 42%–55% $\dot{V}O_2R$ (25), performed for 25–40 minutes, 3 d · wk^{-1} (~800 kcal · wk^{-1}). Increasing the volume of activity (*i.e.*, 3,000 kcal · wk^{-1}), whether by intensity, duration, frequency, or a combination of all three can promote greater improvements in fitness, improve metabolic profile, and weight loss in obese patients (26). However, the overarching goal of the aerobic exercise program for all patients is to have a steady progression of total weekly energy expenditure ≥1,500 kcal · wk^{-1} (27).

Other exercise intensity considerations for those with CVD are presented in Table 20.1.

Table 20.1 Exercise Intensity Considerations for Clients with Cardiovascular Disease

Program Modification
Deconditioned and low–functional capacity clients may need to start at low intensities (<40% HRR or $\dot{V}O_2R$).
Target exercise intensity should fall 10–15 bpm below a heart rate that has previously elicited abnormal clinical symptoms (*i.e.*, chest pain or other angina symptoms).
β-Blockers and other heart rate–lowering medications will decrease the accuracy of exercise intensity prescription methods based on an age-predicted maximal heart rate.
RPE levels of 11 (fairly light) to 14 (somewhat hard) typically correspond to the target heart rate for clients with CVD first initiating an exercise program. RPE can be progressed (14–16) relative to the patients tolerance of activity, when conditioning has improved and no complications are present.

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Designing Resistance Training Programs for Clients with CVD

Resistance training in patients with CVD improves muscular strength and endurance, decreases cardiovascular demands of a given task, helps prevent/treat other chronic diseases (*e.g.*, osteoporosis, Type 2 diabetes), increases ability to perform daily activities, and improves self-confidence, among other benefits (12). Two primary goals of resistance training for those with CVD are as follows (27):

1. To maintain and improve muscular fitness levels for performing activities of daily living (ADL)
2. To reduce the cardiovascular demands (*e.g.*, lower heart rate and blood pressure) associated with performing these tasks

Resistance training is widely considered to be safe in patients with well-controlled CVD, provided that proper form through movements are followed while the Valsalva maneuver and tight griping of weight handles/bars are avoided. Generally, deconditioned patients are recommended to first perform roughly 4 weeks of aerobic training to adjust to and tolerate exercise and then begin incorporating resistance training. Progression of resistance training should be gradual, but often, the Personal Trainer may need to accept maintenance of strength as a more realistic objective. Exercise should be terminated if signs or symptoms such as dizziness, arrhythmias, unusual shortness of breath, or chest discomfort occur (12,27). General resistance training guidelines for clients with CVDs are presented in Table 20.2.

Table 20.2 Resistance Training Guidelines for Clients with Cardiac Disease

Program Component	Program Modification
Exercise mode	■ Dynamic muscle-strengthening exercises include machine and free weights, weight-bearing calisthenics, resistance bands, and similar resistance exercises that use major muscle groups. ■ Isometric exercise is not recommended for clients with CVD.

Exercise frequency	■ Resistance training should be performed on 2–3 nonconsecutive days per week.
Exercise intensity	■ Perform 10–15 repetitions per exercise to "moderate" fatigue, which approximately corresponds to an RPE range of 11–13 (light to somewhat hard) on the Borg 6–20 scale.
Exercise session duration	■ Complete one set of each exercise initially and build up to three sets. ■ Perform 8–10 different exercises focused on major muscle groups ■ Allow adequate rest between exercises to prevent carry over fatigue.
Progression	■ Increase slowly as patient adapts (~1–5 lb · wk^{-1} [1–2.3 kg] for upper body and 5–10 lb · wk^{-1} [2.3–4.5 kg] for lower body as tolerated).

Adapted with permission from American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2021.

Additionally, roughly 16% of patients undergoing a CVD-related procedure undergo a sternotomy (4). To maintain safety, the Personal Trainer is encouraged to inquire with the medical team or cardiac rehabilitation staff (if the client attended cardiac rehabilitation) about limitations one should be aware of when designing the resistance training program. Other unique populations that a Personal Trainer may work with are those with a pacemaker and implantable cardioverter defibrillator (ICD). If working with these patients, it is important to know the heart rate threshold for the ICD to deliver a shock and perform exercise at least 10–15 bpm below the threshold; rigorous upper extremity activities (*i.e.*, swimming, bowling, lifting weights, elliptical machines, and golfing) should be avoided at least 3–4 weeks after device implant. However, lower leg aerobic/resistance exercise is allowed.

Programming for Clients with Diabetes

Diabetes mellitus is a metabolic disorder stemming from abnormal pancreatic insulin production and/or diminished peripheral action of insulin.

Diabetes is positively associated with the development of multiple diseases and disorders of the heart, vascular system (*e.g.*, stroke and hypertension), kidneys, eyes, and nervous system. Diabetes seriously compromises the heart and vascular system such that it is listed as the seventh leading cause of death in the United States (28). Patients with CVD and Type 2 diabetes have a fourfold higher incidence rate of cardiovascular events compared to patients who only have CVD (29). Looking at current data, it is clear that diabetes continues to be a significant problem in the United States. To date, 34.2 million American adults (10.5% of the U.S. adult population) have diabetes mellitus. Of that total, 7.3 million undiagnosed cases for adults reported in 2018 (30).

Two categories are used to classify individuals with diabetes: Type 1 and Type 2. Type 1 diabetes typically results from an autoimmune response whereby the body's own immune system mistakenly destroys the insulin-producing cells in the pancreas. Type 1 diabetes comprises approximately 5%–10% of all diagnosed cases of diabetes. This leaves 90%–95% of all diagnosed adults in the category of Type 2 diabetes. In general, the critical risk factors for Type 2 diabetes are associated with a sedentary lifestyle, whereas the primary risk factors include age, family history, ethnicity, obesity, high alcohol intake, high-fat diet, high blood triglycerides (TGs), high blood pressure, and gestational diabetes (31). Moreover, it is estimated that approximately 84.1 million adult Americans (33.9% of the U.S. adult population) and nearly half of adults 65 years or older have prediabetes, a condition in which blood glucose values are elevated beyond normal levels (*e.g.*, fasting blood glucose of 100–126 mg · dL^{-1}); these individuals have a markedly increased risk of developing Type 2 diabetes in their lifetime (30). Although Type 2 diabetes is more commonly associated with adults, it is now on the rise in children, fueled largely by inactivity and poor diets that lead to obesity. Therefore, Personal Trainers should recognize that diabetes prevention is appropriate for all populations not only for the individuals who are obese but also for the older adults and at-risk children.

Diabetes prevention is appropriate for all populations not only for the individuals who are obese but also for the older adults and at-risk children.

Because the growth of diabetes in the U.S. population is not slowing, the demand for competent Personal Trainers to provide appropriate exercise guidance and supervision to individuals with diabetes will continue to increase. Personal Trainers need to prepare to meet this challenge by continuing to enhance their ability to implement diabetes management and prevention programs.

Pathophysiology of Diabetes

Normally, insulin is released in the pancreas in response to a rise in blood glucose following the intake and digestion of food. In Type 1 diabetes, pancreatic β-cells that produce insulin are destroyed by an autoimmune disorder, creating an absolute insulin deficiency (no insulin production) in the body. In Type 2 diabetes, insulin is produced but is ineffective at controlling blood glucose because of insulin resistance in body tissues. The pancreas increases insulin production to overcome this resistance, causing an excess of blood insulin in these individuals. Hyperinsulinemia (elevated blood insulin concentration) over time can contribute to a host of problems such as hypertension, hypercholesterolemia, excessive blood clotting, atherosclerosis, and kidney stones.

The main goal in the management of diabetes is adequately controlling blood glucose levels (12,32). Normal resting blood glucose level is less than 100 mg · dL^{-1}. Diabetes is typically diagnosed when fasting blood glucose is 126 mg · dL^{-1} or greater on two or more occasions or a 2-hour plasma glucose ≥200 mg · dL^{-1} during an oral glucose tolerance test or glycolated hemoglobin (HbA1C) ≥6.5% or symptoms of hyperglycemia/hyperglycemic crisis and a random plasma glucose ≥200 mg · dL^{-1} (33). Although blood glucose numbers describe a single point in time, the HbA1C provides a better measure of glucose control over the last 2–3 months. In people without diabetes, a normal HbA1C value is somewhere between 3.5% and 5.5%. People with diabetes have higher HbA1C values because their bodies have consistently higher levels of blood glucose. A goal level for HbA1C for most people with diabetes is under 7%. Exercise, among other treatment strategies, can be used effectively to achieve this goal (32).

Programming Goals for Those with Diabetes

Exercise training affects many subclinical health factors associated with diabetes and is critical for diabetes management. The main exercise programming goals for individuals with diabetes are to (12,32)

1. Improve insulin sensitivity and blood glucose control and decrease insulin requirements
2. Improve cardiorespiratory fitness
3. Improve blood lipid profiles
4. Reduce blood pressure
5. Improve muscular strength and endurance through enhancing skeletal muscle mass
6. Improve flexibility and joint range of motion
7. Reduce body weight (particularly reduce intra-abdominal fat)
8. Assist with decreasing the risk of diabetic complications

Consistency in a daily routine is the major pillar in diabetes care. This regularity refers to when meals are eaten; the amount and type of food; when medications are taken; and frequency, intensity, and time (duration and time of day) of physical activity. Personal Trainers, when working with clients with diabetes, should maintain regular contact with the client's physician or other health care provider when designing or making changes to the exercise program. This will enable a more consistent and appropriate treatment plan for the client.

Consistency in a daily routine is the major pillar in diabetes care.

Aerobic Training for Clients with Diabetes

The majority of research regarding exercise training and diabetes has been done in the area of aerobic exercise. A hallmark training adaptation to be expected from increased levels of aerobic activity is improved cardiorespiratory fitness; this positive outcome carries tremendous benefit for clients with prediabetes or diabetes. Individuals with higher levels of cardiorespiratory fitness are at decreased risk for mortality from CVD compared with their counterparts with lower cardiorespiratory fitness levels regardless of body mass index (BMI) status (normal, overweight, or obese) (34,35). The positive effects of aerobic exercise on glucose metabolism and insulin sensitivity in clients with diabetes are known to be "subacute" changes, meaning that they are lost within a few days following the cessation of training (32). For Personal Trainers, this provides support for a consistent, almost daily training regimen for clients with diabetes. If these clients are to achieve the full benefits of aerobic exercise, the program must involve frequent exercise activities with daily adherence. Regular exercise in clients with diabetes assists in controlling blood glucose, enhancing insulin sensitivity, decreasing and managing body weight and blood pressure, improving lipid profiles, increasing cardiorespiratory fitness and exercise capacity, and managing some related conditions such as coronary heart disease or peripheral vascular disease (12,32).

Frequency

ACSM recommends 3–7 $d \cdot wk^{-1}$ with no more than 2 consecutive days between sessions of aerobic activity because of the relatively brief exercise-induced improvements in insulin action (32). Greater frequencies of physical activity have been shown to be more effective in improving glucose tolerance and insulin sensitivity with minimal exercise-induced complications (36). Personal Trainers should consider progressing clients to 5 $d \cdot wk^{-1}$, or perhaps daily, with an appropriate mix of intensity and duration. Clients who are obese or are taking insulin may benefit most by a daily schedule because it allows for greater consistency and an opportunity for increasing caloric expenditure for purposes of weight management (32).

Intensity

ACSM recommends a range of 40%–59% of $\dot{V}O_2R$ or HRR for clients with diabetes (12). In the case when exercise testing data is not available, subjective ratings of exertion should be at "moderate" to "very hard." Individual health status is an important consideration when selecting initial exercise intensity. In individuals who are regular exercisers, better blood glucose control may be achieved at higher exercise intensities (≥60% $\dot{V}O_2R$), and these clients may be well suited for HIIT (12).

For clients who are overweight, sedentary, and/or more deconditioned, an appropriate starting point is 40% of $\dot{V}O_2R$ or HRR or slightly lower depending on the initial fitness level and tolerance to exercise. The decision to progress the client through the intensity range is to be made after taking into consideration the client's age, his or her ability to tolerate exercise, and his or her individual goals. In general, frequency and duration goals should be realized before implementing a significant progression in intensity.

Because some clients with a long history of diabetes may incur a condition that can limit the rise in heart rate (and blood pressure) in response to exercise (12,32), Personal Trainers are encouraged to use the RPE scale as an adjunct method for determining intensity, an RPE range of 11–13 (on the 6–20 scale) falls in line with the prescribed $\dot{V}O_2R$ and HRR values with adjustments made on the basis of the percentage values.

Time

ACSM recommends that both Type 1 and Type 2 diabetes clients accumulate a total of at least 150 minutes of moderate- to vigorous-intensity activity per week (12). However, because many individuals with diabetes are also obese, gradually increasing exercise time to 300 min · wk^{-1} is recommended to facilitate improvements in glucose tolerance and insulin sensitivity and potential changes in body weight (36). This amount may seem high for the client who is overweight, deconditioned, or older; however, exercise may be performed in multiple bouts throughout the day to achieve the overall exercise time goal (12,32). Progressing up to 30–40 minutes of continuous activity will help the client achieve his or her caloric expenditure goals.

Type

Guidelines for choosing a mode of exercise are similar to those for an apparently healthy adult. In general, program adherence is improved if the client chooses an exercise modality that he or she enjoys. Walking is the most common form of exercise for clients with diabetes, however, for clients who are obese or experience diabetic complications (peripheral neuropathy is one), Personal Trainers should minimize high-impact, weight-bearing activities or those that require greater balance and coordination (12). Therefore, alternating weight-bearing activities with non–weight-bearing activities, such as cycling, upper body ergometry, and swimming, may enhance the safety and appropriateness of the exercise program.

Progression

Increasing cardiorespiratory fitness and maximizing caloric expenditure are of high priority in clients with Type 2 diabetes (5). Thus, the Personal Trainer should progressively increase exercise duration (either continuous or accumulated) and develop a program that promotes beneficial adaptations while combating boredom.

Resistance Training for Clients with Diabetes

- The ACSM resistance training recommendations for healthy individuals (see Chapter 14) are applicable for people with either prediabetes or Type 1 or Type 2 diabetes, with the understanding that unique contraindications to resistance exercise exist in this population —

including retinopathy, neuropathy — and following recent treatments using laser surgery (12). A resistance training program is essential for clients with diabetes to assist in managing their disease and associated complications as well as maintaining their physiological function through improving strength and endurance. Some data suggests that the increased risk of diabetes with increasing age is partly related to loss of muscle mass. This age-related muscle atrophy negatively impacts the ability to remain recreationally active, perform ADL, and maintain independence (37). Resistance training should be encouraged for individuals with diabetes or prediabetes in the absence of contraindications, such as uncontrolled hypertension, severe proliferative retinopathy, and recent treatments using laser surgery. Higher resistance (*i.e.*, heavier weight) may be beneficial for optimization of skeletal muscle strength, insulin action, and blood glucose (38) control, although moderate resistance may be equally effective in previously sedentary individuals.

- Appropriate progression of resistance exercise is important to prevent injury. Beginning training intensity should be moderate, involving 10–15 repetitions per set, with increases in weight or resistance undertaken with a lower number of repetitions (8–10) only after the target number of repetitions per set can consistently be exceeded. This increase in resistance can be followed by a greater number of sets and lastly by increased training frequency (39).

There has been an accumulation of evidence demonstrating the effectiveness of circuit weight training for managing diabetes (40). Clients would be well advised to perform circuit weight training regularly to regulate blood glucose and prevent age-related muscle atrophy. In fact, for individuals with diabetic complications such as retinopathy, circuit training with fairly light workloads is recommended because blood pressure will not increase or spike as much as it does with higher loads. In summary, using resistance training to maintain skeletal muscle mass is known to be critical for managing and improving glycemic control and insulin sensitivity, decreasing HbA1C levels, reducing intra-abdominal fat, and improving the overall metabolic profile and quality of life in those with diabetes (12,32).

Special Considerations for Clients with Diabetes

When creating individualized training programs for persons with diabetes, there are other health concerns that often accompany diabetes that need to be considered. Clients with diabetes should check their blood glucose before exercise. Ideally, blood glucose levels need to be between 100 and 250 mg · dL^{-1}. If they are lower than this, the client should eat a carbohydrate-rich snack. Clients with Type 1 diabetes are recommended to check for urine ketones when blood glucose levels above ≥250 mg · dL^{-1} before starting to exercise (12). In the presence of urine ketones, clients are advised not to exercise and should inform the physician managing their diabetes.

Exercise has an insulin-like effect on circulating blood glucose, even in the absence of blood insulin. Thus, hypoglycemia (low blood glucose levels) is one of the most common but potentially serious complications that can occur during or after exercise in individuals with diabetes. The following strategies may be helpful for minimizing a client's risk of developing hypoglycemia.

1. Know the warning signs of hypoglycemia and hyperglycemia (Table 20.3).
2. Avoid exercise during the time when hypoglycemic medication is working at its peak.
3. Client should eat 1–2 hours before exercise (perhaps, eat a snack during exercise if duration is prolonged).
4. Check blood glucose before exercise, and if blood glucose is less than 100 mg · dL^{-1}, the client should eat a snack.
5. Client should exercise with a partner for safety reasons.
6. Have fruit juice or candy available if blood glucose gets too low.
7. Check blood glucose after exercise, and if blood glucose is less than 100 mg · dL^{-1}, the client should eat a snack.

Table 20.3	Selected Signs and Symptoms of Hyperglycemia and Hypoglycemia
Hyperglycemia (>300 mg · dL^{-1})	Hypoglycemia (<70 mg · dL^{-1} or rapid drop in glucose)
Polyuria	Shakiness
Fatigue	Weakness
Weakness	Abnormal sweating
Increased thirst	Nervousness
Acetone breath	Anxiety
Unexplained weight loss	Tingling of the mouth and fingers
Headache	Hunger
Trouble concentrating	Headache
	Visual disturbances
	Mental dullness
	Confusion
	Amnesia
	Seizures
	Coma

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Clients with diabetes are to work with their physician and/or registered dietitian nutritionist for nutritional recommendations related to controlling blood glucose with exercise. Clients need to be made aware that exercising in the evening may increase risk of hypoglycemia within the 36 hours following exercise compared to exercising in the morning (41). Thus, if evening exercise cannot be avoided, the clients should eat following exercise according to their physicians' or registered dietitian nutritionist's guidelines. Personal Trainers who work with clients with diabetes should be knowledgeable of, and able to educate clients about, the warning signs of hypoglycemia. Table 20.3 includes a list of selected signs and symptoms of hyper- and hypoglycemia.

Clients need to be taught the exercise guidelines that are specific for proper management of diabetes. For example, warm-up and cool-down (5–10 min each) are particularly important in this population to avoid exercise-induced cardiovascular complications. Proper footwear is also critical for clients with diabetes, especially for those with or at risk for peripheral neuropathy and peripheral vascular disease. Clients need to be advised to maintain adequate hydration and avoid exercise in hot/humid environments, which will allow them to tolerate exercise better and will assist in proper blood pressure and body temperature regulation. Also, remember to recommend lighter resistance training workloads to avoid high blood pressure spikes (especially in those with retinopathy).

In summary, the main programmatic considerations for Personal Trainers who work with clients with diabetes involve minimizing the risks involved with exercising while maximizing benefits. In cases where the individual has complications of diabetes such as diabetic retinopathy, peripheral neuropathy, or nephropathy, consult the client's physician before beginning the exercise program. These clients may need referral to a medically supervised environment if the condition limits overall exercise tolerance or if they have signs and/or symptoms of CVD.

Programming for Clients with Dyslipidemia

Elevated plasma lipid levels, or dyslipidemia, is a prevalent health concern in many Westernized countries. Readily available high-fatty foods and low physical activity levels are the primary contributors to the development of dyslipidemia. These clients have elevated plasma levels of total cholesterol or low-density lipoprotein (LDL), elevated levels of TGs, or low levels of high-density lipoprotein (HDL). Nearly half (48.6%) people in the United States older than the age of 40 years are eligible to be medically treated for dyslipidemia according to the 2018 guidelines on the management of blood cholesterol (42). If gone untreated, dyslipidemia poses a significant risk for developing CVD (43).

Adopting healthy living practices (modifying diet and increasing physical activity levels) can facilitate the decrease in lipid levels for those with or without cholesterol lowering medications. Regular aerobic exercise training has been shown to decrease LDL levels by 3–6 $mg \cdot dL^{-1}$ but conflicting findings exist on its ability to alter HDL or TG blood levels (44). Some evidence exists to suggest that resistance training can reduce LDL and TG concentrations by 6–9 $mg \cdot dL^{-1}$, but results have been less consistent as compared to aerobic exercise (45). Furthermore, modifying one's diet and losing weight play a significant role in improving the plasma lipids levels in clients diagnosed with dyslipidemia (46).

Although exercise and a healthy diet are the first-line defense in preventing and managing dyslipidemia, statin therapy has proven to be an effective for the treatment that improves survival by preventing myocardial infarctions and stroke (47). Clients should therefore be encouraged to follow their physician's medication regimen recommendations to treat dyslipidemia in addition to lifestyle changes to prevent future adverse events from occurring (45, 47, 48).

Exercise Prescription

The FITT-VP principle for individuals with dyslipidemia without comorbidities is very similar to the exercise prescription for healthy adults. One major consideration for those with dyslipidemia is that weight maintenance should be a major area of focus. Therefore, the progression of exercise volume should work toward maximizing energy expenditure for weight loss, similar to what is recommended (250–300 $min \cdot wk^{-1}$) for overweight and obese clients (49). Individuals should aim to exercise at least 5 $d \cdot wk^{-1}$ at an intensity of 40%–75% $\dot{V}O_2R$ or HRR. Each exercise session can range from 30 to 60 minutes to promote or maintain weight loss; however, 50–60 $min \cdot d^{-1}$ is recommended (12). Resistance exercise training should also be incorporated into the exercise regimen and not as a replacement for aerobic exercise. Similar resistance exercise prescription recommendations apply to individuals with dyslipidemia as health individuals. It should be performed 2–3 d · wk^{-1}, at moderate (50%–69% of one repetition maximum [1-RM]) to vigorous (70%–85% of 1-RM), two to four sets and 8–12 repetitions per set for strength. To promote muscle endurance, less than or equal to two sets, 12–20 repetitions should be completed (12).

Other Considerations for Working with Clients with Dyslipidemia

- Individuals who have developed dyslipidemia as a result of poor eating habits and a physically inactive lifestyle may also have other conditions such as the metabolic syndrome, obesity, and hypertension. If so, the exercise prescription should be modified to accommodate the condition that presents the greatest limitation as discussed in specific guidelines within this chapter and other ACSM resources (49,50).
- Individuals beginning an exercise program may have low fitness levels that reduce their tolerance to continuous activity. Therefore, intermittent aerobic exercise may be performed to accumulate the duration recommendations (30–60 min per session).

Special Consideration

- Clients taking lipid-lowering medications (*i.e.*, statins and fibric acid) may experience muscle weakness and soreness. Although rare, these medicines can cause direct and severe muscle injury. The Personal Trainer should encourage the client to inform his or her health care provider of persistent muscle soreness when exercising while taking these medications.

Programming for Obese Clients

Obesity is currently defined as having a BMI greater than 30 kg · m^{-2} (28). There has been a considerable rise in the number of people meeting the obesity classification. It has been estimated that 39.8% of U.S. adults are classified as being obese and has been shown to be highest in non-Hispanic Black women with obesity rates of 54.8%, followed closely by Hispanic women (50.6%) (51). More sobering is the continuing rise of overweight/obesity in children and adolescents. The percentage of children 6–11 years of age considered obese increased from 13.9% in 1999–2000 to 18.5% in 2015–2016 (51). These data and the known health consequences of obesity require the widespread application and adoption of healthy lifestyle behaviors, particularly physical activity and exercise training.

Reasons for the rising obesity levels are very complex and result from a number of factors including increased caloric consumption (overconsumption), decreased levels of physical activity, genetic predisposition, disease, and cultural/environmental (home, school, work, and community) influences. The close association of obesity with physical inactivity as well as to numerous chronic health issues such as Type 2 diabetes mellitus, CVD, hypertension, and certain types of cancers tend to obscure understanding its cause and may complicate treatment. Although obesity is linked to an increased risk of disability and all-cause mortality, it is not clear if this is a causal association or a result of inactivity. Personal Trainers who work with obese clientele should be prepared to interact and consult with a variety of professionals to design appropriate and effective exercise programming strategies.

Programming Goals

Personal Trainers can make their greatest impact with obese clients by providing sound exercise programs that focus on promoting adherence to an active lifestyle that matches closely with appropriate dietary strategies. This is a challenge because it is common for overweight or obese individuals to have many deeply rooted negative attitudes and barriers to physical activity behavior that must be addressed before they can truly adhere to a program. The common exercise program goals for obese individuals are to (12,49)

1. Maximize caloric expenditure
2. Maintain or increase lean body mass to maintain resting metabolic rate
3. Improve metabolic profile
4. Lower the risk of comorbidities (*e.g.*, hypertension, diabetes, orthopedic problems)
5. Lower mortality risk
6. Promote appetite control
7. Improve mood state

Aerobic Training for Obese Clients

The most recent ACSM position stand (49) recommends a minimum of 150 $\text{min} \cdot \text{wk}^{-1}$ of moderate-intensity physical activity for overweight and obese adults to improve health and to prevent significant weight gain. However, greater weight loss and enhanced prevention of weight regained will likely need much greater doses (approximately 225–420 $\text{min} \cdot \text{wk}^{-1}$) of moderate-intensity physical activity (49). Importantly, most evidence indicates that exercise alone (without dietary restriction) is fairly ineffective for weight loss, with an average of less than a 3% decrease (49).

> Most evidence indicates that exercise alone (without dietary restriction) is fairly ineffective for weight loss.

Extreme exercise or physical activity that results in a large negative energy balance will clearly result in weight loss. However, it is difficult for most individuals to achieve and sustain these high levels of physical activity. Therefore, most individuals who require substantial weight loss may need additional interventions (*i.e.*, energy restriction) to meet their weight loss goals. In terms of successful weight loss, diet with caloric restriction is the most important predictor. However, regular aerobic exercise should be used in concert with a low-calorie, low-fat, and high-fiber diet plan, thereby helping provide a negative caloric balance to achieve weight loss through maximizing energy expenditure (12). To facilitate 1–2 lb · wk^{-1} weight loss, it is generally recommended to reduce energy intake by 500–1,000 kcal · d^{-1} (12). Most importantly, once weight loss has occurred, regular physical activity in the form of exercise is the most significant predictor of long-term weight management.

Frequency

ACSM recommends a training frequency that builds up to 5 or more days per week to maximize energy expenditure in obese clients (12). Several studies have shown the effectiveness of a high-frequency exercise program on fat loss provided that the intensity is set appropriately (52).

Intensity

Moderate- to vigorous-intensity aerobic activity is encouraged (12). Initial intensities should be determined based on current fitness level (*e.g.*, 40%–59% $\dot{V}O_2R$ or HRR). Later progression into more vigorous intensities (>60% $\dot{V}O_2R$ or HRR) may be appropriate for some obese clients but should be individualized on the basis of the client's goals and history. Past research supports moderate-intensity exercise as an effective method for supporting weight loss and successful weight management (53).

Time

ACSM recommends 30 min · d^{-1} (150 min · wk^{-1}) of exercise while progressing gradually to 60 min · d^{-1} or more (250–300 min · wk^{-1}) per day (12). This amount of exercise is consistent with past research and previous guidelines for weight loss and weight management strategies (49,53). However, some clients may be too severely deconditioned or have conditions that limit their ability to exercise for this long. In these cases, prescribing multiple bouts of exercise (10 min per session or more) may be best to begin with and gradually shift to more continuous exercise later in the program(12,54). Although this is more than the recommended level of exercise needed to support general health and prevent chronic disease, successful weight control may be more likely when obese clients are exercising 45–60 minutes per session (200–300 min · wk^{-1}), expending at least 2,000 kcal or more per week (12).

Type

Regular exercise is important for general health and not only for weight loss. Thus, any type of physical activity that the client will do regularly is recommended. However, the primary mode of exercise for large clients should involve large muscle groups and be aerobic in nature to provide the greatest caloric expenditure during exercise (12). Often, resistance training exercise is an appropriate adjunct mode of exercise for obese clients because it can be done without having to support the added weight of the body. This exercise should be in addition to an overall increase in leisure-time physical activity and decreased sitting time.

Resistance Training for Obese Clients

Resistance training programs are commonly treated as an adjunct to a regular, aerobic exercise program and generally should not be used in lieu of an aerobic program. However, resistance training is a critical component of the total exercise program for obese clients and should be incorporated into the program. The benefits of resistance training for clients who are obese are similar to the apparently healthy adult; thus, following the resistance training guidelines highlighted in Chapter 14 is appropriate for obese and overweight clients.

Although there is little evidence that resistance training will reduce body weight without any modification of diet, resistance training has been associated with improvements in many chronic disease risk factors in the absence of significant weight loss (49). Resistance training has been shown to improve blood cholesterol, improve insulin sensitivity, reduce glucose-stimulated plasma insulin concentrations, and improve systolic and diastolic blood pressure (49). In addition, resistance training may also improve the maintenance of lean body mass in clients following a calorically restricted diet (55).

Resistance training may also improve the maintenance of lean body mass in clients following a calorically restricted diet.

Weight Loss Expectations

One major barrier to increasing exercise behavior in obese clients is an unrealistic weight loss expectation. Most people do not understand that exercise alone is not very effective for reducing weight. The Personal Trainer should explain that exercise is beneficial even if weight loss goals are not met. The ACSM recommends that overweight and obese individuals try to reduce their body weight by a minimum of 5%–10%, a value that is associated with initial improvements in risk factors. However, 150 min · wk^{-1} may only elicit up to 3% weight loss (49). Thus, much higher doses of physical activity combined with diet restriction are typically necessary to elicit significant weight change. For example, those in the National Weight Control Registry, who have lost and maintained a substantial amount of weight, report expending the energy equivalent to walking 25–30 miles · wk^{-1} (or more than 400 min · wk^{-1}) regularly (56).

Unfortunately, sometimes, the unrealistic expectations of clients are fostered by Personal Trainers themselves. In a survey of 500 health and fitness professionals (57), 87% responded that they felt “very competent” to prescribe exercise programs for weight loss. In other words, Personal Trainers believe that they can prescribe the amount of energy expenditure necessary for one to lose weight. However, other research indicates that Personal Trainers cannot deliver on their weight loss promises and that obese clients are extremely dissatisfied with their performance (58,59). Dissatisfaction with treatment results runs deep among persons seeking help for obesity (58). For example, obese clients who were asked about potential weight loss results indicated that a minimum of 25% weight loss was acceptable but not ideal. In addition, they noted that 17% weight loss “could not be viewed as successful in any way” (58). Clearly, there is no exercise prescription that the Personal Trainer can suggest that will elicit a 20% or greater weight loss. This amount of weight loss requires careful caloric restriction that should be done under the supervision of a registered dietitian nutritionist. Thus, Personal Trainers need to be mindful of the inconsistency between reality and expectation when working with obese clients. Thus, whereas obese clients need to understand that exercise is not a quick fix, Personal Trainers also need to understand that obesity is not caused by a simple imbalance in energy expenditure. Obesity is a heterogeneous condition that requires a multifocal treatment plan, and there is wide variability in weight loss outcomes in obese people regardless of program design. There is no singularly appropriate weight loss treatment plan for all obese people.

Personal Trainers are obligated to educate obese clients that inactivity may be the problem not body weight per se. Trainers should instruct their clients that exercise and increasing physical activity will improve health but may not cure obesity. The exercise threshold required to improve one’s health may be far below the exercise threshold required for weight loss (60). In other words, exercise is good for them regardless of whether or not they lose much weight.

Personal Trainers are advised to not generalize that obese individuals lack self-control (61) or rationalize that weight loss failure is solely a consequence of poor client compliance. As stated previously, obesity is a complex issue and successful long-term behavior change takes a multidimensional approach. Personal Trainers are encouraged to obtain further experience in motivational counseling, goal-setting strategies, and determining readiness for change before planning to work with obese clients.

Other Considerations for Working with Obese Clients

First, obese clients do not regulate their body temperature as effectively as leaner clients (12). Therefore, Personal Trainers should educate their clients on proper exercise clothing, hydration, environmental issues (hot/humid environments), and signs of heat exhaustion/stroke. Second, obese clients are at greater risk of experiencing orthopedic injuries because of greater stress on joints due to their overall weight (12). Personal Trainers should keep this in mind during program design, in particular with the intensity portion. Considerations should also be made to include non–weight-bearing modalities when appropriate to minimize orthopedic stress. Also, Personal Trainers should be prepared to modify the exercise program on the basis of the presence of other conditions (diabetes, CAD, hypertension, etc.) that may require an adjustment from the prescription given earlier. Lastly, because of size limitations, some exercise machines may not be able to accommodate an obese client. Personal Trainers may need to be creative in their exercise planning and use equipment that can accommodate their particular clients (12). Table 20.4 includes some additional recommendations to follow for weight loss programs.

Table 20.4 Additional Recommendations for Weight Loss Programs

Gradual weight loss of 1 kg · wk^{-1} or less
Daily, negative caloric balance should not exceed 500–1,000 kcal.
Target a minimal reduction in body weight of at least 3%–10% of initial body weight over 3–6 months.
Employ behavioral modification strategies to enhance adherence.
Balanced diet with fat intake <30% of total calories consumed

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Personal Trainers should be prepared to modify the exercise program on the basis of the presence of other conditions (diabetes, CAD, hypertension, etc.).

Programming for Clients with Hypertension

With nearly half (46%) of the adult population with hypertension, it remains the most prevalent risk factor for CVD in the United States (62). Hypertension is the major contributor to the risk of stroke and is also related to the development of CAD (leading to myocardial infarction), heart failure, kidney disease, peripheral vascular disease, and blindness (12). Hypertension is often called the "silent killer" because of the lack of noticeable signs or symptoms of the disease until the development of serious problems. The updated definition of hypertension is an elevated resting systolic blood pressure of ≥130 mm Hg and diastolic blood pressure of ≥80 mm Hg. However, definitions now recognize elevated blood pressure (systolic blood pressure between 120 and 129 mm Hg with diastolic <80 mm Hg) as an equally important diagnosis (62). These lower blood pressure values indicate the need for early management of moderately elevated levels of blood pressure to help prevent hypertension.

Hypertension is often called the "silent killer" because of the lack of noticeable signs or symptoms of the disease until the development of serious problems.

The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure indicated that in people with blood pressure >115/75 mm Hg, CVD risk doubles for each increment of 20/10 mm Hg (63). Personal Trainers can make a positive impact on their clients who have hypertension or prehypertension through appropriate exercise programming as part of a comprehensive lifestyle management strategy (diet, stress reduction, smoking cessation, lower alcohol consumption, etc.) or medication regimen (64,65).

Programming Goals

General programming goals in the management of hypertension are to (50,62)

1. Lower systolic and diastolic blood pressures at rest and during exercise
2. Lower the risk of mortality from CVD (myocardial infarction, stroke, heart failure, etc.)
3. Lower the risk of other comorbidities (kidney disease, eye problems, diabetes, etc.)
4. Incorporate opportunities for clients to pursue other lifestyle changes (stress management, diet, smoking cessation, weight management, etc.)

Aerobic Training for Clients with Hypertension

Aerobic exercise is the cornerstone activity in the total program for clients with hypertension. On average, clients may experience a decline of approximately 3–5 mm Hg for systolic blood pressure and approximately 2–4 mm Hg for diastolic blood pressure from aerobic exercise training (64,66). Greater change may be seen in those with diagnosed hypertension (~6–8 mm Hg and 5–6 mm Hg in systolic and diastolic blood pressure, respectively) (67). These changes in blood pressure due to physical activity alone may not seem significant; however, when coupled with other treatment strategies (diet, medication, etc.), the effect will be much more appreciable. Several studies have shown that higher cardiorespiratory fitness provides a cardioprotective effect of lower mortality risk from all causes and CVD in individuals with hypertension (68). Thus, improving overall fitness in clients with hypertension may be a worthy goal to pursue, independent of the direct effects exercise may have on lowering blood pressure.

Frequency

ACSM recommends exercise for clients with hypertension on most, if not all, days of the week. This is primarily due to greater decreases in resting blood pressure with increased frequency/duration (>150 min · wk^{-1}) of activity (69). Therefore, Personal Trainers should encourage their clients to participate in daily, regular exercise to promote more controlled and consistent blood pressure levels from day to day, which is ideal for clients with hypertension.

Intensity

ACSM recommends moderate-intensity exercise, 40%–59% of $\dot{V}O_2R$ or HRR, as the primary-intensity prescription for individuals with hypertension (5,7). Personal Trainers should apply the lower end of this range for hypertensive clients who are deconditioned, older, or have comorbid conditions that can affect their risk of experiencing cardiovascular complications during exercise (diabetes, CAD, etc.).

RPE can be used to help determine intensity rather than HR in the presence of certain medications that can affect the client's HR response during exercise (*i.e.*, β-blockers). An RPE range of 12–13 (on a 6–20 scale) is appropriate for these clients to achieve moderate-intensity exercise.

Time

ACSM recommends an exercise time of 30–60 minutes of continuous or accumulated exercise per session. Exercise duration goals are to be based on individual goals and personal history (12). A caloric expenditure goal of 2,000 kcal or more per week is indicated to help treat persons with hypertension especially if weight loss is also a goal.

Type

Clients with hypertension should primarily engage in aerobic endurance activities that involve large muscle groups and are rhythmic in nature. Avoid activities that emphasize isometric muscle contractions or that may elicit large blood pressure responses in your clients.

Progression

The basic principle of progression generally applies to those with hypertension. Specific consideration should be given to blood pressure control, recent changes in blood pressure medications, and the other comorbidities that may be present. Progression must be gradual and avoid large increases in any of the FITT-VP components, especially intensity for most people with hypertension.

Resistance Training for Clients with Hypertension

Resistance training is considered a supplement to aerobic exercise and should not be prescribed as the primary form of activity for clients with hypertension (12). When supplementing with resistance training, intensity should be kept at 60%–70% 1-RM, which may be progressed to 80% of 1-RM (12). Although studies have demonstrated a favorable blood pressure response to resistance training, the overall effect is not as great as the response to aerobic exercise training (70). Specific resistance training recommendations for these clients are similar to those used for apparently healthy adults. In addition, teaching clients proper exercise technique, proper breathing, and avoiding larger amounts of isometric work during resistance training will also help minimize large increase in blood pressure.

Other Considerations for Clients with Hypertension

The primary focus of these considerations is safety during and after exercise. As stated previously, hypertension is often associated with a variety of conditions that may require special attention and specific precautions during exercise. In these cases, the general exercise prescription may need to be modified to address these issues (7).

Hypertension is often associated with a variety of conditions that may require special attention and specific precautions during exercise.

The majority of clients with hypertension are likely to be taking some form of antihypertensive medication. Although a decrease in blood pressure following exercise is to be expected, the greatest risk these medications pose is in eliciting an abnormal drop in blood pressure (hypotension) following exercise. Therefore, engaging in gradual and prolonged cool-down activities will be important in minimizing the risk for excessive postexercise hypotension. The cool-down should never be omitted for sake of time. Antihypertensive medications are diverse in their overall action and number. As stated previously, β-blockers lower the heart rate response to exercise, whereas angiotensin-converting enzyme inhibitors lower blood pressure by preventing vasoconstriction without a significant change in heart rate. Thus, Personal Trainers are encouraged to familiarize themselves regarding the types, names, actions, and what the exercise responses are to these medications before working with hypertensive clients. The *ACSM's Guidelines for Exercise Testing and Prescription* (12) is an excellent text to use as a starting point for this information.

Lastly, Personal Trainers working with this population are encouraged to gain skill or enhance existing skills in blood pressure monitoring. Accurate measurement of blood pressure before, during, and after exercise will enhance the safety and appropriateness of the client's program. Precautions dictate that exercise be avoided if resting blood pressure exceeds 200/110 mm Hg and exercising blood pressures should remain below 220/105 mm Hg (12).

Programming for Clients with Comorbidities

In the past century, life expectancy in the United States increased from less than 50 years to greater than 76 years. The United States Census Bureau has projected that by 2030, the number of adults 65 years of age and older will be approximately 70 million. However, current trends also show that although Americans are living longer, the number of individuals with chronic diseases continues to increase. Approximately 80% of individuals aged 65 years or older are living with at least one chronic health problem (71), and another 62% are living with two chronic conditions (72). Moreover, the presence of chronic conditions is linked with an even greater propensity of comorbidities, and it is, therefore, increasingly likely that the Personal Trainer will be interacting with clientele that have multiple chronic conditions.

> Approximately 80% of individuals aged 65 years or older are living with at least one chronic health problem, and another 62% are living with two chronic conditions.

A clear shortcoming of many health care models for the management of chronic conditions is that treatment has historically been approached in a singular fashion. Patients infrequently receive guidance from medical professionals on prioritizing and managing multiple chronic conditions (73). The challenge of working with individuals with comorbidities is understanding that the presence of multiple conditions may compete with a client's self-management resources, thus reducing the time and energy an individual has remaining to devote to each and every condition (74). For instance, an individual with a severe and symptomatic condition, such as heart failure, will likely have lower prioritization of other conditions (*e.g.*, Type 2 diabetes). In turn, these individuals require additional assistance and resources to ensure that their other conditions are managed effectively. Establishing multidisciplinary partnerships is one mechanism by which the Personal Trainer can ensure clients receive the appropriate clinical attention for respective conditions (64,75).

ACSM and the American Heart Association list sedentary lifestyle as a controllable risk factor for many chronic health conditions (12,76).

Accordingly, exercise is a common therapeutic intervention strategy, and although there are exercise program guidelines for older adult and various chronic-diseased populations, these recommendations exclusively address each group separately. This section explains critical measures that can be taken to design safe and effective exercise programs for clients with multiple chronic conditions or those with comorbidities.

Programming Goals

General programming goals in the management of clients with comorbidities are to

1. Lower the overall risk of mortality by identifying the condition with the highest mortality risk; prioritize exercise program design around this condition.
2. Recognize that the presence of comorbidities may serve as competing demands on client's self-management resources, thus reducing time and energy an individual has remaining to devote to each and every condition; these individuals will require additional guidance and resources provided by the Personal Trainer to ensure that all conditions are managed effectively.
3. Have realistic expectations for the expected improvement for all comorbidities; and there will be instances where maintaining functional capacity or stabilizing the disease process can, and should, be viewed as a successful outcome.

Training for Clients with Comorbidities

Exercise training is relatively safe for the majority of clients with multiple chronic conditions provided that appropriate assessment and screening is performed prior to beginning the program (12). The likelihood of an adverse event, although not entirely preventable, can be markedly reduced with baseline assessments, risk stratification, patient education, and client adherence to established exercise recommendations. It is likely that individuals with multiple chronic conditions will be stratified into a high-risk category and therefore will require physician clearance and consent to participate in an exercise program. Clients with comorbidities require a high degree of monitoring to ensure proper adherence of the established exercise regimen and to determine that the physiological responses to each session are normal. Personal Trainers should be knowledgeable of, and able to educate clients about, the potential signs that would warrant the termination of exercise. Importantly, clients and Personal Trainers alike should consult with the medical team about any specific limitations to be aware of when designing the exercise program.

In general, the exercise prescription for individuals with comorbidities can follow the FITT-VP framework. Table 20.5 provides a summary of the basic evidence-based guidelines for common clinical populations. This resource can assist with establishing the basic parameters of the exercise prescription around the various conditions of an individual. For example, consider an individual who has arthritis, dyslipidemia, hypertension, and Type 2 diabetes. One strategy to employ, when designing the program, is to follow the specific exercise prescription for the chronic condition that poses the greatest risk of mortality for the individual. In this instance, Type 2 diabetes is generally considered to increase the risk for heart disease and all-cause mortality (77) to a greater extent compared to the other conditions. Other chronic conditions and specific limiting symptoms must also be carefully considered when formulating the program. In this instance, the frequency and time parameters of the exercise prescription for each condition are comparable. Yet, there are some marked differences in the exercise intensity recommendations between conditions. Therefore, it is prudent for the exercise professional to adopt the appropriate exercise prescription for the most restrictive condition.

Table 20.5 A Quick Glance at the Aerobic Exercise Prescription for Common Clinical Populations

Condition	Frequency	Intensity ($\dot{V}O_2R$ or HRR)	Time

	($d \cdot wk^{-1}$)		($min \cdot d^{-1}$)
Arthritis	3–5	40%–59%	20–30
Cardiac disease	3–7	40%–80%	20–60
Dyslipidemia	≥5	40%–75%	30–60
Hypertension	Most, if not all	40%–59%	30–60
Obesity	≥5	40%–59% (with potential progression to more than 60%)	30–60
Osteoporosis	4–5	40%–59%	30–60
Type 2 diabetes	3–7	40%–59% (60% $\dot{V}O_2R$ or HRR or higher for those already active)	20–60

Moderate-intensity resistance exercise is recommended 2–3 $d \cdot wk^{-1}$ in addition to the amount of aerobic exercise specified earlier.

From American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription*. 11th ed. Philadelphia (PA): Wolters Kluwer; 2021.

Occasionally, a chronic condition may become the primary focus for training rather than the comorbidity that has the highest mortality risk. For example, arthritis is characterized by periodic episodes of acute inflammation. Pain and discomfort are common throughout these flares, and without sufficient caution, exercise can actually exacerbate the symptoms (12). Under these circumstances, it would be ill-advised to pursue the exercise prescription guidelines for Type 2 diabetes despite its status as a higher risk for mortality. In this case, an exercise prescription resembling the recommendation guidelines for arthritis would be more suitable and may require consultation with the individual's health care provider.

Other Considerations for Clients with Comorbidities

The greatest challenge for Personal Trainers in designing exercise programs for clients with comorbidities is the amount of planning required. Considerable preparation is involved in designing programs to be safe (during and after exercise) and effective. The complexity of working with clients possessing multiple chronic conditions requires a thorough preparticipation screening. Baseline assessment and screening will help identify central problems that can prove useful in designing the exercise program and recognizing limitations. For example, insulin resistance is likely to be associated with obesity, hypertension, dyslipidemia, and other metabolic disorders. Likewise, a client with Type 2 diabetes may be expected to suffer from complications of neuropathy, retinopathy, or other microvascular complications. Individuals with multiple comorbidities may also possess conditions (*e.g.*, low back pain, lupus, osteoarthritis, fibromyalgia) that fluctuate significantly within or between days in terms of severity. For example, sometimes pain levels “flare” in the early morning other times they increase just before bed. Personal Trainers must be prepared to accommodate an ever-changing chronic condition landscape with these types of clients and constantly adjust the session to best serve the client on any given day.

Although experienced Personal Trainers can work with clients with stable chronic disease who are able to exercise independently, it is important to recognize situations when consultation with medical personnel is necessary and/or when the Personal Trainer should not take on a new client (*e.g.*, inappropriate changes of resting or exercise heart rate or blood pressure; new-onset discomfort in the chest, neck, shoulder, or arm; changes in pattern of discomfort during rest or exercise; shortness of breath at rest or with light exertion; fainting or dizzy spells; and claudication). Personal Trainers need to know the limits of their expertise and consider additional training and certification to work in concert with medical personnel in helping clients with multiple serious or unstable comorbidities.

Although experienced Personal Trainers can work with clients with stable chronic disease who are able to exercise independently, it is important to recognize situations when consultation with medical personnel is necessary and/or when the Personal Trainer should not take on a new client.

SUMMARY

This chapter explored the special considerations of exercise program design for those with CVD, diabetes mellitus, obesity, or hypertension and individuals with comorbidities. Personal Trainers are ultimately responsible for designing safe and effective programs that make a positive difference in the lives of their clients. Personal Trainers are encouraged to use evidence-based practice to guide their selection and use of a specific intervention in a given situation. Evidence-based practice is the integration of best research evidence with professional expertise and client values. The rationale for basing decisions on sound evidence is clear — programs supported by research lead to an informed action plan that minimizes risk and optimizes effectiveness.

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