### Cardiorespiratory fitness training

Cardiorespiratory fitness reflects the ability of the cardiovascular and respiratory systems to supply oxygen-rich blood to skeletal muscles during sustained physical activity. Cardiorespiratory fitness is one of the five components to health-related physical fitness; the others include muscular strength, muscular endurance, flexibility, and body composition. Cardiorespiratory fitness is vitally important to health and wellness as well as to the ability to engage in normal activities of daily living (ADL) without excessive fatigue. Physical activity and exercise training programs should be designed with the intent of improving each of the key components of health-related physical fitness; however, from the standpoint of preventing chronic disease and improving health and quality of life, cardiorespiratory fitness training should always be near top priority when allocating time and resources during the design and implementation of any exercise training program because of the number of health-related benefits associated with it.

HELPFUL HINT

The five components of fitness include the following:

* Cardiorespiratory (aerobic) fitness
* Muscular strength
* Muscular endurance
* Flexibility
* Body composition

Cardiorespiratory training is a way of planning training programs that systematically progress clients through various stages to achieve optimal levels of physical and performance adaptations by placing stress on the cardiorespiratory system. One of the most common errors made by fitness professionals during the planning and implementation of cardiorespiratory exercise programs is the failure to consider rate of progression. Rate of progression is critical to help clients achieve their personal health and fitness goals in the most efficient and effective use of time and energy. In addition, failure to carefully consider and monitor rate of progression of each client on an individual basis can also result in injury if progression is too fast, or in poor exercise adherence if the progression is too slow. Thus, applying proven scientific principles to the design of cardiorespiratory fitness training programs will help ensure that clients maximize their potential to achieve optimal levels of physical and performance adaptations.

**Benefits of cardiorespiratory fitness**

The benefits of regular physical activity and structured exercise are numerous. Individuals can achieve numerous health-related benefits from modest amounts of moderate-intensity exercise and even greater benefits from vigorous-intensity exercise, or a combination of both. Engaging in regular, sustained physical activity over one’s life span is one of the most reliable predictors of death and disability. In fact, research has confirmed that an individual’s cardiorespiratory fitness level is a strong predictor of morbidity and mortality. In other words, poor cardiorespiratory fitness is related to a marked increase in risk of premature death from all causes, but particularly from cardiovascular disease. Conversely, an improvement in cardiorespiratory fitness is related to a reduction in premature death from all causes.

Research demonstrates that cardiorespiratory exercise and physical activity provide many benefits that enhance health, longevity, and weight loss. Individuals who are more active on a regular basis enhance their likelihood for attaining these benefits, whereas sedentary individuals may experience rapid deteriorations in their overall health and well-being.

**General guidelines for cardiorespiratory fitness training**

Fitness professionals need to understand and appreciate the fact that no two individuals will ever respond and adapt to cardiorespiratory exercise in exactly the same way. In other words, the physical and perceptual responses to exercise are highly variable, even among individuals of similar age, fitness, and health. Thus, all exercise training recommendations, including cardiorespiratory exercise, must be individually determined and should use the FITTE-VP principle. FITTE-VP stands for “frequency, intensity, type, time, enjoyment, volume, and progression.”

**Frequency**

Frequency refers to the number of training sessions in a given time period, usually expressed as per week. Moderate-intensity exercise (e.g., brisk walking) should be performed at least five times per week, whereas vigorous-intensity exercise (e.g., jogging or running) should be performed at least three times per week, or a combination of moderate-intensity and vigorous-intensity is also acceptable.

| **Frequency** | **Time** | **Type** |
| --- | --- | --- |
| At least 5 days per week | 150 minutes per week | Moderate-intensity aerobic activity (i.e., brisk walking) |
| At least 3 days per week | 75 minutes per week | Vigorous-intensity aerobic activity (i.e., jogging or running) |
| 3–5 days per week | Combination of moderate and vigorous intensity: Any combination of moderate- and vigorous-intensity aerobic activities | |

**Intensity**

Intensity refers to the level of demand that a given activity places on the body. For general health requirements, such as reducing the risk of chronic disease, moderate-intensity is recommended. Moderate exercise typically represents an intensity range that is enough of a demand to increase heart and respiratory rate but does not cause exhaustion or breathlessness for the average untrained apparently healthy adult. In other words, the individual should be able to talk comfortably during exercise or physical activity. Higher intensities are generally required for improvements in overall fitness and conditioning. However, any combination of the two will also result in improved health.

Methods for assigning exercise intensity

Cardiorespiratory exercise intensity can be monitored in numerous ways. Some methods for monitoring cardiorespiratory exercise intensity include calculating VO2max, using percentages of maximal heart rate (HRmax), percentages of heart rate reserve (HRR), metabolic equivalents (METs), ratings of perceived exertion (RPE), and the talk test. Some of these methods are more practical for fitness professionals to implement with clients than others.

VO2max

The traditional gold standard measurement for cardiorespiratory fitness is VO2max, often expressed as the maximal volume of oxygen consumed per kilogram of body weight per minute (mL/kg per min). In other words, VO2max is the maximal amount of oxygen that an individual can use during intense exercise. Once VO2max is determined, a common method to establish exercise training intensity is to have clients exercise at a percentage of their VO2max.

However, accurately measuring VO2max is oftentimes impractical for fitness professionals because it requires clients to perform cardiorespiratory exercise at maximal effort and sophisticated equipment to monitor the client’s ventilation response (oxygen consumed and carbon dioxide expired). Thus, submax­imal aerobic tests have become popular for fitness professionals to estimate VO2max.

Maximal heart rate

Calculating HRmax is another method for establishing training intensity during cardiorespiratory exercise. Although measuring a client’s actual maximal heart rate is effective, it is also impractical for fitness professionals because it requires testing clients at maximal capacity. Subsequently, many mathematical formulas that estimate HRmax have been developed. Once HRmax is calculated, fitness professionals can have clients exercise at a certain percentage of their HRmax.

Arguably the most commonly used formula for estimating HRmax is 220 – age. However, this formula was never intended to be used as an instrument for designing cardiorespiratory fitness programs because maximal heart rate varies significantly among individuals of the same age. Dr. William Haskell (one of the developers of the aforementioned formula) has been quoted as saying, “The formula was never supposed to be an absolute guide to rule people’s training”.

For this reason, more appropriate regression formulas have been developed, such as the Tanaka formula, where HRmax is determined using the following formula: 208 – (0.7 × age). It has been shown that this formula is more accurate than Haskell’s 220 – age formula for estimating an individual’s HRmax.

Keep in mind, fitness professionals should never use this, or any other mathematical formula, as an absolute. A person’s heart rate response to exercise is dependent on many additional factors, including genetics, medications, and stimulant use such as caffeine. However, the Tanaka formula is very simple to use and can be easily implemented as a general starting point for measuring cardiorespiratory training intensity.

Consider the following example of a 40-year-old client who is tasked at exercising at 65% of her HRmax. The formula would be solved as follows:

Tanaka formula: 208 – (0.7 × age) = HRmax

208 – (0.7 × 40) = HRmax

208 – (28) = HRmax

180 = HRmax

180 beats per minute (bpm) is the client’s estimated HRmax:

180 × 65% = 117

Thus, 117 bpm is the client’s target heart rate.

Heart rate reserve

HRR, also known as the Karvonen method, is a method of establishing a client’s target heart rate based on the difference between a client’s estimated HRmax and their resting heart rate. This formula is likely more appropriate versus only calculating a percentage of HRmax because it considers an individual’s resting heart rate, which tends to vary from person to person. The heart rate reserve formula is defined as follows:

[(HRmax – HRrest) × desired intensity] + HRrest = Target heart rate

Consider the following example of a 25-year-old client with a desired training intensity of 85% of his HRmax. If this 25-year-old client has a resting heart rate of 50 bpm (which is considered very good), then the formula (using the Tanaka formula to determine HRmax) would be solved as follows:

[(HRmax – HRrest) × desired intensity] + HRrest = Target heart rate

208 – (0.7 × 25) = 191 HRmax

191 (HRmax) – 50 (HRrest) = 141

141 × 85% (desired intensity) = 120

120 + 50 (HRrest) = 170 bpm

Thus, 170 beats per minute is the client’s target heart rate.

Metabolic equivalent

One MET is equal to 3.5 millilitres of oxygen consumed per kilogram of body weight per minute (3.5 mL O2 · kg–1 · min–1) or the equivalent of the average resting metabolic rate for adults. In other words, this represents the amount of oxygen used by an individual at true rest. METs are used to describe the energy cost of physical activity as multiples of resting metabolic rate. MET values are used to relate exercise intensity with energy expenditure. For example, a physical activity with a MET value of 4, such as jogging at a slow pace, requires four times the energy than a person uses at rest (e.g., sitting quietly). There are many resources available for fitness professionals that describe common activities and their average MET values. However, this method is an uncommon practice within a fitness facility.

Ratings of perceived exertion method

RPE is a popular method for estimating exercise intensity. RPE is a technique used to validate how hard a client feels they are working during exercise. When using the RPE method, a person is subjectively rating the perceived difficulty of exercise and is based on the physical sensations, such as increased heart rate, increased respiration rate, increased sweating, and muscle fatigue. The client’s subjective rating should be reported based on the overall feelings of how hard they are working, including an overall sense of fatigue, and not just isolated areas of the body (i.e., tired legs during cycling). Although the RPE scale is a subjective measure, if clients report their exertion ratings accurately, RPE does provide a good estimate of exercise training intensity.

There are two versions of RPE: the original 6 to 20 scale and the newer 1 to 10 scale. The Borg 6 to 20 is the standard, yet it can be somewhat confusing because it starts at a score of 6 (rather than zero) and has 15 different choices. The reason behind the 6 to 20 scale is that each value corresponds to a heart rate, and most adult heart rates range between 60 bpm and 200 bpm. Subsequently, a Borg score of 6 corresponds to a heart rate of 60 bpm, whereas a Borg score of 12 corresponds to a heart rate of 120 bpm. However, for simplicity and ease of use, we recommend fitness professionals use the 1 to 10 scale with their clients, unless their clients are familiar with the 6 to 20 Borg scale.

| **Original Scale** | |
| --- | --- |
| 6 |  |
| 7 | Very, very light |
| 8 |  |
| 9 | Very light |
| 10 |  |
| 11 | Fairly light |
| 12 |  |
| 13 | Somewhat hard |
| 14 |  |
| 15 | Hard |
| 16 |  |
| 17 | Very hard |
| 18 |  |
| 19 | Very, very hard |
| 20 |  |

| **Rating** | **Perceived Exertion Level** |
| --- | --- |
| 0 | No exertion, at rest |
| 1 | Very light |
| 2-3 | Light |
| 4-5 | Moderate, somewhat hard |
| 6-7 | High, vigorous |
| 8-9 | Very hard |
| 10 | Maximum effort, highest possible |

Talk test

Historically, the talk test has been an informal method used to gauge exercise training intensity during exercise. The belief has always been that if clients reach a point at which they are not able to carry on a simple conversation during exercise because they are breathing too hard, then they are probably exercising at a high-intensity level. Several studies have now confirmed that there is a correlation between the talk test, VO2, ventilatory threshold (Tvent), and heart rate during both cycle ergometer and treadmill exercise. Thus, it appears that the talk test can help fitness professionals and clients monitor proper exercise intensity without having to rely on measuring heart rate or VO2max.

When clients can speak comfortably, they are typically exercising below the intensity of ventilatory threshold 1 (VT1). At the first point where clients can no longer speak comfortably during continuous speech (i.e., continuous talking becomes challenging), this intensity approximates VT1. This relationship between the talk test and VT1 has been demonstrated to be valid in several populations ranging from well-trained athletes to sedentary individuals and patients with cardiovascular disease.

| **Method** | **Description** |
| --- | --- |
| VO2max | Target VO2max = VO2max × % intensity desired |
| Maximal heart rate (HRmax) | Tanaka HRmax formula: 208 – (0.7 × age)  Target heart rate = HRmax × % intensity desired |
| Heart rate reserve (HRR) | Target heart rate = [(HRmax – HRrest) × % intensity desired] + HRrest |
| Metabolic equivalent (MET) | One metabolic equivalent is equal to 3.5 mL O2 · kg–1 · min–1 or the equivalent of the average resting metabolic rate for adults |
| Ratings of perceived exertion (RPE) | 1 to 10 scale or 6- to 20-point scale |
| Talk test | The ability to speak during activity can identify exercise intensity and ventilatory threshold |

**Time**

Time refers to the length of time engaged in an activity or exercise training session and is typically expressed in minutes. According to the most current public health guidelines on physical activity, adults should accumulate 2 hours and 30 minutes (150 minutes) of moderate-intensity aerobic activity (i.e., brisk walking) every week or 1 hour and 15 minutes (75 minutes) of vigorous-intensity aerobic activity (i.e., jogging or running) every week, or an equivalent mix of moderate- and vigorous-intensity aerobic activity. The guidelines also recommend that if adults exceed 300 minutes per week of moderate-intensity activity or 150 minutes per week of vigorous-intensity activity, then they will gain even more health and fitness benefits. However, it is also important for fitness professionals to appreciate that any duration of physical activity or exercise, regardless of the individual or accumulated time, can provide some positive health benefits.

**Type**

Type refers to the mode of activity selected. It should be noted that there are three criteria that must be met for an activity or exercise to be considered “aerobic” exercise. For a mode of exercise to be considered aerobic, it should (a) be rhythmic, (b) use large muscle groups, and (c) be continuous in nature. Some examples of modes of aerobic exercise include the following:

* Jogging
* Walking
* Exercising on cardio equipment
* Swimming
* Cycling (indoors or outdoors)

In addition to recognizing modes or types of cardiorespiratory exercise, such as swimming or cycling, it is also important for fitness professionals to be familiar with various cardio formats. Many of these formats also involve stressing both aerobic and anaerobic energy pathways and include interval training, high-intensity interval training, Tabata, and Fartlek training.

Interval training

Interval training has received a great amount of research attention over the years. This training format involves brief periods of higher exertion efforts coupled with lower-intensity periods. The exertion efforts (i.e., intervals) can be moderate to highly intense, depending on the goals, needs, and abilities of the client.

Work-to-rest ratios can be calculated and altered to change the stress applied during each workout. Generally, ratios ranging from 1:1 to 1:5 are used to provide adequate recovery within each interval; however, work-to-rest ratios can vary dramatically depending on the client’s fitness level and the mode of exercise performed. Fitness professionals can alter both the intensity and work-to-rest ratios to vary training stress throughout the program.

Moderately intense intervals involve exercise at a medium intensity with the goal to complete a set number of programmed intervals rather than reach maximal or near-maximal effort during each iteration. Moderate intensities are best for beginning exercisers and for occasional reduction in overall training stress to avoid overtraining.

High-intensity intervals place a considerable challenge on the metabolic energy systems by pushing the client to near-maximal effort during each repetition. This type of interval training is commonly known as high-intensity interval training (HIIT).

High-intensity interval training

*HIIT* is a term commonly used today to describe shorter bouts of high-intensity work at maximal or near-maximal performance (e.g., sprinting) followed by recovery periods (e.g., slow jog or walking). Although interval training has a long-standing reputation in the realm of sports conditioning given the stop-start nature of many sports, its popularity has grown within recreational fitness due to its compressed timeframe for achieving improvements in physical fitness and health when compared to continuous exercise methods.

HIIT has been shown to be an effective mode for improving cardiorespiratory fitness because it can produce comparable results in a compressed period of time and with a smaller volume of work. It also aids in weight loss and reduction of cholesterol levels and blood pressure in a similar manner to steady-state (SS) aerobic exercise. Even though HIIT training offers a key benefit of time efficiency (i.e., less time exercising), not all clients will adhere to its strenuous demands, nor is it required to achieve most health or wellness goals.

TRAINING TIP

When designing HIIT training programs, recognize that “effort” is a subjective measure (e.g., how hard I am pushing myself), whereas “intensity” is an objective measure (e.g., sprint time, load lifted), and they are not the same. If a workout does not provide adequate recovery between intervals, then the intensity of the workout has to decrease, even if the individual’s effort is at a maximum.

Tabata training

Tabata is a type of HIIT training and was created by a Japanese scientist named Dr. Izumo Tabata. The Tabata format involves performing a maximal effort interval lasting 20 seconds, followed by only 10 seconds of rest. The client performs a total of eight intervals, for a total of 4 minutes. This format has been shown to improve aerobic power and improvements in VO2max.

However, a true Tabata format is rarely taught in health clubs. Dr. Tabata and his team of researchers performed their study using elite cyclists as subjects in which each interval was performed at approximately 170% of VO2max. Most fitness enthusiasts are incapable of performing or sustaining exercise at this intensity. Moreover, a true Tabata workout session would only last 4 minutes. However, variations of Tabata training are popular, in which intervals are still high intensity yet the participant can successfully complete the program. It is important for fitness professionals to select interval intensities that are appropriate for their clients and consider their client’s fitness level and tolerance to intense exercise.

Fartlek training

*Fartlek* is a Swedish term that translates to “speed play.” The goals of fartlek training are highly variable, targeting many different physiological systems (i.e., aerobic and anaerobic) by combin­ing different formats into one workout. It is often performed while running, but it can also be completed while cycling or swimming. Unlike steady-state or HIIT formats, Fartlek training is unstructured and combines low-, moderate-, and high-intensity efforts into one workout. Far­tlek training helps break the monotony often associated with one format of training.

**Enjoyment**

Enjoyment refers to the amount of pleasure derived from engaging in a specific exercise or activity. Unfortunately, this component of exercise programming is often overlooked or not considered more seriously. Exercise adherence rates decline significantly when a specific mode of exercise is selected for a client before considering their personality type, previous exercise experiences, and other interests. If the mode of activity or exercise training program is not enjoyable to a client, it is highly likely that they will not adhere to the exercise program and therefore not achieve their personal health and fitness goals. A client is much more apt to continue with a program that is fun and challenging and includes a supportive environment than one that is dull and boring.

**Volume**

Volume of exercise represents the total amount of work performed in each timeframe, typically 1 week. As mentioned previously, public health guidelines recommend adults accumulate 150 minutes of moderate-intensity aerobic activity every week or 75 minutes of vigorous-intensity aerobic activity every week, or an equivalent mix of the two.

However, 150 minutes of moderate-intensity aerobic activity may only provide modest weight loss. Individuals who are seeking to lose weight will likely achieve greater benefits from the inclusion of more than 250 minutes of aerobic exercise per week. Research also reveals that for general health improvements and the prevention of weight gain, individuals should aim to expend 1200 to 2000 calories through physical activity per week.

STRETCH YOUR KNOWLEDGE

Because it is very difficult to expend 1200 calories or more per week through structured exercise, experts suggest including nonstructured physical activity into one’s daily routine. Recent research has demonstrated that expending calories throughout the day through unstructured physical activity is important for health and weight loss efforts. This has shifted some attention away from structured, planned exercise a few times per week as a standalone to including nonexercise activity thermogenesis (NEAT). NEAT represents all the energy expended throughout the day that does not include eating, sleeping, or structured exercise. This energy includes calories expended through fidgeting, standing and moving around, and performing basic tasks of daily living (e.g., chores, grooming) and most often represents a greater quantity of expended calories in a day than what is accumulated through a single exercise session.

**Progression**

Progression refers to how an exercise program advances. Exercise protocols should gradually progress in intensity and/or volume to continually challenge the individual. However, the rate of progression should be specific to the individual and their needs, goals, and abilities. The client’s health status, physical abilities, and responses to exercises must be considered. For example, progression for a 21-year-old elite athlete will differ from a 65-year-old sedentary adult.

A gradual increase of exercise volume (<10% per week) appears to be a safe protocol for most apparently healthy adults. This approach may also increase adherence to the exercise pro­gram because the exerciser feels competent to perform the work and complete the program.

Fitness professionals must be careful and plan cardiorespiratory training programs accord­ing to their client’s ability level. Risk of musculoskeletal injury (e.g., sprains, strains) can occur if intensity of exercise is progressed too quickly.

STRETCH YOUR KNOWLEDGE

If a client is exercising for 150 minutes per week (30 minutes, 5 days per week), then a 10% increase in volume would be:

150 X 10% = 15

150 + 15 = 165 minutes per week

**Recommendations**

The most current public health guidelines on physical activity, which are based on scientific evidence, recommend adults engage in 150 minutes per week of moderate-intensity activity (i.e., brisk walking) to help improve their overall health and fitness and reduce their risk for developing numerous chronic diseases. The guidelines also recommend that if adults exceed 300 minutes per week of moderate-intensity activity or 150 minutes per week of vigorous-intensity activity, then they will gain even more health benefits.

The guidelines presented represent physical activity guidelines for all adults, especially those who are currently sedentary or have little previous experience with exercise. If clients are not able to achieve the suggested minimal guidelines for cardiorespiratory training of 150 minutes per week (or 30 minutes, five times per week) of moderate-intensity aerobic activity on at least 5 days per week, they can break it up into shorter increments, for example 10 minutes at a time, until 150 minutes per week is met.

**Components of cardiorespiratory fitness training**

Exercise training programs should be designed to meet the specific needs and goals of the individual client. Furthermore, the initial exercise program should reflect (a) the initial fitness level of the client, (b) fitness assessment results, and (c) whether the client has any significant risk factors or health limitations to exercise. Each exercise training session should also include the following phases:

* Warm-up phase
* Conditioning phase
* Cool-down phase

Cardiorespiratory Warm-Up Phase

A warm-up is generally described as preparing the body for physical activity. It can be either general in nature or more specific to the activity. A general warm-up consists of movements that do not necessarily have any movement specific to the actual activity to be performed. Ex­amples of a general warm-up include walking on a treadmill or riding a stationary bicycle before weight training. A specific warm-up consists of movements that more closely mimic those of the actual activity, often referred to as dynamic stretches.

| **Benefits** | **Effects** |
| --- | --- |
| Increased heart and respiratory rate | Increases cardiorespiratory system’s capacity to perform work  Increases blood flow to muscles  Increases the oxygen exchange capacity |
| Increased tissue temperature | Increases rate of muscle contraction  Increases metabolic rate  Increases soft tissue extensibility |
| Increased psychological preparation for bouts of exercise | Increases the mental readiness of an individual |

The cardiorespiratory portion of a warm-up period consists of whole-body, dynamic cardi­orespiratory or muscular movements (well below the anticipated training intensity threshold for conditioning). The purpose of the warm-up period is to increase heart and respiration rates, increase tissue temperature, and psychologically prepare the individual for higher training in­tensities.

Suggested warm-up activities

NASM recommends that the cardiorespiratory portion of a warm-up last between 5 and 10 min­utes and be performed at a low- to moderate-intensity level. However, depending on the client’s goals and objectives, these recommendations can be modified by either extending or reducing the time allotted to the warm-up period or by modifying activities based on any known or sus­pected medical or physical limitations a client may have.

New clients who are sedentary or have medical limitations or those with limited previous exercise experience may require more of their dedicated workout time be directed to warm-up activities, at least initially.

Moreover, a comprehensive warm-up should also include a combination of flexibility techniques in addition to cardiorespiratory exercise. Flexibility exercises include self-myofascial techniques (i.e., foam rolling), static stretching, active stretching, and dynamic stretching.

It is vitally important that fitness professionals have a comprehensive understanding of safe and effective flexibility exercises. Fitness professionals should begin each training session with new clients by explaining the benefits to be gained from each new flexibility technique followed by a demonstration of each new exercise, emphasizing safety and proper technique. Once a client has demonstrated a complete understanding of flexibility techniques and operation of the cardiorespiratory equipment, they can begin performing the warm-up before the session with the fitness professional. This will then allow for increased training time in which to focus on other aspects of the training program.

TRAINING TIP

Flexibility techniques used during a client’s warm-up should target muscles that have been identified as overactive during the assessment process. Consequently, fitness professionals should conduct a comprehensive fitness evaluation, including posture and movement assessments, prior to designing a client’s exercise program.

It should be emphasized that the warm-up period should prepare the body for activity; thus, it is important to monitor the intensity at which clients are performing selected warm-up ac­tivities to ensure they do not unduly fatigue before the workout portion of their program begins. Keeping the activity to a moderate duration and intensity level will help ensure a proper warm-up.

| **Components** | **Examples** | **Time** |
| --- | --- | --- |
| Self-myofascial techniques | Calves  Hip flexors  Latissimus dorsi | 30 seconds for each muscle |
| Static stretching | Calves  Hip flexors  Latissimus dorsi | 30 seconds for each muscle |
| Cardiorespiratory exercise | Treadmill | 5–10 minutes |

**Conditioning Phase**

Individuals who engage in cardiorespiratory exercise likely do so for a variety of reasons, includ­ing expending calories to lose weight, reducing stress, or improving their health, or for a host of other reasons. An important point that fitness professionals should share with their clients is that low-intensity cardiorespiratory exercise will typically result in some improvements in health and well-being but not necessarily result in significant improvements in conditioning as compared with higher-training intensities.

|  |  |
| --- | --- |
| Stronger and more efficient heart  Improved ability to pump blood (enhanced cardiac output)  Reduced risk of heart disease  Lower resting heart rate  Lower heart rate at any given level of work  Improvement of lung ventilation (more efficient breathing)  Stronger respiratory muscles  Thicker cartilage and bones with weight-bearing aerobic exercises  Improved oxygen transport  Increase in lean body mass  Increase in metabolic rate | Reduced cholesterol levels  Reduced blood pressure  Improved blood thinning and reduced risk of clot formation  Improved fuel supply (improved ability to use fatty acids, sparing muscle glycogen stores)  Improved ability of muscles to use oxygen  Improved mental alertness  Reduced tendency for depression and anxiety  Improved ability to relax and sleep  Improved tolerance to stress  Reduced risk of obesity or diabetes mellitus |

**Cool-down phase**

A cool-down provides the body with a smooth transition from exercise back to a steady state of rest. In essence, a cool-down is the opposite of the warm-up. This portion of a workout is often overlooked and viewed as less important than the other components. However, proper use of a cool-down can have a significant impact on a client’s overall response to exercise. The overarching goal of a cool-down is to reduce heart and breathing rates, gradually cool body temperature, return muscles to their optimal resting lengths, prevent pooling of blood in the lower extremities (which may cause dizziness or possible fainting), and restore physiologic systems close to baseline. Sufficient time for a cardiorespiratory cool-down period is approximately 5 to 10 minutes.

|  |
| --- |
| Reduce heart and breathing rates  Gradually cool body temperature  Return muscles to their optimal resting lengths  Prevent pooling of blood in the lower extremities  Restore physiologic systems close to baseline |

**Flexibility training during a cool-down period**

Flexibility training should also be included in the cool-down period. Flexibility training, includ­ing self-myofascial techniques and static stretching, has been shown to be effective at managing muscle soreness and promoting optimal joint range of motion.

Initially, fitness professionals should closely monitor new clients during both the warm-up and the cool-down periods to make certain that the activities being performed are appropriate, safe, and effective. It is also important for the client to understand the importance of both the warm-up and the cool-down periods.

| **Components** | **Examples** | **Time** |
| --- | --- | --- |
| Cardiorespiratory exercise | Treadmill | 5–10 minutes (gradually reduce speed) |
| Self-myofascial techniques | Calves  Hip flexors  Latissimus dorsi | 30 seconds for each muscle |
| Static stretching | Calves  Hip flexors  Latissimus dorsi | 30 seconds for each muscle |

TRAINING TIP

Regardless of the goal, always begin an exercise program with posture and movement assessments, such as the overhead squat, pushing, pulling, and single-leg squat tests. These assessments help determine the muscles that need to be stretched during a warm-up. If a muscle is overactive, it may be impeding or altering proper movement and as such needs to be corrected to enhance movement.

1. When used in a warm-up, stretching techniques should only be used on areas that the assessments have determined are overactive.
2. During the cool-down, self-myofascial techniques and static stretching should be used to return muscles to normal resting lengths. Clients should focus on identified overactive muscles and/or the major muscles used during the workout.

**Stage training**

Cardiorespiratory training, as with any other form of training, falls under the principle of specificity. According to the principle of specificity, the body will adapt to the level of stress placed on it and will then require more or varied amounts of stress to produce a higher level of adaptation in the future. For example, a client who begins jogging for 30 minutes 5 days per week will, over time, become more aerobically fit. Consequently, this individual will need to increase the duration or intensity of each jogging session to experience continual fitness im­provements. To accomplish this goal, cardiorespiratory exercise programs should be tailored to the individual, using their own unique metabolic markers (e.g., ventilatory threshold) as a guide for proposing exercise intensities.

The purpose of stage training is to ensure that cardiorespiratory training programs progress in an organized fashion to ensure continual adaptation and minimize the risk of overtraining and injury. The five stages of cardiorespiratory training discussed in this section use different inten­sities (training zones). Each of the four training zones target a specific outcome while remaining customizable for clients. As a result, stage training is appropriate for new exercis­ers, fitness enthusiasts, and performance athletes.

| **Training Zone** | **Metabolic Marker** | **RPE (1–10 scale)** | **RPE (6–20 scale)** | **Description** |
| --- | --- | --- | --- | --- |
| Zone 1 | Below VT1 | 3–4 | 12–13 | * Light to moderate * Starting to sweat but can still carry on a conversation effortlessly |
| Zone 2 | VT1 to Midpoint\* | 5–6 | 14–15 | * Challenging to hard * Noticeable sweating and using larger volumes of breath * Continual talking is becoming challenging |
| Zone 3 | Midpoint to VT2 | 7–8 | 16–17 | * Vigorous to very hard * Profuse sweating * Vigorous breathing and ability to talk is limited to short phrases |
| Zone 4 | Above VT2 | 9–10 | 18–20 | * Very hard to maximum effort * Breathing as hard as possible * Speaking is impossible or limited to grunts of single words |

Stage 1

Cardiorespiratory exercise in stage 1 is beneficial for those new to exercise who are seeking to improve health markers, such as reducing the risk of cardiovascular disease and diabetes. Stage 1 represents the lowest intensities of exercise and is used to introduce individuals to exercise and improve general health and fitness and is also used as a recovery format following higher-intensity exercise sessions. Stage 1 is designed to help improve cardiorespiratory fitness levels in apparently healthy sedentary clients using a target intensity below ventilatory threshold 1 (VT1) and involves steady-state aerobic exercise. In other words, when using the talk-test method to monitor training intensity, the client should be able to easily hold a conversation during the duration of the activity. If using RPE to measure intensity, the client should feel the exercise intensity as light to moderate. The exerciser is starting to sweat, but they can still carry on a conversation effortlessly.

In stage 1, clients should start slowly and gradually work up to 30 minutes of continuous activity. Clients who can maintain a zone 1 intensity for at least 30 minutes three times per week will be ready for stage 2. However, a deconditioned client might take 2 to 3 months to meet this demand, depending on their current fitness level and how often they exercise. Goals of stage 1 training are to help clients build an appropriate aerobic base and foun­dational level of fitness. Moreover, this stage may serve as a motivation tool to help clients ad­here to a physically active lifestyle, because clients are more likely to continue with an exercise program that is moderately difficult yet achievable.

As with any exercise program, rate of progression must be considered. Stage 1 workouts can be progressed by gradually adding duration to each exercise session. For example, a week 1 program may involve 15 minutes of continuous aerobic exercise, 3 days per week. Each subsequent week an additional few minutes can be added to each exercise session until the client successfully manages 30 minutes of continuous exercise three times per week. It is important not to exceed more than 10% of added volume per week to avoid overtraining or burnout.

Stage 2

Stage 2 is designed for clients with intermediate cardiorespiratory fitness levels who are ready and who desire to begin training at a slightly higher intensity. The focus of stage 2 training is on increasing the workload (e.g., speed, incline) in a way that helps clients exercise at higher intensities and achieve greater levels of aerobic fitness. Stage 2 is ideal for fitness enthusiasts who regularly engage in physical activity or recreational sport or for those seeking further improvements in cardiovascular endurance or weight loss.

Prior to initiating a stage 2 workout, fitness professionals should perform the talk test with their client to determine their client’s heart rate at VT1. Once identified, ideally this measurement would be used to monitor exercise intensity throughout the duration of the stage 2 workout.

Stage 2 is the introduction to aerobic interval training in which intensities are varied throughout the workout. A stage 2 workout consists of a mix of recovery intervals just below VT1 (or a score of “moderate to challenging” when using RPE) and work intervals performed at an intensity just above VT1 (or a score of “challenging to hard” when using RPE). Interval training in this manner will likely improve both physical fitness (e.g., increased VO2max) and health markers, such as reducing the risk of cardiovascular disease.

For example, if a client’s heart rate at VT1 is 145 bpm, they should perform exercise intervals slightly above 145 bpm and recovery intervals just below 145 bpm. However, using RPE to gauge exercise intensity is an effective alternative if a heart rate monitor is not available.

Stage 2 work intervals should start out relatively brief (e.g., 30–60 seconds) and progress in duration and intensity over time. Work-to-rest ratios of 1:3, 1:2, and 1:1 are appropriate for stage 2 training. For example, a 1:3 work-to-rest ratio involving a 1-minute interval just above VT1 would include 3 minutes of recovery below VT1. The duration and intensity of intervals should be gradually increased as the client’s fitness levels improve. For example, a 1-minute work interval can be increased to 2 or 3 minutes. In addition, work-to-rest ratios should progress in difficulty from 1:3 to 1:2 to eventually 1:1. These progressions should be based on the ability and willingness of the client to perform higher-intensity exercise.

Example stage 2 aerobic interval program: Stage 2 exercise programs should be individualized and tailored to meet the needs and goals of the client. Following is one example of a stage 2 cardiorespiratory program:

1. Start by warming up for 5–10 minutes.
2. Move into a 1-minute interval in zone 2 that is just above VT1.
3. After the 1-minute interval, return to zone 1 for 3 minutes.
4. Repeat these intervals until the duration of the exercise session is complete.
5. Cool down for 5–10 minutes.

For clients new to interval training, it is a good idea to alternate stage 1 and stage 2 workouts. For example, start with stage 1 on Monday, then move to stage 2 on Wednesday, and go back to stage 1 on Friday. The next week, start with stage 2 and so on. Rotate the stages to keep workouts balanced. This will become very important in stage 3. However, this plan is only a general guide and may be changed based on the client’s training schedule, available recovery time, and unfore­seen external stressors, such as lack of sleep.

Stage 2 steady-state aerobic exercise

Once clients become accustomed to stage 2 intervals and have shown positive signs of adapting to the physical demands, they can begin performing moderately intense steady-state cardio exercise above VT1, if desired. In other words, the client can perform aerobic conditioning in zone 2 just above VT1 for the duration of the exercise session without the use of intervals. It is important to note that stage 2 steady-state aerobic exercise is not a requirement, but rather an option for clients who prefer to perform steady-state aerobic exercise instead of intervals. Mod­erately intense aerobic activity has been proven effective for individuals seeking improvements in fitness and cardiovascular health.

An example stage 2 steady-state workout can proceed as follows:

1. Start by warming up for 5–10 minutes in zone 1.
2. Increase intensity (e.g., speed, incline) until client reaches zone 2, which is just above VT1.
3. Continue the duration of the exercise session at this intensity.
4. Cool down in zone 1 for 5–10 minutes.

CRITICAL

For most weight-loss clients and those new to exercise, stages 1 and 2 are most appropriate and effective for improving health and wellness and promoting a healthy body weight. These two stages should be top priority for the average exerciser and gym goer.

Stages 3 through 5 are most appropriate for athletes and advanced fitness enthusiasts who are seeking greater improvements in cardiorespiratory conditioning and are willing to participate in high-intensity exercise. It is not necessary for fitness professionals to implement all five stages with their clients. Cardiorespiratory exercise should be individualized based on the client’s needs, goals, abilities, and exercise preferences.

Stage 3

Stage 3 is for the moderately advanced client who has obtained a satisfactory cardiorespiratory fitness base. Stage 3 training increases the capacity of aerobic and anaerobic energy systems and is applicable for clients seeking further improvements in exercise capacity. Research demon­strates that high-intensity interval training is a time-efficient strategy to increase physical fitness.

However, stage 3 is not appropriate for all clients. Clients seeking only modest improvements in cardiorespiratory fitness, those who are new to exercise, and individuals who are averse to high-intensity training can skip stage 3 training.

To accurately program stage 3 intervals, measurements of VT1 and VT2 need to be recorded. Recall, at VT1, talking becomes challenging but not difficult for the client during aerobic activity, whereas VT2 corresponds with an individual’s inability to speak more than a word or two during.

For example, if a client’s heart rate at VT1 is 145 bpm and their heart rate at VT2 is 165 bpm, the four training zones are calculated as follows:

* Zone 1: Less than 145 bpm
* Zone 2: 145–154 bpm (VT1 to midpoint)
* Zone 3: 155–164 bpm (midpoint to VT2)
* Zone 4: 165 bpm and higher

The midpoint refers to the intensity level halfway between VT1 and VT2.

A stage 3 program includes the client moving in and out of training zones 1, 2, and 3, while always staying below zone 4. A general rule of thumb is to have a modest mix of time spent in zone 1 (moderate intensity) with brief interval periods in zones 2 (hard intensity) and 3 (vigorous, very hard intensity) to minimize overtraining while simultaneously providing enough overload to challenge energy systems needed for performance adaptations.

Zone 2 and 3 intervals should be client specific based on the client’s goals, needs, and abilities, and zone 2 intervals are typically longer than zone 3 intervals because zone 3 intervals are more intense and physically demanding. Moreover, the volume of training in stage 3 should be progressive, yet in a slow and gradual fashion.

Example stage 3 cardiorespiratory program: Like stage 2, stage 3 exercise programs should be individualized for the client based on their unique goals, needs, and abilities. Following is one example of a stage 3 program:

1. Warm up in zone 1 for up to 5–10 minutes.
2. Then, increase the workload every 60 seconds until reaching zone 3. This will require a climb through zone 2, which may take a couple of minutes.
3. After pushing for another minute in zone 3, decrease the workload back to zone 2.
4. Overload the body again by performing another zone 3 interval.
5. Repeat for the desired number of intervals.
6. Cool down for 5–10 minutes.

It is vital when training at this level to rotate all three stages. There should be a low- (stage 1), medium- (stage 2), and high-intensity (stage 3) day to help minimize the risk of overtraining. The stage 1 day could be considered a recovery day following a hard stage 3 training day.

Work intervals within stage 3 should start out relatively brief, perhaps lasting 30 to 60 seconds. Once fitness and overall conditioning improve, stage 3 programs can be progressed similarly to stage 2 workouts, decreasing work-to-rest ratios and increasing the duration of high-intensity intervals. However, the frequency and duration of intervals in zones 2 and 3 should be client specific based on their goals, needs, abilities, and tolerance to intense activity.

Stage 4

Stage 4 is for the advanced client who has obtained a high-level cardiorespiratory fitness. Stage 4 training increases the capacity of the anaerobic energy system and is applicable for high-level athletes and fitness enthusiasts seeking improvements in anaerobic capacity and power.

Stage 4 is not appropriate for all clients, especially those with only modest levels of physical fitness or those averse to high-intensity conditioning. Consequently, stage 4 should be reserved for those seeking improvement in maximal anaerobic performance, such as athletes and top-end fitness competitors. Like stage 3, measurements of VT1 and VT2 need to be recorded to accu­rately program stage 4 intervals.

A stage 4 workout includes the client moving in and out of all four training zones. A general rule of thumb is to have most of the time spent in zone 1, with brief interval periods in zones 2, 3, and 4 to minimize overtraining while simultaneously providing enough overload to challenge the anaerobic energy system. Furthermore, brief intervals in zones 2, 3, and 4 ensure the client is working at maximum performance rather than maximal effort.

Intervals should be client specific based on the client’s goals, needs, and abilities. The volume of training in stage 4 should be slow and gradual. If the client exhibits signs of overtraining, such as disturbed sleep, excessive fatigue, impaired performance, loss of appetite, or mood swings, volume and intensity of stage 4 workouts should be decreased, and the client should be allowed more recovery time between exercise sessions.

HELPFUL HINT

Maximal performance refers to performing a task where a client or athlete is performing at their absolute peak ability, and work intensity is consistent across all intervals. For example, an athlete runs a 100-meter dash in an attempt to beat their best time. The athlete then sufficiently rests to restore their energy stores (ATP) before attempting another 100-meter dash. The athlete’s goal is decreasing their time in the 100-meter dash, which is a performance initiative.

Maximal effort refers to executing a task where effort is 100% but performance may dwindle due to fatigue. For example, an athlete runs repeated 100-meter dashes with only 30 seconds of rest between each attempt. Consequently, the athlete’s 100-meter times slow with each attempt even though the athlete is giving 100% effort. This format improves conditioning but may not be ideal for improving sprinting performance.

Example stage 4 cardiorespiratory program: Stage 4 exercise programs involve high-intensity exercise and should be client specific. Following is one example of implementing a stage 4 workout:

1. Warm up in zone 1 for up to 5–10 minutes.
2. Then, increase the workload every 60 seconds until reaching zone 4. This will require a climb through zones 2 and 3, which may take a couple of minutes.
3. Push for 10 seconds in zone 4 and then decrease the workload back to zone 1. This 1-minute break is an important minute to help gauge training status and improvement.
4. As improvements are made during several weeks of training, the client’s heart rate will drop more quickly. The faster the client’s heart rate drops, the more fit they are becoming.
5. If the client is not able to drop to the appropriate heart rate during the 1-minute break, assume that they are tired and about to overtrain. The solution is to stay in zone 1 for the remainder of the workout. The bottom line is that the client is not rested enough to do that type of exercise on that day (which may be because of a hard workout the day before, not enough sleep, or poor nutrition).
6. If the client’s heart rate does drop to a normal rate, then overload the body again by performing another zone 4 interval.
7. After this minute, go back to zone 1 for 5–10 minutes and repeat if desired.

When training at this level, it is imperative to rotate all four stages. There should be a low- (stage 1), medium- (stage 2), high-intensity (stage 3), and maximal-intensity (stage 4) day to help minimize the risk of overtraining.

Zone 4 intervals within a stage 4 workout should be brief: 5 to 10 seconds. Once fitness and overall conditioning improve, stage 4 programs can be progressed similarly to stage 2 and stage 3 workouts, decreasing work-to-rest ratios and increasing the frequency of high-intensity inter­vals. However, the frequency and duration of intervals should be client specific based on their goals, needs, abilities, and tolerance to intense activity.

Stage 5

Stage 5 consists of sport-specific training and is applicable for all types of athletes. It focuses on drills that help improve conditioning using linear, multidirectional, and sport-specific activities performed as conditioning and often combines high-intensity interval training with small-sided games and agility drills. This stage incorporates the movements, skills, and drills that coaches often use in practice sessions to apply a sport-related stimulus for metabolic benefits. The timing of the drills, the amount of rest provided, and the length of the session can progressively increase to more stressful, game-like sessions as fitness improves and competition approaches.

While ventilatory testing and heart rate monitoring are not required during stage 5, the fitness professional can benefit from monitoring heart rates or RPE during specific drills to get a picture of the relative intensity of the session. Although consistent aerobic exercise is important for optimal sport preparation, caution is warranted to avoid excessive training volume at the highest intensities. Similar to stage 4 training, volume should be kept at a minimum to avoid overtraining, especially when exercise sessions involve maximal effort. Regular recovery and hydration periods should be included to ensure an optimal training response.

# **Postural considerations in cardiorespiratory training**

When prescribing cardiorespiratory training, it is important to continuously assess the client’s posture during movement. Whether the client is exhibiting poor posture while standing or in motion, it is the fitness professional’s responsibility to correct postural alignment to minimize injury risk and maximize performance. Common postural deviations that clients may exhibit while engaging in cardiorespiratory training include the following:

* Forward head and rounded shoulders
* Anterior pelvic tilt
* Adducted and internally rotated knees and pronated feet

To ensure movement quality during cardiorespiratory training, use the following observa­tion techniques for clients who exhibit these postural deviations.

Rounded shoulders and forward head posture

Rounded shoulders and a forward head posture may negatively affect ventilation and oxygen delivery to muscle cells and, subsequently, performance. The forward rounding of the shoulders theoretically limits the ability to lift the ribcage during ventilation and forcefully contract the diaphragm during inspiration. For clients exhibiting symptoms from this posture during cardiorespiratory exercise, the fitness professional must closely observe for the following postural deviations:

1. During use of stationary bicycles, treadmills, and elliptical trainers, watch closely for rounding of shoulders forward and a protruding head and cue the client to retract their shoulders and head.
2. On steppers and treadmills, watch for the grasping of the handles (with an oversupinated or overpronated hand position), which may cause elevated and protracted shoulders and a forward head. If possible, this equipment should be used without the assistance of the hands to increase the demands on the core musculature, elevating the caloric expenditure and balance requirements of the exercise.
3. In settings in which a television is present, watch for excessive cervical extension (looking upward) or rotation of the head to view the television.

Anterior Pelvic Tilt

An anterior pelvic tilt (arched lower back) may also negatively affect ventilation, oxygen delivery to muscle cells, and performance similar to clients exhibiting upper crossed syndrome. Moreover, an anteriorly rotated pelvis and arched lower back may also result in low-back pain, which can negatively impact exercise performance. The fitness professional must closely observe the client for the following postural deviations:

1. Initial use of bicycles or steppers may not be warranted, or should be minimized, because the hips are placed in a constant state of flexion, adding to what may already be an overactive hip flexor complex for many clients. If they are used, emphasize flexibility techniques for the hip flexors before and after use. Additional strengthening exercises for the core and gluteal complex are also recommended.
2. Treadmill speed should be kept to a controllable pace to avoid overstriding. The hips may not be able to properly extend and may cause the low-back to overextend (arch), placing increased stress on the low-back. Flexibility for the hip flexors should be emphasized before and after use, along with strengthening exercises for the core and gluteal complex.

Adducted and Internally Rotated Knees and Pronated Feet

Individuals with this posture must be careful not to exacerbate faulty lower extremity move­ments, such as knee valgus (knock-knees). Knee valgus is a predictive factor for knee injury. The fitness professional must keep the following factors in mind:

1. Cardiorespiratory exercise that involves the lower extremities requires proper mobility at the ankle joint. Emphasize self-myofascial techniques and stretching for the calves, adductors, and hip flexors. Additional strengthening exercises for the gluteus medius and maximus are also recommended.

Using the treadmill and steppers that require climbing may initially be too extreme for constant repetition if clients are allowed to hold onto the rails and speed up the pace. If these modalities are used, emphasize the flexibility exercises mentioned previously and keep the pace at a controllable speed until these postures are corrected.