21st Century Wellness

THE SCIENCE OF THE WHOLE INDIVIDUAL

second edition

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BRIEF








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Cardiorespiratory Fitness

Where Do I “FIT”?

Overall well-being involves the body, mind, and spirit. It is the ability to reach your full potential in every part of your life regardless of whatever limitations you may have. Optimal well-being is an individual state of balance. What it takes for one person to achieve this will not be the same for another individual, and each person needs to find his or her own balance. Comparison to others often results

CHAPTER OUTLINE

in a feeling of self-defeat and may make it difficult to maintain motivation and compliance to an exercise program. Physical well-being involves integration with the social, intellectual, and spiritual, and it is generally understood that physical well-being has an impact on all the other dimensions, just as other dimensions of well-being impact the physical component.

After reading this chapter, you will be able to:

- **DESCRIBE** the basic anatomy and function of the cardiorespiratory system.
- **IDENTIFY** the health-related benefits of cardiorespiratory fitness.
- **EXPLAIN** the principles of cardiorespiratory fitness.
- **DESCRIBE** the connection between the mind and cardiorespiratory fitness.
- **WRITE** an individualized cardiorespiratory fitness program and assess current fitness status.
- **DEMONSTRATE** important exercise precautions that you should take to avoid injury

WHERE DO I "FIT"?

cardiorespiratory fitness

CARDIORESPIRATORY FITNESS FOR THE WHOLE PERSON

Whenever we participate in a learning task, whether it is physical, or intellectual, or something else, we also expand our mind and engage our brain such that it adapts by making new memories and new synaptic connections. Research has shown that beneficial neurological changes occur in areas of the brain when a person engages in physical activity. These same areas that are stimulated and benefited as a result of exercise are also associated with debilitating mental illness and disease that result, in part, from disuse. It is hypothesized that physical activities that require greater amounts of mental or cognitive processing would strengthen the connection between the mind and the body via the impact that they would have on the brain.

Some may focus too much on improving a single component of well-being, failing to consider the potential synergy that is gained by improving all facets of you. Optimal well-being cannot be achieved by sacrificing one part for another. The whole being is greater than the sum of the parts. Having a level of cardiorespiratory fitness that yields health benefits and desired physical functioning can increase feelings of self-confidence and a sense of controlling one's own destiny. Clearly these feelings demonstrate that the mind and the body are not distinctly separate, but intimately related. Certainly most people would say that they believe that regular physical activity and exercise contribute to overall enhanced well-being, yet many do not participate. The disconnect between what people believe and what they do can be very complicated. However, knowledge can provide a sense of empowerment and ultimately lead to a change in behavior. As you gain knowledge by reading this book and applying the principles taught you can make changes in your own life that will allow you to take charge of your own good health.

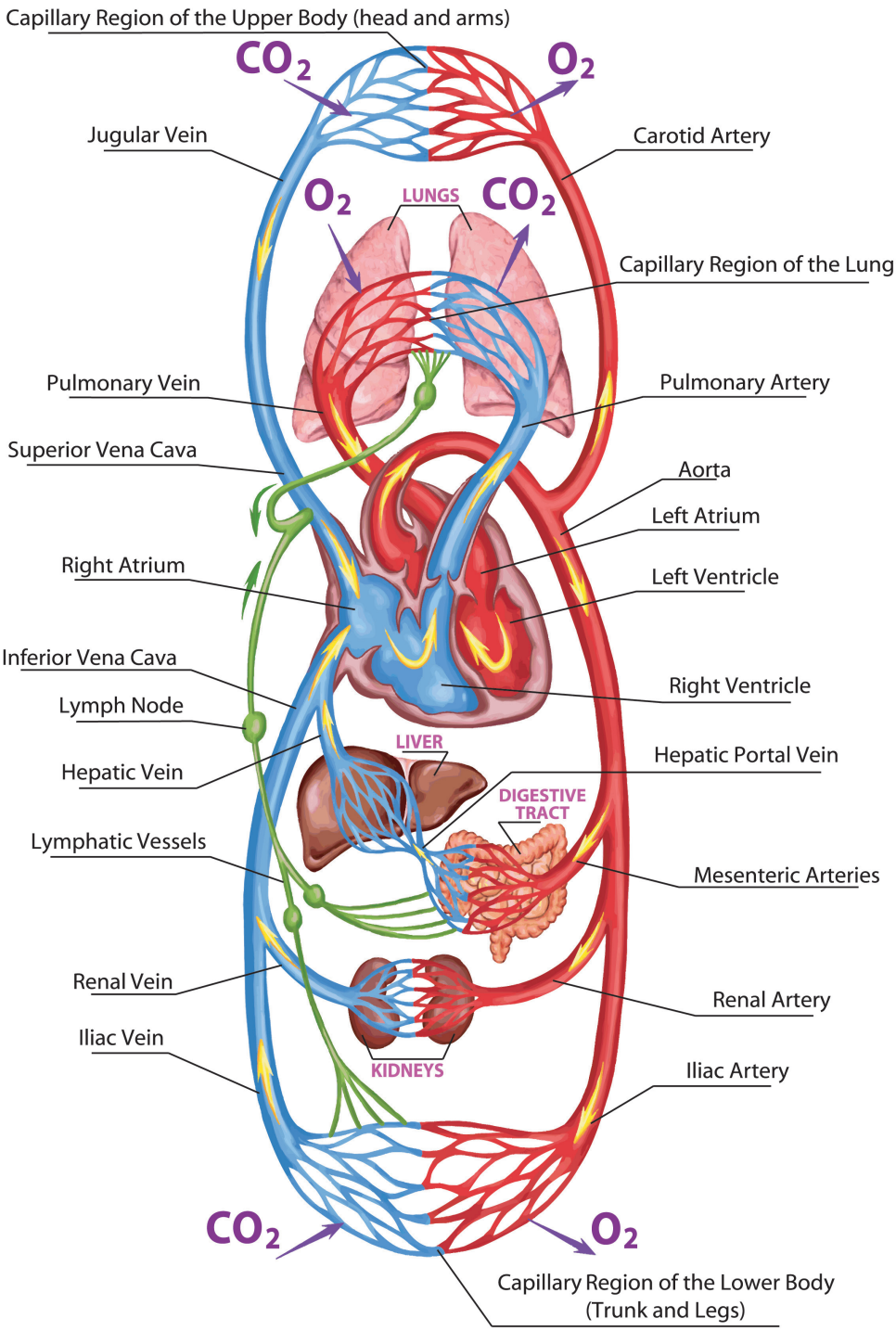

Figure 1. *The cardiorespiratory system.*

OVERVIEW OF THE CARDIORESPIRATORY SYSTEM

To more fully understand the effects and benefits of a proper cardiorespiratory fitness program, it is helpful to review basic cardiorespiratory anatomy and function. The cardiorespiratory system is comprised of the blood vessels, the lungs, and the heart. Each plays important and unique roles in proper body function. The circulatory system is what allows for the transport of oxygen and other nutrients throughout the body. These blood vessels also facilitate the removal of waste by-products of cell metabolism such as CO_2. Exchange of oxygen and CO_2 occur in the lungs through a series of small air sacs called alveoli. Each alveolus is surrounded by capillaries which are the smaller vessels that branch off from the arteries and veins. In essence, the exchange of these gasses in an efficient manner is directly related to ***cardiorespiratory fitness*** ***(Figure 1)***.

The heart, a hollow muscular organ about the size of your fist, acts as a pump to move blood through the vessels and lungs. This is called ***resting heart rate (RHR)***, which is the number of heartbeats per minute when the body is at rest. For adults, the normal resting heart rate is in the range between 60–100 beats per minute.

During activity the heart rate can more than double in order to provide oxygen to the working muscles. Through an appropriate and consistent program of regular physical activity, cardiorespiratory fitness is improved and a number of positive adaptations occur. In the long-term perspective many of these adaptations ultimately contribute to reduced risk for cardiovascular disease, some cancers, obesity, and type 2 diabetes. There are also adaptations that facilitate positive changes in the central nervous system and reduce risk for dementia, depression, anxiety, and Alzheimer's disease. Additionally, more immediate adaptations increase the strength and efficiency of the cardiorespiratory system and therefore allow for a person to participate in physical tasks for longer periods of time without becoming fatigued.

Did you know that the heart sends more signals to the brain than the brain sends to the heart? The ***vagus nerve***—the nerve fibers that control the lungs, heart, throat, and intestinal tract—helps regulate pulse rate. The vagus nerve is composed of nerve fibers, 90 percent of which ascend from the heart to the brain and only 10 percent descend from the brain to the heart. In humans, the control center to coordinate incredible amounts of minute processes is the heart. Physicists and biologists speak of coherence, the integration of vast amounts of complex activities within a system, whether the whole universe or the human being. We feel this phenomenon of coherence when our heart, mind, and body are aligned. It gives us a feeling of wholeness, feeling connected within ourselves. This feeling can transcend to others, feeling a oneness with others, or even to the earth or the cosmos, feeling a oneness with life.

Heart rate variability (HRV) is the interval between each heartbeat. The HRV reflects the action of the autonomic nervous system (ANS) that consists of the sympathetic and the parasympathetic branches. The sympathetic branch is the "fight or flight" system that speeds up the pulse and helps a person respond to challenges. The parasympathetic acts to slow down the pulse so the two branches are working in concert with each other. The pulse rate is not the metronome-like steady beating that we normally think of but rather the result of a delicate, dynamic balancing of these two branches resulting in varying amounts of time actually occurring in the pulse rate. It is much like balancing on a skateboard. A smooth ride results from constant response to conditions but if unable to respond, the rider may flail about causing undo stress and a possible eventual crash. Physicians and exercise scientists consider HRV to be a strong indication of cardiorespiratory fitness and overall health. HRV reflects a person's ability to respond well to stress and other things impacting our lives. People who are not fit have a lower HRV but improved cardiorespiratory fitness and overall healthy living can restore HRV to normal values.

An electrocardiogram is a good measure of HRV and the Institute of HeartMath has a more practical approach to working with HRV. Their app, Inner Balance, and their emWave2 program track HRV over a few minutes displaying heart rhythm. Heart rhythms that appear as smooth rolling waves indicate synchrony or harmony, in other words, coherence.

Heart rhythms that appear jagged and scattered, much like a seismograph during an earthquake, indicate disharmony, lack of integration or incoherence. The heart rhythms are one of the main ways in which the heart communicates with the brain and the rest of the body. Recent findings by an emerging medical field, neurocardiology, are that the heart has its own intrinsic brain, "the heart brain," and this is made up of cardiac ganglia and neurons. It is a complex neural circuitry that can learn, make functional decisions, and even over-ride messages from the brain as a protection to the individual.

Coherent heart rhythm messages from the heart to the brain facilitate brain function whereas incoherent messages inhibit brain functions. The same is true for other systems in the body. Stress, anger, frustration,

and other negative emotions cause incoherent heart rhythms; positive emotions of appreciation, caring, and compassion generate coherence. Heart rhythms have a significant impact on overall health and well-being. Better cardiorespiratory fitness will improve your HRV and heart rhythms and make your heart function more efficiently by lowering your resting pulse rate (RHR).

Cardiorespiratory fitness: Ability of the heart to deliver oxygen and nutrients to the muscles and remove waste products during physical activity. Cardiorespiratory fitness involves the circulatory and respiratory systems and their ability to adapt to increased workloads.

Resting heart rate (RHR): The number of heartbeats per minute when the body is at rest.

Vagus nerve: The nerve fibers that control the lungs, heart, throat, and intestinal tract.

Heart rate variability (HRV): The interval between each heartbeat.

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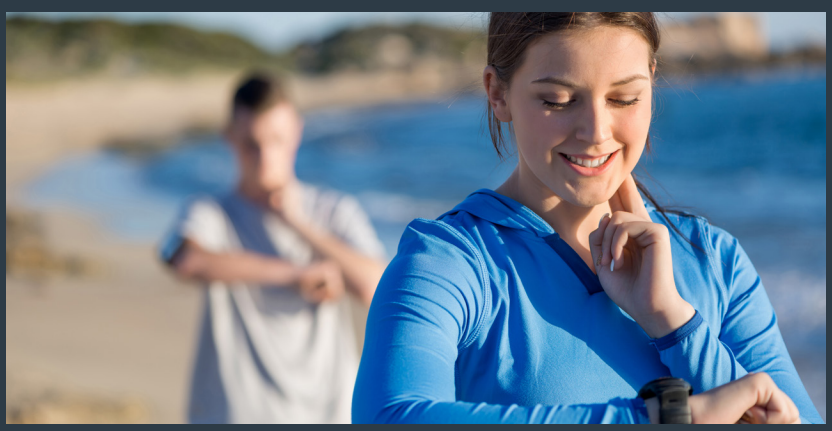
What Is Your RHR?

The most accurate time to measure RHR is in the morning before getting out of bed. You can palpate your pulse on the thumb-side of the wrist, or on your neck on either side of the trachea. When you locate your pulse, simply count the number of beats in 1 minute. Resting heart rate in untrained persons can range from 60–80 beats per minute. However, you can lower your RHR between 10–20 beats per minute on average with a proper training program. Incredibly some elite endurance athletes have an RHR that is below 30 beats per minute.



THE BENEFITS OF CARDIORESPIRATORY FITNESS AND HEALTH

Cardiorespiratory fitness is one of the ***health-related components of fitness***. It is health-related because it plays an important role in decreasing incidence and prevalence of chronic diseases, like cardiovascular disease and type 2 diabetes. Cardiorespiratory fitness is synonymous with some other terms that may be familiar to you. Aerobic fitness, aerobic endurance, cardiorespiratory endurance, and cardiovascular fitness are all used to describe a person's ability to do physical work. Notice that many of the terms use the word endurance. The term *endurance* indicates being able to do work or to be physically and mentally active for longer periods of time and is, in part, what it means to have cardiorespiratory fitness ***(Figure 2)***.

When researchers or medical professionals measure cardiorespiratory fitness in laboratory or clinical settings, it is typically described as VO_2max. This assessment, which can be fairly expensive, involves a maximum physical effort and is usually performed for research and medical evaluation purposes. ***VO_2max*** is a measure of the maximum amount of oxygen a person can use in body tissue, such as working muscle, and is often expressed relative to an individual's body mass as mL•kg−1•min−1 (milliliters of oxygen per kilogram of body mass per minute). You should now understand more clearly that cardiorespiratory fitness involves multiple body systems and organs working together including the heart, lungs, blood vessels, musculoskeletal system, and the central nervous system.

There are many hundreds of research studies that have been published on the health-related benefits of cardiorespiratory fitness and a physically active lifestyle. Most of these health benefits come in the form of reducing risk of chronic diseases that are both physical and mental in nature. Some experts have begun calling these diseases ***diseases of choice*** because how we choose to live, in large part, determines the risk of being diagnosed with a disease like heart disease, cancer, dementia, and others.

Figure 2. *Your aerobic fitness will enable you to do work or be active for longer, in all parts of your life.*

Health-related components of fitness: Components of fitness that impact risk of chronic disease, disability, and premature death. The health-related components of fitness are cardiorespiratory fitness, muscular strength and endurance, flexibility, and body composition.

VO_2max: Maximum volume of oxygen consumed. Typically described per unit of time and relative to an individual's body mass as mL•kg–1•min–1 (milliliters of oxygen per kilogram of body mass per minute).

Diseases of choice: Chronic disease conditions that are acquired in part due to lifestyle habits such as diet and physical activity. Diseases typically include some forms of cancer, type 2 diabetes, obesity, and cardiovascular diseases.

All-cause mortality: Death from any cause.

Improved Endurance and Skill

Another important reason for regular cardiorespiratory exercise is to enhance endurance and skill. When you are more fit, you are less easily fatigued when you are working or playing. For many, it is important to maximize their potential for peak performance. This is especially true for athletes of all ages who enjoy competition. However, many simply want to know that they are performing at an optimum level and doing the best they can.

There is evidence that the more successful a person is at a particular activity or sport (which comes from practice and effort), the more likely they are to participate and maintain participation for years to come. This is one reason why it is important to find activities that you enjoy, so that you will be motivated to keep doing them. However, don't be afraid to try new things. Often, improving skill requires amounts and types of activity that go above and beyond what is necessary for the health benefit. If a person is interested in the performance and skill-related benefits of regular exercise, they will likely also attain the health-related benefits. But for many it is a relief to know that they do not need to put forth a superhuman effort in order to optimize the health benefit derived from regular physical activity.

Better Mental/Cognitive Health

Dementia, Alzheimer's, and cognitive decline are all real concerns especially in aging societies like those of developed nations. Other mental health issues relating to depression and anxiety are also identified as leading health indicators for the populations of many nations. In 1999 the Surgeon General for the United States released a report on mental health and among other things stated that mental health is fundamental to overall health.

Cognition is related to the ability to select, manipulate, store, and recall information in the brain. Studies have shown that cognitive intellectual abilities can be improved during, right after, and after long-term exercise participation. Both animal and human studies have shown reductions in risk for cognitive impairment,

Alzheimer's disease, and dementia. Other studies have found that physical activity delays loss of, or has no effect on, cognitive function in elderly subjects, and no studies have reported an accelerated loss of cognitive function with physical activity participation.

The way that exercise improves mental health conditions is not entirely understood but it is thought to be multifaceted. Some studies have shown exercise to have antidepressant effects due to social interaction and the resultant personal attention between individuals. Other studies have considered that exercise may displace stressful stimuli, in essence allowing for a "time-out" from the daily grind. Even though these are important findings other research has shown that effects of exercise on mood, depression, and anxiety is related to more than the social interaction or relief from the daily routine.

There are known neurocellular mechanisms that help explain, at least in part, the mental health benefit of regular physical activity and exercise. These mechanisms range from decreasing neurodegenerative processes and increasing neural cell proliferation to the effect that physical activity and exercise has on neurotransmitter uptake and release. More simply stated, physical activity and exercise prevents the potential destruction of brain cells from disuse and has even been shown to actually cause neurogenesis, new brain cells to grow. Additionally, the chemical compounds and mechanisms that allow cells to "communicate" with each other become more effective and efficient.

Figure 3. *Cardiovascular disease is the leading cause of death in the United States.*

Lower Risk of Chronic Disease and Increased Quality of Life

From a historical perspective, it is interesting to note that more than 20 years ago in a landmark study from 1989, Blair noted some of the most significant benefits of having a high level of cardiorespiratory fitness. It was discovered that when least fit men and women were compared to most fit men and women, the lower fit men and women were 3.2 times and 5.3 times at higher risk of all-cause mortality, respectively. ***All-cause mortality*** means death from any cause. When the researchers looked at cause-specific mortality, it was found that low-fit men were 7.9 times at higher risk than high-fit men, and low-fit women were 9.3 times at higher risk than high-fit women for death due to cardiovascular disease.

Why do you think that physical fitness is related to all-cause mortality? Does it really make sense that level of fitness would be related to death from any cause? Consider the person who attempts skydiving and their parachute does not open. Could their fitness be related to this tragic situation? Probably not. So what is the connection between fitness and all-cause mortality?

What is the leading cause of death in America? It is cardiovascular disease, and the leading cause of cardiovascular disease death is heart attack or myocardial infarction ***(Figure 3)***. It is now known that being physically active and consequently physically fit significantly reduces risk for cardiovascular disease death. Because of the strong link between fitness and cardiovascular disease there is also a connection between fitness and all-cause mortality because so much of all-cause mortality is made up of cardiovascular disease mortality.

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Mental Health in the United States

Your mental health is important. Many people in the United States struggle with some kind of mental illness that impairs their well-being. Here are some facts:

- 65 million Americans (26.2 percent of adults) suffer from a mental disorder
- 40 percent of disability in the United States and other developed countries is attributed to mental disorders
- Depressive disorders are nearly 2 times more common in women than men
- Age at onset for major depressive disorders is in the middle 20s
- Agoraphobia involves intense fear of any place or situation where escape would be difficult and is the most common phobia among Americans

Research has clearly and consistently shown that a critically important lifestyle habit for improved mental health is the habit of regular exercise. Several studies have shown that physical activity was positively associated with better mental health, measures of well-being, and less anxiety and depression. Furthermore, research comparing the effectiveness of traditional treatments for depression, such as prescription medications and psychotherapy, found that exercise is just as effective in reducing depressive symptoms. Other research has shown that exercise can be an effective intervention for reducing anxiety, improving general psychological well-being, and elevating self-esteem.

Another very interesting finding from the Blair 1989 study relates to family history or genetics. Many people believe that they are destined to the same chronic disease conditions as their parents because of genetic heritability. This is true to some extent. When a person has a family history of high blood pressure, for example, they are at increased risk of also developing high blood pressure themselves. However, one of the most exciting findings from this 1989 study relates to the independent influence that being physically fit has on a person's risk of premature death. For example, it was noted that unfit men and women with no family history of coronary heart disease had 2.7 times and 6.3 times higher risk of all-cause mortality, respectively, than fit men and women with a family history of heart disease. Similar results have been shown for other known risk factors that exhibit familial tendencies such as blood pressure and cholesterol. The results from this study have been confirmed in subsequent studies.

In 2000, Stampher published a classic study involving more than 84,000 women. It is called the Nurses Health Study. This study is designed as a longitudinal cohort of women that are being tracked and assessed over time. Women in this study who were considered "low-risk" had these characteristics: not currently smoking; a body mass index less than 25; consumed an average of at least 1⁄2 a drink of an alcoholic beverage per day; engaged in moderate to vigorous intensity physical activity, including brisk walking for at least 1⁄2 hour per day; and a healthy diet, including high fiber, high marine fatty acids, and high consumption of polyunsaturated fat relative to saturated fat. It is important to note that all of the previously mentioned characteristics of the low-risk profile are completely within the control of the study subjects. During the 14 years of follow-up for this study there were 1,128 fatal and nonfatal coronary infarctions in the more than 84,000 women, and 82 percent of these coronary events could be attributed to not conforming to the low-risk profile. This particular study and others like it demonstrate that the choices we make, including being active or sedentary, contribute to both quality and quantity of life.

As can be seen from these and other studies, reducing risk of disease and improving quality of life is more than just a choice about exercise, it is about a healthy lifestyle.

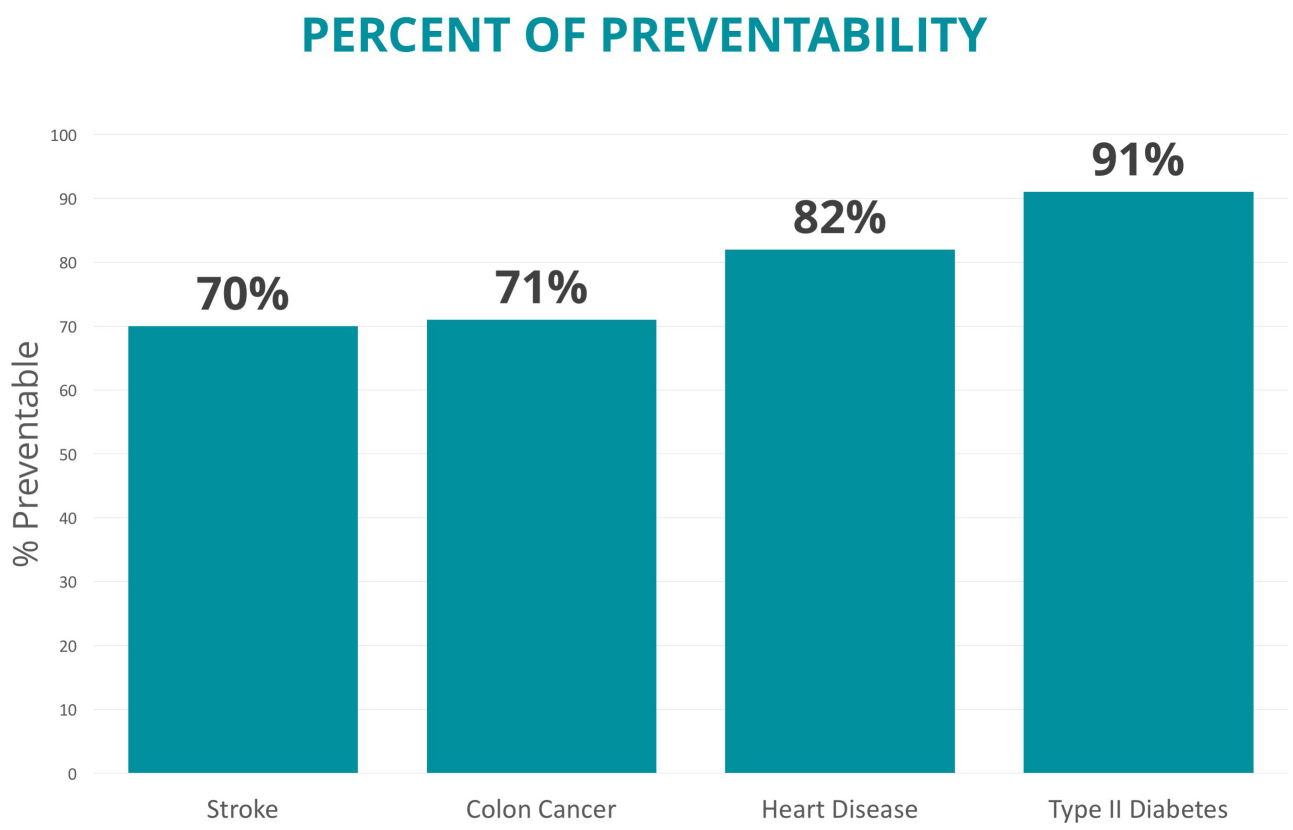

Figure 4. *Percent preventability of common chronic diseases by lifestyle modification.* ***Source:*** *Stampfer, Platz, & Hu.*

The Prudent Lifestyle

Some experts have begun to call a healthy lifestyle a ***prudent lifestyle***. While a prudent lifestyle is related to multiple factors including diet, smoking, body mass, and alcohol, it also includes being physically active to the extent that health benefits are realized, if not maximized. Many studies have confirmed that some of the leading killers in the world are potentially avoidable through adherence to a prudent lifestyle. Some cancers, stroke, heart disease, and type 2 diabetes are thought to be ~70 percent to ~90 percent preventable. In 2006, the American Cancer Society conducted a 5-year update of their nutrition and activity guidelines. With this update the society stated physical activity may reduce the risk of colorectal, breast, prostate, and endometrial cancer, and there is a probable protection against other forms of cancer as well ***(Figure 4)***.

It was further noted that weight control, through proper nutrition and physical activity, independently reduces risk of many cancers. The society suggested that the number of Americans who die of cancer each year would be reduced by over 30 percent if they adhered to current exercise and diet recommendations. Given that more than 500,000 people die each year from cancer, a 30 percent reduction would be an extremely significant number of lives spared. The recommendation for intensity and duration of activity from the cancer society is also in line with the Surgeon General's and the American Heart Association guidelines. The recommendation is at least 30 minutes' duration of moderate to vigorous intensity activity, such as a brisk walk on 5 or more days a week. Forty-five to 60 minutes of intentional physical activity are preferred. In most cases the more activity a person gets, the greater the health benefits they receive. This is called a ***dose-response relationship***.

The amount and intensity of exercise needed for health is different from that needed to optimize performance and is related to something called the dose-response curve. A dose-response curve gives an indication of an amount of something (like exercise or medication) needed to produce an optimal effect (like health benefit or relief of symptoms).

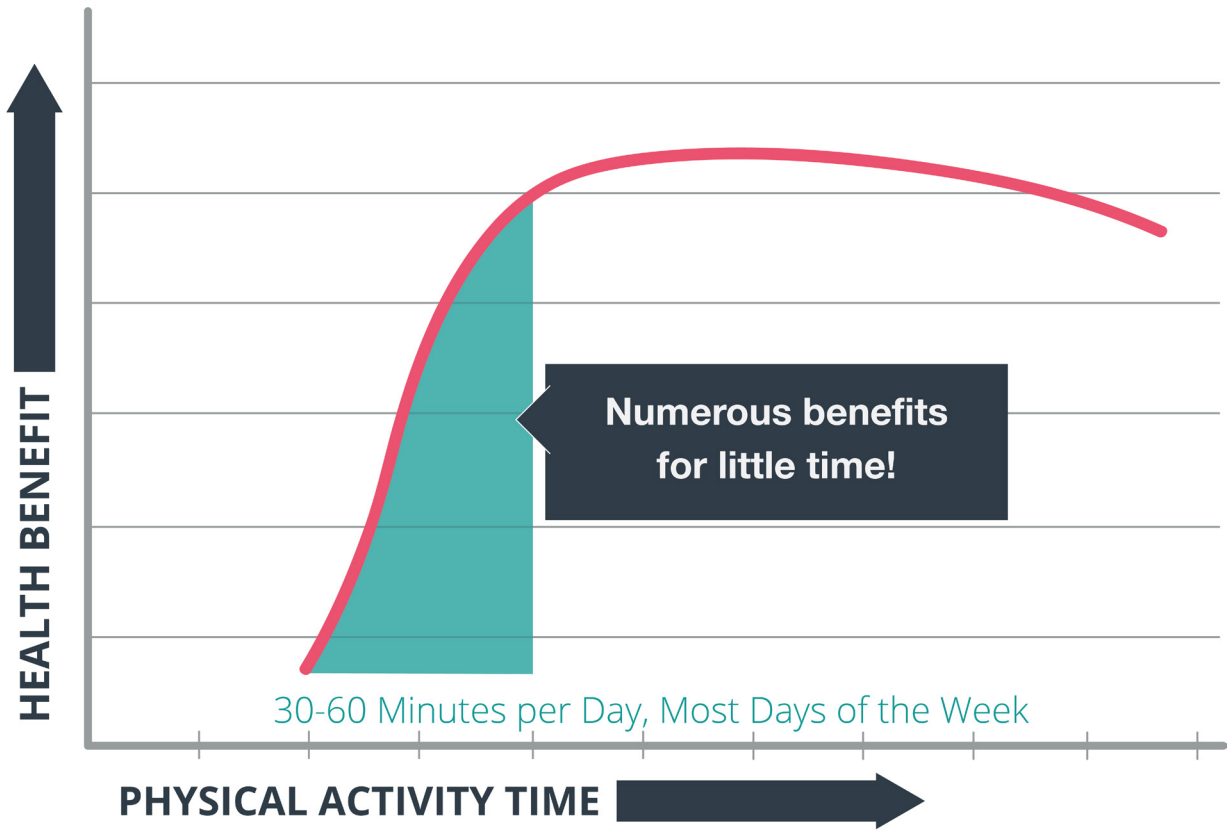

Figure 5. *The dose-response relationship shown here suggests that as cardiorespiratory activity goes up—to a certain point (30–60 min)—the benefits to your health also go up.*

Dose-Response Relationship

The dose-response relationship for physical activity and consequently cardiorespiratory fitness suggests that as activity time increases, the health benefit also increases. Interestingly, as shown in ***Figure 5,*** most of the benefit is attained from doing the minimum recommendation for physical activity.

In 2000 an international consensus committee reviewed evidence-based data and found that an inverse dose-response relationship exists for a number of health outcomes, including: all-cause mortality, cardiovascular and coronary heart disease, overweight and obesity, primary prevention of type 2 diabetes, and quality of life and independence in older persons. An inverse dose-response relationship means as cardiorespiratory activity goes up, the risks to your health go down. There are also other health outcomes that have favorable relationships with physical activity and exercise, including reductions in symptoms for depression and anxiety, and reductions in blood pressure and hypertension.

Regular exercise and physical activity can also improve well-being. Without question, overall health includes mental and emotional components and is not just related to the physical person. Research has shown that regular physical activity improves psychological well-being by elevating a person's self-perception and self-awareness. Exercise has even been shown to improve mood states. Furthermore, some studies have concluded that exercise reduces depressive symptoms more than relaxation training and is as effective as psychotherapy. There are also positive effects of exercise on sleep.

In summary, the benefits of exercise and physical activity and the consequent outcome of improved cardiorespiratory fitness are numerous. From reducing risk of a fatal heart attack to improving psychological state, exercise and physical activity are critical to mindbody harmony and optimal well-being ***(Figure 6)***.

Figure 6. *Cardiorespiratory fitness offers many immediate benefits, such as improved endurance and performance in all parts of your life.*

PRINCIPLES OF CARDIORESPIRATORY FITNESS

There are a number of principles that, once understood, allow for a more individualized approach to developing your own exercise and activity program. By studying the following principles, you will be better able to take charge of your own good health by participating in a program of regular and appropriate physical activity. Additionally, you will notice that these principles can be applied to most aspects of your life, whether physical, mental, spiritual, social, or intellectual.

Overload Principle

One important principle is the ***overload principle***. In simple terms, this principle states that in order for the cardiorespiratory system to become stronger and more efficient, it must be subjected to loads greater than those it is accustomed to. This principle applies to almost everything in life. If a person wanted to become a better public speaker, they would have to practice speaking in public. According to the overload principle, cardiorespiratory fitness increases only when you participate in activities that put an overload on the cardiorespiratory system. Consequently the cardiorespiratory system will become more efficient. This leads to the principle of progression.

Prudent lifestyle: Favorable elements of lifestyle habits that reduce risk of chronic disease. A prudent lifestyle is usually made up of healthy habits related to sleep, stress, diet, exercise, drinking, smoking, and so on.

Dose-response relationship: Indicates a change in health status or reduction in risk due to exposure to, or participation in, certain healthy lifestyle activities. A healthier lifestyle results in greater health benefits. For example: regular physical activity (dose) yields health benefit (response), and more activity, up to a point, yields greater benefit.

Overload principle: Subjecting various body systems (cardiorespiratory system) to loads greater than those to which they are accustomed.

Principle of progression: Indicates the body's ability to adapt to an overload by becoming more fit, and therefore requires increasing intensity or overload in order to make gains in fitness.

Principle of Progression

The ***principle of progression*** states that gradual increases in intensity and duration of activity are needed in order to ensure that the system is being overloaded. This is because the body will eventually adapt to the overload placed on it. If cardiorespiratory endurance is low, start with short bouts of low intensity activity, then increase the number or length of bouts until you do a minimum of 30 minutes of moderate to vigorous intensity activity most days of the week. Do not increase the frequency, intensity, or duration of activity until

you are comfortable working at the current frequency, intensity, and duration of activity. The principle of progression naturally leads to a final principle to consider, the principle of reversibility.

Figure 7. *How do you think the principles of cardiorespiratory fitness apply to other parts of your life?*

Principle of Reversibility

The ***principle of reversibility*** is commonly recognized by these five simple words: "Use it or lose it." Elevated levels of cardiorespiratory fitness will be lost if not maintained. Failing to exercise regularly means losing the fitness gained. Remember, the more support you have from others and the more you enjoy your activities, the more likely you will be to stay active and reach your goals. In the words of Dr. Kenneth Cooper, who is considered to be the 'Father of Aerobics,' "It is easier to maintain good health through proper exercise, diet, and emotional balance than it is to regain it once it is lost."

Given your understanding of these principles, can you think of how they might apply to other aspects of your life ***(Figure 7)***? For example, how might the overload principle be applied to your goal of earning a good grade in this class, or developing a positive and productive relationship with another person, or reaching your highest potential in your career? Would the principle of progression or the principle of reversibility also apply to these examples or others that you can think of?

Principle of reversibility: Improvements previously attained through habitual physical activity are lost when the training stimulus is removed.

Warm-up and Cooldown

Part of every good exercise program is the warm-up and cooldown. The warm-up should typically include 5–10 minutes of low-intensity activity. Most find that doing the mode of activity preferred for the exercise session at low-intensity is a convenient way to warm up. For example, if the preferred activity is brisk walking then the warm-up would be slow walking for 5–10 minutes. If the preferred activity is bicycling at 12–15 mph then the warm-up could be to cycle at 5–7 mph for 5–10 minutes. A warm-up period can also include a period of time for static stretching. If stretching is included in the warm-up it should follow the more active portion of the warm-up. By following this sequence you increase body temperature and consequently the stretching may be more productive. Some of the beneficial effects of a proper warm-up include increasing body temperature, elevating heart rate, directing blood flow to the target muscles, and reducing the risk of musculoskeletal injury.

The main purpose of the cooldown is to reduce heart rate and lower body temperature. It is also important to remain active after an extended bout of exercise, 30 minutes or more of continual cardiorespiratory activity, in order to facilitate venous return of blood to the heart. This is called an active cooldown. The veins have relatively little pressure and one way valves in them. The contraction of the muscles in the lower body during a cooldown that incorporates movement creates a milking action on the veins that prevents blood from pooling in the lower extremities. ***Figure 8*** shows how the veins have one-way valves and how the muscles can provide force to move blood toward the heart.

If the blood pools it can create a state of hypotension or low blood pressure and increase the likelihood of dizziness or fainting. Movement and blood flow during the cooldown also decrease lactic acid levels and promote recovery from fatigue. Additionally, a proper cooldown may decrease the risk of cardiac irregularities, especially in high-risk individuals.

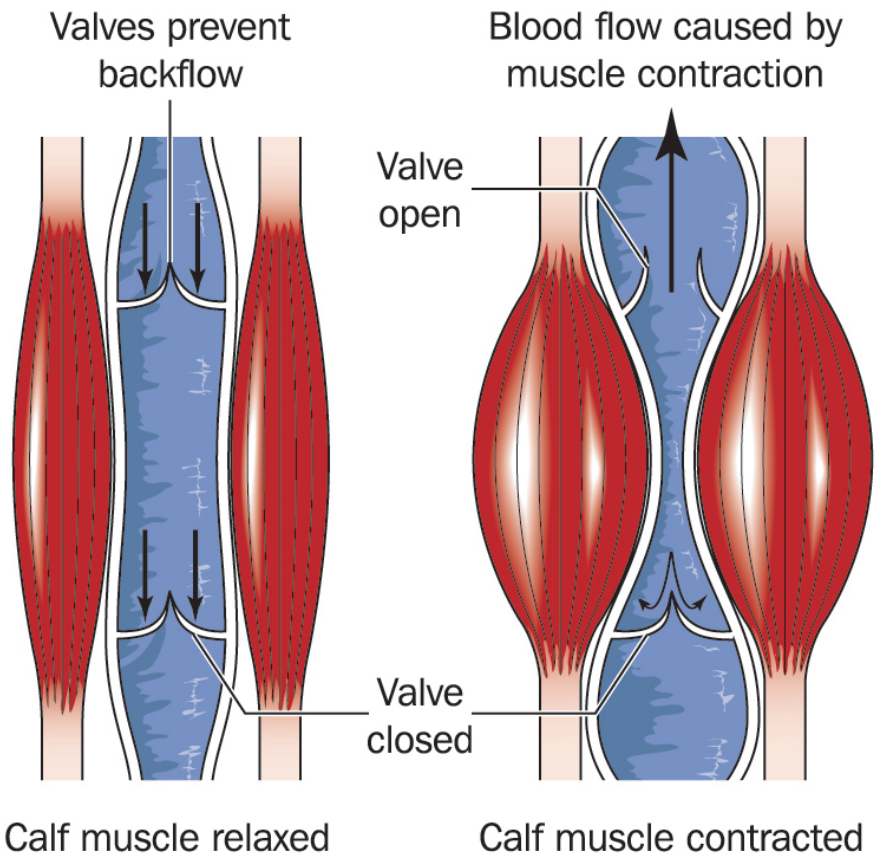

Figure 8. *The active cool-down helps direct the blood flow back to the heart.*

F.I.T.T. Formula

As with most good things in life, principles drive our actions. Regular cardiorespiratory exercise is no different. In order to make improvement, certain correct principles must be considered. As it pertains to cardiorespiratory exercise this is called the ***F.I.T.T. formula***. F.I.T.T. is an acronym that stands for:

Frequency is the number of exercise sessions per week necessary to improve cardiorespiratory fitness.

Intensity is the intensity of the exercise bout and usually referenced as percent of maximum heart rate or as level of perceived exertion.

Time is the duration of the exercise session or the total accumulation of exercise minutes over the course of a day.

Type means the type of activity that uses large muscle groups, can be maintained for a given duration, and is rhythmical in nature.

Sometimes the letter E is used at the end of the F.I.T.T. acronym to represent the word enjoy. While enjoyment of an activity does not directly and physiologically affect the cardiorespiratory system, it is known that an enjoyable activity is more likely to evoke feelings of satisfaction and promote long-term adherence. So, try to find something that you enjoy since it will create a win-win situation. If you like to do the activity and the activity benefits your health, that's a win-win ***(Figure 9)***.

Figure 9. *Skateboarding is not just a mode of transportation. It also qualifies as a type of physical activity that you can enjoy.*

PREPARING FOR PHYSICAL ACTIVITY

Prior to beginning any exercise program, common sense should tell you that if you have previous or current limiting conditions or injuries that could increase health risk, you should consult with a medical professional before you begin your exercise program. There are a number of pre-participation screening tools that could be used to determine readiness for participation in a program of physical activity. One of the most common screening instruments is called the PAR-Q. PAR-Q stands for Physical Activity Readiness-Questionnaire. This questionnaire was developed by the Canadian Society for Exercise Physiology and is used in many clinical and non-clinical settings. While there are always going to be inherent risks associated with exercise participation, risk can be minimized by completing the PAR-Q and following the recommendations based on individual responses. The seven questions, to which a person responds with a "yes" or "no" answer are:

1. Has a doctor ever said that you have a heart condition and that you should only participate in physical activity recommended by a doctor?
2. Do you feel pain in your chest when you participate in physical activity?
3. In the past month, have you had chest pain when you were not participating in physical activity?
4. Do you lose your balance because of dizziness or do you ever lose consciousness?
5. Do you have a bone or joint problem that could be made worse by a change in your physical activity?
6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?
7. Do you know of any other reason why you should not participate in physical activity?

If you answered "yes" to any of these questions you should consult with your doctor or other medical professional before engaging in a program of regular physical activity. Under most circumstances, you know yourself better than anyone. If you feel uncomfortable or simply that something is not right before beginning or after starting an exercise program, it is best to stop until you can resolve the issue. Additionally, if your health status changes, relative to the questions in the PAR-Q, after you have started an exercise program you should tell your doctor or other qualified medical professional.

PERFORMANCE OR HEALTH: WHICH ONE IS FOR YOU?

There are basically two lines of thinking when it comes to writing a cardiorespiratory conditioning program. One line of thought is often referred to as the exercise prescription model (EPM). This approach is more structured than the alternate approach, which is sometimes called the Lifetime Physical Activity Model (LPAM). Both models can incorporate the F.I.T.T. formula and yield significant health benefits.

F.I.T.T. formula: Variables used in designing programs of physical activity and exercise (F = frequency; I = intensity; T = time; T = type of activity)

Exercise Prescription Model (EPM)

The exercise prescription model (EPM) is a guideline used to determine frequency, intensity, time, and type of exercise needed to achieve cardiorespiratory fitness. The EPM traditionally states that an individual perform cardiorespiratory exercise at least 3–5 times per week at an approximate intensity of 40–85 percent of heart rate reserve (HRR) in one continuous bout of 20–60 minutes' duration. The primary benefit of using heart rate reserve to calculate exercise intensity is that it accounts for the individual variability in a person's resting heart rate. This model has been used for more than two decades and has been effective for designing exercise programs for adults who are interested in enhancing skill and performance combined with optimizing health benefit.

Use these steps to determine the intensity of your exercise program.

1. Calculate your maximum heart rate (maxHR). Maximum heart rate can be determined by performing a maximal exercise test while monitoring heart rate and is defined as the maximum number of heartbeats per minute achieved during a maximal effort. Regression analysis has shown that maximum heart rate can also be predicted using an age-based equation that results in age-predicted maximum heart rate:

   208 – (0.7 × age) = maxHR

   This formula is a more sophisticated means of reaching the same information as the formula (220 – your age).

2. Figure out your heart rate reserve (HRR). The formula for determining HRR is:

   Maximum heart rate (maxHR) – resting heart rate (RHR) = HRR

3. Determine the intensity of your exercise. To do this, use this formula:

   Intensity (HRR × intensity percent) + RHR = target heart rate

Apply the Exercise Prescription Model

Margot is female and has been previously sedentary, but would like to start an exercise program that will reduce her risk of disease, help her maintain an ideal body weight and body fat percentage, and improve her level of cardiorespiratory fitness. Another reason she wants to get in shape is so she can participate in 5K and 10K races. She is 21 years old, has a resting heart rate of 65 beats per minute, and answered "no" to all of the questions on the PAR-Q. Margot's age-predicted maximum heart rate is 193 beats per minute (bpm).

- Margot's maxHR = 208 – (0.7 × 21) = 193
- Margot's HRR = 193 – 65 bpm = 128
- Margot's moderate intensity target heart rate = (128 × 40 percent) + 65 bpm = 116
- Margot's vigorous intensity target heart rate = (128 × 84 percent) + 65 bpm = 172.5

According to the American College of Sports Medicine recommendations, Margot should start exercising at the lower end of her heart rate training zone because she has been previously sedentary, and as she gets into better shape she can increase the intensity by exercising at the higher end of her training zone. The recommended training zone is approximately 40–85 percent of heart rate reserve for moderate to vigorous

intensity activity, respectively. Margot should monitor her heart rate by palpating her pulse or use an electronic heart rate monitor during her bouts of exercise. Her threshold for moderate intensity activity is 116 beats per minute and goes up to 173 beats per minute for vigorous intensity activity.

By following the exercise prescription model (EPM) Margot should exercise at the lower range of her training zone for a minimum of 20 minutes at least 3 times per week. As she increases her fitness she can exercise at a higher intensity for longer periods of time and more days per week. A heart rate monitor can keep track ***(Figure 10).***

Figure 10. *A heart rate monitor, like the one this man is wearing, is a good way to monitor your target heart rate during physical activity.*

Lifetime Physical Activity Model (LPAM)

Now let's consider the alternative, the lifetime physical activity model (LPAM). In recent years epidemiological research has shown that there is value in lifestyle physical activities for health promotion. The Centers for Disease Control and Prevention and the American College of Sports Medicine suggest that the accumulation of moderate intensity activity for 30 minutes per day on most, but preferably all, days per week can have significant health benefits. The LPAM is different from the EPM in that the focus is on the amount and type of physical activity needed to produce health benefits, not necessarily skill or performance benefits. This does not mean that a person cannot include some days of vigorous activity as well for the purpose of improving performance. Activities can be from planned exercise such as jogging, or more lifestyle oriented like taking the stairs instead of the elevator, or walking instead of driving for short trips. The key is to know what moderate intensity is. The ACSM's Guidelines for Exercise Testing and Prescription states that moderate intensity cardiorespiratory exercise is defined by an exercise heart rate of 40–50 percent of heart rate reserve.

There are other ways to determine appropriate exercise intensity that are based on overall feelings of exertion and fatigue. One such method uses the ***Rating of Perceived Exertion (RPE)*** scale. A common RPE scale

uses a 15-item classification based on the original scale which begins at 6 and goes to 20. Intensities from 7–11 qualify as light intensity with 6 representing no effort at all. Intensities from 15 to 20 indicate vigorous intensity with 20 representing maximal exertion. Moderate intensity (recommended for health benefit) are intensities 12, 13, or 14. A revised RPE scale based on a 0 to 10 range may be more intuitive to use. Using this revised scale moderate intensity would be in the range of 3 to 4 out of a total possible of 10, with 10 being maximum intensity. With practice most people can learn to use the RPE scale to rate their intensity of exercise.

Table 1. Scales for Ratings of Perceived Exertion

Original RPE 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	*Maximal*

Revised RPE Scale	
0	*Nothing at all*
0.5	*Very, very weak*
1	*Very weak*
2	*Weak*
3	*Moderate*
4	*Somewhat strong*
5	*Strong*
6	
7	*Very strong*
8	
9	*Very, very strong*
10	*Maximal*

Another method for determining exercise intensity that is somewhat objective is the ***talk test***. If a person is exercising too hard, it is also too difficult to talk. However, if a person could sing a song while exercising, the intensity is likely too easy. But if a person could carry on a conversation with limited difficulty, being able to say two or three words between breaths, they would likely be in a moderate intensity range.

Rating of Perceived Exertion (RPE): A scale used to subjectively quantify the intensity of a given activity.

Talk test: A subjective measure that is practical and easy to use to monitor intensity of exercise.

Figure 11. *Interval training effectively builds cardiorespiratory capacity in less time and is very efficient.*

Intermittent and Interval Training

Both the EPM and the LPAM can incorporate an intermittent activity approach. Intermittent activity involves breaking up exercise time into smaller amounts of time throughout the day, and for some, this may be more appealing. Interval training on the other hand involves varying intensity of exercise from high to low with a rest in between as opposed to doing continuous cardio activity such as walking, jogging, or running for 30–45 minutes. Interval training might consist of doing ten 3-minute intervals of jogging with a 1–minute rest in between during the 30–45 minute time period ***(Figure 11)***.

While accumulating activity intermittently throughout the day might be preferred for those who have busy days with little time for long exercise sessions, interval training is the preferred method to better athletic performance as it is more effective in achieving higher levels of fitness. Because of the intensity of interval training, historically it was assumed that it was too difficult a method of cardio for the average person to do. Only recently have researchers considered it an appropriate cardio method for helping people to enjoy better health. Lockhart, one of the co-authors of this book, has developed an interval training program called CardioWaves. In this interval training program, you do a wave-like pattern of exercise and then rest, exercise, and then rest. In many interval training programs, it is recommended that you simply slow down in between exercise intervals. Dr. Lockhart recommends actively bringing your pulse as low as possible during the rest interval, basing the work you do on your own individual pulse rate.

Why do interval training rather than steady state—what are the advantages, if any? Some research suggests that interval training effectively builds cardiorespiratory capacity in less time than traditional continuous bouts of exercise and is therefore very efficient. Interval training has the potential to improve the working of the parasympathetic nervous system or the slow-down system. Most exercise works primarily on the sympathetic or fight-or-flight mechanism. A balance of both systems will serve to enhance your immune system and help you enjoy better health.

Figure 12. *A Fitbit is an example of an activity tracker that you can wear on your wrist.*

Physical Activity Trackers

Activity amount can also be measured in total number of steps taken per day. There are a number of wearable devices that can measure physical activity, such as Fitbits, pedometers, and even apps that you can download on your smart phone ***(Figure 12)***. Current recommendations for adults suggest 10,000 steps daily as a goal for achieving appropriate health-related activity levels. ***Table 2*** provides the current activity level by number of steps per day by the average adult.

The total number of steps can be done at once or in an intermittent fashion. A number of studies have shown that intermittent activity can enhance fitness and reduce disease risk. It is important to realize that there are a variety of approaches to formulating an exercise or physical activity program. Hopefully, given what you have learned to this point, and will continue to learn, you will find an approach that works best for you.

Table 2. Activity Level by Number of Steps per Day

STEPS PER DAY	ACTIVITY LEVEL
0 - 3,000	*Inactive*
3,000 - 6,000	*Low Active*
6,000 - 10,000	*Moderately Active*
10,000 - 15,000	*Active*
15,000 +	*Very Active*

PERSONALIZE YOUR CARDIORESPIRATORY TRAINING PROGRAM

A "one size fits all" cardiorespiratory training program is not ideal. While it is true that everyone can benefit from consistent physical activity, not everyone benefits to the same degree, at least according to typical outcome measures such as VO_2.

A number of studies have shown that two people with similar lifestyles, including cardiorespiratory exercise participation, do not respond the same way. Even though they may be the same age, sex, height, and weight, the likelihood that both would make the same physiological gains in fitness is slim. Sometimes this is called heritability of trainability, meaning that the degree to which a person is trainable is, in part, due to genetics. It has been shown that the heritability for cardiorespiratory fitness is about 10–25 percent. So not only are people different in terms of cardiorespiratory fitness level in an untrained state, they also respond differently to a training program. Research has shown that some people achieve 10 times the physiological benefit from a training program as another person who engages in an identical program.

Remember the F.I.T.T. formula when developing a program for yourself. A person who is more fit, either due to heritability or training, or who is younger rather than older, will be able to tolerate more frequent exercise sessions. The same applies to intensity. What is moderate intensity for one person may not be moderate intensity for another person. In fact, going to get the mail at the curbside mailbox for a cardiac rehabilitation patient may be nearly exhausting, but for a healthy person it certainly would not constitute an overload to the cardiorespiratory system and result in a training or health benefit. The duration of the activity also needs to be considered at an individual level. The key is to do what you can, given any limitations you have, and build your fitness level slowly. Use the Personal Program Development Worksheet, which is available in the *21st Century Wellness* self-assessment online module, to develop a physical activity program that is right for you ***(Figure 13)***.

For many, exercising with a friend or family member is motivating and promotes adherence to a program. Just be careful not to compare yourself to others now that you more fully understand the concept of heritability of trainability, or you may feel cheated and discouraged. Exercising with someone who has a fitness level and fitness potential as you, and enjoys similar activities as you, will likely encourage you to adhere to a long-term exercise program.

Figure 13. *Everyone is different, so use the F.I.T.T. formula to create an exercise program that is best for you.*

Identify Your Current Fitness Status

As was discussed at the beginning of the chapter, a maximal exercise test using a metabolic cart is the only way to measure exactly your aerobic capacity or VO_2max. However, these tests are expensive and typically only performed in clinical or research settings. Fortunately there are a number of submaximal self-administered tests that can be used to predict cardiorespiratory fitness level. One common assessment for self-monitoring cardiorespiratory fitness is the Walk/Jog/Run test. This test is good because it accommodates any beginning fitness level, is easy to perform, and can be repeated often to check fitness status and improvement.

Figure 14. *When you feel pain during exercise, stop or reduce the intensity of the activity. Listen to your body.*

Use Exercise Precautions

"No pain, no gain" is sometimes heard from those who exercise, referring to the belief that pain must be felt when exercising in order to improve. This is a myth. Improvement is possible without pain. In fact, if you experience pain while exercising, either stop doing that type of exercise or reduce the intensity ***(Figure 14)***. Some pain (such as that associated with a sprained ankle or medical procedure) may require a person to stop all exercise for a time until the body heals. Everyone experiences the aches and pains of everyday life. However, any pain beyond daily bumps and bruises is not required to improve cardiorespiratory fitness.

The health benefits derived from regular physical activity participation far outweigh the potential risk. However, there is inherent risk that comes with exercise and physical activity participation that is linked to both exercise intensity and exercise frequency. Studies show that there is risk for both fatal and non-fatal myocardial events (heart attacks) associated with exercise. In young people the risk of sudden cardiac death is lower because the prevalence of cardiovascular disease is lower. Typically the types of chronic conditions related to cardiovascular disease death are slow progressing and develop in the later years. The risk of exercise-related cardiac events in older versus younger is higher. It should be remembered that no matter the age, the risk of death is far lower than the risks associated with not exercising. Furthermore, remember that exercise cannot cause a cardiac event unless there is underlying heart disease.

Be Aware of Your Environment

A few other considerations worth learning about are exercise and temperature, and proper hydration. It does not matter whether a person is at rest or exercising, their body is producing heat. Heat is a natural by-product of metabolism. During exercise however, heat production increases because of the increased need for energy. One of the primary ways for the body to eliminate heat is through evaporation, which occurs as air moves over the skin. Cooling occurs when sweat or perspiration evaporates. Excessive sweating can lead to dehydration. Dehydration will impair performance and can lead to more serious health issues. Risk of dehydration is increased when exercising in hot conditions that cause excessive sweating or during prolonged activity. It is a good idea to drink about 2 cups of fluid 2 hours before exercise and then make sure to replace lost fluid during exercise. Chilled water is an optimal fluid replacement choice for the average person who is active for typical exercise session durations of 20 to 40 minutes. If the duration of the exercise session lasts more than an hour there may be some advantage to utilizing a sports drink for fluid and electrolyte replacement.

In hot and humid conditions body temperature can rise and the evaporation of sweat can be compromised. If the body cannot get rid of the heat, serious heat-related illness could occur. The American College of Sports Medicine recommends wearing clothing that facilitates evaporation, exercising during cooler times of the day or indoors where the environment is controlled, and reducing intensity or taking rest breaks during exercise sessions to maintain target heart rate.

In cold conditions there are two precautions to be aware of. One is hypothermia, a reduction in the body core temperature, and the other is frostbite or freezing of the skin. Exposure to cold air and wind in cold conditions promote body heat loss. Generally, there is no greater risk exercising in the cold than more comfortable conditions because the body does generate heat. A person simply needs to use common sense and avoid exposure to extreme conditions. Like exercising in the heat, wearing proper clothing, especially in layers, can reduce risk of exposure ***(Figure 15)***.

Figure 15. *Ice skating is a fun activity. Dress warmly.*

MOVING FORWARD

Having completed this chapter, expected outcomes for you include:

1. Know which activities develop cardiorespiratory fitness and find some that you particularly enjoy doing.
2. Wisely develop a plan to incorporate cardio activities into your life. Take a step-by-step approach so you do not overdo and risk injury or discouragement.
3. If you are so inclined, look for other people who might enjoy these activities with you.
4. Be aware of your environment, climate, and level of conditioning so you benefit from your cardio activity under the conditions in which you live.
5. Consider interval training as well as steady-state cardio to give you variety and stimulate interest over the long term.

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