



PHASE 4: ANAEROBIC- POWER TRAINING



Cardiorespiratory training has taken on many new forms over the past few decades. Many modes of activity can be performed to strengthen the heart and cardiorespiratory system. The fitness industry has evolved from Jazzercise to Zumba, from step aerobics to kickboxing, and from Walk America to marathon running.

In recent years, however, there has been a surge of prevalence in using interval training as a training modality, and a controversy has erupted over which method of training is more efficient at improving cardiorespiratory fitness: steady state (SS) endurance training or high-intensity interval training (HIIT) (Zuhl & Kravitz, 2012). This course discusses the physiological adaptations to cardiorespiratory training and presents information on how these parameters are affected by either SS or interval training.

SS cardiorespiratory exercise refers to an intensity at which the body is able to meet the physiological demands placed upon it and maintain that intensity for a period of time. Generally speaking, cardiorespiratory activity such as running, swimming, or cycling that is done for longer than 20 minutes at a fixed intensity is considered SS training (Zuhl & Kravitz, 2012). HIIT consists of cardiorespiratory activity with varying intensities and durations (Zuhl & Kravitz, 2012). Intervals can be done in many modes, and consist of high exertion for a period of time followed directly by active rest or lower-intensity activity. There are benefits to SS training and HIIT, and both of these forms of cardiorespiratory training have been used for years to improve cardiorespiratory efficiency. Before discussing both forms of training and their respective physiological adaptations, it is important to understand some of the general physiological adaptations to cardiorespiratory training.

Cardiorespiratory training provides benefits for both health- and performance-related outcomes. In terms of basic health, doing regular physical activity has been shown to improve markers of health, including warding off chronic diseases, preventing early death, maintaining/lowering blood lipid profiles, improving mental health, improving functional

movements, lowering the risk of some cancers, and lowering the risk for heart disease. Because heart disease is still the leading cause of death among Americans, according to the Centers for Disease Control and Prevention (Heron, 2010), any measures that will decrease the incidence of this preventable disease are important to understand and address with clients. According to the findings reported in the U.S. Department of Health and Human Service's *2008 Physical Activity Guidelines for Americans*, 150 minutes of "moderate" aerobic exercise that causes an increase in heart rate above what is normal is appropriate to elicit such improvements (U.S. Department of Health and Human Services, 2008). Also noted in the *2008 Physical Activity Guidelines for Americans* are the positive effects of 75 minutes of vigorous-intensity aerobic exercise each week. Whether a client is performing vigorous- or moderate-intensity exercise, greater benefits are seen with an increase in duration beyond these recommendations. Those benefits from physical activity that specifically relate to cardiorespiratory changes include increased aerobic capacity (the ability to do more work for a longer period of time), increased stroke volume, decreased resting heart rate, increased cellular mitochondria, and increased ventricular volume.

When SS cardiorespiratory training first made its mark on the fitness industry, HIIT training was not recognized as a type of exercise protocol. However, as people (primarily athletes and their coaches) sought to find a more effective and time-savvy means of improving performance, interval training began to emerge as a popular option (Zuhl & Kravitz, 2012). Countless studies have measured the effects of interval training, and most have found that improvements in cardiorespiratory measures can be made with this type of training. One of the landmark studies in this area was performed by Japanese speed skating coach Izumi Tabata, who found that after his elite speed skating athletes performed only six weeks of a specific interval training protocol (20 seconds of work followed by 10 seconds of rest, repeated for four 4-minute cycles), their anaerobic capacity and $\dot{V}O_{2max}$ both increased significantly (Tabata et al., 1996). This



protocol, now referred to as “Tabata training,” is widely known as an intense interval training system designed to improve cardiorespiratory fitness. Subsequent studies have provided additional evidence that with interval training, cardiorespiratory improvements are made as quickly as, if not more quickly than, with SS endurance training (Embets, 2013).

The changes seen within the Tabata et al. (1996) study and many others like it show that if high-intensity exercise bouts are matched with appropriate rest intervals, gains in athletic performance can be achieved. For example, when heart rate increases with exercise, this helps to strengthen the heart over time. This tissue can produce more force with training and will elicit a greater stroke volume in the long term. Stroke volume is the amount of blood pumped from the left ventricle of the heart with each beat and is key to providing an adequate supply of oxygenated blood to the working body. When fewer heart beats are necessary during work or at rest to provide the same level of oxygenation, this equals cardiorespiratory efficiency. From a performance standpoint, athletes with higher stroke volumes during competition will be able to perform more work in a shorter period of time, giving them an athletic advantage. Another performance-related advantage to HIIT training with endurance-trained athletes stems from the ability to program workouts that elicit cardiorespiratory benefit, but that decrease the volume of overall training time. Because of this, HIIT training can be a way for endurance athletes to avoid the overtraining syndrome, which has been known to cause decreases in performance. Overtraining stemming from endurance training is generally seen in individuals who perform an excessive amount of volume in their training program. Because HIIT training is more time-efficient, volume-related overtraining may be avoided when HIIT is programmed appropriately.

From a health perspective, cardiorespiratory training can be thought of as strength training for the heart, and is therefore an important addition to the exercise routine. Both HIIT and SS training help to make the performance of activities of daily living (ADL) easier. ADL could be anything from vacuuming to walking up several flights of

stairs. If weight loss is a health goal, HIIT and SS training can both be effective in using energy to create a calorie deficit. With HIIT training, however, this calorie deficit is created by oxygen debt due to the changes in intensity and the body’s inability to supply adequate oxygen in the time given. This causes more calories to be used after the exercise bout is completed in order to restore the body to homeostasis. The term for this physiological state is excess post-exercise oxygen consumption (EPOC).

EPOC created during HIIT can be compared to using a credit card. When you make a purchase on your credit card, you have gone into debt. If this debt is paid off in full before the next billing cycle, no interest is charged. However, if you keep charging the credit card and are not able to fully pay off the amount owed, you will be charged interest on your purchases. This is very similar to your body using oxygen during exercise. If you keep using high amounts of oxygen for HIIT exercises, you will go in to oxygen debt, or EPOC. This debt must be repaid in the form of calories (with interest) after the bout of exercise is concluded. Due to the intensity of HIIT, an individual requires more time to return to homeostasis. This metabolic effect is an important component of HIIT and is widely used to combat plateaus in weight-loss progress.

As both anecdotal evidence and research studies have shown, SS training and high-intensity training are both effective methods of improving cardiorespiratory efficiency (ACE, 2014), but is one more appropriate than the other? Depending on the goals of the individual exerciser, more focus might be placed on one technique in order to elicit changes in a desired energy system. SS training mainly affects the aerobic, or oxidative, energy system, which provides the body with adequate oxygen while still buffering any by-products of exercise that may cause fatigue (i.e., lactic acid). Depending on the length and intensity of intervals, HIIT training is completed using the ATP-PC (or phosphogen) system or anaerobic glycolysis energy pathway. Although the phosphogen and anaerobic pathways allow for higher-intensity exercise due to the availability of adenosine triphosphate (ATP) and the muscles’ force production, these exercise bouts are generally only able to be maintained for less than three minutes.

What types of clients might choose to use one form of cardiorespiratory training over the other? While a marathon runner might benefit from HIIT, he or she should rely heavily on SS training based on the principle of specificity. In order to receive the benefits needed to



complete the 26.2 miles of running, longer-duration SS exercise is necessary. Conversely, a high school football player will benefit more from HIIT training. Because the average football play lasts less than 10 seconds, it would be appropriate to train this athlete within the phosphogen energy system using HIIT. It is important to note, however, that although the marathon runner would benefit from HIIT training within his or her training plan, the opposite may not be said for the high school football player. Several studies have shown that not only is SS aerobic training ineffective at improving performance for athletes who perform mainly using the anaerobic system, but it can actually be detrimental (Elliott, Wagner, & Chiu, 2007). Aerobic training utilizes mostly type I muscle fibers, which are oxidative and produce less force. The type II fibers primarily accessed during power training or HIIT are not utilized and can lose efficiency, causing a marked decrease in force production during the athletic event. It may be valuable, however, for these power athletes to use the off-season to develop an aerobic base using SS training so that when their pre-season, in-season, and competition phases approach, they are able to more effectively use HIIT without a decrease in performance.

When programming for both HIIT and SS endurance training, it is important to remember the FITT principle, which stands for frequency, intensity, time, and type. Depending on the goals of the client or athlete, the frequency of either HIIT or SS training can vary between two and six days per week, with more emphasis being placed in the energy system that the individual requires in order to reach his or her goals. For example, a marathon runner would benefit from one or two sessions of HIIT per week with varying interval lengths, but he or she should be performing perhaps two to four SS workouts in order to better apply the training to the event. The high school football player, on the other hand, might benefit most from two or three HIIT sessions per week (depending on the time of year) and very little, if any, SS cardiorespiratory efforts lasting longer than 20 minutes. Intensity is the primary difference between HIIT and SS endurance training. Generally, SS training requires an effort that

can be maintained for more than 20 minutes. For many individuals, this can be equated to a rating of perceived exertion (RPE) of 3 to 4. Interval training moves into the anaerobic-endurance and anaerobic-power phases of the ACE Integrated Fitness Training® (ACE IFT®) Model, and include intervals at an RPE of 6 to 7. Time is a very important part of cardiorespiratory programming, and is easy to determine for SS efforts. The positive effects of cardiorespiratory training begin with around 20 or more minutes of duration, which is therefore a minimal threshold for SS endurance exercise. With HIIT, timing is of the essence, especially with recovery intervals. These work-to-rest ratios can range from 1:1 to 1:3 depending on the goals of the individual, and actual lengths of intervals can be determined by what energy system should be utilized. The type of exercise should be determined by the client's preferences, sports participation, and availability. Regardless of the mode (e.g., swimming, biking, or running), SS exercise and HIIT can be programmed to improve both performance and health.

By understanding the benefits of both SS endurance training and HIIT, trainers and coaches can effectively program cardiorespiratory workouts to help improve the health and performance of their clients and athletes. It is important to keep in mind the goals of each individual and to use the FITT principle to effectively manage their training sessions. With the use of these two styles of cardiorespiratory training, cardiorespiratory benefits are guaranteed. ◆

References

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