Optimal Cardio Programming

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Aerobic training is associated with many benefits. With regular cardiovascular exercise, the heart becomes stronger and more efficient, pumping more blood with every beat. Resting heart rate decreases. There is also an increase in the number of capillaries in the muscle tissues. Capillaries are blood vessels which absorb blood, oxygen, and nutrients, and clear waste products. This occurs because the number of enzymes required for the oxidation of free fatty acids increases. The end result is that the muscles involved in the aerobic activity become more efficient at using fats for fuel, both during exercise and at rest. Cardio training also keeps the metabolism elevated for at least one hour after the exercise is completed.

Most experts agree that cardio is not only helpful, but necessary to accelerate fat loss. However, how to implement cardio work into a fat loss program has been a matter of great debate among fitness professionals.

On the one side, many argue that steady-state cardio burns more fat. Steady state refers to working at a moderate pace (60-70% of maximum heart rate) for longer time periods (45 minutes or more). Proponents of interval training or high intensity interval training (HIIT), argue that periods of working at near maximum effort (80-90% of MHR) alternated with periods of lower intensity results in a greater fat loss. In the last decade, several clinical studies have been published in an effort to determine which method is more effective. The results of the studies sometimes seem to contradict each other, but upon closer examination, a coherent theory of optimal cardio programming can be reached.

How Your Body Makes Energy

Your body has a natural hierarchy of fuel sources upon which it relies for energy. These energy systems are:

1) ATP-CP or Phosphagen
2) Anaerobic & aerobic glycolysis
3) Aerobic lipolysis

For illustration purposes, let's assume you are training close to 100% of your aerobic capacity. For the first one to twenty seconds, the body relies on stored ATP (adenosine-tri phosphate) and CP (creatine phosphate) for the initial burst of power. From twenty seconds to about 10 minutes, your body uses a mix of circulating blood glucose (carbs), stored muscle glycogen (carbs), and a small amount of certain amino acids (protein). During this process, called anaerobic glycolysis, carbohydrate stores are converted to ATP without the presence of oxygen. Lactic acid is a by-product of this process, which is responsible for the "burn" you feel in the working muscles. Somewhere between 10 and 20 minutes, your intensity level will inevitably decrease, and you will begin to use oxygen to convert carbohydrate to ATP. This is referred to as *aerobic glycolysis*. After about 20 minutes, as your glucose and glycogen supply is depleted, the process of *aerobic lipolysis* begins. In other words, fat stores are broken down to produce energy.

There is an inverse relationship between intensity and time of aerobic activity. No one, (except perhaps professional athletes in training for a specific event) is able to give 100% effort for very long. So what does that mean for the average trainee looking for maximum fat burning?

Depending on whether interval or steady-state exercise is being performed, the hierarchy of fuel usage is slightly different. This is related to the types of muscle fibers involved in each kind of training.

Steady-state cardio engages your type I muscle fibers, which are most efficient at using fat for fuel, as well as some type IIa fibers, which can derive fuel from glycogen or fat. So during a typical session of working at 60-75% MHR, your body will first burn through a mix of circulating blood glucose and stored glycogen, both products of carbohydrate metabolism. After that point (anywhere from 10-20 minutes depending on your intensity and blood glucose level), you begin to tap into stored fat, along with a small amount of certain amino acids (protein). From about 20 minutes onwards, your body should be using fat as its primary fuel source. The fact is that this type of cardio will burn more fat *during* the session than interval training.

High intensity interval training engages all muscle fiber types: I, IIa, and IIb. Type IIb fibers are called upon during the sprinting phases. Type IIb fibers primarily use the ATP-CP and glycolytic pathways for their energy. Even during the lower intensity interval phases, glucose and glycogen (carbs) are the main sources of energy. Fat is not used for fuel and in fact its use is inhibited for several reasons. Type IIb fibers are inefficient at converting fat to energy, and fat cannot be converted quickly enough to keep up with the energy demands of muscles. Also, the lactic acid generated by glycolysis apparently traps fatty acids in the fat cells. Blood flow through fat tissues is decreased at high exercise intensities. Finally, since HIIT is of short duration by nature (often 20 minutes or less), the process of aerobic lipolysis may not even be initiated.

So far, HIIT doesn't sound too productive for fat loss. However, the benefits come from the after-burn effect. The muscle tissues that have been worked need to be repaired, and glycogen needs to be replenished. This post-exercise repair process uses up calories. Following HIIT, a large release of fatty acids occurs. Converting fat to energy requires oxygen, and this extra oxygen use results in an increased metabolic rate for hours after the exercise is completed. So interval training burns very little fat during the session, but expends more total calories when the cost of exercise and the metabolic after-burn are considered.

The current trend in cardio programming is to recommend interval training over steady state because although steady state burns a greater percentage of calories from fat, HIIT burns more total fat due to its extended effects on the metabolism. The fuel used during the session is of secondary importance compared to the amount of calories expended. As long as more calories are burned than are consumed, the body will reduce its fat stores. The other obvious advantage of HIIT is the time factor. One landmark study comparing HIIT and steady state aerobics demonstrated that subjects lost nine times the amount of body fat in less than half the time using HIIT. Generally, you can burn the same amount or more calories in 15-20 minute HIIT session as you can in a 45-60 minute slower one.

Recommendations: The Basic Plan

If you have achieved a basic level of fitness and need to lose 5 lbs. of fat or more, you are probably best served by following a periodized high intensity interval training program. Periodization here refers to gradually making each session more difficult than the previous one. This is accomplished by manipulating several variables: the total time of the session; the number of intervals; the duration of the work vs. rest periods; the intensity (speed or resistance level) of the work intervals.

To ensure that you do in fact accomplish more work in the same amount of time or less, it is recommended that you stick with the same mode of aerobic work for at least 4-6 weeks. If each session consists of a different mode of cardio (bike, running, jump rope) there is no way to measure if you actually worked harder. Staying with one mode for several weeks may sound less exciting, but it does make you more focused. Each session has a clear and predetermined goal that will result in a greater number of calories burned. The entire program should be planned out in advance and in detail before you ever set foot on a piece of equipment.

After the 4-6 week cycle is completed, you should change aerobic modalities. If you have been doing treadmill running, try the stair-stepper, for instance. About every 8 weeks, it is highly recommended you take a full week off. If your cycles are running four weeks, that works out nicely. If you finish a 6-week cycle, take a week off at that time before moving on. This type of de-training has a purpose. It is not just a reward for working hard. The human body is incredibly proficient at adapting to any demands imposed upon it, which is why trainees hit plateaus in their training. You need to let your body become *un*-adapted so to speak, so that the next cycle will be more effective.

Exceptions

Men or women of any age who are beginning an exercise program for the first time or after an extended layoff should develop a basic level of aerobic fitness. This is best accomplished with 3-4 steady state cardio sessions per week, of 20-30 minutes duration at about 60-70% of MHR.

Obese trainees (those whose body fat exceeds 30%) may be better served by adhering to a steady-state cardio program. Recent studies find that fat people have a more difficult time tapping into fat stores. This may be due to a lack of oxidative enzymes in muscle needed to burn fat, or because of a low level of fat cell enzymes needed for liberating fat as an energy source. Doing low to moderate intensity aerobic work results in an increase in the number of both types of enzymes, and a more direct use of body fat for fuel.

Elderly trainees or those with joint or low back injuries may also be better suited to steady-state cardio. High intensity work lends itself more easily to injury. These trainees should also be advised to do low-impact aerobic work, such as recumbent bike, elliptical trainer, swimming, or incline treadmill. High impact cardio, such as running, jumping rope, stepping, etc. will aggravate the joints or injured area. However, high intensity does not necessarily mean high impact, and an interval training program can be gradually implemented on low-impact equipment.

Advanced trainees or bodybuilders who have less than 5 lbs. of fat to lose will probably be better served by steady-state cardio. One adaptation to intensive interval training is the shift of type IIb fibers towards type I and IIa characteristics. The result is less muscle size and strength. Most likely, these trainees will be on a restricted diet with less than optimal glycogen levels. HIIT relies on carbs as its main fuel source. When glycogen stores are depleted, the body must convert either protein or fat to glucose to continue. In a lean individual with plenty of muscle but little fat to spare, the body will secrete the hormone cortisol and break down muscle tissue for fuel in a process called gluconeogenesis. Normally, amino acids account for about 5% of the total energy yield in men, and less in women (about 6g of branched chain amino acids per hour). This increases to about 10% (10-13g of BCAA's) in a glycogen depleted/ketogenic state. This process may be avoided if the trainee supplements with extra protein or amino acids before and after the HIIT session (see *Supplement Recommendations* below). The best advice for lean individuals trying to shed the last few pounds is to stick to 30-50 minutes of moderate intensity (60-70% of MHR) sessions.

Those who opt to perform cardio immediately after weight training should carefully consider whether HIIT or steady state cardio is appropriate for them. Because glycogen stores may be depleted after intense weight training, average trainees face the same issues as very lean individuals concerning muscle catabolism. However, glycogen is only depleted from the muscles that are trained. If only upper body has performed resistance training, and the aerobic work is primarily lower body, then HIIT should not be a problem. If a lower body or total body workout has been performed, steady state cardio is a better choice.

The type of diet someone is eating should also be a consideration. If the trainee is on a ketogenic (carb-restrictive) diet, glycogen reserves will be low to start with. As previously noted, the body will metabolize about 10-13g of BCAA's per hour for fuel in a ketogenic state. This may not be an important issue for someone with high body fat who is just trying to lose weight, but it can be detrimental to a bodybuilder. For this reason, ketogenic dieters should avoid HIIT after intense resistance training. Steady state cardio is probably a better choice. They may opt to do HIIT on alternate days or times from weight training, but even in this instance I would recommend supplementation.

Gender Considerations

The process of evolution has produced differences in the physical capabilities of men and women. Men are primarily built for strength. That is to say, most men have almost even numbers of fast twitch (type II) and slow twitch (type I) muscle fibers. Most men are also likely to have an even balance between type IIa fibers, which are called upon in muscular endurance activities, and type IIb fibers, which are used for short bursts of muscular strength and power. Women, on the other hand, are better designed for endurance activities. Most women have more slow twitch (type I) fibers than fast twitch, and more type IIa fibers than IIb fibers. Environment plays a role in this as well. Type II fibers can take on characteristics of the *a* or *b* subtype based on whether a person engages in more endurance or strength activities.

Other physiological differences between men and women include the sex hormones. Men have an abundance of testosterone with a minimal amount of estrogen; women, the opposite. Higher concentrations of testosterone produce more muscle and burn more fat; higher estrogen levels result in more fat accumulation.

There are also differences in the concentration and types of adrenoreceptors in each sex. Adrenoreceptors exist on the membranes of fat cells and regulate how much fat should be stored or released. Beta-receptors signal fat to be released; alpha-receptors prevent fat from being liberated. Men have more beta-receptors and more of them; women have more alpha-receptors and more of them.

On both of these counts, women are at a disadvantage. Women store fat more easily and lose it with more difficulty. Two studies done in 1993 and 1996, respectively, examined body composition changes in subjects performing aerobic exercise without any calorie reduction in diet. Men were still able to lose fat, but most women were not.

Another interesting study measured fat oxidation in men and women doing steady state cardio. Women were able to tap into stored body fat after about 30 minutes. It took men almost 60 minutes to reach that point. Women more readily switched to using fat for fuel, while men relied on carbs preferentially. Women's bodies are more sparing of carbs and protein, resulting in less muscle glycogen depletion.

How do these gender issues apply to cardio programming for fat loss? It seems women can derive benefits from steady state or HIIT, whereas men probably shouldn't even waste their time with steady state cardio *unless* they fall into one of the exceptions categories previously discussed. This conclusion correlates to the different muscle fiber types predominant in men and women (power vs. endurance). Because women are more sparing of carbs and protein, most don't need to concern themselves with amino acid supplementation, *unless* the meet the requirements described in the next section. Finally, women cannot expect cardio exercise to produce significant fat reduction without reducing their calorie intake.

Supplement Recommendations

Trainees who meet certain criteria are more at risk for using protein as a fuel source than others. These criteria include:

- Very lean individuals (men with less than 10% or women with less than 15% body fat)
- Ketogenic (very low-carbohydrate) dieters
- Those who perform cardio immediately after weight training

Although the average trainee working at a moderate intensity uses about 6g of protein for fuel per hour, certain amino acids are metabolized in far greater amounts given the factors listed above. Numerous studies have demonstrated that the branch chain amino acids (leucine, valine and isoluecine), glutamine and glutamate play vital roles as precursors to virtually all energy pathways. These are the amino acids the body will preferentially convert to glucose if glycogen levels are low. These are also the same amino acids that are critical to muscle growth. Research demonstrates that most forms of exercise utilize these amino acids at such a phenomenal rate, little or nothing is left to affect mechanisms of muscle growth. By supplementing with 5-10 grams of L-glutamine and 2-4 grams of BCAA's, your body uses the ingested aminos over those stored in muscle tissue. Those who are concerned with preserving and building muscle mass should supplement with the extra amino acids about 30 minutes prior to a cardio session. Do the same immediately after the session to replenish your amino acid supply. A whey protein shake/supplement that contains these aminos in the correct proportions can be substituted or used interchangeably with free form amino acid powders or capsules.

The Most Effective Activities

Certain types of aerobic activity burn more calories than others. Any activity that involves using your entire bodyweight (such as running) is going to burn more calories than those that isolate only certain limbs (cycling). Any activity that requires constant motion is going to be more productive than recreational sporting activities. These activities are ranked from greatest number of calories burned per hour to least. The number of actual calories burned is not provided because there are wide variations based on weight, age, gender, and skill level.

1) In-line skating (12.4 mph, vigorous pace)
2) Running (7 mph)
3) Jumping rope (120 turns per min.)
4) Swimming (fast crawl, vigorous pace)
5) Kickboxing
6) Boot-camp style workout
7) Spinning (moderate-high intensity)
8) NordicTrack ski machine (76% MHR)
9) Boxing (sparring w/opponent)
10) Step Aerobics (120 beats per min.)

11) Elliptical Trainer (moderate-high intensity)
12) Stair-stepping (80% MHR)
13) Basketball
14) Bicycling (road, moderate effort)
15) Circuit training
16) Football
17) Tennis (singles)
18) Beach volleyball
19) Soccer
20) Downhill skiing
21) Hiking (hills)
22) Weightlifting
23) Walking (4 mph, brisk pace)

The Best Time To Train

When you perform your aerobic work is critical to optimize fat loss. The ideal time to do cardio is first thing in the morning, preferably on the days you are not weight training. By doing your cardio first thing in the morning on an empty stomach, your blood glucose will be very low. This enables you to tap into fat stores sooner. If you perform HIIT, your metabolism should be stoked for most of the day. If possible, do not eat for about an hour after you finish the session (other than the aforementioned amino acid supplementation). This will allow for maximum lipolysis (fat breakdown) as your body struggles to replenish its glycogen stores. By performing weight training and cardio on alternating days, you are doing something every day to stimulate your metabolism, as well as giving your muscles the recovery time they need from an intense lifting session.

There are other options if the morning training is not convenient. If you are doing cardio on a separate day from weight training, try to do it about 3 hours after your last meal and about an hour before your next one. The logic is the same: 3 hours allows enough time for your meal to be completely digested and your blood glucose levels should be low or at least stable. If you are doing cardio on the same day as weight training, the best option is immediately after you finish lifting. Your glucose/glycogen should be depleted at that point and fat oxidation should happen quickly. However, don't neglect proper supplementation if you meet the criteria previously described.

When is the worst time to do cardio? Immediately after a meal, or immediately before a weight training session (other than a brief warm up). I would also caution against doing cardio on the day after an intense leg training session. These muscles need at least 48 hours for repair and recovery. HIIT immediately after or even the next day is not recommended. If you don't want to go two days without doing any cardio, do it the morning of (but not just before) your leg workout, or do steady state cardio just after your weight training.

Conclusion

Recent clinical research has demonstrated that the one-prescription-fits-all approach to cardio programming is seriously flawed. It is not as simple as claiming one mode is clearly superior to the other. A periodized program of high intensity interval training is the most effective method of cardio for maximum fat loss for the majority of trainees. However, there are many other factors which may influence the optimal type of cardio program. These factors include gender, age, weight, diet, equipment, time of training, and level of experience. Ultimately, each individual must find the ideal combination of intensity and duration that maximizes calorie expenditure without sacrificing muscle tissue.

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