

## Interval Training

By Michael Boyle

Date Released : 16 May 2008

What is interval training? In the simplest sense, interval training is nothing more than a method of conditioning that uses alternating periods of work and rest. The complicated part of interval training may be figuring out how to use it.

Interval training has been around for decades. However, only recently have fitness enthusiasts around the world been awakened to the value of interval training. The recent popularity of interval training has even given it a new name in the literature. Interval training is often referred to as High Intensity Interval Training (HIIT), and it is now the darling of the fat loss and conditioning worlds.

### Research

A recent study done on strength training showed that resistance exercise reversed the genetic fingerprint of elderly people. "The genetic fingerprint [of the elderly participants] was reversed to that of younger people - not entirely, but enough to say that their genetic profile was more like that of young people than old people," said Simon Melov, director of genomics at the Buck Institute in Novato, California. Although this study actually looked at strength training, the concept could also apply to interval training. Interval training stresses not only the energy system but the muscular system. Another study, done in Canada at McMaster University and often referenced as the Gibala Study after lead researcher Martin Gibala, had a similar result. The Gibala study compared 20 minutes of high intensity interval training, consisting of a 30 second sprint followed by a four minute rest, with 90 to 120 minutes in the target heart rate zone. The result was amazing. Subjects got the same improvement in oxygen utilization from both programs. What is amazing is that the 20 minute program only requires about two minutes and 30 seconds of actual work.

A third study that has become known as the Tabata study again shows the benefits of interval training. Tabata compared moderate intensity endurance training at about 70 percent of VO<sub>2</sub> max to high intensity intervals done at 170 percent of VO<sub>2</sub> max. Tabata used a unique protocol of 20 seconds work to 10 seconds rest done in seven to eight bouts. This was basically a series of 20 second intervals performed during a four minute span. Again, the results were nothing short of amazing. The 20/10 protocol improved the VO<sub>2</sub> max and the anaerobic capabilities more than the steady state program.

Further evidence for the superiority of higher intensity work can be found in the September/October 2006 issue of the *ACSM Journal*. Dr. David Swain stated "running burns twice as many calories as walking." This is great news for those who want to lose body fat. I am not a running advocate, but we can put to rest another high intensity (running) versus low intensity (walking) debate.

Do the math. Swain states that a 136 pound person walking will burn 50 calories per mile and proportionally more as the subject's weight increases. In other words, a 163 pound person, weighing 20 percent more, would burn 20 percent more calories. This means that expenditure goes from 50 to 60 calories, also a 20 percent increase. Swain goes on to state that running at seven miles per hour burns twice as many calories as walking at four mph. This means a runner would burn 100 calories in roughly eight and one half minutes or about 11 calories a minute. The walker at four miles per hour would burn 50 calories in 15 minutes (the time it would take to walk a mile at four miles per hour). That's less than four calories per minute of exercise.

### Interval Training Methods

#### *Work to Rest*

There are two primary methods of performing interval training. The first is the conventional work to rest method. The work to rest method uses a set time for work and a set time for rest. Ratios are determined, and the athlete or client rests for generally one, two or three times the length of the work interval before repeating the next bout. The big drawback to the work to rest method is that time is arbitrary. We have no idea what is actually happening inside the body. We simply guess. In fact, for many years, we have always guessed as we had no other "measuring stick."

#### *Heart Rate*

With the mass production of low cost heart rate monitors, we are no longer required to guess. The future of interval training lies with accurate, low cost heart rate monitors. We are no longer looking at time as a measure of recovery, as we formerly did in our rest to work ratios. We are now looking at physiology. What is important to understand is that heart rate and intensity are closely related. Although heart rate is not a direct and flawless measure of either intensity or recovery status, it is far better than simply choosing a time interval to rest. To use the heart rate method, simply choose an appropriate recovery heart rate. In our case, we use 60 percent of theoretical max heart rate using the Karvonen method (see The Problem With Formulas below). After a work interval of a predetermined time is completed, the recovery is simply set by the time it takes to return to the recovery heart rate. When using HR response, the whole picture changes. Initial recovery in well conditioned athletes and clients is often rapid and shorter. In fact, rest to

work ratios may be less than 1:1 in the initial few intervals. An example of a typical workout for a well conditioned athlete or client is show below.

- Interval 1 - Work 60 sec rest 45 sec\*
- Interval 2 - Work 60 sec rest 60 sec
- Interval 3 - Work 60 sec rest 75 sec
- Interval 4 - Work 60 sec rest 90 sec

*\*In a conventional 2:1, time based program, rest would have been too long for the first three intervals, rendering them potentially less effective. The reverse may be true in a de-conditioned athlete or client. I have seen young, de-conditioned athletes need rest up to eight times as long as the work interval. In fact, we have seen athletes who need two minutes rest after a 15 second interval.*

## The Problem with Formulas

At least 70 percent of the population does not fit into our age-old theoretical formulas. The 220 minus age formula is flawed on two key points: it doesn't fit a significant portion of the population, and it is not based on research. Even the developer of the now famous formula admits that his thoughts were taken out of context. The more accurate method is called the Heart Rate Reserve Method or Karvonen formula.

Karvonen Formula:  $(\text{Max HR} - \text{Resting HR}) \times \% + \text{RHR} = \text{THR}$

Example:  $(200 - 60) \times .8 + 60 = 172$

The key to the Karvonen formula is that it looks at larger measures of fitness by incorporating the resting heart rate and is therefore less arbitrary.

## Additional Physiological Problems

The field of exercise science is in a state of flux unlike anything we have seen in the last 30 years. There is a distinct lack of clarity in the former bedrock of exercise physiology. In the past, we had firm belief in concepts like anaerobic threshold and lactate threshold. But now, the more we know, the more we don't know. The fact is that we know very little about exercise, lactate, etc., and yet we present ourselves as experts. Here are some simple things I do know that will help you with designing interval programs.

- Shorter intervals produce less HR elevation, yet can feel as difficult as longer intervals. In other words, it's not simply about heart rate elevation.
- Intervals of less than a minute don't elevate HR as significantly as longer intervals. This does not mean they are not beneficial. It only means that the heart needs time to elevate. Strangely enough, you may not recover as rapidly from a shorter interval as you will from a longer interval when the recovery is viewed as a multiple of the work interval. In other words, a 30 second sprint may require a one minute recovery (2:1 rest to work) where a one minute sprint might only require an additional 30 seconds (1.5:1 rest to work).
- Shorter intervals (15 to 60 sec) have a higher muscular demand and a lower perceived cardiovascular demand. The cardiovascular demand may be perceived to be lower based on less elevation in heart rate.

Just remember, even though I am recommending heart rate as the best way to dictate interval training, based on the Gibala study, heart rate may not tell the whole story.

## Interval Training Recommendations

### Rest to Work Ratio

The longer the interval, the shorter the rest as a percentage of the interval. In other words, short intervals with a high muscular demand will require longer rests when viewed as a percentage of the interval. Fifteen second intervals will need at least a 2:1 rest to work ration. Three to one will work better for beginners.

Interval rest recommendations are as follows:

- 15 seconds. Beginners at least 45 seconds (3:1), more advanced 30 seconds (2:1)
- 30 seconds. Rest one minute to one minute 30 seconds (3:1 or 2:1)
- 1 minute. Rest one to two minutes (2:1 or 1:1)

Just remember, as the intervals get longer, the recovery time does not need to be as long as it relates to the interval. In other words, a

two minute interval may only need to be followed by a two minute rest.

### **Aerobic Intervals?**

The biggest benefit of interval training is that you can get a tremendous aerobic workout, without the boredom of long steady state bouts of exercises. In fact, you can get superior benefits for both fitness and fat loss by incorporating interval training. If the heart rate is maintained above the theoretical 60 percent threshold proposed for aerobic training, then the entire session is both aerobic and anaerobic. This is why we do almost no "conventional" aerobic training. All of our aerobic work is a by-product of our anaerobic work. My athletes or clients can get their heart rate in the recommended aerobic range for 15 to 20 minutes, yet in some cases, they do only five to seven minutes of actual work.

### **Modes of Interval Training**

Although most people visualize interval training as a track and field concept, our preferred method of interval training is the stationary bike. Although I think running is the theoretical "best" mode of training, the facts are clear. Most Americans are not fit enough to run. In fact, statistics estimate that 60 percent of those who begin a running program will be injured. In a fitness or personal training setting, that is entirely unacceptable. Females, based on the genetics of the female body (i.e., wider hips, narrower knees) are at potentially even greater risk. Physical therapist Diane Lee says it best in her statement, "You can't run to get fit. You need to be fit to run."

Interval training can be done on any piece of equipment. However, the most expeditious choice in my opinion will be a dual action bike like the Schwinn AirDyne. The bike allows, in the words of performance enhancement expert Alwyn Cosgrove, "maximum metabolic disturbance with minimal muscular disruption." In other words, you can work really hard and not injure yourself on a stationary bike.

Fit individuals can choose any mode they like. However, the bike is the best and safest choice. In my mind, the worst choice might be the elliptical trainers. Charles Staley, another noted training expert, has a concept I believe he calls the 180 Principle. Staley advocates doing exactly the opposite of what you see everyone else in the gym doing. I'm in agreement. Walking on a treadmill and using an elliptical trainer seem to be the two most popular modes of training in a gym. My conclusion, supported by Staley's 180 Principle, is that neither is of much use.

### **Interval Training Modes in Detail**

#### **Running**

- Maybe the most effective and most likely to cause injury.
- A combination of shuttle running (intensive) and tempo running (extensive) are best. Both can be done in standard rest to work format or with a heart rate monitor.
- Shuttle runs have both high muscular demand (acceleration and deceleration) and high metabolic demand.
- Running is relative. Running straight ahead for 30 seconds is significantly easier than a 30 second shuttle.
- Shuttle runs produce more muscular discomfort due to the repeated acceleration and deceleration.

#### **Treadmill Running**

- A close second to ground based running in both effectiveness and injury potential.
- Getting on and off a moving treadmill is an athletic skill and can result in serious injury. Therefore, treadmill interval running is probably not for the average personal training client.
- Treadmill speeds are deceiving. For example, 10 MPH is only a six minute mile yet can feel very fast. However, 10 MPH is not a difficult pace for intervals for a well conditioned athlete.
- High quality interval treadmills should be able to go to 15 MPH.

#### **Additional Treadmill Drawbacks**

- Lack of true active hip extension may under train the hamstrings.
- In treadmill running, the belt moves, you just stay airborne. Treadmill times do not translate well to running on the ground. This may be due to lack of ground contact time.

#### **Stationary Bike**

- Dual action bikes like the AirDyne produces a higher HR. This is due to the combined action of the arms and legs.
- Probably the best "safe" tool.
- Requires limited skill.
- Limited potential for overuse injury.

#### **Slideboard**

- Best “bang for the buck” after the AirDyne.
- Added benefits of a standing position and ab and adductor work.
- Works great for groups. No adjustment needed.
- Safe in spite of “experts.” Some so-called experts have questioned the effect of the slideboard on the knees however, there is nothing more than the anecdotal evidence of a few writers to support this theory.

### Climbers and Ellipticals

- The key to using any climbing device is to keep the hands and arms off of the equipment.
- The StepMill is the least popular, and as Staley points out, the most effective. Think 180 again. If it's popular, it's probably not good.
- Conventional Stairclimbers are easier to abuse than the StepMill. Many users ramp up the speed while allowing the arms to do the majority of the work. Keep your hands off the rails. If balance is poor, keep the speed low until balance improves.
- The elliptical machine is most popular because it is easiest. This is nothing more than human nature at work. Discourage your clients from using an elliptical trainer. If they insist, let them do it on their off days.

Research continues to mount that interval training may improve fitness better than steady state work, so if you or your clients are after results, interval training is the way to go.

### References:

1. Resistance Exercise Reverses Aging in Human Skeletal Muscle." Simon Melov, Mark Tarnopolsky, Kenneth Beckman, Krysta Felkey and Alan Hubbard PLoS ONE 2(5): e465. doi:10.1371/journal.pone.
2. "Short Term Sprint Interval Versus Traditional Endurance Training: Similar Initial Adaptations in Human Skeletal Muscle and Exercise Performance Journal of Physiology Sept 2006, Vol 575 Issue 3.
3. Effects of moderate-intensity endurance and high-intensity intermittent training on anaerobic capacity and VO2max. Tabata I, Nishimura K, Kouzaki M, Hirai Y, Ogita F, Miyachi M, Yamamoto K. Department of Physiology and Biomechanics, National Institute of Fitness and Sports, Kagoshima Prefecture, Japan.
4. September/October ACSM Health and Fitness Journal. Dr. David Swain Moderate or Vigorous Intensity Exercise: What Should We Prescribe?

---

[close](#)