NAFTA

HIIT MANUAL

CHAPTER 1: WHAT IS HIIT

High-intensity interval training (**HIIT**), also called **high-intensity intermittent exercise** (**HIIE**) or **sprint interval training** (**SIT**), is a form of interval training, a cardiovascular exercise strategy alternating short periods of intense anaerobic exercise with less intense recovery periods, until too exhausted to continue. Though there is no universal HIIT session duration, these intense workouts typically last under 30 minutes, with times varying based on a participant's current fitness level.

HIIT workouts provide improved athletic capacity and condition as well as improved glucose metabolism. Compared with other regimens, HIIT may not be as effective for treating hyperlipidemia and obesity, or improving muscle and bone mass. However, research has shown that HIIT regimens produced significant reductions in the fat mass of the whole-body. Some researchers also note that HIIT requires "an extremely high level of subject motivation" and question whether the general population could safely or practically tolerate the extreme nature of the exercise regimen.

Procedure

HIIT exercise sessions generally consist of a warm up period, then several repetitions of high-intensity exercise separated by medium intensity exercise for recovery, then a cool down period. The high-intensity exercise should be done at near maximum intensity. The medium exercise should be about 50% intensity. The number of repetitions and length of each depends on the exercise but may be as little as three repetitions with just 20 seconds of intense exercise. The specific exercises performed during the high-intensity portions vary. Most of the research on HIIT has been done using a cycling ergometer, but other exercises like running, stair climbing and uphill walking can also be effective.

There is no specific formula to HIIT. Depending on one's level of cardiovascular development, the moderate-level intensity can be as slow as walking. A common formula involves a 2:1 ratio of work to recovery periods, for example, 30–40 seconds of hard sprinting alternated with 15–20 seconds of jogging or walking, repeated to failure.

The entire HIIT session may last between four and thirty minutes, meaning that it is considered to be an excellent way to maximize a workout that is limited by time constraints. Use of a clock or timer is recommended to keep accurate times, the number of rounds, and intensity.

WHO CAN PERFORM HIIT

Anyone can perform HIIT that meets the ACSM guidelines.

HIIT WORKOUT PROGRAMS

Peter Coe regimen

A type of high-intensity interval training with short recovery periods was used in the 1970s by the athletics coach Peter Coe when setting sessions for his son Sebastian Coe. Inspired by the principles propounded by the German coach and university professor Woldemar Gerschler and the Swedish physiologist Per-Olof Åstrand, Coe set sessions involving repeated fast 200 metre runs with only 30 seconds recovery between each fast run.

Tabata regimen

A version of HIIT was based on a 1996 study by Professor Izumi Tabata et al. initially involving Olympic speedskaters. The study used 20 seconds of ultra-intense exercise (at an intensity of about 170% of VO_2max) followed by 10 seconds of rest, repeated continuously for 4 minutes (8 cycles). The exercise was performed on a mechanically braked cycle ergometer. Tabata called this **the IE1 protocol**. In the original study, athletes using this method trained 4 times per week, plus another day of steady-state training, for 6 weeks and obtained gains similar to a group of athletes who did steady state training (70% VO_2max) 5 times per week. The steady state group had a higher VO_2max at the end (from 52 to 57 mL/(kg•min)), but the Tabata group had started lower and gained more overall (from 48 to 55 mL/(kg•min)). Also, only the Tabata group had gained anaerobic capacity benefits. In the original study from 1996, participants were disqualified if they could not keep a steady cycling pace of 85RPM for the full 20 seconds of work.

In popular culture, "Tabata training" has now come to refer to a wide variety of HIIT protocols and exercise regimens that may or may not have similar benefits to those found in Tabata's original study.

Gibala regimen

Professor Martin Gibala and his team at McMaster University in Canada have been researching high-intensity exercise for several years. Their 2010 study on students uses 3 minutes for warming up, then 60 seconds of intense exercise (at 95% of VO_2max) followed by 75 seconds of rest, repeated for 8–12 cycles (sometimes referred to as "The Little Method"). Subjects using this method training 3 times per week obtained gains similar to what would be expected from subjects who did steady state (50–70% VO_2max) training five times per week. While still a demanding form of training, this exercise protocol could be used by the general public with nothing more than an average exercise bike.

Gibala's group published a less intense version of their regimen in a 2011 paper in *Medicine & Science in Sports & Exercise*. This was intended as a gentler option for sedentary people who had done no exercise for over a year. It included 3 minutes of warm-up, 10 repetitions of 60-second bursts at 60% peak power (80–95% of heart rate reserve) each followed by 60 seconds of recovery, and then a 5-minute cool-down.

Zuniga regimen

Jorge Zuniga, assistant professor of exercise science at Creighton University, set out to determine how to fit the highest volume of work and oxygen consumption into the smallest amount of time. He found that intervals of 30 seconds at 90% of power output at VO_2 max followed by 30 seconds of rest allowed for the highest VO_2 consumption and the longest workout duration at specified intensity. Alternative protocols considered included 100% of maximum power output on the same interval schedule, similar to the Coe regimen, and 90% of maximum power output for three minutes, similar to traditional interval training.

Zuniga's protocol has been implemented to great success by his students participating in Creighton's Army ROTC program. Cadets completing the protocol twice a week saw greater improvements in APFT scores than in years past.

Vollaard regimen

Dr Niels Vollaard at the University of Stirling proposed that when high-intensity intervals are done at ‘all-out’ intensities, associated health benefits plateau after performing 2 or 3 sprint repetitions. This led to the development of a 10-minute exercise routine consisting of easy pedalling interspersed with two 20-second ‘all-out’ cycling sprints. In a 2017 meta-analysis, Vollaard indeed showed that common protocols with as many as 6 to 10 repetitions of 30-second ‘all-out’ sprints do not improve aerobic fitness more than the ‘2x20-s’ protocol. It is claimed that this short protocol may remove many of the drawbacks that make other high-intensity interval training protocols unsuitable for the general population.

In a BBC *Horizon* program in February 2012, Jamie Timmons, professor of systems biology at the University of Loughborough, put Michael Mosley through this exercise bike regimen, but with three sprints instead of two. This was done three times a week for a total of 30 minutes of exercise per week (3 minutes of intense exercise), plus warm-up and recovery time.

Regimen comparison

Wood et al. compared High-intensity interval training of eight 1-minute bouts at 85% Wmax interspersed with a 1-minute active recovery at 25% Wmax v Sprint interval training of eight 30-second bouts at 130% Wmax interspersed with 90-second active recovery at 25% Wmax. (Total time matched at 24 mins including warm up & cool down). Their conclusion was "HIIT is the recommended routine" but "the magnitude of differences in various parameters between regimens was small; therefore, preference for either modality may be up to the individual".

BENEFITS OF HITT

Cardiovascular fitness

A 2015 systematic review and meta-analysis of randomized controlled trials found that HIIT training and traditional endurance training both lead to significantly improved cardiovascular fitness in healthy adults ages 18–45 but greater improvements in VO_2 max were seen in those participating in the HIIT exercise regimen. Another analysis also found that HIIT regimens of one month or longer effectively improve cardiovascular fitness in adolescents and lead to moderate improvements in body composition. Furthermore, a separate systematic review and meta-analysis of seven small randomized controlled trials found that HIIT (defined as four intervals of four minutes at 85–95% of max heart rate with three-minute intervals at 60–70% of max heart rate) was more effective than moderate-intensity continuous training at improving blood vessel function and markers of blood vessel health.

Cardiovascular disease

A 2015 meta-analysis comparing HIIT to moderate intensity continuous training (MICT) in people with coronary artery disease found that HIIT leads to greater improvements in VO_2 max but that MICT leads to greater reductions in body weight and heart rate. A 2014 meta-analysis found that the cardiorespiratory fitness, as measured by VO_2 max, of individuals with lifestyle-induced chronic cardiovascular or metabolic diseases (including high blood pressure, obesity, heart failure, coronary artery disease, or metabolic syndrome) who completed a HIIT exercise program was nearly double that of individuals who completed a MICT exercise program. In a study published out of Arizona State in 2018 found that, "*HIIE protocols performed ~18 h before ingestion of a high-energy fast food meal attenuated but did not entirely eliminate postprandial endothelial dysfunction in young men largely by improving fasting endothelial function."* These findings suggest that HIIT training has a physiologically protective mechanism associated with it which can carry over into successive days of non-training.

Metabolic effects

HIIT significantly lowers insulin resistance compared to continuous training or control conditions and leads to modestly decreased fasting blood glucose levels and increased weight loss compared to those who do not undergo a physical activity intervention. Another study found that HIIT was more effective than moderate-intensity continuous training at fasting insulin levels (31% decrease and 9% decrease, respectively).

Fat oxidation

A 2007 study examined HIIT's physiological effects on fat oxidation in moderately active women.· The participants in the study performed HIIT (defined as ten sets of 4-minute cycling bursts at an intensity of 90% VO2max separated by 2 minutes of rest) every other day over a 2-week period. The study found that seven sessions of HIIT over a 2-week period improved whole body fat oxidation and the capacity for skeletal muscle to oxidize fat in moderately active women. A 2010 systematic review of HIIT summarized the results of HIIT on fat loss and stated

that HIIT can result in modest reductions of subcutaneous fat in young and healthy individuals, but greater reductions for overweight individuals.

Brain power

A 2017 study examined the effect of HIIT on cognitive performance among a group of children (N=318). The authors show that HIIT is beneficial to cognitive control and working memory capacity when compared against "a blend of board games, computer games, and trivia quizzes" and that this effect is mediated by the BDNF polymorphism. They conclude that the study "suggests a promising alternative to enhance cognition, via short and potent exercise regimens".

HOW HIIT COMPARES TO OTHERS

Crossfit Vs HIIT

If you've been paying attention to fitness trends, you've heard plenty about CrossFit®. You've heard it can be difficult, it's a great workout, and it's offered just about everywhere. However, what you might not be as clear on is whether CrossFit® is right for you, and how it differs from your HIIT workouts at FIT36.

CrossFit® is, by definition, designed to help you be better at what you may or may not encounter on a daily basis. CrossFit® is a core-strengthening program, and strives to make you bigger and better in ten specific fitness domains including: power, strength, flexibility, stamina, speed, coordination, balance, and accuracy. Expect to see a few fitness props in CrossFit® classes such as kettlebells and battle ropes.

How HIIT and CrossFit® are the same:

- They both offer cycles of exercises. Lest anyone get bored in a class, both of these exercise styles keep it fresh and exciting by moving quickly between activities.
- They're overachievers. They pack a LOT in to an exercise session. Lots o' muscle groups, lots o' cardio, lots o' results.
- They're not for wimps. While both CrossFit® and HIIT can arguably be scaled to benefit anyone at any fitness level, they both provide a really, *really* good workout. If you want a lot of bang for your exercise buck, these classes are the way to go.
- Both types of exercise are best done under the instruction and supervision of a trained coach.

Although they share a few features, they are not identical. Here's why:

- CrossFit® often adds in more "exotic" features such as gymnastics, throwing, and Olympic weight lifting.
- With CrossFit®, you're encouraged to complete a set of exercises in as little time as possible. Because of this, less attention is paid to actual body form or positioning, leading to a greater potential for injury.
- HIIT focuses more on timed intervals, with periods of high aerobic activity followed by very brief periods of rest. Because of the intensity of the intervals, you can get a complete workout done in a shorter amount of time.

- HIIT prides itself on MAJOR calorie burn and muscle development in the shortest amount of time. You're hard-pressed to find an exercise that yields a higher rate of calorie burn per session.
- CrossFit® contains an element of competition that's not necessarily present in HIIT classes. This is a big draw for some, and a deterrent for others.

Tabata vs HIIT

- Despite the buzz over "Tabata" training, many fitness clients—and some fitness pros—aren't aware that they're not doing true Tabata, meaning the protocol that was first analyzed and reported on in a 1996 edition of *Medicine & Science in Sports & Exercise* (Tabata et al. 1996).
- "When professor Izumi Tabata performed his breakthrough research, the Tabata protocol was performed on high-level athletes on specialized cycle ergometers at 170% VO2max versus a control group exercising at steady state, 70% VO2max," notes Bryce Taylor, DPT, a physical therapist at Downtown Physical Therapy in Indianapolis. In the study, the Tabata protocol was executed for 4 minutes at a time.
- Of course, average fitness clients don't really *need* to be doing true Tabata. In fact, it's probably a good thing they aren't: "If group instructors pushed their clients to this super-elevated heart rate for 4 minutes, class retention would be very low," says Taylor.
- Regardless of what you call it, the goal is to get people active and enjoying it. However, since Tabata has received a lot of media attention as a time-saving workout with astonishing results, it's a good idea to instruct clients on what they can and can't expect.

	TABATA	**HIIT**
This table summarizes the differences between Tabata and other HIIT methods.		
Why we call it that	named after Japanese researcher Izumi Tabata	stands for high-intensity interval training
Interval ratio	2:1	varies (e.g., 1:1, 2:1, 3:1, 1:2, etc.)
Length of intervals	20 seconds of work/10 seconds of recovery	varies (e.g., work/recovery intervals—in seconds—are 30/30, 45/15, 60/30, etc.)
Number of cycles	eight total (4 minutes)	varies (e.g., 2.5 minutes, 3 minutes, 6 minutes, etc.)
Intensity	anaerobic	anaerobic or aerobic

What are the Safety Concerns with HIIT Training?

Before you begin a HIIT exercise program, take a fitness test or substantially increase your level of activity. Medical clearance from a doctor may be an appropriate safety measure to consider before staring a HIIT or any other form of exercise training.

Extra caution should be taken by anyone who has been living a sedentary lifestyle, smokes, has a family history of heart disease, hypertension, diabetes, obesity, abnormal cholesterol levels. Consult a physician before taking a fitness test or substantially increasing your physical activity

Regardless of your age, sex or fitness level, an absolute must for safety when participating in a HIIT training session is to modify it's intensity to a suitable level for the participant. Because HIIT training is much more exhaustive than steady state endurance exercises, a longer recovery time is often needed.

If you are just starting HIIT training, you could begin with one HIIT workout per week and use steady state workouts on your other days. When you feel ready to increase your HIIT exercises you could add in a second one, making sure you spread the HIIT workouts throughout the week.

Persons who have been living rather sedentary lifestyles or periods of physical inactivity may have an increased coronary disease risk to high intensity exercise. Family history, cigarette smoking, hypertension, diabetes (or pre-diabetes), abnormal cholesterol levels and obesity will increase this risk. Medical clearance from a physician may be an appropriate safety measure for anyone with these conditions before staring HIIT or any exercise training. Prior to beginning HIIT training a person is encouraged to establish a foundational level of fitness. This foundation

is sometimes referred to as a "base fitness level". A base fitness level is consistent aerobic training (3 to 5 times a week for 20 to 60 min per session at a somewhat hard intensity) for several weeks that produces muscular adaptations, which improve oxygen transport to the muscles. Establishing appropriate exercise form and muscle strength are important before engaging in regular HIIT to reduce the risk of musculoskeletal injury. Regardless of age, gender and fitness level, one of the keys to safe participation of HIIT training is for all people to modify the intensity of the work interval to a preferred challenging level. Safety in participation should always be primary priority, and people should focus more on finding their own optimal training intensities as opposed to keeping up with other persons.

Final HIIT Message

Interval training has been an integral part of athletic training programs for many years because a variety of sport and recreational activities require short bursts of movement at high intensities. Interval training is becoming an increasingly recognized and well-liked method of training. The incorporation of interval training into a general conditioning program will optimize the development of cardiorespiratory fitness as well as numerous other health benefits. Give HIIT a try.

CHAPTER 2: THE SCIENCE BEHIND HIIT

Most bodybuilders incorporate some form of aerobic conditioning or "cardio" into their workout routines in order to develop and maintain cardiovascular fitness for both health reasons as well as increasing endurance capacity. In addition, cardio along with dieting or caloric restriction have been the cornerstones for bodyfat management. Unfortunately, there has been much misinformation and misapplication regarding the actual impact of aerobic exercise with regards to bodyfat management.

For the most part, this derives from the fact that scientific studies upon which these ideas are based are usually part of weight loss / fitness programs for either obese individuals or those with cardiac disease. In addition, public health advocates in an effort to induce the greatest number of couch potatoes to take up exercise have typically reduced scientific information to a simplified, palatable form that is directed towards overweight, sedentary individuals with little applicability or guidance for someone who is already fit.

Interval training in terms of its impact on cardio programs and bodyfat management will also be introduced. Finally, in part three, various interval routines will be presented with results from studies in order to compare the various methodologies. In addition, simplified interval routines with proven results will be outlined. In as little as 4 weeks, substantial progress in terms of aerobic fitness as well as bodyfat reduction can be achieved with the right program along with the right commitment.

Exercise Physiology - How To Burn Fat For Energy Instead Of Carbs Or Protein

In order to understand the physiology of interval training and its applications, a general outline of exercise physiology must be introduced. Energy for exercise (or any physical activity) is derived from two primary, dietary fuel sources: carbohydrates and fats. Protein can also be used, but generally, durations of less than 60 minutes involve little protein burning, although under extreme low carb conditions, this can increase.3 for each fuel, there are also two primary sources working muscle can call on: intramuscular (within the muscle itself) or peripheral (derived from the blood).

When peripheral sources are utilized, glucose (the major carb or sugar form in the body) comes either from the blood itself or the liver which releases glucose it has either stored or produced in order to maintain blood sugar levels and prevent hypoglycemia.

Peripheral fat stores are any fat depots in the body including subcutaneous (directly under the skin) and intra-abdominal (fat stored underneath the abdominal muscles) fat. The process of releasing fat from peripheral fat stores into the blood is known as lipolysis. Intramuscular stores of carbs are known as glycogen (a large complex of glucose attached to itself). Intramuscular stores of fat are in the form of triglyceride, similar to the storage form of fat in peripheral fat stores.

How A Muscle Determines It's Fuel

During exercise four fuel sources (two carb and two fat) are typically utilized. How a muscle determines its fuel mixture, both the form of the fuel and its source, is based on:

- The intensity and duration of the exercise.
- The training status of those specific exercising muscles
- The general diet (relating to specific percentages of fats and carbs).
- The time interval since the last meal prior to exercise.

In addition to the exercise itself there is also a recovery period after exercise where energy expenditure is greater than an equivalent period of time following rest. Finally, the exercise itself induces hormonal changes that impact longer term fuel selection and utilization as well as fuel (that is food) intake.

By following an exercise routine, you will burn more fat and calories even while you are at rest!

There has been a lot of confusion about intensity and duration with regards to fuel selection in terms of optimal training protocols specifically related to bodyfat reduction. A better understanding of the overall process will clear the air so stick with me! While carbs and fats supply the major energy fuels for most activities, they have dramatically different properties in our bodies. One major difference is that fats require more oxygen to burn than carbs. This implies that as exercise intensity is increased, there is a natural shift to burning more carbs because less oxygen is needed to extract the needed level of energy output to support that intensity. When oxygen is not limiting (that is at low intensity), fats are the preferred fuel. Now, the situation is not as simple a low intensity burns fat / high intensity burns carbs.

Carbs are utilized to some extent at all intensity levels with a gradual and progressive absolute as well as percentage increase as intensity is increased. Fats on the other hand, provide the bulk at low intensity and gradually increase with intensity (in this case, absolute amount of fat burning increases, even while the percentage contribution to the total is going down), but then taper off at moderate to high intensity because of oxygen limitations (during this phase, the absolute as well as percentage declines). However, the details of fuel selection get more complicated because of differences in where these fuels come from. The source of these fuels also has implications especially in the post-exercise period which in turn plays a role in bodyfat management.

Understanding The VO2max

To understand fuel selection in more detail, the concept of VO2max will be introduced. VO2max simply refers to the maximum rate of oxygen you can utilize during exercise. As intensity increases so does your heart rate and so does oxygen utilization. Eventually, at some point if you increase intensity further, your heart rate will not increase further (you've reached your max heart rate) and oxygen utilization won't go up anymore; your oxygen usage has maxed out (overall intensity can still increase, but you are going anaerobic at that point). Intensity then can be

indicated by some percentage of that maximum aerobic intensity. Therefore, we can quantify intensity with some percentage of VO2max.

At rest, you are about 5-8% of your VO2max. Resting VO2 is sometimes referred to as a MET or metabolic equivalent. Some exercise equipment can relate the workload as the number of METs. Low intensity is typically in the range of 25 - 40% VO2max. A 25% VO2max effort would be a comfortable walking pace. 40% would be in the range listed as the fat burning zone on some cardio equipment. 45 - 70% VO2max is squarely in the range of moderate intensity and is labeled as the aerobic training zone.

Bonus! To calculate how many calories you are burning during over 600 exercises and activities. This is based on the MET calculations.

A trained individual should be able to maintain this level of intensity for 1.5 - 3 hours or more. Above 70-75% VO2max is in the range of high intensity. Duration is severely limited because at these levels, the reliance on carb burning to generate a high percentage of the total energy begins to produce lactic acid. At some point (that is, a specific percentage of your VO2max), the level of lactic acid hits a threshold and begins to skyrocket in the blood and brings about muscle failure. Once you are above your lactic acid threshold, duration can only be sustained for 3-10 minutes.3

Now that intensity levels are set, we can follow fuel selection across the intensity spectrum, since both fuel usage and source is determined by intensity. At low intensities, fat is primarily used (assuming no pre-exercise meal as been ingested). In addition, the source of the fat is circulating fat in the blood derived from release of peripheral fat stores. In other words, at low intensity, such as casual walking, calories are derived from fat coming from peripheral fat stores and supply the major fraction (85%) of total calories expended. The remainder of the calories is supplied by carb burning from uptake of sugar in the blood. However, at this level of intensity the overall level of caloric expenditure is low.

A resting value of caloric expenditure is on the order about 1 calorie per minute which scales roughly with lean body mass. The more muscle you have, the more calories you will burn at rest. Low intensity exercise like casual walking ups this value to the range of 3 - 6 calories per minute. This is the basis for recommendations for low, sustained intensity levels for fat burning, sometimes called the fat burning zone, since about 85% of the energy expended will be derived from fat burning. However, total calories burned and hence the quantity of fat actually burned will be quite low. In addition, these intensities are too low for a substantial aerobic training effect to occur which has long term impact on fuel utilization, during and after exercise.

As an example, even at the upper range of 6 calories per minute, one hour at this intensity yields 360 calories expended. Since only 85% of these calories are fat derived, we've burned 306 fat calories or 34 grams of fat (1 gram of fat is worth 9 calories). In terms of weight control, that's not too bad since 34 grams of fat can be a substantial portion of

one's daily intake, but from the standpoint of fat reduction, over 11 hours of this exercise would be necessary to burn off one pound of fat (about 3500 calories per pound).

The general rule of 20 - 30 minutes for these types of activity to "turn on fat burning" comes from the idea that as fat is pulled out of the blood by the working muscles, the level in the blood will eventually begin to drop after, surprise, 20 - 30 minutes. As this happens, there is a hormonal response to restock fat levels in the blood. These hormones (both adrenaline and noradrenaline, coming from adrenal glands and nerves, respectively) stimulate fat cells to break down their fat stores and release them into the bloodstream, through the process of lipolysis. This is also where diet and food composition is important, since insulin released in response to dietary intake of carbohydrate opposes the action of these hormones. Insulin is antilipolytic, shuts down fat release, and promotes fat storage in peripheral fat cells.

Increasing Exercise Intensity: More Or Less Fat Being Burned?

As the intensity of the exercise is increased, the whole process ramps up for greater energy expenditure. Both fat and carb burning are increased. Although carbs assume an increasing percentage of the total, the absolute level of fat burning still continues to increase. The major difference with moderate versus low intensity is for the source of the fat derived energy. As intensity is increased, the working muscles require more oxygen and hence more blood flow, which explains the increase in heart rate (more blood volume and hence more oxygen is pumped per minute). In addition, since muscle is only about 25% efficient in terms of work, 75% of the calories expended are lost as heat. This heat must be dissipated which is why we sweat. In order to sweat, some blood flow must be directed to the surface skin, which is different from the peripheral fat stores just below the skin.

These two factors (more blood to the working muscle and increased blood flow to the skin for sweating) combine to limit the blood flow that can be allocated to peripheral fat stores for loading the blood with released fat through. Thus, at some point with increasing intensity, the release of fat into the blood stream from peripheral fat stores levels off. Peripheral fat stores have a maximum rate of fat release into the blood which has been determined to be the primary limitation for this fuel source. However, the rate of fat burning by the working muscle continues to increase.

To meet increased energy needs for moderate intensity (relative to low intensity), the muscle begins to breakdown its own fat stores, the intramuscular triglyceride. Since this store is more limited than the peripheral fat store, the muscle prefers to preserve this store until absolutely needed. In other words, at low intensities, working muscles prefer to utilize fats from peripheral fat stores which are the most flexible in terms of fat storage (because they can become huge). But peripheral fat stores are limited in the rate at which they can release fat and so fat stores within the working muscle itself are involved when the intensity increases enough to require more fuel than peripheral fat stores can provide. Intramuscular fat stores are limited by the absolute amount of fat available.

Your Maximum Fat Burning Zone

Maximum fat burning rate occurs during moderate intensity at about 60 - 65% VO2max which corresponds to about 75% max heart rate for most people (this assumes an aerobically trained individual). The absolute burn rate is size dependent, but will typically fall into the range of about 0.5 - 0.8 grams of fat per minute with about equal contributions from peripheral and intramuscular sources. Total caloric expenditure for moderate intensity exercise again is size dependent (larger people expend more calories because they are moving larger masses and working larger muscles) and falls in the range of about 8 - 15 calories per minutes with fat contributing on the order of about 50 - 70% of the total caloric expenditure. With longer durations, this amount tends to the higher value, mainly due to intramuscular glycogen depletion that occurs at this level of intensity. Most trained individuals can sustain this rate of expenditure for 1.5 - 3 hours, at least, but because of the level of carb burning at this intensity, the duration will be limited by total carb stores in the body.

As intensity is further increased (to 85% VO2max), oxygen supply begins to become limiting. This causes a further shift to greater carb burning with breakdown of the muscle's intramuscular store of carb in the form of glycogen1. Similar to fat burning, as intensity is increased, fuel source shifts to a greater reliance on intramuscular carb stores in the form of glycogen. If the level of intensity is held below the lactic acid threshold (which varies from the high 60's% of VO2max to the 80's%), the activity can be sustained for about 45 - 60 minutes until glycogen stores are exhausted necessitating a fall back to an intensity level where fat can supply the majority of energy needs.

If on the other hand, the intensity is above the lactic acid threshold, then in a matter of a few minutes, lactic acid levels will climb intolerably high in the blood and failure results. As will be seen in part II, interval training is designed to improve this situation.

An important aspect to this complex pattern of fuel usage is the effect of training on fuel selection. This is vital to understand because an understanding of training effects identifies the orientation of the overall system and permits exploitation of fuel selection for maximum desired results. Simply put, aerobic training serves to enhance greater energy generation from fat sources at all intensity levels. The rationale for this is simple, carbohydrate stores of energy are quite limiting and can be depleted during the course of a single exercise session of sufficient intensity and/or duration.

During a marathon race, 'hitting the wall' occurs when carb stores have been depleted and underscores the focus on carb loading regimes. Under conditions of glycogen depletion, the muscle must begin to breakdown protein since branched chain amino acids present in protein can substitute for carbs, in terms of supplying energy directly as well as substituting for carbs in the process of maintaining the system for aerobic energy generation (something fats cannot support). Alanine (another amino acid in protein) released from protein breakdown can also be converted by the liver into glucose further increasing carb supplies from the blood.

Training allows for a higher sustainable level of intensity to be performed by sparing carbs in working muscle (by reducing the rate of depletion) and generating a greater percentage of energy from fat derived sources. In other words, since at a given intensity level, a specific level of energy generation is needed, endurance training allows for higher energy outputs to come from fat burning and improves duration by sparing carbs. Alternatively, training will also result in a potentially higher intensity level for a specific time period.

Typically, an aerobic training effect increases VO2max by as much as 25% in as little as 3 - 4 months of consistent training 3 - 4 times per week in the range of 60 - 85% maximum heart rate for 30 - 45 minutes per session. Fuel usage at the same absolute workload pre and post training (the post training workload is a lower relative intensity because VO2max has increased as a result of training) differs so that a greater reliance on fat for energy occurs. In addition, the greater reliance on fat for energy is derived largely from the greater utilization of intramuscular fat stores rather than peripheral sources. While this may appear counterproductive for fat loss, part two will discuss the importance of this development with regards to post-exercise effects and interval training and the relationship to bodyfat management.

What Effect Does Your Diet And Food Intake Have On All This?

Finally, diet and food intake need to be addressed in the context of fuel selection. Diet refers to the macronutrient composition that occurs in the range of two weeks prior to the exercise period. Unfortunately, many dietary studies typically involve a short adaptation period of as little as three days, although prior work suggests as many as 10 - 14 days are needed for complete adaptation to changes in macronutrient composition to fully manifest.

Specifically, the macronutrient composition that matters is the amount of fat and carbs in the diet. Simply put, the less carbs ingested over time, the greater the reliance on fat burning. To achieve a faster response than changing the diet, specific glycogen depletion exercise routines can be employed. A sustained, reduced carb intake leads to a reduction in carb utilization at comparable work intensities. After four weeks of complete carb elimination, moderate intensity exercise can be performed with no reduction in endurance capacity, but two-thirds reduction in carb burning with a corresponding increase in fat burning.

In other words, the less carbs you eat, the less your body will try to burn carbs while you are exercising. This means that you will naturally be burning more fat!

Food intake in the immediate pre-exercise period also affects fuel usage. Carb intake prior to exercise will result in release of insulin which retards lipolysis and fat utilization during subsequent exercise. Insulin in general promotes carb utilization throughout the body including working muscle and limits peripheral fat stores from releasing fats. Exactly how long after eating the system takes to return to baseline (defined as an overnight fast) depends on the specific meal. Studies with mixed meals suggest that effects can persist for 4 - 6 hours. Carb intake during exercise has a similar effect

Understanding the Science behind Interval Training

While fuel selection during exercise is primarily determined by the training status of the individual and the intensity of the exercise, in terms of weight management, the calories burned during exercise do not typically contribute substantially to a caloric deficit that is required for weight loss. Much of this is simply a numbers game. Mild to low-moderate intensity does not produce sufficient caloric expenditure to result in noticeable weight loss by itself.

Walking for example, typically will result in about 100 calories per mile expenditure; thus even a pace of 3.5 miles per hour (which is a brisk pace to maintain) will yield only 350 calories after one hour. Even if 100% of the calories were derived from fat, 10 hours would be necessary for 1 pound of body fat to be lost. Alternatively, higher intensities are limited by the duration that they can be sustained as well as a lower percentage of fat burned since carb burning increases with intensity.

The Post Exercise Period

Fortunately, the effect of exercise is not limited to simply the exercise period. Just as importantly is the effect of exercise on the post exercise period. This period can be examined from the standpoint of the immediate time frame after exercise to the remainder of the entire non-exercise time period. In terms of the overall impact on weight loss, the inclusion of exercise offers a clear benefit. Typically, with any caloric restriction diet to generate weight loss, over time the rate of weight loss tends to zero and weight plateaus.

This phenomena is usually due to a fall in the basal metabolic rate (resting metabolism) that is probably related to both a slight reduction in lean body mass that can accompany weight loss as well as hormonal adaptation to the lowered caloric intake.2 Exercise in this setting, even of mild intensity will promote preservation of lean body mass (assuming the calorically restricted diet is still able to supply sufficient protein taking into account increased protein required with physical activity) and prevent or reduce the fall in basal metabolic rate due to hormonal adaptation.

Burn Fat For 3 Hours After Exercising?

Of more particular relevance however, to an already physically active group of individuals is the immediate post-exercise period. Studies have revealed that following aerobic exercise, there is a period of excess oxygen consumption relative to a similar period of time following rest. In other words, after an aerobic session, more oxygen is consumed during rest than would be if the exercise had not occurred.

Greater oxygen consumption implies that something is being burned, either fat or carb. In fact, most studies suggest that fat burning is providing the bulk of the excess oxygen consumption. In addition, the magnitude of the excess consumption is directly related to exercise intensity and duration. Thus, the higher the exercise intensity, the greater the degree of increased fat burning in the post exercise period which can extend for well over three hours following exercise.

The presumed mechanism for this effect is directly related to the fuel utilization during the

exercise period. Recall that with increasing intensity from moderate to high, the percentage of energy supplied by fat burning declines (although the absolute decline is slower to trail off), while carb burning continues to increase. Also, carb sources in the body are quite limited. Depending on the exercise, one session can significantly reduce carb stores (glycogen) in the specific working muscles. Even with just rest, carb stores can be exhausted in 2 - 3 days if not replenished by food intake. Thus, following an exercise session that has depleted the muscle's glycogen content, the body will attempt to replenish these stores.

This means that carb uptake by the muscle will go to make glycogen, rather than burned for energy needs. However, even under resting conditions, the muscle still has basal metabolic energy requirements. To meet these requirements, the muscle will burn fat for fuel and this is the basis for increased fat burning in the post exercise period, since the conversion of carbs to glycogen in muscle will require some energy itself.

Clearly, following low intensity exercise, the muscle has little to do since neither intramuscular carb or fat stores have been significantly impacted. In addition, at low intensity, energy can be supplied by peripheral fat stores slowly releasing fat into the bloodstream. These fat stores are the most flexible since they can grow and contract as needed, but the rate of mobilization (or release) of fat from peripheral fat stores is limited. However, once moderate intensity is initiated, the situation changes dramatically.

Under moderate intensities, intramuscular fat stores must be tapped to support the level of energy generation, since the fat contribution from peripheral fat stores has reached its limit. In essence, moderate intensity can be viewed as the point where intramuscular fuel stores begin to be utilized. Carb burning will also increase linearly with intensity and the breakdown of intramuscular glycogen stores become significant during upper levels of moderate intensity.

Thus, following moderate intensity exercise, the two major intramuscular energy stores of fat (in the form of intramuscular triglyceride) and carb (in the form of glycogen) need to be replaced. Since carbs are limiting as discussed above, carbs, in the form of blood sugar, are diverted exclusively for glycogen replacement. Fat uptake is also increased and fuels energy needs as well as intramuscular triglyceride replacement. Endurance athletes develop increased intramuscular triglycerides as a part of training.

This fat, both for energy needs as well as intramuscular triglyceride replacement, is derived from fat circulating fat in the bloodstream and comes from peripheral fat stores. Given that depletion of peripheral fat stores is limited in their rate of release of fat (the speed at which they can be depleted) continuing peripheral fat store depletion following exercise offers an attractive method to enhance bodyfat management. Desirable weight loss and bodyfat loss implies depletion of peripheral body fat stores.

The Intensity Of Exercise And How It Will Affect You

In summary, the intensity of exercise, regardless of the amount of fat burned during the exercise directly influences the amount of fat burned in the post exercise period. Since this fat is derived from peripheral fat stores, the higher the intensity and longer the duration that can be sustained, the greater the post-exercise fat burn that can be achieved. In essence, the combination of intensity and duration generate a carb and fat depleted state in the working muscle that shifts fuel metabolism towards fat burning to allow the muscle to return to its baseline levels of glycogen and intramuscular fat stores, ready for another round of exercise.

Sustained moderate intensity (in the range of 8 - 15 calories per minute) exercise can create this condition, but we will now turn our attention to another training modality, namely interval training, that will achieve this same effect within a shorter time period, and also contribute an added benefit from a cardiovascular training standpoint.

Interval training arose as means for endurance athletes to improve their performance capability. We have seen how VO2max measures the level of aerobic fitness; however, maintenance of an intensity at 100% VO2max can only be sustained for a few minutes because of the accumulation of lactic acid. Lactic acid, derived from carb burning, will gradually accumulate in the blood as a result of increased production in working muscle as intensity is increased.

Calculate Your VO2max, Click Here!

This lactic acid must be cleared from the bloodstream to avoid high levels that upset the pH balance and cause the biochemical steps that generate energy from being disrupted because these steps function in a narrow pH range. Once in the blood, lactic acid can be removed a number of ways: 1) working muscles can buffer themselves against the drop in pH as a result of the acid load, 2) the liver can remove lactic acid from the blood and convert it back into glucose (since lactic acid is produced as a result of glucose breakdown, high levels of lactic acid imply that muscles are using a lot of glucose in the first place), 3) non-working muscles can take up lactic acid and burn it for fuel, conserving glucose for working muscles, and 4) the heart, which must always operate under aerobic condition can utilize lactic acid for fuel.

Lactic Acid

Lactic acid is produced during any exercise to some extent, but increases with intensity. Lactic acid accumulates in the blood, but remains relatively steady until a specific intensity (specific to the individual) is reached, at which time lactic acid levels rise uncontrollably resulting in muscle failure. This threshold level is referred to as the lactic acid threshold. Prior to the threshold level, the body's ability to remove lactic acid from the blood allows it to balance lactic acid production with removal. Above the threshold, the removal system has maxed out and can no longer keep pace with production.

The key for endurance performance lasting greater than a 45 - 60 minute time frame is to operate at an intensity that is below the lactic acid threshold5. Lactic acid threshold is somewhat

individual, but has been shown to be a better predictor of athletic performance than overall aerobic fitness (VO2max). For example, athlete A with a lactic acid threshold at 71% VO2max could maintain a 60 minute intensity at 70% VO2max, while athlete B with a lactic acid threshold of 81% VO2max could maintain 80% VO2max during the same period. If their VO2max levels were equal (and they were the same size), athlete B would win a competition lasting an hour since he could sustain a greater intensity over the time period of the event.

How Do You Raise Your Lactic Acid Threshold?

The question then becomes how to train or raise your lactic acid threshold. This is the intent behind interval training. While performance at events lasting 60 minutes or longer may not be everyone's goal, the adaptations that occur with interval training are valuable beyond the improvement in athletic performance and contribute to body fat management in a productive manner. In addition, interval training can result in aerobic fitness improvements and maintenance with far less time investment than the more traditional increasing volume (meaning more time) work.

The essence of interval training is to work at an intensity level above one's lactic acid threshold, thus causing an increase of lactic acid that would result in muscle failure. This intensity is sustained for a duration that is somewhat less than the maximum possible time (that is, before failure occurs), typically on the order of several minutes. This is followed by a rest period or extremely light exercise to allow the body's systems to clear the lactic acid from the blood. The cycle is then repeated.

Thus, the body is exposed to a long cumulative total duration (longer than could be produced from continuous exercise) of elevated lactic acid and will learn to adapt to improving its ability to clear lactic acid from the blood. Cycling is typically repeated 8 - 15 times. If conditions are chosen appropriately, lactic acid levels will slowly climb and each cycle will become progressively more difficult. With this general type of protocol, the lactic acid threshold can be increased so that a higher intensity can be maintained for long periods (60 minutes or longer) without failure due to lactic acid levels.

For an endurance athlete, the value of lactic training is clear. With any program of aerobic training, there is typically an increase in VO2max of about 25% relative to sedentary levels. Greater gains can only be achieved with reductions in body weight (since VO2max is measured in terms of liters of oxygen consumed per minute per kilogram of body weight). After this initial gain which occurs over 3 - 5 months of aerobic training, further increases in training volume (that is longer training sessions), do not lead to further gains. To increase performance further, interval training allows for a higher level of intensity to be maintained under conditions relevant for athletic competition. While most sporting events do not operate at 100% VO2max, athletes typically perform at or just slightly above their lactic acid threshold.

Even for those interested in non-endurance activities, interval training can achieve several goals.

First, interval training is relatively time efficient in terms of producing aerobic benefits. Second, interval training, along with other vigorous activities of comparable intensity have been associated with reductions in body fat, specifically in terms of a reduction in skinfold thickness.

While the physiologic basis for this effect has not been identified, the likely effect is a combination of post exercise fat burning as discussed above, along with secretion of growth hormone that occurs during intense physical activity. Growth hormone besides its obvious effects on muscle mass is also known to produce a lipolytic effect that would promote a loss of fat.

What Is Interval Training?

Interval training routines will now be discussed in more detail and variations will be offered to present a wide array options followed by general guidelines for customizing routines. Keep in mind, interval training (sometimes called high intensity interval training or HIIT) is not routine. When performed properly with appropriate intensity and duration, while the benefits are substantial, even trained endurance athletes may finish their workout "over a bucket" (PB Laursen, personal communication).

In addition to the clear cut HIIT routines presented, some alternative protocols that are less strenuous, but nevertheless employ some aspects of interval training that positively impact bodyfat management will be offered as well. One important aspect to note before undertaking an interval training program is that these are not physically easy routines, rather they are cardiovascularly demanding by design. One should only begin interval training after a solid aerobic conditioning base has already been developed.

In addition, for anyone with heart disease, a family history of heart disease, or over 35, a physical exam is warranted. Many of the described routines involve maximal or even supramaximal effort (maximal refers to maximum aerobic performance, while supramaximal adds an anaerobic component). Some individuals may only be able to perform submaximal exercise testing for health reasons; therefore, alternative routines that employ submaximal efforts are also presented.

The essence of any interval training routine is to maintain an intensity above the lactic acid threshold (see part II for more details) for a set period of time (usually on the order of minutes) that is somewhat less than the maximum time possible at that intensity, before failure occurs (referred to in the scientific literature as volitional fatigue).

This period is followed by a rest (also called recovery) or at least light activity to complete one cycle. This cycle is then repeated a number of times, typically 5 - 15. Obviously, since lactic acid thresholds are individual, knowing one's personal lactic acid threshold would be ideal. In fact, this is done for many athletes during training.

For the average individual though, determination is not trivial since it requires blood drawing

during exercise sessions and medical laboratory analysis. However, when the overall goal is not to specifically raise the lactic acid threshold (as is the aim for a specific athletic performance), but rather to perform training protocols that would accomplish this effect along with other desirable outcomes, routines can be selected without knowing the specific level by choosing intensity levels assured to exceed lactic acid thresholds. In addition, under these circumstances, there is no need to objectively quantify improvements in threshold levels. Other parameters of aerobic fitness will improve to show progress.

Bicycling: The Common Interval Training Exercise

Most of the studies on interval training deal with bicycling (the term 'bicycling' will be used to avoid confusion with the term 'cycling' related to the repetitions of work and rest phases of the interval training routine) and as such will comprise the bulk of recommendations, although some non-bicycling routines will also be presented. Bicycling from a research standpoint is convenient because the upper body is somewhat isolated and there is less of a concern with balance which makes cumbersome breathing tubes and blood draws easier during exercise. Before proceeding to a discussion of training routines, some aspects of stationary bikes need to be understood. Stationary bikes, depending on their price can come with either one or two modes, bicycle and bicycle/ergometer.

Cheaper stationary bikes typically only have a bicycle mode and this is the case for most home units. This mode functions exactly as it sounds, like a bicycle, meaning that the faster you pedal, the more work you are doing. If the maximum pedaling rate that can be maintained is insufficient to deliver the desired workout intensity, friction or resistance can be applied to increase the work load at a given pedaling rate, but the relationship of faster pedaling - more work still holds. Ergometer mode on the other hand, which is sometimes found on more expensive health club type models, is different from bicycle mode.

What Is A Workload?

In this case, a workload is set, (typically measured either in watts or calories per hour) and the bike's microprocessor (the basis for the higher cost) automatically adjusts the resistance in relation to the pedaling frequency to match the desired workload.

In other words, with a constant workload, slower pedaling increases the resistance, while faster pedaling lowers the resistance. With the ergometer mode, a specific workload can be selected and regardless of changes in pedaling rate over the course of the routine, the rate of work performed (which in physics is the definition of power) stays constant. If you have access to this type of exercise equipment, by all means utilize it, although recognize that not all health club employees are knowledgeable about details of their own equipment.

Another point to emphasize is that total work read by a bike in terms of calories burned is a rough estimate, especially if you are not asked to enter your weight. In ergometer mode however, the reading is quite accurate because you are performing a defined amount of work (weight is immaterial because it measures actual work performed).

For physicists and engineers who attempt to convert watts over time to total calories burned, one additional factor is required; calories burned are about 4 times the actual work performed due to inefficiency of energy production in muscles. This is why we sweat; 75% of the calories burned are lost as heat with only 25% use to produce the actual work performed. This makes our muscles about as efficient as an internal combustion engine. The initial routines described assume availability of this type of equipment.

One of the initial studies that has been extensively referenced regarding interval training for bodyfat management is by Tremblay and coworkers. This study compared continuous aerobic exercise with a mixture of continuous aerobic and interval training. Interval routines were performed twice weekly compared to 4 - 5 times weekly for the continuous group only. In addition, the interval group began with continuous routines, but gradually progressed to only performing interval routines.

The Tremblay interval routine is somewhat complicated consisting of both short and long routines. Both sets progressed in terms of both work times and the number of cycles. Several general features of interval routines can be delineated by examining their procedures in depth which is useful for customizing routines. The short interval workload was set at 60% of the maximum workload produced in 10 seconds, in essence an all out effort.

They performed intervals at 60% of the 10 second maximum (for example if the 10 second maximum was 500 watts, the interval routine used 300 watts) for 15 seconds for 10 cycles progressing to 30 seconds for 15 cycles over the course of several weeks. The rest period between intervals allowed heart rates to fall back to a range of 120 - 130 before starting another cycle. The long intervals followed a similar scheme with workload set at 70% of the 90 second maximum and beginning with 4 - 5 cycles of 60 seconds progressing to 90 seconds and a similar rest interval as for the short bout. The intensity of the workload was increased by 5% every 3 weeks.

The results as commonly reported were a 9-fold greater reduction in skinfold thickness of the HIIT routine versus the continuous routine. One point to emphasize is that this difference was corrected for energy expenditure and since the HIIT routine required only about half the energy output to perform, the actual measured difference of 4.5 fold becomes 9-fold. In percentage terms, the continuous exercise resulted in a reduction of 5.7% for the sum of 6 skinfold measurements (triceps, biceps, calf, subscapular, suprailiac, and abdominal) versus 14.7% reduction for the HIIT group.

One further point is that there were no significant weight changes during this period which implies these skinfold changes occurred in the absence of caloric deficits. In terms of time investment, it is difficult to assess how long these routines took, since the rest interval is based on heart rate recovery to a defined range which may vary, but can probably be estimated at about 3 - 4 minutes for the long routine at most. For the long routine, 5 cycles of 90 seconds with even

4 minutes of rest means a maximum total time of 32.5 minutes, including a 5 minute warmup.

The short interval protocol has a similar time period for cumulative high intensity phase (15 cycles for 30 seconds each). The rest interval would expected to be shorter because not only is the duration shorter, but 30 seconds is unlikely to provide enough time for the heart rate to even come close to max heart rate (maxHR). Most likely, the total exercise time would be similar.

In terms of choosing (since there was no attempt to distinguish between the short and the long bouts in terms of which is superior), the ease of identifying applicable workloads should be the deciding factor. If an ergometer is available at the gym, the long routine is probably better to perform because 5 cycles would be easier to tolerate and count off. To set the appropriate workload will require successive testing, over the course of several days prior to any cardio workouts. Obviously, interval training of this type should only be undertaken on top of a trained aerobic base.

Begin with a workload about 300 watts and determine if this can be maintained for 90 seconds. Increase by 50 watts each time if 90 seconds has been achieved over consecutive sessions (but space them out over several days with one trial per day). Once failure occurs, use the previous completed level and determine 70% of that value. That workload should be increased by 5% about every 4 weeks or sooner if the workout become easier (easily monitored by the max heart rate achieved during the 90 seconds intervals). Without an ergometer, the 10 second max workload is preferable. Simply identify the resistance required for failure after 10 seconds of an all out effort. Use 60% of that resistance for the 30 second cycles.

With the availability of an ergometer bike, there are other protocols that have been shown to also be effective. Several will be presented for variation. Most protocols involving bicycling are referenced to peak power output (PPO). PPO refers to the maximum power achieved during a graded test which differs from a single all out effort at one intensity. The test is simple to perform. Using an ergometer, begin with a warmup at 100 watts for about 5 minutes, then increase the wattage by 15 watts every 30 seconds until failure.

The highest wattage completed for 30 seconds is PPO. Many protocols then use some percentage of PPO to set conditions. For example, 175% PPO for 30 seconds followed by a 4.5 minute rest cycled 12 times.8 For those less capable of supramaximal efforts, 8 cycles of 4 minutes at 85% PPO with 90 seconds recovery works just as well8. Note that this routine is the only one with a rest phase shorter than the work phase (except for perhaps rest intervals determined by heart rate recovery) and as such, somewhat challenging in this regard.

Putting The Methods To The Test

Recently a study compared several methods head to head. The authors compared 3 training protocols, the 175% PPO described above as well as two variations of percentage of time to exhaustion at 100% PPO4. The rationale for these protocols is derived from earlier running protocols (discussed below). Basically, a PPO test is performed to identify the individual PPO.

At a later time, another test is performed at 100% PPO until failure to determine the time to exhaustion (Tmax). The work interval is then set at 100% PPO for 60% Tmax for eight cycles.

For example, if PPO was determined to be 350 watts and Tmax at 350 watts was 3.5 minutes, then the interval would be 350 watts for 2 minutes and cycled 8X. Two different recovery methods were used either 2X the work interval or resting until 65% of maxHR (which can be determined relative to your heart rate at your max PPO from the previous graded test). All three protocols lead to increases in aerobic fitness in the range of 5 - 8% after only 4 weeks which is actually quite significant for highly trained endurance athletes. In addition, while the study was only conducted for 4 weeks, testing at 2 and 4 weeks showed continued improvement suggesting that further gains may be possible. In terms of overall performance, the 100% PPO tests were slightly superior to the 175% PPO protocol.

In terms of convenience, the 100% PPO protocols are cumbersome to perform solo since the time and rest intervals need to be calculated (a stopwatch that can be reset might be most useful). For most trained individuals, the Tmax times are going to be in the range of about 3 - 5 minutes. With a rest interval double the work interval, the total time to perform 8 cycles will be about 60 minutes or slightly more. With a rest interval based on heart rate, it could be slightly less, but recovery times will increase through the 8 cycles.

Using a rest interval based on heart rate has the added convenience of one less time period to follow, but does require a continuous heart rate monitor. All of these routines are quite difficult to complete. Even well trained endurance athletes failed to complete all cycles each time, so approach these protocols with caution. Also limit these sessions to no more than twice per week since these are quite demanding routines.

For running routines, the treadmill is fairly standard; however, many are limited by top speeds in the 10mph range. This upper limit should be sufficient for most conditioned athletes. Typically, VO2max (see part I for a complete description) is determined by treadmill testing, but those treadmills employ inclines that go beyond normally available. For a surrogate, begin at a brisk walking pace of about 3 - 3.5 mph.

Increase the pace by 0.2 mph every minute until failure. If using a heart monitor, maxHR should be reached (bear in mind that this form of maximal testing should only be undertaken by someone free of cardiovascular disease and already aerobically trained). Submaximal testing cannot be substituted even though protocols exist to measure aerobic fitness from submaximal results. This is because you are interested in the top speed achieved during the graded test. The top speed for a full minute is defined as your vVO2max (your velocity at your VO2max). Intervals are now set relative to this speed in a manner analogous to the bicycling routines above.

Several variations have been evaluated. In one case, you can determine a Tmax (maximum time sustainable at your vVO2max) and run intervals at 60 - 75% Tmax at vVO2max followed by a rest interval equal to the work interval and done at 60% vVO2max and cycled 5 times7. Another

protocol involves cycling between 100% vVO2max and 50% vVO2max for 30 seconds for each interval for 12 cycles.2 This particular routine was not evaluated for its effects over time as in most of the other protocols presented; however, the study results do suggest that in terms of sustaining a high intensity effort (which is the goal of interval training with regards to bodyfat management), it is qualitatively similar to other protocols.

Obviously, not everyone has the capacity, determination, nor desire to engage in supramaximal or even maximal effort during a workout. While high intensity activity is clearly associated with favorable responses with regard to bodyfat management, submaximal strategies can also be employed. As discussed in part I, moderate intensity does allow for a substantial energy expenditure (in the 8 - 15 calorie per minute range) with an intermediate post-exercise fat burn relative to high intensity.

Some strategies to enhance fat burning include exercising in a postabsorptive state, in other words, on an empty stomach, typically after an overnight fast. The goal here is to eliminate any insulin effect on inhibiting lipolysis during the exercise. It goes without saying not to consume carbs during the routine as well. In a carb depleted state, fuel selection is shifted towards fat burning so that at every intensity level, more fat is burned. Assuming that intensities stay in the low - moderate range, there is no decrement to fatigue time.5

Carb depletion routines can also be employed selectively in working muscles. A simple routine on an ergometer is to alternate 2 minutes intervals between 80% (dropping to 70% when 80% cannot be sustained) and 50% PPO until failure.6 This routine can be viewed as a modified interval routine that is at the lower end of the minimum intensity to qualify as HIIT. The fact that it can be sustained for so long suggests that the intensity is insufficient to create enough lactic acid to train the threshold.

Subjects will typically require about 1 hour to completely deplete carbs in the working muscles. Alternatively, the 85% PPO 8X4 minutes with 90 seconds recovery would provide a similar effect, although probably not as significant in terms of complete carb depletion. If a moderate intensity cardio routine is performed the following day without carb replacement, the percentage of energy derived from fat will be substantially higher.

Another Strategy

Another strategy is to perform incremental exercise from low to moderate to high intensity during the course of one session.11 In this case, the exercise performed at the higher intensity burns fat at a greater rate than a routine of just the high intensity, most likely due to the priming of lipolysis. Alternatives to this strategy are to employ interrupted sessions. This has been demonstrated for two intensity levels, moderate and moderate/high. In these cases, cardio is performed at either at 60% max HR for 1 hour or 75% max HR for 30 minutes, followed by a rest interval of one hour and then the routine is repeated.9,13 The fat burn during the second

routine is higher than during the first.

Admittedly, these are not time efficient, but as discussed above, these offer routines to enhance fat burning for those not disposed to the HIIT routines. Finally, studies with excess post-exercise oxygen consumption have shown that splitting routines throughout the day provide for a greater cumulative post-exercise fat burn than if performed all at once.1 In this case, 30 minutes split into two 15 minute routines in the morning and evening is slightly better in the combined post-exercise period than all at once.

Finally, for those who wish to design their own customized routines, there are several guidelines to keep in mind. The overall concept behind interval training is to be working at an intensity level that is not sustainable for more than several minutes. This intensity level will demand a lot of effort to maintain. The higher the intensity level, the shorter the work phase should be, but 15 - 30 seconds is probably the lower limit.

Especially when using stationary exercise equipment factor in the ramp times to transition between high and low intensities. Another factor to consider is as the intensity increases, the work phase time period should decline and the rest phase can equal the work phase in terms of time. As the work phase increases to 1 - 4 minutes, the rest phase lengthens more than the work phase. More rest is required the longer the work phase, since more lactic acid will accumulate and needs to be cleared. Five minutes should probably be viewed as an upper limit to the work phase to ensure that the intensity is well above the lactic acid threshold.

HR can be used as a general guideline to follow recovery allowing a fall back to about 65% of maxHR. Also, do not simply stop activity for the rest phase, some movement will assist in clearing lactic acid more rapidly. Do not attempt these routines more than twice per week due to their demanding nature. Begin with once per week and continue with some cardio and gradually work in twice per week sessions.

It would still be advisable to maintain at least one, low to moderate cardio session as well, preferably on a day following an interval routine. Keep in mind that the goal of HIIT from the standpoint of bodyfat management is to maximize the total time spent at high intensity. It is this combination of high intensity and duration that leads to the post-exercise fat burning. Therefore, as intensity goes down, duration must go up.

Conclusion

In conclusion, interval training offers several attractive features to justify its incorporation into the bodybuilder's workout. It offers time efficient aerobic conditioning which is athletically useful as well as smart health wise. Since growth hormone (GH) secretion is dependent on exercise intensity, it offers another avenue for natural GH production.

Finally, the exercise intensity effect on the post-exercise period offers substantial benefits in terms of bodyfat management relative to traditional continuous cardio workouts.

CHAPTER 3: HIIT and NUTRITION

High-intensity interval training (HIIT) has become hugely popular thanks to real results in shorter periods of time and extensive benefits. With busy schedules the norm, it's no wonder so many clients and potential clients are now seeking out these kinds of workouts. HIIT, which involves repeated sessions of relatively brief, intermittent exercise, usually performed at very high intensity, can be easily modified for various client needs and fitness levels. When combined with an expert nutrition program, personalized HIIT programs can elicit serious results and health benefits, including:

- Improve blood pressure and cardiovascular health
- Improved insulin sensitivity
- Improved body composition

Whether you're adding HIIT to your own personal fitness program or ramping up client results and health benefits with this style of training, it's important to understand the nutritional needs to support it from start to finish. While nutritional needs do vary by individual and training program, these nutrition plans and meal ideas for pre- and post-workout nutrition can help.

General Nutrition to Support a H.I.I.T. Program

To get the most out of any fitness program, clients should follow a healthy meal plan in general. Effective and well-rounded nutrition programs are based on a variety of healthful ingredients such as whole grains, fruits and vegetables, and lean proteins. The best nutrition plans provide adequate calories and macronutrients such as carbohydrates to fuel the body and provide energy stores for workouts. It's important that these are expertly created programs that allow you to stay within your scope of practice and prevent clients adopting a restrictive diet that may inhibit their success. Adequate water is also a must to ensure complete hydration during workouts.

Pre-workout Nutrition for HIIT

Due to the intensity of these workouts, it's vital to follow a healthy nutrition plan with adequate nutrition in the days and hours leading up to a workout. Plan on a moderate- to high-carbohydrate meal that also includes protein approximately three to four hours before the HIIT workout, and then another high-carbohydrate snack within an hour after the workout. Good options for a pre-workout meal include:

- Whole-wheat toast with peanut butter and banana
- Non-fat Greek yogurt or cottage cheese with fruit
- Dried fruit and almonds

Post-workout Nutrition for HIIT

The biggest nutritional concern post-workout is replacing energy stores (glycogen) and repairing muscles that have been broken down during the intense workout. Again, a combination of carbohydrates and protein has been shown to be most effective. Research shows that a 3:1 ratio of carbohydrates to protein within 30 minutes of completing a HIIT workout is best for replacing

energy stores in preparation for the next high-intensity workout. Suggestions for post-workout nutrition are similar to pre-workout meals and include:

- Whole-grain cereal with fruit and soy milk
- Whole-wheat crackers with fruit and cheese
- Hummus and pita bread

The best pre- and post-workout nutrition boosts energy and results—and client motivation. Help clients to achieve the results they demand while you improve client retention with an effective nutrition program for high-intensity interval training.

Day-to-Day Nutrition Considerations

Even if your pre- and post-workout nutrition is on par, it won't mean much if your everyday eating habits brings your overall diet quality down. Good nutrition habits keep your weight on track, reduce your risk of chronic disease and boost your energy levels.

A quality diet doesn't have to follow some fad like paleo or macro-counting. Rather, focus on eating whole, mostly unprocessed foods. Ample vegetables and fruits, whole grains, lean proteins — such as chicken and fish — and healthy fats, including avocado and olive oil, give you the vitamins, minerals and phytonutrients you need to support exercise and good health. Minimize your intake of added sugars, refined grains, alcohol and saturated fat.

Watch portion sizes, too. A protein serving at most meals should be about the size of your palm. Fill a quarter of your plate with grains or a healthy starch, such as sweet potatoes or winter squash, and another half of your plate with green veggies of choice. A thumb-sized serving of unsaturated fats — a sprinkling of sunflower seeds or drizzle of olive oil — makes for a complete meal.

CHAPTER 4: HIIT and WEIGHT LOSS

Smart exercisers use high-intensity interval workouts for weight loss. Why? Because high-intensity interval training (also called HIT or HIIT) really works when you want to slim down. Even scientific researchers have found that HIT training for weight loss really works.

But this style of short interval training has to be set up correctly. Do you have to hire a coach to set up the workout? No. You can be your own personal trainer and set up a plan that will help you to lose weight and change your body composition in no time. Here's how.

Set Up Your HIIT Weight Loss Program

Before you start an exercise program that involves high-intensity activity, you need to be sure that you are healthy enough for vigorous activity. You'll be working very hard, so check with your doctor to be sure that you are in good health.

Next, you need to include your interval workout program in a well-designed exercise schedule. That means you should be well rested going into the workout and you'll need a recovery day (not a rest day!) afterward. Never do back-to-back HIIT workouts to lose weight. Believe it or not, this could make the whole weight loss workout plan less effective.

Lastly, you'll need to be equipped with a stopwatch and some method for monitoring your workout intensity. A heart rate monitor works best. If you don't own a monitor, you can use perceived exertion or take your pulse manually.

Interval Workouts for Weight Loss

Intervals are simply short periods of time. When you do an interval workout you alternate short periods of hard work with short periods of easier work. The cycle of work/rest is repeated several times in the course of an interval workout.

Researchers who have studied high-intensity workouts have used different interval lengths and have found success with different interval types. In several recent studies, exercise physiologists used work intervals that lasted two minutes, followed by rest intervals lasting three minutes. The cycle was repeated five times.

- *2 minutes hard, then 3 minutes active rest x 5 cycles*

You can adjust your intervals if necessary. The general rule of thumb is the shorter the interval time, the more intense it should be. But remember that intensity is the key, not duration. So, longer intervals are not necessarily better because you can't work as hard for five minutes as you can for 20 seconds.

Complete HIIT Workout to Lose Weight

Once you've chosen your interval length and workout schedule, it's time to get to work. Choose your favorite activity for the workout; just about anything works. If you are a runner, you might complete your workout at a local sprint track. If you enjoy cycling, you can do interval bike training for weight loss. You can do intervals on stairs, with a jump rope or even by dancing in place! The intensity matters more than the mode.

Be sure that you begin your interval training with a 7-10 minute steady state warm-up. It's a good idea to do a less strenuous version of whatever activity you've chosen for the workout. If you'll be doing running intervals, for example, your warm-up would consist of a light jog or a fast walk.

A sample workout looks like this:

Warm up: 10 minutes

Intervals:
2 minutes @ 85-90% of max heart rate (working very hard)
3 minutes @ 60% of max heart rate (light workload)
2 minutes @ 85-90% of max heart rate
3 minutes @ 60% of max heart rate
2 minutes @ 85-90% of max heart rate
3 minutes @ 60% of max heart rate
2 minutes @ 85-90% of max heart rate
3 minutes @ 60% of max heart rate
2 minutes @ 85-90% of max heart rate
3 minutes @ 60% of max heart rate
Total: 25 minutes

Cool down: 10 minutes

Total workout time: 45 minutes

HIIT Weight Loss Program Results

A review of interval training programs found that many trainers used a high-intensity interval training program on their clients for two to 16 weeks to see fat loss and an increase in lean muscle mass. Most of the more successful HIIT weight loss programs lasted eight weeks.

As you progress through your interval training program, be sure to eat enough protein to help your body burn calories and build muscle with each workout. Following a HIIT-friendly diet will help you to see results faster. And remember that consistency is the most important component of every weight loss program. If you stick with it, you'll see your fitness level improve and your body change for the better.

Not every new fitness trend lives up to the hype. But high-intensity interval training, aka HIIT, has been exactly what its name promises: a big "hit."

This form of cardio workout intersperses intervals of all-out exercise, such as sprinting or fast-paced bodyweight work, with recovery periods of either low-intensity exercise, such as walking at a slow pace, or complete rest. It's a huge departure from continuous steady-state, slow-and-steady cardio that most people do at a moderate intensity for 30-60 minutes.

During a high-intensity interval training routine, you'll be running--or cycling or whatever--like a bat out of hell for brief stretches, and your heart rate will skyrocket. But when all's said and done, your workouts will be shorter, and you'll have improved cardiovascular fitness and better results in less time.

You don't have to be an elite athlete to benefit from interval training, though. I'll share the incredible science behind this style of training, and then give you a routine that can take any beginner into a conditioned HIIT beast in just 8 weeks!

The Beginner-To-Advanced 8-Week HIIT Program

It starts with a work: rest ratio of 1:4 in Phase 1 for a total workout time of just under 15 minutes. Phase 2 bumps up the amount of time in the "work" phase, bringing the ratio up to 1:2 and the total workout time to 17 minutes.

In Phase 3, the rest ratio is cut in half, bringing the ratio up to 1:1. The total workout time increases to 17 minutes.

Finally, in Phase 4, the rest ratio is cut in half again, raising the ratio to 2:1 and the total time at 20 minutes.

During the "work" or high intensity periods, don't just pick up the pace a little. You want to really go all-out. During recovery periods, make sure you slow down enough to actually recover.

The suggested time of each phase is just that: suggested. If you need to spend more than two weeks at a particular phase before moving up, go for it. If 15 intervals is way out of reach, do 10 and build up to 15. Ditto if a phase seems too easy and you want to jump right up to the next phase: Do it!

Do the workout 2-4 times per week. Start with 2, then gradually increase to 4 as your fitness improves.

You can do this conditioning routine using a wide variety of exercises. Here are just a few to consider:

Good Options for HIIT Workouts

- Jump rope
- Jumping jacks or other fast bodyweight moves
- Sprinting
- Sprinting in place
- Stationary bike
- Jumping in place
- Jump squat
- Bodyweight squat
- Lightweight goblet squats
- Kettlebell swings
- Push-ups
- Use your imagination. Just follow the work-to-rest intervals as indicated.

Phase 1 (1:4): Weeks 1-2

- 15 seconds: High-intensity exercise
- 60 seconds: Rest or low-intensity exercise

Repeat another 10 times, followed by a final 15-second high-intensity blast.

Total time: 14 minutes

Phase 2 (1:2): Weeks 3-4

- 30 seconds: High-intensity exercise
- 60 seconds: Rest or low-intensity exercise

Repeat another 10 times, followed by a final 30-second high-intensity blast.

Total time: 17 minutes

Phase 3 (1:1): Weeks 5-6

- 30 seconds: High-intensity exercise
- 30 seconds: Rest or low-intensity exercise

Repeat another 16 times, followed by a final 30-second high-intensity blast.

Total time: 17.5 minutes

Phase 4 (2:1): Week 7-8

- 30 seconds: High-intensity exercise
- 15 seconds: Rest or low-intensity exercise

Repeat another 25 times, followed by a final 30-second high-intensity blast.

Total time: 20 minutes

Benefits of HIIT

More fat-loss, less time
One of the first studies to dig deep into HIIT workouts was done in a 1994 study by researchers at Laval University in Quebec. They reported that young men and women who followed a 15-week HIIT fitness program lost significantly more body fat than those following a 20-week continuous steady-state endurance program. This, despite the fact that the steady-state program burned about 15,000 calories more during the routines themselves.

Overweight? Burn more with HIIT
A 2001 study from East Tennessee State University demonstrated similar findings with obese subjects who followed an 8-week program of HIIT workouts. These subjects dropped 2 percent in body fat, as compared to those who followed a steady-state cardiovascular program on the treadmill and lost none.

Lose six times more fat
A study from Australia reported that females following a 20-minute interval training program, consisting of 8-second sprints followed by 12-second recovery periods, lost six times more body fat than the group who followed a 40-minute cardio program performed at a constant intensity of 60 percent of their maximum heart rate.

Post-Workout Calorie Burn: The Key to HIIT
The major reason that high-intensity interval training works so well to drop fat to a greater degree than continuous steady-state aerobic exercise appears to be the ability of all-out sprinting to boost your resting metabolism following a workout.

Round-the-clock burn

A 1996 study from Baylor College of Medicine backed this up, reporting that subjects who followed a high intensity interval training workout on a stationary cycle burned significantly more calories during the 24 hours following the workout than those who cycled at a moderate steady-state intensity. The 2001 East Tennessee State University study mentioned above also found that subjects following the interval training program burned almost 100 more calories per day during the 24 hours after exercise.

More calorie burn in a fraction of the time

In a study presented at the 2007 annual meeting of the American College of Sports Medicine by Florida State University (Tallahassee), researchers reported that subjects who performed HIIT workouts burned almost 10 percent more calories during the 24 hours following exercise as compared to those who performed continuous steady-state exercise, despite the fact that the total calories burned during the workouts were the same.

Boost your fat-burning machinery

In addition to the increase in resting metabolism, research confirms that high intensity interval training is effective at enhancing the metabolic machinery in muscle cells that promote fat burning and blunt fat production.

Boost fat-burning enzymes

For example, a 2007 Study in the Journal of Applied Physiology reported that young women who performed seven HIIT workouts over a two-week period experienced a 30-percent increase in both fat oxidation, and in the levels of muscle enzymes that enhance fat oxidation.

Create fat-burning muscle

The Laval University study that found a decrease in body fat with HIIT conditioning also discovered that the subjects' muscle fibers had significantly higher markers for fat-burning than those in the continuous steady-state exercise group.

Decrease fat-producing enzymes

A study from the Norwegian University of Science and Technology in Trondheim, reported that subjects with metabolic syndrome who followed a 16-week HIIT routine lost twice as much of the fat-producing enzyme fatty acid synthase as compared to subjects who followed continuous moderate-intensity exercise.

Use more fat for workout fuel

A new study published in the American Journal of Physiology sheds some light on another way that interval training burns more body fat. Researchers reported that six weeks of HIIT workouts increased the levels of special proteins in muscle that are responsible for carrying fat into the mitochondria, where fat is burned away for fuel, by up to 50 percent. Having more of these proteins means that more fat can be burned for fuel during workouts, but also when resting.

But Is HIIT A Hit For Bodybuilders?

In a word, yes. While many bodybuilders and trainers argue that going slower and longer with cardio is best to burn fat and protect lean mass, the opposite appears to be true.
Aerobic exercise done at a higher intensity, with the heart rate at 80 percent of max or above, will not only help you maintain your muscle, but can actually help you build more.

When you train at a slow and steady pace for a longer period of time, you are training your muscle fibers to be more aerobic and have greater endurance. Do you know how they adapt? By becoming smaller and weaker!

The smaller a muscle fiber is, the less time it takes for nutrients to travel within it. This speeds up the rate that the nutrients can be burned for fuel.

But even if you think of this from a common-sense perspective, it makes perfect sense. Stating that slow and steady cardio for longer periods of time is best for maintaining lean mass is similar to saying that curling 5-pound dumbbells for 30 minutes straight will build more muscle than curling 40 pound dumbbells for sets of 10 reps with 2 minutes of rest between sets.

Sure, both might work to a certain degree, but the higher-intensity workout clearly builds muscle better. If you think about it, weightlifting is actually a form of HIIT! In fact, the research backs this up.

Muscle gains with no lifting

One study in the Journal of the International Society of Sports Nutrition reported that male subjects following a 6-week high-intensity interval program while supplementing with beta-alanine gained more than 2 pounds of lean mass after 3 weeks—despite no lifting during the program. The program wasn't anything wild, either: Just 15 minutes, three days per week, at a 2:1 ratio of exercise-to-rest.

Boost testosterone 100% with HIIT workouts

In another study, New Zealand researchers had competitive cyclists complete four weeks of high intensity interval training involving 30-second sprints on a stationary cycle separated by 30-second recovery periods. One group sprinted with high resistance on the pedals, making it harder

to pedal, while the other group used a lighter resistance, which was easier to peddle. Both groups peddled as fast as they could during the 30-second sprints.

The researchers found that the men peddling at the highest resistance increased their testosterone levels by almost 100 percent, while the group peddling at a lighter resistance only increased test levels by about 60 percent. Since testosterone is critical for boosting muscle size and strength, the takeaway is that HIIT with greater resistance may help with growth and strength.

More variety, less boredom

Interval training also helps you to maintain your sanity by getting you done with cardio quicker. I can't think of anything more monotonous than being stuck on a treadmill, stairmaster, stationary cycle, or elliptical machine for a good 30-60 minutes straight!

With HIIT workouts, the intensity bursts may be more grueling, but they are short and challenging. That makes the workout more "fun" and completes it quicker, while raising your heart rate and conditioning your cardiovascular fitness to a greater degree.

Another benefit of HIIT is that you can do it almost anywhere with any piece of equipment—or without any equipment at all! Although it can be done on gym machines, you can also do bodyweight moves, like in a conditioning class.

The possibilities are virtually limitless. You can use it with a jump rope, with weights, with elastic bands, or just with your bodyweight.

So consider doing less slow and long workouts and do more HIIT. Think of it as "conditioning" rather than cardio, because you'll be training like an athlete--and looking like one!

The benefits will be maximal fat loss due to a ramping up your resting metabolism and fat burning enzymes, while building muscle, all in a minimal amount of time.

CHAPTER 5: HIIT and Cardio

These days cardio machines are everyone's choice of conditioning. Why? Probably because you hardly break a sweat, feel no pain, and you're able to read the latest Gossip Magazine or text message while you're at it. Yet as much as I do advocate using cardio machines, the correct way that is, there are other effective conditioning workouts out there.

The Energy Systems

Before we pop the bottles of champagne, I want to educate you on some of the energy systems that are going to be used during these workouts. There are three energy systems that you will use.

#1 High Energy Phosphate System

The first being the high energy phosphate system which provides energy for muscles in the initial 1 to 15 seconds of high intensity activity (1). ATP (quick burst of energy) will be activated during this system, which is great because that's what causes the body to make metabolic changes.

#2 Anaerobic Glycolytic System

The second being the Anaerobic Glycolytic System which the body relies primarily on anaerobic metabolism for the energy required to perform intensive exercise of greater than 12-15 seconds and less than 3 minutes duration (2). This system will be another way to overload your muscles, as you will be firing those muscle fibers so fast, you are going to recruit the fast twitch fibers and evidently you're going to cause muscle damage (a good thing).

#3 Aerobic Oxidative System

The third system being the Aerobic Oxidative System which consists primarily of exercises that are performed at an intensity lower than that of the anaerobic threshold (3). Meaning that you will not get any lactic acid (burning sensation) production when you're in this system and it will be mainly a brisk to fast pace walk or light jogs to keep your heart rate elevated.

Six HIIT CARDIO WORKOUTS

#1 Car Pushes

Car pushes! If you have never tried car pushes then you are missing out on one of the best HIIT cardio workouts around. This is one of the best ways to improve cardio conditioning, leg drive and power, some upper body pressing power and build a great physique. I've found that my squats and leg pressing power have improved since doing these because of the overload the car puts on your legs and you have to use a tremendous amount of lower body strength, as well as upper body strength to move the car. Car pushing is very underrated for strength training and power in my opinion. The cool thing about car pushing is that there are literally hundreds of yards of empty space around somewhere near you, so all you have to do is put it in neutral, drop your head down, arms straight, get low and push with all you've got for 10-30 seconds.

The Protocol

- 10 minute brisk walk or slow paced jog for warm up
- 4 intervals of 10-30 second all out pushes and 3-4 minute brisk walk in between intervals
- 10 minute brisk walk to cool down

#2 Sled Drags

I'm sure some of you are saying what the hell are sled drags? Sled drags are very effective for the athlete, power lifter, or down-right bad ass that wants to get in tip top shape. Dragging a weighted sled by using a harness tied to your waist allows you to activate the core to work harder as well as your glutes and hams. The harness also forces you to keep a straight, stiff spine throughout the exercise, regardless of how tired you get. Rounding the back at anytime will immediately look and feel very awkward, giving instant feedback to straighten out or stop and rest. The great thing about sled dragging is it can have a carryover effect to many things, such as: Football, athletes learning how to explode when moving. Powerlifting, sled dragging strengthens your posterior chain and that can help with deadlifting. Track and field, overloading your waist and sprinting with weights can lead to more explosive movements when you train without them. If you aren't sled dragging, then you are missing out on superior strength gains and conditioning.

If you decide to sled drag, a good rule of thumb is "you've got too much weight when you're walking like you're drunk."-Louie Simmons

The Protocol

- 10 minute brisk walk or slow paced jog for warm up
- 5 intervals of 10-30 seconds all out sled dragging and 2-3 minute brisk walk in between intervals
- 10 minutes brisk walk to cool down

#3 Heavy Rope Training

Heavy rope training was originally developed for specific combat sports such as Football and Mixed Martial Arts; it is now becoming very popular for conditioning work and HIIT cardio. If you're looking for a new twist to your fitness routine or if you're one of those that complain about other HIIT cardio workouts being too demanding on your legs the day after a leg session, then this is what you're looking for. Along with increasing your strength, power, and endurance, the constant motion of rope battling will give you a hell of a workout. Some common movements include waves, slams, throws, spirals, and whips. These all involve swinging your arms up and down (or side to side) for timed intervals. With each of these exercises, you want to create a solid base by planting your feet in a shoulder width stance and stabilizing your core, think of an athletic stance.

You'll quickly discover that these exercises engage not just your arms and shoulders, but your whole body.

The Protocol

- 5 minute moderate jump rope for warm up
- 3-5 sets of 10-30 second intervals (waves, slams, throws, spirals, whips) and 45-60 seconds of rest in between intervals
- 5 minutes of moderate jump rope to cool down

#4 **Kettlebell Swings**

Believe it or not but kettlebells are starting to be increasingly popular. Specifically kettlebell swings have become a great HIIT cardio workout to activate your glutes and hamstrings. A study in the Journal of Strength and Conditioning found as the movement progressed from the bottom of the swing to the top of the swing, back muscle activation peaked first at around 50% of MVC (maximal voluntary contraction), followed by abdominal/oblique activation at around 20-30% of MVC, followed by gluteal muscle activation at around 75% of MVC (4). As you can see kettlebell swings stimulate your glutes, strengthen your back muscles, engage your core muscles and help strengthen the hip and knees. Muscle activation ramps up during a half-second

interval in the concentric phase (top of the swing) and then transitions to almost complete relaxation during much of the eccentric phase (coming down with the swing) (5). So every time you are swinging that kettlebell you are firing muscle fibers and this could lead to overall muscle growth. If you've never tried kettlebells for HIIT then your booty and hamstrings are in for a long day!

Make sure to be wise when you choose the weight, you aren't going for a 1 rep max, pick a comfortable weight that you can swing and use good form to really activate all the muscles.

The Protocol

- 5 minute moderate jump rope for warm up or 10 minute brisk walk/jog
- 5 sets of 10-30 second intervals (all out swings) and 45-60 seconds of rest in between intervals
- 5 minutes of moderate jump rope or 10 minute brisk walk/jog to cool down

#5 Boxing

Here's a HIIT workout you can do after your boss was on your ass all day or if you have one of those days when you feel a big weight on your shoulders…Hit the heavy bag! Hitting a punching bag is a great upper body workout and tailors well for those that have lower body injuries or limitations. One recommendation I will make is to not do a heavy upper body workout following this workout or the day after. Make sure to have an off day or lower body day. Your shoulders and arms will feel like you got in a bar fight with Mike Tyson after this workout.

The Protocol

- 10 minutes of jump rope for a warm up
- 5 rounds of 10-30 second all out (everything you've got beating the crap out of that bag)
- 2-4 minutes of jump roping in between rounds
- 10 minute brisk walk to cool down

#6 Sprints

Last but not least how can I leave out good old sprints that have been tried and true for the longest time. Just look at sprinters legs compared to a long distance runners legs. Obviously the sprinter has more muscle mass on their legs because they're activating fast twitch muscle fibers and creating muscle damage which leads to muscle growth. If you don't believe me, go do sprints and you'll see how sore you are the next day, it'll feel almost the same as if you did an intense leg workout and that's because you activated and broke down those muscle fibers. A

recent study by Metcalfe et al. shows if you perform what Metcalfe and colleagues call the "minimal amount of exercise for improving metabolic health" a 3x per week 10min exercise regimen with no more than two (yes, I said it only 2 times!) all-out sprints, everything you've got, you will make changes to your metabolic rate (6). This 6 week exercise program was compared to the results of a 10 month intervention program in subjects who exercised 3x a week for 40min (steady state).

Metcalfe's study goes to show that it's a more efficient way to burn fat by doing 3x per week for 10 min with only 2 all out sprint intervals because the steady state endurance study was not only four times more time-consuming, but it also failed to improve the glucose tolerance test and produced no improvements in insulin sensitivity.

The Protocol

- 10 minute brisk walk
- 5 sets of 10-30 second intervals (all out, everything you've got) and 1-4 minutes of rest in between intervals
- 10 minute brisk walk to cool down

Wrapping it up

Now don't get all bent out of shape after this, but you must understand the pros and cons of doing HIIT cardio workouts. They should be used as a tool and not be overused. I wouldn't recommend more than 3-4 HIIT cardio workouts a week and I would definitely not do them after a high intensity leg workout day. Also, you're probably wondering why I keep saying 10-30 seconds of intervals and that's because everyone's AT (anaerobic threshold) is different. You have to build your tolerance and get conditioned for these types of workouts and the more you do it and push yourselves, the more your AT will improve. With that in mind, we are all different and respond differently to certain things. So experiment yourself and see what you like best and what works best for you. Start with 10 second intervals and see if you can eventually get to 30 seconds.

Just don't overdo it or take that risk of injuring yourself. Now that you have these 6 workouts in your gym bag of tricks… go HIIT it!

CHAPTER 6: HIIT and CROSS TRAINING

Spice up your workout routine with cross training for whole-body fitness that mixes aerobics, strength training, and flexibility.

Blast out of the same-old, same-old. Varying your workouts is better for you. By using different muscle groups, you reach a higher level of fitness. Keeping things interesting also helps you stick with it.

A sample cross-training schedule might look like this:

- Monday: Swim laps
- Tuesday: Lift weights at the gym
- Wednesday: Do yoga
- Thursday: Take an aerobics class that includes muscle-toning exercises
- Friday: Rollerblade

You can also mix different exercises -- strength and aerobic -- into a full-body workout. For example, during one 30-minute session you might walk or jog for 10 minutes, lift weights for 10 minutes, and then do yoga for 10 minutes. No time? Break it up into shorter, 10-minute segments and still see a benefit.

Pick your exercises based on your interests. Include at least 30 minutes of moderate-intensity aerobic exercise on most days of the week, and at least two days of strength training. Try to also do flexibility exercises like stretching and yoga every day.

Intensity Level: Medium

The intensity level with a cross training workout is really up to you. It depends on what you choose.

You can bring down the intensity by walking instead of running, or bring it up by doing higher-impact exercises and using heavier weights.

Areas It Targets

Core: Yes. Sit-ups, planks, and other core exercises should be part of your cross-training program.

Arms: Yes. The strength-training portion of your workouts should include biceps, triceps, and other arm exercises using hand weights, weight machines, or resistance bands. You can also use your own body weight for resistance by doing exercises such as push-ups, pull-ups, and chair dips.

Legs: Yes. Include strength-training exercises like lunges and squats to work your leg muscles. You'll also work your legs by running, climbing stairs, and doing some of the other aerobic components of the program.

Glutes: Yes. Many of the same exercises that work the legs, including lunges and squats, are also good for the glutes.

Back: Yes. This is a full-body workout, so you will want to incorporate exercises for your back, like pull ups and rows.

Type

Flexibility: Yes. The ideal cross-training program starts with a warm-up and ends with a cool-down stretch. It also includes yoga or stretching.

Aerobic: Yes. Your cross-training routine should include aerobic exercises, such as running, stair climbing, or dancing.

Strength: Yes. You should do strength-training exercises like lifting weights or bodyweight exercises like push-ups at least twice a week.

Sport: No, but it can help athletes get into better shape for their sport.

Low-Impact: Yes. You can adapt your workout to be low impact. For example, walk instead of run during the aerobic parts.

What Else Should I Know?

Cost. None. You can cross train on your own at home without spending any money. Or you can invest in a cross-training class or personal trainer.

Good for beginners? Yes. You can modify this program to your fitness level. If you're new to exercise, start slowly with low-impact exercises like walking or swimming, and use light weights for toning. Gradually make it more challenging when you're ready.

Outdoors. Yes. You can do many parts of a cross-training program, like jogging or swimming, outside.

At home. Yes. You can cross train just about anywhere, including in your home.

Equipment required? No. You don't have to buy any equipment. If you already have weights and a stair climbing machine, you can use them. Or use things you already have, like stairs at home.

What Dr. Michael Smith Says:

Cross-training is ideal for anyone, whether you're a beginner who wants to get in shape or an experienced exerciser looking to take your fitness to the next level.

It's the backbone of any well-developed exercise program. The wide variety of activities means you can choose what works for you.

One of the most common mistakes people make with exercise is repeating the same routine week after week. To continue to improve your fitness level and reap all the benefits of regular exercise, you need to keep your body guessing. Cross training does this for you.

When you do the same activity over and over, you also set yourself up for overuse injuries. Cross training helps solve this problem, too.

If you run out of things to do in your workout, book a couple of sessions with a personal trainer, watch online fitness videos, or read exercise magazines to learn some new moves.

Is It Good for Me if I Have a Medical Condition?

Getting in shape, losing weight, and building muscle not only help prevent certain medical conditions but are also a key part of treatment for diabetes, high blood pressure, high cholesterol, and heart disease.

Check with your doctor if you're new to exercise. Once you get the OK, cross training should be where you start. It's a good way to try different activities, so you can find what you like. If you're not sure where to start, sign up for a session or two with a certified personal trainer to learn the ropes.

Cross training is an excellent option if you have arthritis, too. Of course, if you're having a flare, you want to scale back on activity until your joints calm down. But when you get the OK from your doctor, exercise is absolutely crucial for treating the joint pain of arthritis. Losing weight takes significant stress off your joints. Building muscle provides more support for your joints and curbs pain. And flexibility exercises help prevent stiffness. Cross training lets you include low-impact activities, like bike riding and swimming, that provide the benefits you need without putting more stress on your joints.

Cross training can also help you recover from a back or knee injury. Early on, you'll want to lay off any activity that aggravates the injury. But once you're on the road to recovery, look for activities that help strengthen muscles, which lessens pain and helps prevent further injury.

To help prevent another injury, cross training is key, so you're not overstressing your body by doing the same activity over and over again.

Even if you have a physical limitation or disability, you can find activities that work for you. The beauty of cross training is in the wide variety of exercises you can choose from.

If you're pregnant, did you cross train before your pregnancy? If so, you can probably continue, as long as your doctor says it's OK. Staying fit during pregnancy is good for you and your baby. It may even make giving birth a bit easier with shorter labor. As you progress along in your pregnancy, you'll likely have to change up some of your activities. With cross training, this is easy to do.

CHAPTER 7: HIIT and Endurance

The fitness industry is seeing a surge of interest in high-intensity interval training (HIIT), a burst-and-recover cycle that can offer a viable alternative to continuous aerobic exercise.

HIIT, which pairs quick bouts of high-energy exercise with low-effort rest intervals, is not exactly a new idea. As early as 1912, the Finnish Olympic long-distance runner Hannes Kolehmainen was using interval training in his workouts (Billat 2001). As our knowledge of HIIT has increased, exercise scientists have demonstrated that HIIT can

- boost the performance of competitive athletes;
- improve the health of recreational exercisers; and
- provide the benefits of continuous-endurance training with fewer workouts.

The standard way to improve cardiovascular fitness is to increase the volume of exercise—for example, with longer runs or bike rides, or more time on an aerobic machine. HIIT is intriguing because, according to current research, it can yield a broad range of physiological gains, often in less time than high-volume continuous exercise (Daussin et al. 2008).

With that in mind, this article will discuss the body's cardiovascular, skeletal-muscle and metabolic adaptations to HIIT and compare them with the body's responses to continuous endurance exercise. (Continuous aerobic training is defined as exercising—running, cycling, swimming, etc.—for more than 20 minutes at a steady intensity.) Also included here are research-based examples of HIIT and continuous endurance training.

Cardiovascular Physiology 101: Basic Reponses and Adaptations of Aerobic Training

Before we can compare HIIT and continuous endurance training, it's important to review how the body's cardiovascular system adapts to an aerobic workout. During aerobic exercise, heart performance is based on heart rate, **stroke volume** (the amount of blood pumped per beat) and **heart contractility** (the forcefulness of each heart contraction). These variables increase blood flow and oxygen supply to meet the demands of exercising muscles.

The contraction of the skeletal muscle also boosts the flow of venous blood returning to the heart, which increases ventricle blood filling (called the **preload**). This elevated preload contributes to the heart's enhanced stroke volume during exercise, and this in turn is a major determinant of aerobic performance (Joyner & Coyle 2008).

Progressive increases in endurance training trigger adaptations in the heart muscle structure: heart muscle thickens, and the left ventricle expands, improving heart function during exercise. Consistent endurance exercise—such as 30–60 minutes of continuous running or cycling 3–7 days a week—causes a long list of cardiovascular adaptations and responses (see Figure 1).

HIIT vs. Continuous Endurance Exercise: HIIT vs. Continuous Endurance Exercise: Cardiovascular Adaptations

Recent research shows that the cardiovascular adaptations that occur with HIIT are similar, and in some cases superior, to those that occur with continuous endurance training (Helgerud et al. 2007; Wisløff, Ellingsen & Kemi 2009). Helgerud et al. showed that 4 repetitions of 4-minute runs at 90%–95% of heart rate maximum (HRmax) followed by 3 minutes of active recovery at 70% HRmax performed 3 days per week for 8 weeks resulted in a 10% greater improvement in stroke volume than did long, slow distance training 3 days per week for 8 weeks (total oxygen consumption was similar in both protocols).

Another study (Slørdahl et al. 2004) demonstrated that high-intensity aerobic training at 90%–95% of maximal oxygen consumption (VO2max) increased left-ventricle heart mass by 12% and cardiac contractility by 13%—improvements comparable to those observed with continuous aerobic exercise.

VO2max is considered the body's upper limit for consuming, distributing and using oxygen for energy production. Commonly called maximal aerobic capacity, VO2max is a good predictor of exercise performance. Improving cardiovascular function increases the body's VO2max. Some research suggests that HIIT is better than endurance training for improving VO2max.

Daussin et al. (2008) measured VO2max responses among men and women who participated in an 8-week HIIT program and a continuous cardiovascular training program. VO2max increases were higher in the HIIT program (15%) than they were in the continuous training program (9%).

Improving cardiovascular function and increasing VO2max are major goals of patients with cardiovascular disease, which is why some cardiac rehabilitation centers are beginning to include interval training for heart disease patients (Bartels, Bourne & Dwyer 2010). Although traditional low-intensity exercise produces similar gains, improvements from interval training happen in a shorter time, with fewer sessions.

HIIT vs. Continuous Endurance Exercise: HIIT vs. Continuous Endurance Exercise: Skeletal-Muscle Adaptations

An increase in the size and number of **mitochondria** (the "energy factory" of a cell) is becoming a hallmark adaptation with HIIT (Gibala 2009). The increase in mitochondria density, as scientists call it, has been thought for many years to occur only from chronic endurance training.

During aerobic exercise, mitochondria use oxygen to manufacture high levels of **ATP** (adenosine triphosphate, the energy molecule of the cell) through the breakdown of carbohydrates and fat. As mitochondrial density increases, more energy becomes available to working muscles, producing greater force for a longer duration (allowing an athlete to run longer at a higher intensity, for example).

In a 6-week training study, Burgomaster et al. (2008) showed similar increases in levels of **oxidative enzymes** (proteins in mitochondria that accelerate biological reactions to liberate ATP) among subjects who performed a HIIT program consisting of four to six 30-second maximal cycling sprints (followed by 4.5-minute recovery bouts) 3 days per week and subjects who completed 40–60 minutes of steady cycling at 65% VO2max 5 days per week. An increase

in mitochondrial oxidative enzymes leads to more effective fat and carbohydrate breakdown for fuel.

Related work by MacDougall et al. (1998) demonstrated higher levels of the oxidative enzymes citrate synthase (36%), malate dehydrogenase (29%) and succinate dehydrogenase (65%) in the skeletal muscle of healthy male undergraduate students engaging in 7 weeks of HIIT cycling sprints. Three days per week, subjects performed four to ten 30-second maximal cycling sprints followed by 4-minute recovery intervals. The higher levels of mitochondrial enzymes seen among the subjects led to improved skeletal-muscle metabolic function.

There has been a spike of current research explaining the complex molecular pathways that lead to increased mitochondrial density. HIIT can cause physiological changes that mirror the results of traditional endurance training, but the HIIT changes are accomplished through different message-signaling pathways (see Figure 2).

In this model, calcium–calmodulin kinase (CaMK) and adenosine monophosphate kinase (AMPK) are signaling pathways that activate peroxisome proliferator-activated receptor-g coactivator-1α (PGC-1α). PGC-1α is like a "master switch" that is believed to be involved in promoting the development of the skeletal-muscle functions shown in the figure. High-volume training appears more likely to operate through the CaMK pathway, whereas high intensity appears more likely to signal via the AMPK pathway.

HIIT vs. Continuous Endurance Exercise: Metabolic Adaptations

Increasing mitochondrial density can be considered a skeletal-muscle and metabolic adaptation. One focal point of interest for metabolic adaptations is the metabolism of fat for fuel during exercise. Because of the nature of high-intensity exercise, its effectiveness for burning fat has been closely examined. Perry et al. (2008) showed that fat oxidation, or fat burning, was significantly higher and carbohydrate oxidation (burning) significantly lower after 6 weeks of interval training.

Similarly, but in as little as 2 weeks, Talanian et al. (2007) showed a significant shift in fatty acid oxidation with HIIT. Horowitz and Klein (2000) reported that an increase in fatty acid oxidation was a noteworthy adaptation observed with continuous endurance exercise.

Another metabolic benefit of HIIT is excess postexercise oxygen consumption (EPOC). After an exercise session, oxygen consumption (and thus caloric expenditure) remains elevated as the working muscle cells restore physiological and metabolic factors in the cell to pre-exercise levels. This translates into higher and longer calorie burning after exercise has stopped.

In their review article, LaForgia, Withers and Gore (2006) noted that exercise-intensity studies indicate higher EPOC values with HIIT training than with continuous aerobic training.

Final Verdict: And the Winner of the Battle of the Aerobic Titans is . . .

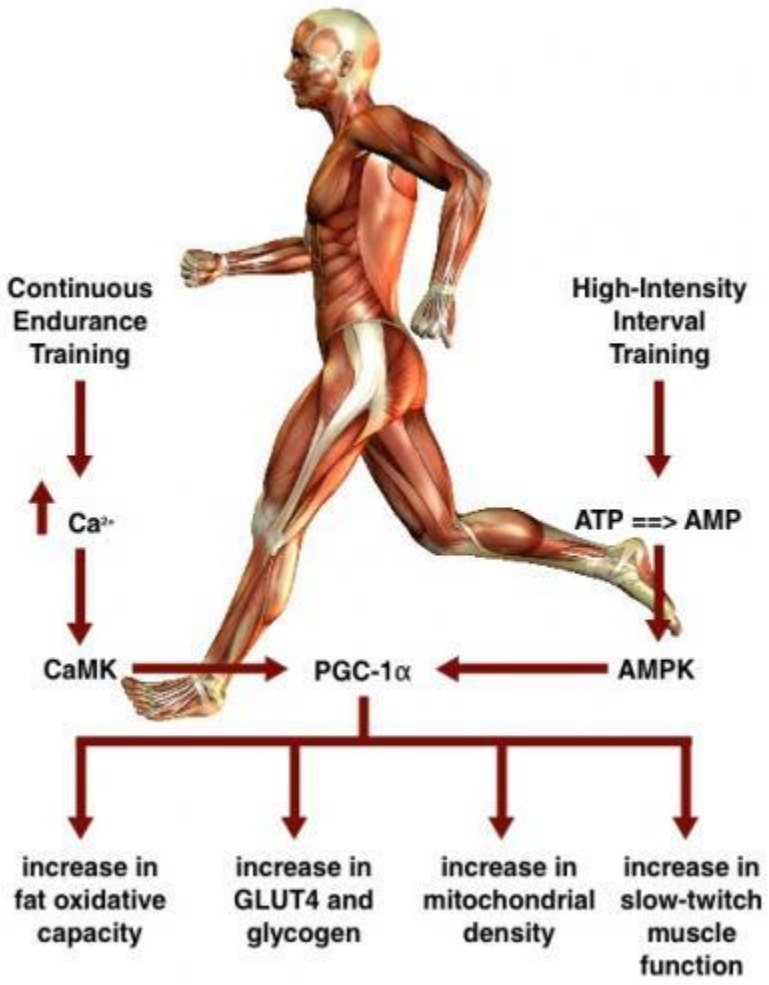
The major goals of most endurance exercise programs are to improve cardiovascular, metabolic and skeletal-muscle function in the body. For years, continuous aerobic exercise has been the chosen method for achieving these goals. However, research shows that HIIT leads to similar and, in some cases, better improvements in less time for some physiological markers. Incorporating HIIT (with appropriate intensity and frequency) into your clients' cardiovascular training gives them a time-efficient way to reach their goals.

And since both HIIT and continuous aerobic exercise programs improve all of these meaningful physiological and metabolic functions of the human body, incorporating a balance of both programs in clients' training is clearly the "win-win" approach for successful cardiovascular exercise improvement and performance. Go HIIT and go endurance!

Figure 1. Cardiovascular Responses and Adaptations to Endurance Training

Source: Joyner and Coyle 2008; Pavlik et al. 2010.

Figure 2. Signaling Pathways of Continuous Endurance Training and HIIT



4 Great Endurance Programs

The following endurance exercise programs are adapted from research investigations reviewed by LaForgia, Withers & Gore (2006). Perform an adequate warm-up (~10 minutes of light exercise) and cool-down (~5–10 minutes of low-intensity exercise) for each program. All of the workouts below can be performed on any aerobic mode.

1. Maximal-Lactate Steady-State Exercise

The maximal-lactate steady-state (MLSS) workout is the highest workload an exerciser can maintain over a specified time period. MLSS exercise work bouts can last 20–50 minutes. The client works at a maximal steady state of exercise for the desired time (20–50 minutes).

2. Alternating-Aerobic-Modes Endurance Exercise

The client alternates aerobic modes (treadmill and elliptical trainer, for example) every 20–40 minutes of aerobic exercise, keeping the exercise intensity at ≥70% HRmax. Time spent on each mode is the same. The number of alternating modes depends on the client's fitness level.

3. Stepwise Endurance Exercise

The client progresses from 10 minutes at ≥50% HRmax to 10 minutes at ≥60% HRmax to 10 minutes at ≥70% heart rate max on any aerobic mode. For a slight modification, the intensity might increase stepwise and then decrease stepwise as well. Thus, after completing the 10 minutes at ≥70% HRmax, the client would switch to 10 minutes at 60% HRmax and then 10 minutes at 50% HRmax.

4. Mixed-Paced Endurance Exercise

Using the selected mode of exercise, the program randomly varies endurance duration (e.g., 5-, 10- or 15-minute blocks) and exercise intensity. A 45-minute endurance treadmill workout could begin with 10 minutes at 50% HRmax, then sequence into 5 minutes at 70% HRmax, then 15 minutes at 60% HRmax, then 10 minutes at 75% HRmax, and finish with 5 minutes at 50% HRmax.

HIIT Program Development

Developing a HIIT program involves two prime considerations: the duration, intensity and frequency of the high-effort (or "work") interval; and the length of the recovery (or "rest") interval. The work interval can last from 5 seconds to 8 minutes. Power athletes tend to perform shorter work intervals (5–30 seconds), while endurance athletes will have longer work intervals (30 seconds to 8 minutes) (Kubukeli, Noakes & Dennis 2002). Intensity of the work interval should range from 80% to more than 100% of maximal oxygen consumption (VO2max), HRmax or maximal power output.

The intensity of the rest interval can range from passive recovery (very little movement) to the more common active recovery of about 50%–70% of the intensity measures described above.

The relationship of work and rest intervals is also a consideration. Many studies use a ratio of exercise to recovery. For example, a 1:1 ratio could be 30 seconds of work followed by 30 seconds of rest. A 1:2 ratio would be a 30-second work interval followed by a 1-minute rest. Typically, the ratio is designed to challenge a specific energy system of the body.

These workouts have been used in studies to induce cardiovascular and skeletal muscle changes. Each component of a training session is included.

PROGRAM 1:

Track Workout

Warm-up: Light 10-minute run around track.

Work interval: 800-meter run at approximately 90% of maximal heart rate (based on estimated HRmax: 220 − age). Each 800-meter interval should be timed.

Rest interval: Light jog or walk for the same time it took to run 800 meters.

Work-to-rest ratio: 1:1.

Frequency: 4 repetitions of this sequence, if possible.

Cool-down: 10 minutes of easy jogging.

Comments: The interval distance can be adjusted from 200 to 1,000 meters. Also, the length of the rest interval can be adjusted.

Source: Adapted from Musa et al. 2009.

PROGRAM 2:

Sprint Training Workout

Warm-up: 10 minutes of light running.

Work interval: 20-second sprint at maximum running speed.

Rest interval: 10 seconds of light jogging or walking after each sprint.

Work-to-rest ratio: 2:1.

Frequency: 3 groups or sets of 10–15 intervals. 4-minute rest between sets.

Cool-down: 10 minutes of easy jogging.

Comments: This is a sprint workout. The first few intervals should be slower, letting muscles adapt to the workout. It is important to avoid muscle damage during maximal sprinting. The warm-up session is very important.

Source: Adapted from Tabata et al. 1996.

PROGRAM 3:

Treadmill Workout

Warm-up: 10 minutes of light jogging.

Work interval: With treadmill incline at 5% grade and speed at 3 miles per hour (mph), switch to high-intensity interval—increasing speed to 5–6.5 mph—without changing grade. Each interval should be 1 minute.

Rest interval: Two minutes of walking at 3 mph. Do not adjust incline.

Work-to-rest ratio: 1:2.

Frequency: 6–8 repetitions of this sequence.

Cool-down: 5–10 minutes of easy jogging.

Comments: This is a hill-running interval session. Incline, running speed, interval length and rest interval can be adjusted.

Source: Adapted from Seiler & Hetleilid 2005.

CHAPTER 8: HIIT and Weightlifting

Everyone wants to work out less and see more gains, right?. Sweat for 20 minutes instead of an hour *and* get in shape faster? Come on. What could be better than that? That's the appeal of high-intensity interval training, or HIIT. Keep your heart rate way up for a short period of time by doing brief, intense bursts of movement and see the same (and sometimes more) improvements in cardiovascular endurance, muscle strength, and many other aspects of physical fitness. It's traditionally an aerobic regimen, though you still see strength gains, but a recent study by the American Council on Exercise applied HIIT to resistance training.

You might know "resistance training" better as weight lifting—the resistance is the added weight. For those who have tried more traditional HIIT, the idea of applying it to deadlifts and squats might seem odd. HIIT exercises involve rapid, successive body movements. Lifting seems slower in comparison.

But the idea isn't actually new. It just usually goes by a different name: high-load training, or simply lifting heavy.

For those unfamiliar with lifting, when deciding on a weight lifting regimen you generally choose between doing more repetitions with lighter weights or fewer reps with heavy weights. HIIT for lifting is basically just doing fewer reps with heavier weights for an overall shorter workout.

Though the idea is not revolutionary, it means that instead of relying on a single study to assess the workout we can look to past studies.

This recent study focused on one outcome: how much more weight could participants lift at the end of the study period than they could at the beginning. Or, in gym-bro terms, how much gains they made (or how many? I'm not fluent). One group did a single set of five reps at their five rep max (or the highest amount of weights they can hold), whereas the other did one set of 10 (then later, two sets of twelve) at a slightly lower weight. The researchers found that lifting heavier weights for fewer sets produced faster gains in general, or at least equivalent. By the end of the study those on the HIIT regimen could lift more weight, and they did it in less time per session.

That's largely consistent with what many studies have found and in line with our current understanding of how humans build muscle. Meta-analyses show that gains in muscle strength are greatest when the weight load is greatest. This intense weight overloads your muscle, which prompts your muscles to add more cells in order to prevent this overload from happening again (your personified muscles think you're failing at something critical, like perhaps pushing off a

bear). You have to keep increasing the weight because you have to keep forcing your muscles into overload, otherwise you'll grow accustomed to however much you're lifting and instead maintain the same muscle mass. This is also why a limb in a cast will shrink—the immobilized muscles think you don't need them anymore, and so your body conserves energy by removing cells that otherwise drain your energy.

This phenomenon is called hypertrophy. The more you strain your muscles the faster and stronger they'll grow. It's why powerlifters (those who do deadlifts, squats, and bench press over the more explosive Olympic lifting moves like the clean and jerk) train with weights approaching their one rep max.

So that's essentially what HIIT for lifting is: it's just lifting heavy for fewer sets and reps. Heavier loads can mean you're more likely to get injured, so making sure you work your way up to the hefty loads and maintaining proper form are crucial. Trying to deadlift 200 pounds without knowing how to do it could easily lead to a back injury.

As for whether you should do it, that depends on your fitness goals. If you want to lift the most weight possible, hypertrophy should be the aim and HIIT is a great way to do it. You'll spend less time at the gym and see at least the same gains. But if you're aiming for endurance, lifting heavier won't necessarily help you. Carrying around a lot of muscle drains your energy quickly, and though aerobic HIIT can help increase your aerobic endurance, lifting HIIT probably won't. But hey—at least there's an HIIT for everyone.

We're big fans of high intensity interval training (HIIT). It strengthens our hearts, builds endurance, and can be done just about anywhere. From running on the treadmill to gliding away on the elliptical, HIIT can be stacked with other forms of cardio for a quick and killer workout. That said, HIIT and strength training might not initially make sense as a pair—and they shouldn't always go hand-in-hand. "Once you're at a certain training level, HIIT is HIIT, and strength is strength. There are different energy systems involved," explains trainer Mark Sayer.

Basically, each type of exercise focuses on different systems in the body. Strength training zeroes in on your muscles, while HIIT largely targets your heart rate. This, of course, doesn't mean that HIIT can't target your muscles and vice versa. This also doesn't mean that these exercise styles can't be merged. But to really target either part, you want to work them alone more often than together. However, if you already do this and find that you're short on time or that your strength workouts are getting lackluster, test the HIIT and strength training waters. Read on to see how you can take your strength session to a higher intensity.

Take shorter rests.

The goal of HIIT is to elevate your heart rate quickly. This is usually done by performing short bursts of high-intensity activity, followed by a brief resting period. You repeat this format throughout your workout, with your heart constantly adjusting to new intensities. Typically, in between weight lifting sets, you'll take a short rest. According to Sayer, the easiest way to work HIIT into your strength routine is "to shorten the rests." This will keep your heart rate from

falling into full-on break mode. While this may prove difficult at first, it'll continually shock your heart rate. It will also test (and therefore improve) your endurance and aerobic capacity.

Add cardio between sets.

If shortening your rests isn't doing it for you, go a step further and turn those rests into cardio sets. "If I'm between structured programs and I want to have a workout that gets both a good sweat in and a pump, I love taking a typical bodybuilding workout and then just adding one minute of jump rope after each set," Sayer explains. Then, depending on the size of the muscles being worked, he'll take a 15- to 30-second rest (when working larger muscles, such as lower body muscles) or no rest at all (when working smaller ones, such as the biceps). During these cardio sets, you can do anything that gets your heart racing. Try jumping jacks, mountain climbers, or burpees.

Use movement patterns.

"[Working] larger and more muscles burns more calories and require[s] more oxygen. So focus on compound movements," Sayer says. "Push-pull is a classic pattern, for example. This way, your pressing muscles rest while the pulling muscles work and vice versa. And your heart is pumping blood the whole time," he explains. Working more muscles in this way will not only build your overall strength but raise your heart rate in a way similar to classic HIIT.

Alternate between simple strength training moves like bicep curls (pull) and an overhead press (push). Other examples could be going from a bench press (push) to a back row (pull). "For your lower and upper body, try 30 seconds of kettlebell swings, 15 seconds rest, and then 30 seconds of push-ups," Sayer says. Keep the pattern going throughout your workout to target more muscles and challenge your heart and lungs. Minimal adjustments with maximum benefits? We'll take it.

Do weighted movements.

If you're strength training, chances are that you're going to use a weight (or several). Rather than perform your typical sitting or standing weighted movements, focus on ones that involve more movement. Kettlebells are ideal, here. Kettlebell swings, in particular, are great for quickly raising your heart rate. Performing a few sets of these targets your muscles and keeps you moving—and therefore, keeps your heart and lungs really working. Other moves, like the clean and press, will have the same high-intensity effect. When sticking to kettlebells (or any other type of weight) you can quickly and easily move between different exercises, avoiding rest for too long. The same idea could be applied to free weights, barbells, and similar equipment. Just make sure that you're performing moves you've done before or that you've taken the time to practice in front of a mirror.

CHAPTER 9: EXERCISE OPTIONS

Have you ever skipped the gym because you think doing a fat-burning workout requires spending an hour on the treadmill doing cardio?

I don't blame you. Who wants to walk or jog nowhere for hours at a time? And for minimal results at that.

Well, I'm here to put an end to your cardio vs. fat-burning vs. time dilemma.

How? By introducing you to the power of a type of training that will have you in and out of the gym in *less than 30 minutes.*

And not only that, but you'll get the fat-burning and muscle-sculpting results you've been looking for.

What Is HIIT?

As you know we have discussed this in every chapter of the book but is always good to be reminded. This type of training is called high-intensity interval training, or HIIT.

HIIT workouts consist of alternating between bursts of high-intensity exercise and low-intensity exercise, usually with a ratio of 20 to 30 seconds of intense exercise followed by 15 to 30 seconds of rest or less-intense exercise.

While at first glance HIIT might not look like anything special, once you learn its benefits and fat-melting powers, you'll want to add it to your workout regimen a couple days a week.

Fat-Burning Benefits of HIIT

More and more studies are pointing to HIIT's fat-melting benefits.

For instance, HIIT workouts have proven in countless studies to be superior to steady-state cardio when it comes to burning fat. In fact, in one study, HIIT exercisers burned 900 percent more fat than their steady-state cardio counterparts .

However, the fat burning doesn't stop there. HIIT workouts actually help your body burn more calories *after* your workouts than steady-state workouts. This is another reason they can be so short yet still effective.

The ramp-up in after-workout fat burning is due to a phenomena called excess post-exercise oxygen consumption, or EPOC.

After you do a hard workout, your body has to work extra hard to return your systems to normal: body temperature, heart rate, blood pressure, and more. That requires extra calories, which is the EPOC effect – for hours post-workout, your body burns up that extra fuel.

Speaking of long-term, HIIT has also been shown to improve glucose tolerance, blood sugar regulation in Type 2 diabetics, and even increase the function of your mitochondria, which are your cell's energy "powerhouses," allowing you to fuel your body more efficiently.

How to Do HIIT (The Right Way)

Often, when people think of HIIT, they think of speeding up their jog to a run a couple times during their workout, or adding in some other exercise with a slightly higher intensity.

Yes, while a little intensity is better than nothing, *true* HIIT workouts are not necessarily a jog in the park.

In reality, HIIT workouts done the right way should be *intense.*

Whether you're doing a HIIT workout of bodyweight exercises like burpees and mountain climbers, or you opt for interval sprints on a bike or treadmill, you shouldn't be able to maintain a conversation while you're doing them.

This means you should be pushing yourself hard during every second of the "intense" or "work" phase of your HIIT workout. Think at least 75 percent of your maximum effort for those 20 to 45 seconds of work.

This way, when your recovery period comes, you're truly using each of these precious seconds to recover.

HIIT Workout Examples

Now that you're ready to really push yourself, let's look at some HIIT workout examples that will blast fat fast.

Don't forget to warm up your muscles with a 5- to 10-minute dynamic warm-up consisting of light stretching, cardio, and dynamic moves like leg swings before getting your HIIT on.

1. 10-Minute Treadmill Blast

Level of difficulty: Beginner (intermediate and advanced options)

Equipment needed: Treadmill

Time: 10 minutes

This 10-minute treadmill HIIT is an excellent option if you're new to interval training. The beginner level of this workout has a work-to-rest ratio that gives your body enough recovery time but still keeps the workout challenging.

Plus, keeping this HIIT at just 10 minutes lets you get used to the feel of "high-intensity" without becoming overwhelmed.

2. Total-Body HIIT Workout for Beginners

Level of difficulty: Beginner

Equipment needed: None

Time: 22 minutes

This total-body HIIT workout combines basic cardio and bodyweight moves you can do anywhere, anytime.

You'll rotate through exercises that target your legs, glutes, core, and upper body that, combined, will help you feel fitter, fast.

3. The Perfect HIIT Yoga Workout

Level of difficulty: Beginner

Equipment needed: Yoga mat

Time: 20 minutes

While yoga and HIIT might seem like two words that don't belong in a sentence together, this workout proves otherwise.

Poses like downward dog and chair pose work to tone your entire body, while intense bursts of cardio moves like burpees and jump squats get you a burst of HIIT. Is jumping not for you? Substitute regular squats and still get an awesome workout.

4. 10-Minute Tone Up Beach Workout

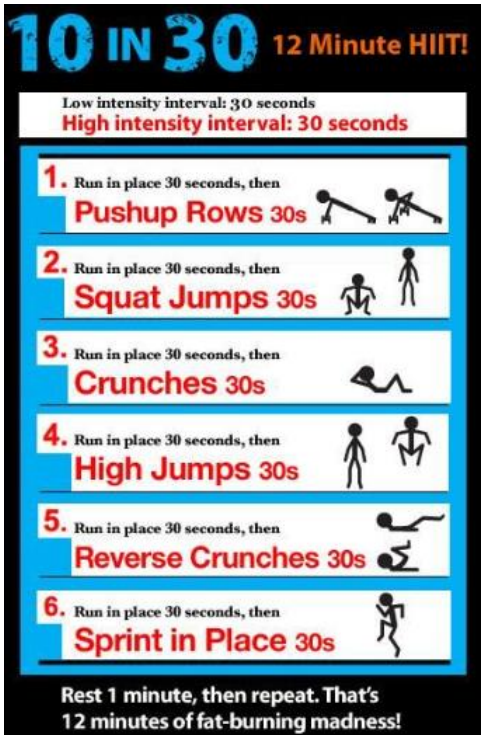
Level of difficulty: Beginner

Equipment needed: Towel or sliders

Time: 10 minutes

While this workout is meant to be done on the beach while getting in your daily dose of vitamin D, it can technically be done anywhere.

Using just a towel and the weight of your body, this 5-exercise workout will give you three rounds of total-body toning in the form of intense intervals.



5. The 12-Minute Leg Workout You Can Do At Home

Level of difficulty: Beginner

Equipment needed: None

Time: 12 minutes

Think you can't get in a HIIT workout doing only squats? Think again.

This workout uses nothing but 3 different variations of squats to quickly tone your legs, lift and strengthen your glutes, and get your heart pumping.

6. Take Five

Level of difficulty: Beginner – Intermediate

Equipment needed: Sliders

Time: 5 to 15 minutes

Technically, you can also take 10, or even 15. That's because this innovative workout lets you choose between a 5-, 10-, or 15-minute version of intense bodyweight exercises like eccentric pushups and lateral lunges that will have you feeling the burn – fast!

Your goal is to keep pushing and see how many minutes you can get in.

7. 7 Moves in 7 Minutes

Level of difficulty: Beginner – Intermediate

Equipment needed: Kettlebell, dumbbells, bench or box

Time: 7 minutes

Short on time, but still want to squeeze in a thorough HIIT workout? This workout drives home the point that 7 minutes is more than enough time to blast fat and build muscle.

Prepare yourself for rigorous intervals using your bodyweight, kettlebells, dumbbells, and the nearest bench.

8. 10-Minute Kettlebell Cardio

Level of difficulty: Beginner – Intermediate

Equipment needed: Kettlebell, dumbbells, bench or box

Time: 10 minutes

Using kettlebells for your HIIT workouts is a great way to quickly get your heart rate up when you're pressed for time.

The aerobic swinging motion combined with the weight of the kettlebell helps to tone your entire body, giving you a full workout in as little as 10 minutes.

9. Upper Body HIIT

Level of difficulty: Intermediate

Equipment needed: Dumbbells

Time: 9 to 15 minutes

Let's face it: sometimes you just want to work on building tank-top arms.

This workout delivers, and then some. Thanks to the power of dumbbells, you'll get your heart rate up while creating a massive burn. In as little as 9 minutes, you'll work your entire upper body, plus rack up a good dose of fat-blasting cardio.

10. Jump Rope and Abs Interval Workout

Level of difficulty: Beginner – Intermediate

Equipment needed: Jump rope

Time: 20 minutes

The jump rope just might be HIIT's best friend. It's portable and quickly ups the intensity of any workout. Here, HIIT cardio in the form of jumping rope will help blast away belly fat, while the addition of planks help strengthen and tone your abdominal muscles.

11. Lower Body Blast

Level of difficulty: Intermediate

Equipment needed: Dumbbells, bench, upright bench, stability ball

Time: 20 to 30 minutes

Looking to build your lower body and booty while also getting in some fat-burning cardio?

This workout uses moderate weights to build strength and get your heart pumping. If you want you can use lighter weights or even just your own bodyweight. The sprint finisher at the end leaves no calorie un-torched.

12. Total-Body Rowing HIIT

Level of difficulty: Intermediate

Equipment needed: Rowing machine

Time: 16 minutes

Sometimes you just need another option for HIIT cardio than the treadmill.

The rowing machine is an excellent choice not only for variety, but also for blasting calories and easily structuring your intervals since you don't have to adjust your speed dial at every interval.

Plus, unlike a lot of machine-based cardio workouts, the rowing machine helps strengthen your upper body.

This workout describes proper rowing form and offers two options: one workout of just rowing and another that incorporates bodyweight exercise intervals.

13. Bosu Ball Circuit

Level of difficulty: Intermediate

Equipment needed: BOSU Balance Trainer

Time: 10 to 15 minutes

HIIT meets core stability training in this BOSU circuit.

The BOSU is a domed half-ball that allows you to target your core and stabilizer muscles. In just 10 to 15 minutes – and with just 3 exercises – you'll get your heart pumping while improving your balance and toning your core.

14. Step-Up Interval Workout – Lower Body Intensive Option

Level of difficulty: Intermediate – Advanced

Equipment needed: Bench or box

Time: 5 to 10 minutes

This workout incinerates fat by using a combination of high-intensity step-up jumps and lower-intensity regular step-ups on a bench or box.

You can stick with just this option, or scroll down to try out the lower-body intensive option that sculpts your legs and glutes with challenging bodyweight exercises.

15. Interval Workout – Upper Body Intensive Option

Level of difficulty: Intermediate – Advanced

Equipment needed: None

Time: 5 to 10 minutes

This workout is on the same page as the step-up interval workout above, but provides a fat-torching upper-body-focused option instead.

Using only your bodyweight, you'll move through a variety of challenging moves that help sculpt a toned chest, back, and arms.

16. 20-Minute TRX Back and Core Workout

Level of difficulty: Intermediate

Equipment needed: TRX straps

Time: 20 minutes

Not only is this TRX HIIT workout only 20 minutes long and a fat-blaster, the 5 exercises also work to improve your posture and core strength by counteracting the negative effects of sitting all day (slouching).

17. "When I Say Jump" HIIT Workout

Level of difficulty: Advanced

Equipment needed: None

Time: 15 minutes

When did jumping up and down go from “this is so much fun” to “there’s a fire in my muscles”?

I’m convinced this workout had something to do with it.

The combination of plyometric moves and bodyweight exercises in this workout will have your heart rate up in a heartbeat, while having you feeling the burn.

18. The Ultimate Fat-Frying Tabata Workout

Level of difficulty: Advanced

Equipment needed: Dumbbells

Time: 30 minutes

Tabata is one of the most intense forms of HIIT, with some experts estimating you can burn up to 14 calories a minute – which obviously depends on how big you are, your sex, and how hard you’re working.

This particular Tabata combines bodyweight with dumbbell exercises in intervals with very little rest, so prepare to chase your breath during this effective workout.

19. Speed Workouts X 3

Level of difficulty: Advanced

Equipment needed: None

Time: Varies

Sprinting is another form of very intense HIIT that rapidly gets your heart rate up to help melt away fat.

In these workouts, you're given three sprint workout options with different variations (one uses stairs) and varying lengths. This one also includes a warm-up.

20. Slay the Spare Tire HIIT Workout

Level of difficulty: Advanced

Equipment needed: None

Time: 30 minutes

This strength-based HIIT will have your fat quickly melting away. You'll go through 6 rounds of moves like push-up rows and skier swings, helping strengthen your entire body and reveal those abs you're working so hard for.

21. One Crazy Workout

Level of difficulty: Advanced

Equipment needed: None

Time: Roughly 15 minutes

This workout takes intensity to the next level with plyometric bodyweight moves (moves that involve jumping) like push-up jacks and power jumps. This type of training is amazingly effective for quickly blasting fat and building total-body strength.

Halfway through this one, you might wonder if you were crazy for trying it. But challenge yourself to keep going, even if you have to swap power jumps for bodyweight squats.

How Often Should You HIIT It?

Keep in mind that HIIT workouts are extremely taxing on the body.

And when it comes to working out this hard, it's important to make sure you're getting adequate rest and recovery.

If you're a beginner, your body may only be able to handle one HIIT workout per week. For everyone else, 2 to 3 times a week on non-consecutive days will be enough to get you results without falling into the trap of overtraining and burnout.

Also, be sure to limit your HIIT workouts to a maximum of 40 minutes, tops.

Chances are if you're reaching this time limit and can still work out, you're probably not pushing hard enough during your work intervals.

Say Goodbye to Fat

As you can see, the options for incorporating HIIT into your weekly routine are truly endless and customizable.

All of these options in less than 30 minutes? Wave goodbye to your fat forever.

How It Works

As you can tell from the name, high-intensity interval training (HIIT) is challenging. It takes your cardio workout to another level, as you push your pace out of your comfort zone.

You can use HIIT with any type of cardio workout, whether it's running, using a stair climbing machine, rowing, or jumping rope.

You'll work up a sweat fast, working at a very intense level and then backing off for a slower recovery period, followed by another round of high intensity.

That strategy can save you time: You don't have to work out as long as you would if you were keeping a steady pace.

You'll lose weight, build muscle, and boost your metabolism. Plus there's a post-workout bonus: Your body will burn calories for about 2 hours after you exercise.

Intensity Level: High

You'll work harder than you do when you do a typical cardio workout. But you'll do it in spurts of 30 seconds to 3 minutes. Then you'll have a chance to recover for about the same amount of time or longer.