PE 9a: Fit or Fat Papers for Critique
Listing of Papers

1. Women, Body Image and Self Esteem

Many women struggle with low self-esteem because of distorted views of their bodies. External pressures to be thin can negatively affect the way a person views herself. Self-esteem, related to body image and body weight is an issue many women faced at some point in their lives. Many women sometimes judge their self worth solely by appearance. Women need to become more comfortable in their own skin, accept themselves "as is", make any changes or improvements that will benefit their health and happiness, and not to worry about other people's perceptions of their appearance. Women should be judged not by their looks, but by the content of their character.

Through external influences, ideals of society, and one's own internal beliefs and attitudes, a person develops and shapes her self-image. Body image can be altered due to changes in mood, environment and physical experiences and is not based on fact, but psychological in nature (Lightstone, 1999). How you view yourself and your body image will determine your self-esteem. Self-esteem refers to how much a person values or accepts themselves for who and what they are (Women's Health Queensland Wide, 2000).

In our society, men's self-esteem seems to be based on their power status (income and profession) and achievements. On the other hand, women's self-esteem seems to be often judged on their appearance. We are bombarded by media images from newspapers, magazines, bumper stickers, billboard ads, television, radio and films that define cultural ideals of beauty and attractiveness. Our society has become obsessed with thinness.

Marilyn Monroe would be considered fat when compared to today's models. 20 years ago the average model weighed 8% less than the average woman. Now, the average model weighs 23% less than the average woman (Kilbourne, 1995). Only 5% of American women have the "ideal" model type body – genetically thin, tall, broad shoulders, small breasts – that the media portrays as the only one acceptable and desirable (Kilbourne, 1995).

At a young age, we are socialized to believe that fat on our bodies is an indication of weakness and we can only control our lives by controlling our bodies (PeltonCooper, 2002). Self-esteem, derived solely by our body image, causes many women to develop negative views of themselves.

Family and friends also influence the development and status of our self-esteem. The roots of a positive sense of self can be found in childhood (Fahey, 1999). If a child felt loved, valued and respected, she will more likely have a better view of herself as an adult. A young girl who was constantly teased and made fun of because of her body weight by classmates, friends or family members, may start to base her self worth on her appearance. Even at a young age, body weight has become an obsession. A study of one teen adolescent magazine, over the course of 20 years, found that all of the articles included statements emphasizing weight loss as a means to improve appearance (Eating Disorders Awareness and Prevention, Inc. 1999). The pressure to succeed and fit in often seems attainable only if you have the right type of body.

The promotion of the "ideal" looking woman has influenced the internal mechanisms a woman uses to define her own self worth and value. Her self-confidence is undermined by the constant ads that seem to tell women that they need to be beautiful to be valued. This reinforces the belief that the way women look is related to their success, finding a partner and happiness. It seems that health is not even a concern.

The 1995 National Health Survey reported that almost 40% of young women aged 15 to 24 estimated that they were heavier than their BMI indicated (Women's Health Queensland Wide, 2000). The study also showed that over 27% of the women who were underweight considered themselves to be in an acceptable weight range (Women's Health Queensland Wide, 2000). In her film Slim Hopes, Kilbourne estimates that 75% of women at their "normal" weight consider themselves overweight. Many women have developed a distorted self-image and corresponding poor self-esteem.

The concern should center on the health, both mental and physical for both young girls and women. The obsession with weight loss has created a $33 billion diet industry (Kilbourne, 1995) that is more concerned with selling products and services than the health and well being of the consumer.

The striving for this impossible physical perfection has created an increase in eating disorders such as anorexia nervosa, bulimia and depression. Kilbourne gives the following statistics in her film Slim Hopes.

80% of 10 year olds are on diets – causing damage to their bones, metabolism, spirit and psyche

1 out of 10 young women has an eating disorder

11.3% of college women have bulimia

The number one wish of the majority of older women is to lose weight

The number one wish of the majority of teenage girls is to lose weight

Of those women who think about weight, 9 out of 10 obsess about it

The obsession with body weight and image, for severely overweight women, can lead to not only lasting physical problems but also psychological health concerns such as depression, anxiety and stress. A study of 156 obese individuals, in a multidisciplinary weight management program, completed by the Cape Psychological Center indicated that an increased perception of poor body image was significantly related to binge eating. Analysis also indicated that body image, particularly characterized by a sense of shame and concern with public appearance, had the strongest correlation to binge eating among all the components examined in the study (Cargill, 1999). In many cases it appears that when an individual significantly loses the control and power over their weight, they lose hope of obtaining the "ideal" body, being accepted by others and sink into a cycle of depression, low self-esteem and binge eating.

Overcoming the obstacles that cause women to have low self-esteem due to their never-ending struggle to reach the ideal cultural body image is an extremely difficult challenge. Self-esteem, self-confidence and self-respect are all related (Maynard). Having a high self-esteem makes for a happier existence: you allow yourself to be your own person and not have external influences define you.

How can we shift the huge emphasis in judging a person's character on their appearance to ensure the health and well being of the person while giving them a chance to let their true individuality prosper and grow? A start would include encouraging the facets of media to present more diverse and real images of people with positive messages about self-esteem and health. This will start to reduce the pressure many people feel to make their bodies conform to one ideal, reduce feelings and emotions of body dissatisfaction and decrease the potential for eating disorders (Eating Disorders Awareness and Prevention, Inc., 1999).

According to the Eating Disorders Awareness and Prevention, Inc., the average young adolescent watches 3 to 4 hours of television a day. Also stated in the same article was a study of 4,294 network commercials revealed that 1 out of every 3.8 commercials send out some kind of "attractiveness message", explaining to viewers what is or is not attractive. The researchers estimate that the average adolescent sees over 5,260 "attractiveness messages" a year. There is ample opportunity for the media to communicate and present to this easily influenced group that individuality is special and there are many types of beauty.

Some media outlets have taken more responsibility in their advertising and promoting that there is more than one ideal body type. Shared stories from celebrities who have dealt with an eating disorder have been beneficial in making people more aware of the increasing problem; examples include the late Princess Diana openly discussing her struggles with bulimia and more recently, actress Tracy Gold speaking of her continued battle with anorexia nervosa.

Parents also need to be careful in giving children mixed messages. Parents and other adults' own obsession with thinness, body and food issues, and constant dieting can send the wrong messages to children. How children perceive and internalize these childhood messages from the adults closest to them, will determine their ability to build self-esteem and confidence in their appearance as they grown older (Maynard, 1998).

We need to search for the underlying causes associated with a person's overeating and unhealthy weight – be it psychological, physiological, and/or behavioral – and find the root of their problems. Through support groups, psychotherapy, yoga, and other methods, individuals can build their self-esteem and learn to like themselves "as is". We need to realize that a healthy weight can be different for each person and everyone can have sound nutritional habits that work within their lifestyle. The health of the individual should be the number one priority, not if they fit the unrealistic and unattainable ideal body.

Recognizing and appreciating all types of body shapes and sizes benefits all of society, not just women. The less emphasis we place on looks and the more emphasis we place on being healthy will help develop more confident people in a stronger and more prosperous nation.

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2. Heredity and Body Weight

There are many factors that play a significant role in determining an individual's body weight. These factors include behavior, environment, genetic makeup, culture and social characteristics and background of the individual. The genetic factor appears to be the most prevalent in setting the groundwork for one's adult body weight. Genetic coding determines a person's body size and shape, body fat distribution and metabolic rate. In this paper, an examination will be made to determine if an individual who is predisposed by heredity to fat will be likely to have body weight problems later in life.

The 1986 adoption study headed by Dr. Albert Stunkard of the University of Pennsylvania and his colleagues, examined the role of heredity in determing body weight. 504 adoptees along with their their biological and adoptive parents were studied. Denmark's adoption records, comprehensive in scope, included data on weight and height not only for the adoptees but also for the biological and adoptive parents.   All of the adoptive children were separated early in their life from their biological parents, and thus gained no influence on eating or exercise habits from them.

The results showed that the weight of the children most closely resembled the weights of their biological mother. The next strongest resemblance was with their biological father. There was no relationship between the weight of the adoptive children and their adoptive parents.

In another study, Dr. Stunkard examined 1974 pairs of identical twins and 2097 pairs of fraternal twins in Sweden. He concluded that the variability in body weight was explained by genetic factors.   This study helped back up his results from the Denmark Adoptive Study.

Along with his research colleagues, Dr. Stunkard also studied 673 pairs of twins of which 93 were raised separately. He concluded that the weights of the twins were the same regardless of them being raised together or apart.

In Canada, Dr. Claude Bouchard studied 12 pairs of identical twins to see if there was a genetic link in their ability to gain weight. For 100 days, the twins were overfed by 100 calories. The results showed a large variability of weight gain between the different sets of twins, but similar weight gain within each pair. Not only did each twin set gain a similar amount of weight, but also distributed the excess weight in the same body areas.

Dr. John Castro monitored the eating habits of both fraternal and identical twins. He found that identical twins significantly had more similarity in their food choices and how they ate. This study provides more evidence that eating habits are influenced by genetic makeup.

It has been shown that if both parents are overweight, there is a two times greater likelihood their children will be overweight, than if only one parent is overweight. The National Centre for Eating Disorders (1999) concluded that 20% of children with neither parent overweight become overweight; 40-60% of children with one parent overweight become overweight; and 80% of children with both parents overweight become overweight. From these statistics, the National Centre for Eating Disorders estimates that genetics can account for up to 70% of an influence on an individual's becoming overweight.

Per Bjorntorp and his colleagues have developed some insights as to why people stop weight loss programs. Their research studied 26 individuals who were trying to lose weight. The researchers measured their fat cell size before weight loss and again when they stopped losing weight. They found that 23 of the 26 individuals stopped not when they had reached their goal weight, but when their fat cells reached normal size. This helps to prove that there is a strong biological pressure to keep fat cells at about their normal size, even if this means a person is technically or culturally overweight.

This leads us to the Set Point Theory. The theory explains that the body tends to maintain a certain weight (experts now believe that there may not be an exact weight, but a broad range of about 10%) by adjusting appetite, hunger and food energy intake with the metabolic rate of the individual. In essence, an individual's conscious efforts to lose weight become fruitless. It has been shown that approximately 90% of those who lose weight will regain that weight or near as much of that weight back (Jade, 1999). Environmental factors seem to affect the set genetic levels of controls, but cannot change them.

Researchers, Price, Reed and Guido from the University of Pennsylvania studied the resemblance of body mass index in 1185 families of obese African American and European American women. They found a parent-offspring and sibling BMI correlation of similar heritability within each family. They also found similar levels of heritability of BMI in families of obese African American and European American women.

Scientists at the Brookhaven National Laboratory in Upton, New York, have studied the possible link between obesity and brain receptors. In brain scans obese people, similar to those of drug addicts, have been shown to have less receptors for dopamine, the neurotransmitter that assists in the production of feelings of satisfaction and pleasure.

In their research, scientists measured the number of dopamine receptors in the brains of 20 people; 10 obese individuals and 10 people deemed at a normal body weight. The researchers found that the subjects with the highest BMI had the fewest number of dopamine receptors. This study lends more evidence to the argument that individual body weight has physiological causes.

Research is also being conducted on the protein leptin, a hormone thought to regulate body weight by signaling the amount of fat stored. Jeffrey Friedman and other researchers at The Rockefeller University have been conducting tests on mice to find out whether leptin stops transmitting signals to halt eating when the mice have a defect in a gene called obese (ob). It was found that a mutation in the obese gene showed an increased body weight in the mice. The mice used for this part of the study had a defect in their obese gene. Mouse 1 received for four and a half weeks, daily injections of the hormone, leptin, and reduced his body weight. Mouse 2, who received no leptin injections, weighed almost two times as much as mouse 1.

It appears that the mouse that received the leptin injections reduced his body weight by decreased eating and increased energy expenditure. The scientists also found that the weight loss was without side effects and was loss of body fat. The mice with a mutant obese gene were not producing their own leptin. The normal mice (obese gene was normal) receiving leptin also lost almost all of their body fat. In these animal studies, of interesting note, researchers have found that dopamine levels increased as do the number of receptors when exercise is done.

Chen et al (Proceedings of National Academy of Sciences, December 1996) and Muzzin et al (Proceedings of National Academy of Sciences, December 1996) have also done studies with leptin and mice with the same results as found by The Rockefeller University researchers.

Research on leptin and humans is starting to boom. The Rockefeller University has currently started a leptin “Replacement Therapy” study on obese women. Additionally, studies are beginning on specialized populations (Pima Indians, Old Order Amish, Mexican Americans) to try to control some of the environmental factors.

Debates to explain humans’ genetic predisposition to fat have been going on for years and will continue until the issue is solved. Finding one specific “fat” gene seems unlikely, but the research studies and theories presented here support heredity as a major influence in determining an individual’s adult body weight.

Genetic studies have shown links with environment to body weight problems and concerns. Most environmental influences on weight gain are “unique” not “common”. Unique being circumstances each person experiences in his own life, as opposed to common factors, which are shared by members of a group (i.e. Living in the same house). Additionally, environmental influences change over time (Jade, 1999).

Individuals can develop and learn to control some aspects of their body weight – watching their food intake, seeing a therapist or joining group therapy to discover underlying causes of weight gain, scheduling regular doctor visits to ensure their body is functioning properly and becoming active and exercising – but you cannot change or control your heredity.

When society is seeing an increase in obesity and weight problems across all ages, ethnic groups and genders, we must teach children with a genetic disposition to fat, good eating and exercising habits when they are young to ensure that they develop sound nutritional habits as they grow older.

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3. Parameters for Success in Endurance Activities

After years of studies and research projects, scientists, analysts, athletes and their coaches have divined a relatively clear idea of what limits the body's capacity for endurance exercise. The two major factors that affect performance in endurance activities hold true for elite athletes and couch potatoes alike, no matter what age or ethnic background. Due to this universality, a firm understanding of the nature and ways to improve each factor behooves anyone willing to follow the principles leading to a higher level of endurance performance. These two factors are the ability of the body to consume oxygen (oxygen consumption) and the availability of fuel for the body to use.

An endurance exercise is any exercise that is done over extended period of time. Examples of endurance exercise, often called cardiovascular exercise, include jogging, swimming, cycling, hiking and various aerobics classes. Endurance in such activities can be defined as the ability of the body to sustain the muscle contractions necessary to continuously do an activity. This requires four major fuel sources; water, carbohydrates, fats, and oxygen. A further parameter to be examined is the efficiency at which the body processes these fuels. The following will address important issues concerning oxygen consumption as well as delve into more specific characteristics of adequate fuel.

FUEL

Water is vital to nearly every biochemical reaction that occurs in the human body, so it should be no surprise that a lack of it can severely inhibit peak performance during activities; specifically those that take place over a greater period of time when fluid is continually lost through sweating. Sweating is necessary to help dissipate heat produced by the metabolic creation of energy and is nearly always an issue when exercise is conducted. Various negative effects have been attributed to a lack of water (dehydration) in the system.

Most notably, since blood consists of approximately 90% water, a lack of water results in a lesser amount of blood circulating, receiving and delivering carbohydrates and oxygen to muscle cells needed to sustain continuous exercise. Dehydration has also been known to unnaturally elevate heart rate and body temperature, the latter being linked to a more rapid accumulation of lactic acid, leading to muscle fatigue. Studies have shown that even at lower intensity output, heart rate can reach near maximal levels (in accordance to age) due to severe dehydration (Robergs & Roberts 1997).

Hydrating (drinking) before and during exercise will help decrease deleterious effects of dehydration. Though there are some conflicting theories concerning what carbohydrate drinks are best to consume during exercise, it is clear that replenishment of water is a vital element of peak performance.

There is no argument surrounding the need for carbohydrates in the process of doing anything with the body, endurance training or otherwise. Though both fats and carbohydrates are used to produce energy during endurance activities, fats are only consumed at a significant rate when the intensity is relatively low; approximately less than 55-65% of the VO2 max (Robergs & Roberts 1997). The percentage and efficiency of metabolizing fat increases with consistent training in that VO2 percentage range. Being that the amount of fat stores in any persons body is relatively limitless compared to carbohydrates, fuel availability is less of a factor when considering exercise in less intense (below 65%) VO2 max. Thus consistent training in this range will improve performance due to the body's ability to use solely fat as a fuel source (often called substrate), leaving carbohydrates for more intense activity.

Since most competitive endurance activities hover at an energy output very close to the lactic acid threshold (when the body starts producing more lactic acid than can be readily removed from the muscles, causing fatigue), carbohydrates invariably become the main substrate, whereas fat use is nearly non-existent. Due to this, its ready availability and replenishment is a crucial factor in endurance performance.

Availability can be improved by understanding the principles of glycogen storage. For many years, athletes have followed the approach of what is commonly called carbohydrate loading, which entails decreasing glycogen (carbohydrate) consumption a week prior to a competition or an event, and then eating copious amounts of carbohydrates the next week while increasing exercise intensity. Physiological factors related to the body's response to store energy for times of scarce food supply allows the body to temporarily increase its maximum level of glycogen storage, thus giving the competitor more fuel in the tank, allowing her to last longer than normal during endurance activity. A less mentally trying yet still effective technique to increase glycogen storage capacity is to eat greater than the average amount of carbohydrates the week before competition (Robergs & Roberts 1997).

Studies have shown that replenishing carbohydrates with sports drinks or some other source of carbohydrates allows the athlete to continue exercise despite exhausting any previous glycogen stores (Coggan & Coyle 1991). What is less clear is exactly what type of drink is best for endurance exercises demanding long-term carbohydrate replacement (Jeukendrup & Jentjens 2000). Scientists are still debating which of the many drinks out there is the best per situation, and in what amounts they should be consumed. Further studies are needed to clarify this discussion. Nonetheless, regardless of what type of sugar (maltodextrin, fructose, sucrose, etc.) is in the drink, all are considered to allow athletes to exercise for greater periods of time without accruable fatigue.

The last fuel component mentioned above is oxygen. Assuming typical conditions of available oxygen, at issue is not availability of the vital element, but rather its proper and efficient use. In lactic threshold, VO2 max, and the economy of motion we find the three parameters that determine how well oxygen is combined with the above fuels to determine endurance exercise proficiency.

OXYGEN CONSUMPTION

It seems that with practice nearly everything becomes easier to the human mind. This holds true for the body as well. Oxygen consumption can be discussed more easily when it is broken down into three distinct components: Cardiac uptake (as influenced by stroke volume), economy of motion (exemplified by proper and efficient technique), and lactate threshold (the intensity of exercise at which lactic acid buildup spikes to a level then creates significant fatigue).

By far the most limiting factor holding back endurance athletes is stroke volume. This factor alone is attributed to 70-85% of the difference between untrained and trained athletes (Bassett & Howley 2000). Stroke volume is the actual amount of blood pumped per heart beat, and more fit individuals who have the same heart rate as others in a given moment will have far greater oxygen fed to their muscles and tissue due to this higher stroke volume. Both ventricles of the heart, particularly the left one, become stronger, more expansive, and more powerful, allowing it to push greater amounts of blood further with one pump. A study of untrained individuals saw their stroke volume intensity level off at approximately 50% of their VO2 max, whereas trained athletes stroke volume did not cease to increase until the very end of VO2 max immediately before lactate threshold (Robergs & Roberts 2000).

Another characteristic of any exercise that can be improved is the efficiency of movement to do a certain task, called exercise economy. After years of proper practice, athletes have learned to eliminate any wasted motion or resistance, thus using less energy (oxygen, carbohydrates, etc.) to produce the same work than someone who is less efficient with their movement. Studies have shown that through endurance training related to biomechanical improvements in the technique of a given activity, exercise economy can be increased (Robergs & Roberts 1997).

Lactate threshold varies in trained and untrained individuals, and this level at which the body begins to fatigue is considered a main factor in endurance perfomance (Wilmore & Costill 1999). As stated before under fuel availability, the average non-conditioned individual starts fatiguing at approximately 60% of their VO2 max. With endurance training, that number improves to 75%, and amongst elite athletes, upwards of 85% has been routinely recorded (McArdle, Katch & Katch 1996). This allows highly trained individuals to maintain a higher level of intensity over an extended period of time.

Looking closer at the reason for improved lactate threshold, one finds physiological adaptations on the cellular level. Mitochondria, (often known as the powerhouses of the cell, and are, in fact, the site where the most efficient ATP energy molecule is synthesized into energy within a muscle cell), increase in size and abundance while its enzyme levels also increase with consistent endurance training. After training, 50-100% improvement is mitochondrial capacity has been found (Holloszy & Coyle 1984).

GENETICS

Despite all of the above information, there are still some things beyond the weather that cannot be controlled by eating and exercising properly. This realm is genetics. There is evidence accumulated by many researches that suggest that 10-30% of limitations in VO2 max can be attributed to genetics (Bouchard et al. 1999). Much of these studies take a close look at slow-twitch vs fast-twitch muscle fibers within muscle groups predominately used by the athletes for their particular sport or activity. For example, studies of elite marathon runners show that some of nearly 90% slow-twitch fibers in their legs (Costill, Fink & Pollock 1976). With the greater capacity to generate energy through the use of oxygen (a characteristic of slow-twitch fibers over the more explosive yet less oxygenated fast-twitch variety), these individuals have a predetermined head start in endurance performance. Other studies support a strong genetic effect on cardiac output, as much as 50% in some cases (McArdle, Katch & Katch 1996).

Though the findings that support genetic influence on performance can be discouraging to those familially less capable than others in the world of endurance activities, there are nonetheless many ways to greatly improve one's performance in such arenas. These include ensuring abundant fuel stored in the body at the outset of activity and further sources to replenish lost carbohydrates and water to continue activity at a high level. Furthermore, through practice over time, an individual can improve cardiac output, lactic acid tolerance, stroke volume and efficiency of motion, eventually reaching a level of proficiency unachievable previously. Genetics notwithstanding, those who understand the fundamentals of the limitations of endurance performance have powerful knowledge that can be used to improve upon one's success in any endurance field.

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4. Interval Training Benefits and Applications

Interval training has long been associated with the standard practices of high-level to elite athletes. Perhaps due to this exclusive, beyond-the-common-person reputation, many never consider incorporating some of its practices and principles into their workouts. Through the work of scientists who have systematically studied the human body's response to a wide length, range and intensity of aerobic and anaerobic activity, it is clear that the general public can benefit greatly from interval training. This can be done by modifying protocols to address individuals of varying levels of cardiovascular fitness, building up to a level that will grant the substantial benefits that interval training has been known to offer for years; ie., increased aerobic capacity, greater anaerobic threshold, higher metabolism, and natural production of the Human Growth Hormone (GH). Following is a general definition of interval training, description of the benefit of interval training and some possible guidelines for interval training with individuals of various fitness levels.

Standard interval training involves a cycling of an individual's exercise intensity from the aerobic (with oxygen) to the anaerobic (without oxygen) level, resulting in a greater demand for oxygen than can be provided to prevent the accumulation of lactic acid, and ultimately fatigue, in the muscles. An example of this would be jogging for two minutes, sprinting for fifteen seconds and returning to jogging for another two minutes, when the sprinting would begin again. Each jump in intensity level is mirrored by a drop after a certain period of time. During the up phase, many more calories are burned, the heart pumps at a higher rate, the act of speaking becomes arduous, and muscles fatigue. A similar routine can be developed within other sports as well. Classic weight training (8-12 reps, two to three minute rest between sets, multiple sets) is also another example of this type of training. More mundane examples would include encountering a neighborhood hill on your bicycle while going for a ride, sprinting for a bus that you see stopping two blocks down the road, or chasing after one's children when they are in danger of hurting themselves at the park.

Of the four benefits of interval training cited above, improved aerobic capacity linked with an extended anaerobic threshold are the two most important reasons why athletes looking for performance improvement use such rigorous protocols in their workouts. After developing a tolerance for lactic acid buildup, improving its removal, and producing less of it at higher levels of exertion, athletes have been recorded at 110% of their estimated VO2 max, the maximum potential cardiovascular exertion. Not only has it been shown that interval training helps athletes maintain higher levels of aerobic activity for longer periods of time, but once passing through the point when they are no longer using solely oxygen to produce all their energy, anaerobic activity has also been extended in time due to lactic buildup intolerance. To simplify, the heart, lungs and remaining cardiovascular system becomes, through anaerobic interval training, more efficient in feeding the body oxygen while eliminating waste buildup that would otherwise impede performance.

The other two benefits, GH production and higher metabolism, are of more value to those individuals seeking to improve their body composition, become more energized, and to retard, and in some cases reverse, the effects of aging. Metabolism is the measurement of the amount of energy the body needs to repair and maintain body processes. If the rate of metabolism outstrips the caloric intake (food, caloric beverages, etc.), the body starts to use body stores of fat to fuel its needs. Interval training not only increases caloric consumption, but the anaerobic phase actually does minor damage, in the form of micro-tears, to skeletal muscle. This damage requires protein, nutrients, and even more energy to fix. Thus, after incorporating anaerobic cycles in one's workout, the metabolism of that person will be greater. Given the same caloric (and hopefully balanced and nutritional) intake, the body will begin to develop more lean body mass while using some of its fat stores to build that muscle. Furthermore, with more lean body mass, there exists more active tissue (as opposed to fat) to maintain and repair, increasing yet again the needs of the body for energy.

The increased production of the human growth hormone is the fourth and perhaps most powerful benefit of interval training. On July 5, 1990, the New England Journal of Medicine published a clinical study by Dr. Daniel Rudman, on a drug that had a large impact on future studies in the medical field. The human growth hormone, a substance produced naturally by the pituitary gland, was hailed as a fountain of youth. Injections of synthetic human growth hormone had turned 12 men, ages 61 to 81into sleeker, stronger, younger selves. After just six months of treatment, the men gained significant lean body mass, and lost an average of 14.4 percent in fat mass. In addition, their skin thickened, the bone density of their lumbar spines increased, and both their livers and spleens grew substantially. In language rarely used in conservative medical journals Rudman and his colleagues at the Medical College of Wisconsin wrote, "The effects of six months of human growth hormone on lean body mass and adipose tissue mass were equivalent in magnitude to the changes incurred during 10 to 20 years of aging." Since 1990, many studies have linked anaerobic, weight and interval training to a stimulation of the endocrine system, including natural production of GH from the pituitary gland.

Other studies followed within exercise physiology departments at universities across the country. Soon it was discovered that the body could only naturally produce GH after more intense training while normal or moderately aerobic activity showed no positive effect in its production. Furthermore, amongst other characteristics of the ailment, individuals with the physically debilitating fibromyalgia were unable to produce GH in the same amounts as their completely healthy counterparts after similar intense exercise. Amongst athletes trained for endurance events compared to those trained in sprinting events, the latter have been found to produce more GH after 30 second treadmill sprints, indicating the body can improve its ability to produce human growth hormone through repeated and consistent sprint (anaerobic) training.

Further studies have continued to refine the optimal conditions needed for GH to be produced. It was discovered that a minimum of 10 minutes of interval type anaerobic training resulted in the greatest output of GH. When cycling, GH production was greater in relation to faster cadences (pedal revolution speed) than slower ones. There have been studies that draw links between certain amounts and timing of key nutrients with GH production. Due to its unique, healthful qualities and the body's capacity to produce it naturally and consistently up until middle age, GH will no doubt continue to be subject to increasing analysis and scrutiny.

With all these positive effects occurring from this type of training, it is necessary to come up with some models helping everyone from the most to least fit to take part. With this goal in mind, it is important to study the guidelines for a typical interval training session and pare percentages of maximum heart rate and duration of the anaerobic phase while increasing the rest phase. A necessary tool for such workouts would be a heart rate monitor, as taking one's pulse during high-intensity exercise is impractical. Its immediate accuracy allows close monitoring of rapid increases and decreases of heart rate that can be used to ensure progress and/or maintenance of fitness levels over a period of time.

Classic interval training for the performance athlete or superbly fit individual are done only by persons who have already reached a level where their maximum steady (aerobic) rate is close to 85 percent of their VO2 max. After a warm up period that can last from 5 minutes to something comparable to a full aerobic workout of 45 minutes, an interval will start. An elite athlete will train at a 1:2 ratio, meaning recovery will be 2 times longer than the effort phase. While effort lasts for 30-90 seconds, the intensity is very high, above 90% VO2 max. The Rate of Perceived Exertion (RPE) can also be used to measure effort. In this scale, with 1 being no effort while 10 being the pinnacle of exertion, it is possible to estimate intensity by measuring how one feels during intervals. During the up phase, the RPE may be between 8-10, while the down phase will hover close to 2-3 RPE. The duration of effort can vary as long as the ratio and % of VO2 max or RPE is observed. A slight step down yet still within the very high fitness range, the next lower level of interval training consists of a ratio of 1:3 effort to recovery; the effort phase followed for 30-90 seconds at approximately 85-90 percent of the VO2 max (RPE 5-8). The number of intervals can vary due to time and fitness goals. Usually 3-6 intervals are done.

A more typical person will have a toned-down version of the above process. The ratio will again be 1:3, but the actual intensity depends greatly upon at which point the individual attains her anaerobic threshold (AT). Once this is determined, the goal would be to go slightly beyond this level of intensity, usually to at least a 7 RPE. For example, person Z has been tested and shown to reach her AT at approximately 75% of her VO2 max. To ensure that she gets the benefits of interval training, she must push herself beyond that 75%, but not so far as to put her in jeopardy of acutely over-training, over-taxing the cardiovascular system, leading to vomiting, light-headedness, and black outs. This is important with everyone, athletes included, yet the problem more readily occurs as one walks down the fitness level scale. Less fit individuals have a greater risk of over-training than persons of greater fitness levels.

For individuals who are complete novices to physical fitness and have had little or no experience with an elevated heart rate because of a sedentary lifestyle, a more modest interval training model is necessary. The golden ratio of 1:3 is still upheld, but the training and intensity is mostly put in the hands of the person involved. RPE becomes and invaluable tool in such situations, and deference is paid to the feelings of the one doing the work. These individuals can slowly build up to the point where more vigorous intensity is within their reach. Soon, with proper training, this individual will be looking to reach beyond a 7 RPE, purchase a heart rate monitor, determine his own AT, and then refine the interval portion of his workout to maximize this time and effort.

Though interval training is an integral part in many athletes' lives, it is becoming common for more typical gym members to utilize its protocols. This is for good reason, as the four major benefits of interval training lead to a healthier, more fit and energized life. With greater GH circulating in the veins using stored fat to help repair micro-tears in the muscle, increased aerobic capacity, improved tolerance of lactic acid build-up, and a higher metabolism, persons are duly rewarded for their intensity and effort. It is crucial to follow guidelines when conducting such workouts, and determining one's AT is an important step in creating an appropriate interval training plan per fitness level.

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