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Lactic Acid: Friend or Foe?

Dan Vannatta

In the arena of exercise, reference to lactic acid has commonly evoked the most negative of responses. For years, lactic acid has been considered an exercise evil whose presence was believed to induce muscle soreness, fatigue, oxygen debt, and anaerobic threshold. No longer can such an all-encompassing and destructive label be placed on this metabolite. While lactic acid may play a role in fatigue (3, 6), its supposed role in muscle soreness has been disproved (9), and it is now being recognized as more of a positive player in metabolism. George A. Brooks has described lactic acid as Ra key substance used to provide energy, dispose of dietary carbohydrate, produce blood glucose and liver glycogen, and promote survival in stressful situationsS (3). This paper briefly describes the metabolic functions of lactic acid and relates the functions to recovery from exercise.

Muscle glycogen is one of the main energy sources for exercise. In order to be utilized, stored muscle glycogen must be broken down into glucose, a process known as glycolysis. During glycolysis, each glucose molecule is cleaved into two pyruvic acid molecules, and energy is released to form adenosine triphosphate (ATP). Normally, the pyruvic acid enters the mitochondria (the principal cell sites where energy is generated) and undergoes the oxidative stage of glycolysis to produce yet more ATP. However, when there is not enough oxygen present for this reaction to take place, the pyruvic acid transforms into lactic acid. From this point, lactic acid can diffuse out of the muscle cell into the blood. It is by this process (known as anaerobic glycolysis) that muscle glycogen can be converted into energy without the presence of oxygen as opposed to ATP production via aerobic glycolysis (6). Such a conversion allows glycolysis to proceed for minutes, when it could otherwise last only seconds (6). Thus, energy is supplied to promote survival in stressful times.

Once sufficient oxygen is restored, the lactic acid produced via anaerobic glycolysis can be utilized for energy or reconverted into glucose by the liver and other tissues (a process known as oxidation). This brings us full circle, and the rest of the metabolic functions as quoted earlier from Brooks have been met. This process also applies to the world of exercise.

In exercise, human bodies use energy for the purpose of muscle contraction. To accomplish this, both aerobic and anaerobic energy-producing systems need to function. Regardless of the system, lactic acid is continuously being formed and removed, even at rest (2). Studies show that during aerobic glycolysis lactate production seems to increase in proportion to our metabolic rate (2, 5). At some point, depending on exercise duration and intensity, a workload will be reached in which lactate concentration is greatly magnified. This is known as the lactate threshold and can usually be elicited between 50-80 percent of a personUs maximal oxygen consumption, VO2max (10). It is at this point in which the rate of lactic acid appearance becomes greater than the rate of disappearance (1, 10). This manifestation will often occur in anaerobic activities such as the 400 meter dash, 100 meter swim, tennis, or soccer (6, 7). What is the significance of this fact?

When lactic acid accumulates in the cell following anaerobic glycolysis, there is potential for problems. It is necessary to maintain the proper degree of acidity in the cell because when acidity increases important contractile and metabolic functions are hindered. In the case that acidity is not regulated, the accumulation of lactic acid may be a factor in fatigue.

Coaches, teachers, and athletes can address both training regimen (including warm down) and diet to successfully combat excessive lactate formation, glycogen depletion, and the consequent fatigue that may result. According to Brooks, "a major goal of training should be to minimize lactic acid production and to enhance lactic acid removal during competition"(5). He suggests a combination of high intensity interval training and prolonged submaximal training. Interval training will help to maximize cardiovascular adaptation and increase VO2max. The more oxygen consumed, the less reliance on the anaerobic breakdown of carbohydrate to lactic acid. Prolonged submaximal training can help to induce muscular adaptations such as increases in
capillary and mitochondrial functional capacity. These adaptations will help to reduce lactic acid formation by

increased utilization of fatty acids as a mitochondrial fuel source and will facilitate lactic acid removal (5).

Many athletes incorporate a warm down period into their training for the purpose of decreasing blood lactate concentration. In recent times, questions have emerged regarding the benefits of active versus passive recovery. Here, active recovery implies light exercise while passive refers to rest. In a study by Choi et al. (4), this question was addressed. They found that blood lactate levels decreased more rapidly during active recovery than during rest. However, the difference was not found to be very significant. Attention thus focuses on glycogen depletion.

Although active recovery decreased lactic acid levels faster, it may also further deplete the glycogen stores that need replenishment. Therefore, a combination has been suggested whereby active and passive recovery are utilized together to decrease lactic acid levels while promoting maximal glycogen resynthesis (4). In other words, the athlete should warm down until normal rates of breathing return and then rest. At this time, a high carbohydrate meal should be consumed to help replace the glycogen stores, which have been depleted through exercise.

In summary, lactic acid is not a useless metabolic by-product. It can serve as a very important and useful energy source. However, if the lactate threshold is reached during exercise, excessive lactic acid can accumulate, causing fatigue. Fortunately, this negative effect can be partially offset by proper training, warm down, and a high carbohydrate diet.

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Weighty Matters

The Proper Use of Belts During Weight Training

Dave Bercades

The practice of wearing weightlifting belts used to be limited to Olympic weightlifting and powerlifting. In recent years, however, even recreational lifters of varying degrees of skill and experience are wearing belts. Is such a device necessary for recreational lifting? If so, what are the proper ways to use a belt? What are improper ways to use a belt? What ill effects can result from its misuse?

The design of weightlifting belts varies. Standard weightlifting belts start at one-quarter to one-half inches wide becoming four-to-six inches wide at the widest part, which may extend from the back to the sides of the trunk (3, 5). Powerlifting belts are four inches wide all the way around. Traditionally, belts were made of one or more layers of leather, but synthetic materials are being used as well. No matter what the construction, belts serve the same purpose.

A weightlifting belt has two main purposes. It reduces stress on the lower back while the person is lifting in an upright position and prevents back hyperextension during overhead lifts (2). A belt reduces low back stress by compressing the contents of the abdominal cavity (3, 5). This increases the intra-abdominal pressure (IAP), providing more support in front of the bones of the lower back. This allows the spinal erector muscles, which would normally provide this
support of the lower back, to produce less force during the lift (2). Another benefit of increased IAP is a reduction in the amount of spinal shrinkage (lower back compression) a lifter may experience during circuit weight training (1). Some belts have a wide back and a narrow front. Therefore, it would be advisable to wear the belt backwards if increased IAP is desired, as the area gives the contents of the abdominal cavity more surface area to push against.

The belt prevents back hyperextension by forming a rigid wall around the lower torso, connecting the rib cage to the hip (2, 6). This not only limits back movement, but it also prevents sideward bending and twisting. A powerlifting-style belt that is the same width all the way around would be ideal for this purpose. Otherwise, a conventional belt can be worn in the usual manner with the wide part of the belt in the back.

Wearing a belt also causes the lifter to be more aware of the position of his or her back (7). This is because the physical sensation of a belt against the skin provides additional information prompting the lifter to consider his or her back position and what muscles must be activated to maintain good posture. In this case, the belt does not need to be worn too tightly for an effect. Some lifters report feeling more secure and confident while wearing a belt even if IAP and muscle activity are unaffected (6).

However, a belt must be worn tightly to maximize its usefulness. This is physically taxing and should not be done for long periods of time. Research has shown that wearing a tight belt during exercise can elevate blood pressure (4). For this reason, belts should only be used on two primary occasions. The first is when performing maximal or submaximal lifts in exercises such as the squat or deadlift, in which the weight is supported by the lifterUs back. The second is while performing exercises, such as the military press, which may cause the back to hyperextend (2, 7). The belt should be loosened to allow blood pressure to return to normal levels in between sets.

Belts are especially important when performing multiple submaximal lifts to failure (i.e., the point at which the lifter cannot perform another repetition) (5). During the latter part of the set, the muscles supporting the lower back may experience fatigue and may not be able to perform their task. Thus, the belt could provide an extra form of protection in case these muscles fail.

Weightlifting belts are not necessary for other types of weight training exercises in which the spinal erectors do not work against heavy resistance. For example, the use of a belt will not affect performance on exercises such as the lateral pull down and leg extension (2). Belts also have little or no effect on performance weight loads that are fairly light (6). However, elevated blood pressure that results from using a belt can increase over time, even when fairly light work or aerobic activity is performed (4). Lifters with heart disease and blood pressure problems should exercise caution when wearing a tight belt for long periods of time.

Constantly wearing a belt can also cause decreased strength development in abdominal muscles (5). Electromyographic research has found that there are lower levels of muscle activity in abdominal muscles when a belt is worn while lifting. The muscles that would normally keep the abdomen stabilized are inhibited when a belt is used, which could result in weaker abdominal muscles in the long run.

Strong abdominal muscles are important in maintaining trunk stability in the absence of a support belt. Studies have shown that substantial IAP can be achieved by simply holding oneUs breath while lifting (6, 7). It is also important not to be too dependent on belts while training as they may not be admissible during competition (2).

Weightlifting belts can help support the back by increasing intra-abdominal pressure and preventing back hyperextension. They are most effective when used for maximal or submaximal lifts in which the spinal erector muscles work against heavy resistance. However, many ill effects, such as high blood pressure and abdominal muscle weakness, may result from improper use of weightlifting belts. They should be used sparingly in training.

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Effects of Resistance Training for the Elderly

Ellen Huppert

Research has demonstrated that above age forty a decrease in muscle mass and strength often occurs with increasing age. It is also believed that this decrease contributes to the loss of mobility, gait disorders, postural problems, falls, and hip fractures found in the elderly population. Thus, increasing the muscle mass and strength of elderly people may allow for enhanced independence and lessen the risk of injury. One method to offset this aging process is resistance training, which has been shown to increase muscle strength and mass (1). However, before starting a training program for the healthy elderly adult, both the effectiveness of resistance training and the issue of safety have to be addressed.

As aging occurs, muscle mass decreases resulting in the need for recruitment of more skeletal muscles to produce a given amount of power. However, recruiting more muscles to produce needed power causes earlier onset of fatigue in the elderly. This muscle fatigue can result in mobility, postural, and gait deficiencies. On the other hand, increasing the amount of muscle mass in an elderly person can help decrease the amount of fatigue he or she experiences with muscle activity. Lack of muscle loading, because of decreased activity levels, may be a contributing factor to the large decrease of muscle mass in this age group. The loss of strength (muscle mass, muscle fibers, motor units, and motor neurons) starts between age fifty and sixty. Nearly half of the original muscle mass and strength are lost by age eighty. Researchers believe that muscle loss, as opposed to decreased aerobic capacity (VO2max), may be the major factor in the loss of mobility in the elderly. There is evidence, however, that individuals between ages sixty and ninety can maintain or even increase their muscle mass with resistance training (2).

Other research has also found that resistance training in the elderly population may lead to significant increases in muscle strength and structure. For example, a one-year study found increases in muscle strength and hypertrophy (enlargement) of muscle fibers in subjects, following a resistance training program. The most rapid response to training was seen in the first eight weeks of the program, leveling off with only small gains in strength for the remainder of the study. Strength gains of 30 percent (hip extension) to 95 percent (hip flexion) were found after completion of eight weeks of training. This level was maintained with continued resistance training through the one-year period (3).

Before beginning a resistance program it is important to look at nutritional factors that may affect a participantUs training results. As individuals age, they experience a decrease in necessary energy requirements. An energy requirements study showed that resistance training significantly increased the energy needed in older men and women. The subjects needed approximately 15 percent more calories to maintain their body weights during the resistance training as compared to no training. Another issue is the decrease in resting metabolic rate (RMR) that normally occurs with age, which can lead to an increase in body fat. By increasing muscle mass through resistance training, it is believed the RMR may concomitantly be increased.

Another reason for proper nutrition is that damage to muscle tissue may occur with resistance training. Muscle repair requires increased protein synthesis. As the muscle strengthens, it increases in sizeQhence more muscle protein is needed. Attention should be given to proper nutrition because it is important to maintain healthy body weight (4).

Resistance training programs are only as effective as the participants adherence to the program and its safety level. A study by Pollock et al. (1991) found that the elderly population acquired relatively few injuries when adhering to a strength training program. Typical resistance training programs are designed using a percentage of the subjectUs maximum weight that he or she could lift one time for a specific exercise. This maximum weight level is called the 1-RM, or one repetition maximum. In determining a 1-RM, researchers found that subjects with prior orthopedic problems were more likely to suffer from reinjury. Therefore, the 1-RM strength test may be inappropriate for older individuals that have had previous joint problems. In general, carefully observed resistance training does not lead to injury. For example, higher rates of injury were found in subjects participating in a walking and jogging program than in those partaking in a resistance program. Injuries in the walking and jogging program were observed in the lower extremities because of an increase in intensity and impact that comes with jogging. While older men and women can significantly increase strength and aerobic capacity with training, precautions should be taken to avoid injury.

Prior to beginning any exercise program, it is imperative to have a physician's approval. Also, finding a trainer experienced with the elderly population, who can design and monitor a safe resistance program, is advised. Adherence to a resistance training program with adequate nutritional intake can lead to increased muscular strength and structure in the healthy, elderly population without the occurrence of significant injury. Increase in muscular strength may also have an impact on gait and postural stability, decreasing the chance of falling and hip fractures, and increasing quality of life in the elderly population (2).

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Why We Don't Follow Doctor's Orders:

The Crisis of Nonadherence

Karen Schoeller

Introduction

If one has ever attempted to keep a New Year's resolution, remain faithful to a diet, quit smoking, or eat less chocolate, and failed with the commitments, one has firsthand experience with a major medical problem -- adherence. At first glance, a person cheating on his or her diet or forgetting to take a vitamin pill every now and then does not create an earth-shattering problem. However, consider a child with diabetes who fails to monitor his or her glucose levels, the middle-aged adult who quits an exercise and diet program after a diagnosis of coronary heart disease, and our society's widespread noncompliance to lifestyle interventions for the prevention of AIDS.

When considering nonadherence in this context, it can be a matter of life and death. As Meichenbaum and Turk observe, "The efficacy of all of our efforts with our patients is predicated on the assumption that they follow our proscriptions and prescriptions. Lack of adherence is likely to be a major cause of therapeutic failure; and therefore, it interferes with our ability to determine the effectiveness of our treatment" (13).

Consider the clinical researcher. An inadequate appreciation for the importance of compliance can easily lead to gross misinterpretations of research results by which the effectiveness of various treatments are compared and contrasted (12). This means that some medications and regimens prescribed by doctors went through testing trials in which subjects may not have adhered to trial criteria. Therefore, the results may not be valid.

Another factor of nonadherence that directly touches people's lives, is the rising cost of our health care system. Repeated outpatient visits, unnecessary hospitalizations to investigate unsuccessful treatment efforts, and the failure of prophylactic programs to prevent unwanted illness (e.g., strokes secondary to long standing uncontrolled high blood pressure) all contribute to increased health care expenditures (12).

As the above examples show, the extent of the problem is varied, widespread, and well studied. Currently, researchers can predict through screening which patients are at high risk for nonadherence. Excellent data explores how biological, sociological, economical, and psychological factors affect adherence. The issue of how to improve adherence has also received attention in the literature. In practice, however, little more than lip service is paid to improving patient adherence. This will have to change as society struggles with the hard choices it is increasingly forced to make about the health care system and its attendant rising costs.

The Incidence of Nonadherence

At a time when much of our collective, national attention focuses on the issue of health care, how much it costs, and who should pay for it, 30 to 60 percent of patients do not adhere to their doctors' advice (Masek, 1983 [13]). The United States spends more on health care than ever before. Americans buy over-the-counter medications, try strange and exotic diets, and eat zillions of vitamins and millions of oat bran muffins. People enroll in exercise programs and buy high-tech shoes and flashy warm-ups that many will only wear to the grocery store, as 50 percent drop out within the first year (6).

Consider this astonishing overview of nonadherence reported by Meichenbaum and Turk: "The nonadherence rate for life-term medication regimens and lifestyle changes is 50 percent. Of all patients, 30 to 40 percent fail to follow preventive regimens and 20 to 30 percent fail to follow curative medication regimes. Of adolescent cancer patients, 40 to 60 percent fail to take prescribed medication as directed. Among diabetic patients, 80 percent administered insulin in an unacceptable manner, 73 percent did not follow their diets, 50 percent exhibited poor foot care, and 45 percent did not test urine correctly. Only 7 percent of diabetic patients adhere to all steps considered necessary for good control. In renal dialysis treatment only 50 percent of patients adhere to the complex treatment regimen. The attrition for general medical treatments can be as high as 80 percent and the drop-out rate from self-help and commercial groups is in the range of 50 to 80 percent. Forty-nine percent of postmyocardial infarction patients drop out of the exercise programs within the first year. Among individuals who begin an exercise program, 30 to 70 percent drop out with the majority of drop outs and relapses occurring within the initial three months, followed by continued deterioration and eventual leveling off between 50 to 70 percent after twelve to twenty-four months."(13)

These numbers are staggering. When considered together with the seriousness of many of these conditions, it appears that society is facing a crisis of passive forms of suicide. These statistics fly in the face of common sense assumption that if people fall ill, they will do everything in their power to become well again.

Factors Affecting Adherence

In an attempt to understand the startling data listed above, researchers have conducted sophisticated scavenger hunts looking for precise constellation of factors that will reliably identify the nonadherent patient. In his comprehensive review of determinants of patients compliance with therapeutic regimens, Haynes (10) identified more than 200 variables that have been examined in relation to adherence. These variables can be generally categorized as: (a) characteristics of the patient, (b) characteristics of the treatment regimen, (c) features of the disease, (d) the relationship between the health care provider and the patient, and (e) the clinical setting (13). This research has challenged many commonly held assumptions. Seventy-six percent of physicians surveyed attributed nonadherence to patients characteristics, and a substantial proportion of physicians reported little sympathy with their patients' adherence difficulties, viewing the nonadherent behavior most often as the result of an attitude problem on the part of the patient (13). While people may hope that their personal physicians are more sympathetic than the ones cited above, such an attitude is easy to understand, after all, most people believe that they are responsible for their own behavior.

So, who are these patients with bad attitudes, and how did they get this way? Studies in which various demographic factors have been examined suggest that age, sex, education, social class, religion, and marital status are not significantly related to compliance (2). Preliminary research in the Ontario Exercise Heart Collaborative Study indicated that patients who exhibited four clinical variables (i.e., smoking, blue-collar work, inactive leisure time, and low energy expenditure during work) had a drop-out rate of 95 percent within the twenty-three months of entering the study. When the first three variables were present, 80 percent dropped out (14).

When looking at psychosocial and biological factors related to adherence to exercise programs, Dishman (6) found that the percentage of body fat, self motivation, and body weight were most related to exercise adherence. Combined within a psychobiologic model, these components accounted for nearly 50 percent of the variance in adherence behavior.

Just as interesting are the factors that he found not related to adherence in an exercise program, such as attraction to physical activity, a perceived health locus of control, and placing high value on physical activity. Most people believe that if they really like something, have control over it, and value it that they will stick with it. Dishman's research suggested this may not always be the case.
However another study by Martin supports the idea that beliefs do shape behavior. He states: "Studies on exercise performance and adherence suggest that a person's thoughts during exercise as well as their exercise goal-setting behavior have an important influence on their maintenance of the exercise habit. For example, individuals who believed their own preferences were incorporated into their exercise prescription were more likely to have higher adherence levels. Those who were encouraged to set flexible exercise goals daily and weekly, as opposed to having rigid goals set for them by trainers, also showed significantly higher exercise adherence levels. Exercisers who set time-based goals (e.g., jog for fifteen minutes) had superior adherence when compared to those who set distance-based goals (e.g., jog 1.25 miles). In perhaps the most intriguing of our findings on cognitive control of exercise adherence, we discovered that exercisers who were taught to use distracting thoughts (smell the roses, think about anything but the exercise) showed significantly better exercise adherence.(11)

Martin suggests that exercise adherence is a behavior, and behaviors can be trained or modified. It has long been recognized in the field of addiction recovery that replacing negative additions, such as cigarette smoking, with positive addictions can be one way to increase adherence. But what about the factors that are outside the person, the ones we don't have as much control over?

The factors that appear to be most significant involve interpersonal relationships. In study after study, what remained the most consistent and possibly most important factor or motivator for positive adherence is the attitude and support of significant others. In a study pertaining to exercise compliance, it was found that "a lack of individualized attention by the exercise program staff result in a drop out rate approximately twice that of those who perceive a high level of attention" (2). This same study found that of all individual questions asked, those pertaining to spousal approval were most significant; the drop out rate of those with little or no spousal support being three times that of those with positive family encouragement.

In his efforts to enhance patient exercise compliance, Martin (11) discovered this constellation of factors: "The highest risk candidates for drop out are blue collar workers who smoke, are overweight, unmotivated, and who have little or no support for their exercising from significant others in the home or work environments." Therefore, the attitudes of parents, spouses, coworkers, bosses, and friends can have an enormous impact on whether people stick with medical or exercise programs.

Just as important is the relationship with a health care provider or the staff of an exercise program. "Unlike the demographic variables considered earlier, the patient-provider interaction system is not an immutable given and as such might well represent the most reasonable and promising intervention point in attempts to improve compliance. The emotional tone or impact of the interaction may dramatically influence the patient's willingness to adhere to treatment proposed" (12).

While many studies have searched for the noncompliant personality type patient and failed to find one, researchers should have been looking for the health care provider who creates the noncompliant patient. This health care provider fits a very distinct profile. He or she tends to view patients as diseases rather than people and do not believe patients know very much, certainly not as much as he or she does. She or he believes that his or her time is more valuable than everyone else's. He or she speaks in medical jargon, takes no personal interest in patients, fails to hear patient concerns, allows frequent interruptions of an interview, and dismisses patients when he or she is finished with them.

Although much has been learned about ways in which to improve the health care provider-patient relationship and to facilitate treatment adherence, little change has been dividend in how most health care interactions occur. Few medical schools or residency programs pay much heed to the importance of communication. This is unfortunate because the evidence indicates that physicians could benefit from training in adherence enhancement procedures and in particular in communication skills. (13)

Exercise and the Prevention of Disease

Cardiovascular diseases and cancer have replaced infectious diseases as the leading causes of morbidity and mortality in developed nations. Whereas, previously the leading cause of death could be avoided by brief screening of vaccination procedures, preventing cardiovascular disease or cancer requires a complicated and sustained struggle to alter diet, exercise, and other habits (9).

Given what research has revealed about adherence, the development of interventions to support long-term behavior change is imperative if individuals and this nation are to achieve stated goals of prevention. If people view adherence as a behavior or habit, then they have a powerful tool at their disposal as they seek to modify their lifestyles toward healthy changes in diets and exercise, placing regular exercise at the top of the personal priority list.

Evidence suggests that regular physical activity may reduce the incidence and severity of chronic disease and perhaps extend the life span by a few years. Regular physical activity also contributes positively to mental health and to self-assessed health. Exercise has been shown to increase worker satisfaction and productivity, decrease absenteeism and personnel turnover, and in some situations shown a decrease of industrial injuries. In addition to an improvement of overall lifestyle, potential societal benefits of greater personal physical fitness may include a reduction in demands for acute and chronic medical services, lower indirect costs of illness, and less costly physical dependence during the retirement years. (5)

Conclusion

An ounce of prevention is worth a pound of cure. Very few would argue with this bit of wisdom; yet by people's behaviors, they do indeed argue. Every day that goes by and adults do not begin an exercise program or miss one that was begun, individuals argue. Every time physical education programs are cut from schools, people argue. Tragically, these are the very programs that develop lifelong habits in children for adherence to exercise, which is a powerful ounce of prevention. Prevention is not free, but adherence to medical regimens can be a bargain, compared with the expense of pain, suffering, and a cure--if there is one.

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Protein supplements: sound idea or snake oil sales

Carolyn Petersen

If the advertisements in many sports magazines are true, many athletes are missing out on an important dietary component, protein. Typically, the ads feature beautiful, highly muscular models who promise that if readers consume special amino acid supplements, they too will have incredible strength and endurance in the gym and in all their daily activities. Even athletes who don't train specifically for strength - for example, long distance runners - are tempted by these claims of easy performance improvement. The claims seem too good to be true, too simple to be accurate. But if the supplements don't really work, advertisers couldn't make such claims, could they?

High-protein meals such as steak are a longstanding tradition in many sports, probably as a result of the folk belief that eating muscle helps an athlete develop muscle. Amino acids, the compounds from which proteins are made, gained publicity about 10 years ago when popular media reported that consuming large quantities of certain amino acids could improve an athlete's strength. Supposedly, the amino acids arginine and ornithine promote release of growth hormone, a natural hormone that influences muscle development (1). Glutamine and carnitine also have been marketed as strength-enhancing proteins. By ingesting large quantities of these compounds and sometimes other amino acids, athletes attempt to enhance performance naturally without running afoul of drug tests.

Many researchers, however, question the wisdom of eating large quantities of protein, whether in the form of food or dietary supplements. When too much protein is ingested, the body must eliminate it, resulting in dehydration and calcium loss through the urine (2). Instead of eating more meat and dairy products, they say, athletes should concentrate on eating a balanced diet that meets the U.S. Department of Agriculture's Recommended Daily Allowances. Who should athletes believe?

Protein dynamics

In simple terms, proteins are food units that contain nitrogen, as well as the carbon, oxygen, and hydrogen that are found in fats and carbohydrates. Many functions including muscle development, tissue repair, and maintenance of body structural components cannot be accomplished without protein. Because the body cannot store excess protein (3), athletes must consume an adequate amount of protein each day or training and body functions will be impaired.

When an athlete eats protein (for example, a piece of chicken), enzymes in the stomach known as peptidases break it down into its constituent components, the amino acids. As amino acids pass into the bloodstream, they follow one of four paths. They can be 1) consumed immediately as an energy source, 2) used to make a protein the body needs for maintenance functions, 3) processed into another amino acid for maintenance or energy needs, or 4) used to make hormones and biochemicals needed by the body. Conversion of amino acids to compounds that can be used to produce energy is inefficient biochemically because the nitrogen in amino acids must first be removed, a process that itself requires energy. Thus, the body will avoid using amino acids for energy unless an athlete is not consuming enough calories to fuel basic metabolism and training. When an athlete consumes more protein than the body needs, the body must dispose of the extra amino acids. It does this by removing the nitrogen atom from the amino acid (deamination) or transferring the nitrogen to another biochemical (transamination) to yield compounds the body can store. These processes yield the energy source glucose and acetyl Coenzyme A, a substance that is used in energy production or converted to fatty acids for energy or storage.

These metabolic pathways permit the body to gain some benefit from the excess protein. However, something must be done with the remaining nitrogen. When nitrogen is broken off the amino acid, it forms ammonium molecules. Ammonium is toxic to the body, so the body quickly converts it to two less lethal compounds, the glutamate amino group and the glutamine side chain amide nitrogen. The body can store small amounts of these compounds, but if large quantities of excess protein have been consumed it must eliminate the unneeded nitrogen. To do so, it converts ammonium to urea in the liver. From there, blood carries the urea to the kidneys for excretion. To flush out this urea, the kidneys require additional water, which they draw from the blood and cells in the body. Unless athletes are careful to consume extra water beyond what is required for normal metabolism and exercise demands, they may become dehydrated fairly quickly (2).

When very high levels of protein are consumed, calcium loss through the urine increases. One researcher reports that when consumption increases from 0.8g to 2.0g/kg body weight (from 1.76g to 4.4g/lb body weight) per day, urinary calcium loss increases 50% (2). Little is known about how urinary calcium increases affect athletes, but with bone density a concern for many athletes, the issue must be taken into consideration during nutritional planning.

To supplement or not?

Despite these serious health issues, some athletes may be willing to take amino acid supplements if they believe that such products will improve their performance. On this count, too, the evidence weighs against the use of supplements. In one study of elite junior weightlifters, participants who consumed a pre-meal supplement of multiple amino acids and a pre-workout supplement that included glutamine and carnitine showed no hormonal responses during a period of heavy training (4). A study of male bodybuilders found no changes in blood growth hormone levels after consumption of various commercial mixtures of arginine, ornithine, and other amino acids in accordance with the manufacturers' directions (5).

Because the body cannot store amino acids, then, there is no advantage to consuming large quantities of protein supplements. Too, the additional metabolic demands placed on the kidneys make extreme protein consumption undesirable. Athletes can make greater performance improvements by determining how much protein they need to fuel metabolism and athletics and working to meet this requirement through a healthy diet.

So how much protein does an athlete need? The U.S.D.A. recommends that adults eat 0.8g/kg body weight (0.36g/lb body weight) per day, or about 54g for a person weighing 150lb (6). This allowance includes a "fudge factor," making it more than adequate for persons of average activity. But athletes who train intensively, for example, every day, do require more protein than the RDA. According to one study, elite runners require 1.67 times the RDA level, while bodybuilders need 1.12 times the RDA level (7). At these levels, a 150lb runner would need to eat 90g protein, while a 150lb bodybuilder would need 61g protein.

Even at these higher levels, most athletes who eat a balanced diet should have little difficulty getting enough protein. A 3-oz. portion of roast white chicken meat (likely just half the amount consumed at a typical meal) contains 26g protein, while a half-cup of low-fat cottage cheese weighs in at 14g. Beans average about 15g per cup, pasta contains 5g per cup, and bagels pack 5-10g protein each depending on size and variety. Unless an athlete avoids all legume, meat, dairy, and egg products, the diet will already contain a solid protein foundation. Vegetarians and those following special dietary restrictions can meet their requirement by identifying the high-protein foods they can eat and planning meals around these foods. Finding the truth in advertisements can be difficult, especially for athletes eager to do almost anything to run faster, jump higher, or build muscle. By keeping in mind what the body does with proteins and amino acids, however, athletes can evaluate high protein programs and amino acid supplements and make wise decisions about what they should eat.

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Sources of dietary protein

Athletes who eat a good mix of nutritious foods usually have no difficulty getting enough protein from their regular diet. Foods commonly eaten by athletes contain varying amounts of protein. The following chart lists some protein-rich foods.

Product	Protein/g	Calories
Cheddar cheese, 1 oz.	**7**	115
Egg whites, two	7	35
Nonfat cottage cheese, 1/2 cup	14	70
Nonfat plain yogurt, 1 cup	8	140
Skim milk, 8 oz.	8	85
Swiss cheese, 1 oz.	8	110
Tofu, 1/2 cup raw	10	100
Canadian bacon , 2 slices grilled	11	85
Chicken breast w/out skin, roasted, 1/2	53	285
Cod or sole, 3 oz. precooked	15	70
Ground beef, lean, 3.5 oz broiled	25	275
Trout or halibut, 3 oz. precooked	18	95
Tuna, light chunk, canned in water, 3 oz	19	90

Turkey, light w/out skin, roasted, 3.5 oz	30	160
Bagel, 1 medium	9	240
Pasta, 2 oz. dry	7	210
Gardenburger patty	11	190
Kidney beans, boiled, 1 cup	15.5	225
Lentils, 1/2 cup dry	16	200
Pea soup, condensed, made w/water, 1 cup	8.5	165

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What do we know about running addiction

Carolyn C. Kyle

> *I am going to run until I'm 90. If the weather is bad on my last day, I'll collapse and die on an indoor track. Don't let anyone try to keep me alive, Fred. Just take a pushbroom and shove me off the running surface. Then, when you have finished your run, call the coroner. (8)*

Since the "running boom" of the 1970s, much has been written regarding the psychological benefits of running, including its ability to decrease anxiety, relieve depression, and enhance physical self-esteem (1, 3, 4, 13). In recent years, however, a growing body of research has revealed that dedicated runners can become psychologically dependent and even addicted to running to a point where they experience anxiety and depression when forced to abstain from their exercise routine (3, 5, 6, 9, 13).

Sachs and Pargman (14) defined running addiction as: "dependence of a physiological and/or psychological nature, upon a regular regimen of physical activity, characterized by withdrawal symptoms after 24-36 hours." Morgan (12) described running addiction in terms of its effects on a runner's life outside of the activity:

> Exercise addicts give their daily run(s) higher priority than job, family, or friends. They run first, and then, if time permits, they work, love, and socialize. And, they often exercise to the point where overuse injuries have near crippling effects, the pain becomes intolerable, and they search for the perfect shoe, orthotic, injection or psychological strategy that will enable them to run ('shoot up') again.

Obligatory running has also been described as an "affect regulator," a means for enhancing positive affect and reducing negative affect (i.e., tension, anxiety, depression). However, the addicted runner develops a dependence on running as the exclusive method for managing negative affect (1).

The key to determining whether individuals are addicted to something (whether it be to a substance or an activity) is how they react when it is taken away from them. If running were a low-injury sport, then addicted runners might be able to continue using running as a coping mechanism without apparent physical or psychological harm. Unfortunately, because running is associated with high rates of injury and the most common running-related ailments are associated with overtraining, most habitual runners experience at least a few forced layoffs from their sport. Moreover, as running frequency and duration have been positively correlated with running addiction, marathoners and ultra-marathoners are especially vulnerable to developing a dependence on running (3, 13). For example, more than 1,000 of the 16,000 runners entered to run the 1984 New York City Marathon were forced to drop out before the race due to injuries incurred while training for it (7).

Research has shown that athletes from a wide range of sports (including distance running) suffer from depression, anxiety, and a decline in physical self-esteem when injured (10, 16). The problem with measuring the psychological effects associated with running loss in injured runners is that injury in itself is distressing to most athletes. It is thus difficult to distinguish between the psychological impact of the injury from the psychological impact of the withdrawal from running. Furthermore, running injuries vary greatly in type, severity, and duration and thus are difficult to control for in an experimental setting. Finally, research that uses injured runners to assess psychological effects of running loss is only generalizable to injured runners (2, 6). One cannot, therefore, conclude from these studies that habitual runners unable to run due to inclement weather or personal conflicts will react similarly to a loss of running.

Although a withdrawal from an addictive substance or activity is typically necessary to observe addictive behavior, most research has measured running addiction on a single occasion (usually after a race) in runners who continue to run without interruption (3, 6, 9, 11, 15). In the few exceptions, the hiatus from running was previously scheduled or of short duration (5).

In order to further address the question of how habitual runners react when unable to run for a prolonged period due to factors other than illness or injury, future running addiction research should: 1) measure addiction in healthy (rather than injured) runners during a voluntary withdrawal from running; 2) assess running addiction multiple times throughout the intervention; 3) use a 2-week (or greater) withdrawal period, more than double that of most previous research; 4) recruit competitive recreational marathoners as subjects, a prevalent, but under-researched population; and 5) employ clinical diagnostic techniques to assess the severity of psychological symptoms, including depression, anxiety and physical self-perceptions. In addition, future studies should explore effective psychological coping strategies to help habitual runners deal with an inability to run, regardless of the reason.

Furthermore, now that research has recognized running as a psychologically addictive activity (3, 5, 6, 13), additional studies should address methods for reducing the potential for running dependence and identifying characteristics of runners most at risk for developing an addiction. There are cases, for example, of former alcoholics and drug addicts who discover running only to transfer their addictive tendencies to a more socially acceptable activity. This population may be at a particular risk for developing an addiction to running as a means of coping with negative affect.

Runners can obtain many psychological and physical benefits from a regular running regimen. However, if individuals lack alternative coping strategies for managing negative affect, they may be at risk for developing a psychological dependence on running. In order to avoid running addiction, habitual runners should be encouraged to learn other techniques for reducing depression and anxiety and increasing physical self-esteem. Potential alternatives to a psychological reliance on running include: biofeedback; various relaxation techniques; meditation; and self-talk. Athletes can also seek the services of a qualified sport psychologist. If runners are prevented from running due to injury, they should be encouraged to cross-train in order to maintain both physical conditioning and psychological health until they are able to run. Finally, while addiction to other forms of exercise has not been widely studied, evidence suggests that individuals may be as susceptible to dependencies on physical activities other than running (6). Future research should therefore examine whether individuals involved in other sports and exercise may be at risk for psychological addiction.

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Patellofemoral syndrome

By Catherine Muller

Since everyone, from your doctor to your conscience, is telling you to exercise, it is no wonder that many people are experiencing overuse injuries. In the past, overuse injuries were the prerogative of athletes, but not any more. Nowadays, with many people concerned about being in shape, cardiovascular equipment is popular and aerobic classes in fitness centers all over the United States are well attended. Along with the use of the StairMaster type cardiovascular machines and aerobic step classes a higher incidence of certain overuse injuries has been observed. Because these types of exercises involve repetitive movements using a higher degree of knee angle than most other exercises, overuse injuries occur frequently at the knee. One common injury is known as the patellofemoral syndrome.

Patellofemoral syndrome has many other names such as: "retropatellar painsyndrome, patellofemoral arthralgia, lateral patellar compression syndrome, patellagia, patellofemoral dysfunction and extensor mechanism disorder" (2). This condition occurs via two mechanisms, either when the extensor mechanism of the knee is malaligned or as a result of repetitive microtrauma from overuse. Basically, overuse can cause irritation on the articulation between the patella bone and the femoral condyles, the rounded projections on the femur (commonly called the thigh bone). To make this clear let us take a look at the anatomy of the knee. The patella is a small, round bone, commonly called the knee cap. It is situated within the lower end of the quadriceps tendon and the upper end of the patellar tendon (or ligament). There are two projections at the lower end of the femur that hold the patella in place. Patellofemoral syndrome affects the tracking of the patella within this region. People who exercise excessively may develop this condition by causing microtrauma in the area of patellofemoral joint, which means that through external stresses tracking is compromised.

The pain associated with this condition is probably due to the strain placed on the retinaculum, the structure that holds the patella, often times to the lateral side of the knee, causing inflammation. Inflammation of the soft tissues surrounding the area, along with the irritated, yet highly enervated patella, causes pain. The patellofemoral syndrome is recognized by a dull, aching pain behind or above the knee. Inflicted exercisers often have pain while sitting for any length of time with a flexed knee position. Sharp pain may be observed upon activities that require squatting and climbing or descending stairs. Another common symptom is cracking noises that come from the knee during bending and stretching, called crepitus (4). Often these symptoms do not appear at one instance but develop gradually, which is characteristic of an overuse injury.

Treatment of patellofemoral syndrome is varied. Noninvasive procedures are recommended (3). Treatment therapy for patellofemoral syndrome include anti-inflammatory medication, physical therapy (proper exercises), and cryotherapy (ice application), along with cessation of the activity that caused the initial problems. The most common exercises to counter patellofemoral syndrome are those that strengthen the quadriceps muscle (1). It is thought that a muscular balance would promote proper patellofemoral tracking. When using ice, it is recommended that application times last between fifteen and twenty minutes, up to six times per day. The most important times are directly prior to and following exercise. Once symptoms have subsided, the individual should gradually and carefully return to exercising.

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The effects of different treatments on delayed onset muscle soreness

By Tara Cooley

Delayed onset muscle soreness (DOMS) is a widely recognized and, yet, controversial injury phenomenon both in terms of the origin and cause of the injury (etiology) and treatment.

DOMS is defined as the muscular pain or discomfort that follows physical activity, usually eccentric, to which an individual is not accustomed (1). This applies to everyone, including all levels of fitness, as long as the activity is either novel or of a greater intensity than the individual's normal activity. Other symptoms of this type of injury include decreased range of motion (ROM) and decreased strength (1, 3). The soreness usually begins eight to twenty-four hours after exercise, peaks between twenty-four and seventy-two hours postexercise and subsides over the next five to seven days (1, 5). DOMS should be differentiated from acute onset muscle soreness, which begins during exercise and continues for about four to six hours after exercise (5).

According to Armstrong (1), there are four possible etiologies for DOMS that induce some type of tissue damage. The first indicates that high tension causes physical damage; the second, that increased metabolism produces toxic waste products; the third, that increased temperature causes injury; and the fourth, that altered nerve control, resulting from deficiency of blood flow caused by constriction of blood vessels, initiates a pain-spasm-pain cycle.

It follows, then, that there are also many proposed mechanisms for the analgesic (pain relieving) effects produced by various treatment methods. One such mechanism is the "gate mechanism," which utilizes increased stimulation of nerves that carry sensations of touch and pressure to the brain. These type of nerves transmit their impulses more efficiently than do the nerves that transmit pain sensation. Therefore the brain receives fewer impulses, which relieves the patient from some of their discomfort by "closing the gate" to pain sensation (1, 2). It has been suggested that it is this mechanism that interrupts the aforementioned pain-spasm-pain cycle, resulting in a concomitant increase in ROM (3, 6). These are precisely the concepts that high frequency transcutaneous electrical nerve stimulation (TENS) as well as ice treatments have been proposed to utilize (2). In TENS treatment, a mild electrical current is passed between electrodes which are placed on the skin surrounding an injury site. The patient can adjust the electrical current to maximize the analgesic effect.

Cryotherapy, the application of ice bags, ice massage, or cold whirlpool, is generally implicated in the reduction of the inflammatory response, swelling, pain, and muscle spasm associated with soft tissue injury. However, there is conflicting evidence with regards to the use of cryotherapy as a therapeutic modality in the treatment of DOMS (3, 5, 6). Denegar and Perrin found significant decreases in pain perception and significant increases in ROM in subjects who had received cold treatment. Alternatively, Isabell et al. indicated that ice may have actually aggravated the DOMS condition. However, the subjects in that study received treatments followed by measurements at 0, 2, 4, 6, 24, 48, 72, and 96 hours postexercise. Since one of the dependent variables was strength, at each observation subjects were required to complete two repetitions each of 25 percent, 50 percent, 75 percent, and 90 percent of their maximum one repetition value. This could have been a confounding factor in their results. It can be said that if both TENS and cryotherapy have been shown to reduce the adverse effects of DOMS, then simultaneous usage should result in greater effects. Interestingly, some research has indicated that this is true (Denegar & Perrin, 1992). It was found that the combination of cold and TENS had a greater increase in ROM than cold or TENS alone. However, the same results were not found for decreases in perceived pain.

It is recommended that athletic trainers, coaches, sports physical therapists, as well as the athletes themselves observe the changes in perceived pain and ROM immediately following a treatment of either ice, high frequency TENS, or a combination of the two to identify the best option for the individual.

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