

Getting the Most from Exercise

Exercise is a proven life extender. Literally thousands of clinical trials have documented the benefits of a regular exercise program. It has been shown to reduce the risk of many diseases, including heart disease, the leading killer in the United States. It is effective in preventing obesity and depression, and it helps people of all ages maintain flexibility, strength, and even independence.

Yet many people who exercise regularly aren't getting all the benefits they could from their program, and some wonder why they never seem to make any progress at the gym. The fact is, although any sustained exercise is helpful, results are about more than the time spent in a gym or jogging on a treadmill. That's only half the picture. Nutrition is a critical component of any exercise program, and there are proven ways to maximize your exercise program that you might not hear about from your family physician or from the government.

PROVEN BENEFITS OF EXERCISE

Exercise has been shown to increase life span by an average of one to four years for people who engage in moderate to difficult exercise routines (Jonker JT et al 2006; Franco OH et al 2005). Better yet, those additional years will be healthful years because exercise benefits the heart, lungs, and muscles. Even moderate levels of exercise have been documented to stave off many dreaded diseases of aging. Walking briskly for 3 hours per week reduces one's chances of developing many chronic health problems (Chakravarthy MV et al 2002). Exercise may also alleviate depression and enhance self-image and quality of life (Elavsky S et al 2005; Schechtman KB et al 2001).

Exercise has been proven to improve the quality of life in people disabled by diabetes, muscular dystrophy, stroke, multiple sclerosis, myasthenia gravis, and chronic obstructive pulmonary disease (Stout JR et al 2001; Rochester CL 2003). Regular exercise can improve blood glucose control, delay or prevent type 2 diabetes, offset age-associated increases in inflammatory cytokines, and reduce cardiovascular risk, diabetes-related mortality, and depression (Goldney RD et al 2004; Vitartaite A et al 2004; Babyak M et al 2000; Suh MR et al 2002; Church TS et al 2004; Short KR et al 2003; American Diabetes Association 2003; McFarlin BK et al 2004).

Routine exercise contributes to thicker and stronger bones (Martini FH 1995). Studies of postmenopausal women have shown that exercise produces increased mineral density of bone at the hip and femoral sites, areas with particularly high fracture rates in older people (Cussler EC et al 2005; Kerr D et al 2001). Older adults with knee osteoarthritis showed improved balance following an exercise regimen of weight training and aerobics (Messier SP et al 2000).

Regular exercise in the childhood and teen years can help ensure healthy bone late in life. Pregnant women can positively influence the size of their infant by means of exercise (Clapp JF III 2003).

METABOLISM—GETTING THE ENERGY WE NEED

To make the most of an exercise program, it is important to understand how exercise affects the metabolic process and how it can be enhanced through diet and nutrition. In many ways, an effective exercise program begins at the breakfast table, where the first nutrients of the day are consumed.

After it is consumed, food is broken down into components used for energy. Organic molecules, including amino acids, lipids, and simple sugars, are broken down in a process called catabolism. Ultimately, catabolism ends in the production of adenosine triphosphate (ATP) in the mitochondria. ATP is the body's main energy molecule.

ATP is necessary for virtually every energy-requiring process in the body. Furthermore, ATP is essential for anabolism, or the synthesis of new organic molecules that are used to perform repairs, support growth, and produce secretions. When living cells use ATP to create new molecules, a high-energy phosphate bond is broken to release the energy, thereby creating adenosine diphosphate.

Food is usually metabolized in a predictable pattern: carbohydrates are broken down first, with simple carbohydrates such as sugar entering the bloodstream almost immediately. More-complex carbohydrates are broken down into simple sugars, which are absorbed into the bloodstream; fats are broken down into fatty acids, which are absorbed with the help of bile acids; and protein is broken down into amino acids, which are absorbed. Sugars, mainly glucose, are the body's primary source of energy, followed by fats. Only when these two energy sources are depleted is protein, or muscle mass, used for energy. In general, metabolizing

protein for energy is not desirable. More energy is needed to metabolize proteins than to metabolize carbohydrates or lipids. Also, protein catabolism (breakdown) produces ammonia as a byproduct, and ammonia is harmful to cells. Continued catabolism of protein will damage cells and body systems and reduce the effectiveness of any exercise program.

MUSCLE ACTIVITY DURING EXERCISE

The goal of a nutritionally sound exercise program is to support healthy muscle function by providing enough energy for both the exercise itself and the recovery period immediately after the workout. To design a healthy exercise program, it is valuable to know how energy is consumed by working muscles.

The first energy source to be used by a muscle is ATP, which is stored in the muscles in very limited quantities—enough for only one contraction. Immediately when exercise begins, more ATP must be synthesized from creatine phosphate, which is also stored in the muscle tissue. Like ATP, creatine phosphate stores are consumed quickly.

These two short-term energy supplies are supported and replenished through the metabolism of glucose. Almost as soon as the muscle goes to work, glucose is released from glycogen reserves in the muscles in a process known as glycogenolysis. When adequate oxygen is available, glucose is burned through oxidative (aerobic) metabolism, with a high yield of ATP. When adequate oxygen is not available (as in sudden bursts of activity), anaerobic metabolism occurs. A byproduct of anaerobic metabolism is lactic acid. When lactic acid builds up, it creates the “burn” that is familiar to weight lifters and others who get a lot of anaerobic exercise.

As muscle stores of glycogen are depleted, the body turns to yet more energy sources: fats are metabolized for energy first, and then protein. After a workout, during recovery, oxygen demand is high while muscles restore ATP, creatine phosphate, and glycogen.

Muscle performance and energy metabolism are determined by the type of muscle fibers being used and by physical conditioning. Anaerobic activity is characterized by brief, intensive workouts, such as 50-meter dashes or weight lifting with relatively heavy weights and few repetitions. Strength training, which usually relies on short bursts of activity with relatively heavy weights, involves using free weights and machines to progressively increase resistance (Aniansson A et al 1981). This kind of exercise builds muscle mass.

Aerobic endurance training, such as jogging and distance swimming, involves sustained low-level muscle activity. Increased aerobic function is used to produce weight loss (provided that fewer calories are consumed than expended) as well as improved respiration and cardiovascular function. Since aerobic activity does not result in increased muscle mass, a combination of aerobic and anaerobic regimens (interval training), along with reduced caloric intake and other factors, such as nutritional status, will result in both weight loss and increased muscle mass. Body type is also a factor (Martini FH 1995).

MUSCLES AND AGING

As humans age, our muscles atrophy and weaken (a condition termed sarcopenia), regardless of exercise regimen or lifestyle (Bross R et al 1999). The muscles become smaller and less elastic, and muscle injuries become more common (Bross R et al 1999; Baumgartner RN et al 1998). The ability to recover from injuries also decreases, as does tolerance for exercise.

Our senior years are a good time to exercise. Exercise by older people improves quality of life. Sarcopenia, even in severe cases, can be reversed through strength training (Aniansson A et al 1981; Frontera WR et al 1992). Exercise has also been shown to control body weight (very important in preventing diabetes, cardiovascular disease, and hypertension) and strengthen bones. It is important for older people to engage in regular, low to moderate exercise rather than strenuous activity (Martini FH 1995).

What You Have Learned So Far

- Exercise results in weight reduction, enhanced physical and mental status, reduced risk of illnesses, and extended life.
- Metabolism is the process of breaking down food for use as energy for all body functions.
- During muscle contraction, ATP is used for energy. ATP stores are replenished by creatine phosphate, while glucose continues to generate new ATP from both aerobic and anaerobic metabolism.
- Aerobic activity improves cardiovascular function and results in weight loss. Strength training (resistance training) uses weights to build muscle from repeated, increased resistance.

EXERCISE-ENHANCING SUPPLEMENTS

A number of supplements have been shown to promote strength by supporting muscle function. These include the following:

Carnitine. Carnitine, an amino acid, helps transport fat into mitochondria, where it is metabolized. Exercise capacity is increased among people with arterial disease following carnitine supplementation (Barker GA et al 2001). In addition, studies show that carnitine supplementation increases muscle function and exercise capacity in people with kidney disease (Brass EP et al 1998).

Carnosine. Carnosine is found in high amounts in skeletal muscle; muscle levels of carnosine are elevated during peak activity (Suzuki Y et al 2002). Among other reported advantages, carnosine scavenges free radicals, which is important because exercise produces abundant free radical activity (Boldyrev AA et al 1997; Wang AM et al 2000; Yuneva MO et al 1999; Nagasawa T et al 2001). Additionally, carnosine protects against cross-linking and advanced glycation end product formation, both of which damage protein (Hipkiss AR et al 1995; Munch G et al 1997). Carnosine also acts as a pH buffer, protecting muscles from oxidation during strenuous exercise (Burcham PC et al 2000)

Creatine. Studies show that creatine supplementation effectively increases lean muscle mass and strength (Nissen SL et al 2003; Kreider RB 2003; Gotshalk LA et al 2002). Creatine donates a phosphate molecule to adenosine diphosphate in order to produce more ATP for energy demands. The buildup of lactic acid may also be delayed after creatine supplementation.

Studies support the use of creatine to increase strength in older people (Gotshalk LA et al 2002; Chrusch MJ et al 2001). Other studies demonstrate that creatine can help those with degenerative neurological disorders and enhance memory in older adults (Wyss M et al 2002; Beal MF 2003; Tarnopolsky MA et al 2001; Matthews RT et al 1998; Tabrizi SJ et al 2003; Laakso MP et al 2003; Yeo RA et al 2000; Valenzuela MJ et al 2003; Watanabe A et al 2002; Rae C et al 2003).

Branched-chain amino acids. Amino acids are the building blocks of protein. Essential amino acids, which are not synthesized by the human body and must be obtained from outside sources, include phenylalanine, isoleucine, methionine, valine, histidine, arginine, lysine, and leucine. Of these, isoleucine, leucine, and valine are branched-chain amino acids. They improve performance and prevent muscle metabolism during endurance exercise (Workman J 2002; Shimomura Y et al 2006; Ohtani M et al 2006). In a study comparing amino acid and carbohydrate supplements, amino acid supplements improved walking and isometric muscle strength in older participants (Scognamiglio R et al 2004).

Glutamine. Although glutamine is the most abundant amino acid in the body, at times the body cannot produce all the glutamine it needs because of extreme stress caused by surgery, prolonged exercise, or infection (Talbot SM 2003; Workman J 2002; Hendler SS et al 2001; Bassit RA et al 2002).

Various studies have shown the beneficial properties of glutamine during exercise. Athletes who engage in strenuous activity are at elevated risk of developing upper respiratory infection. This heightened risk could be due to decreased glutamine as a result of the intensive exercise (Castell LM 2002; Parry-Billings M et al 1990). Glutamine supplementation resulted in a reduction of respiratory infection in a study of marathon runners (Castell LM 1996).

Glutamine, in conjunction with L-cysteine and glycine, helps promote the synthesis of glutathione, a powerful antioxidant, and regulate muscle metabolism (Rennie MJ et al 1998). Glutamine helps build and maintain lean muscle tissue (Workman J 2002). If glutamine levels are low, the body may break down muscle to obtain glutamine, resulting in low muscle mass. Supplemental glutamine may prevent this breakdown of muscle as well as promote greater protein synthesis (Antonio J et al 2002; Hankard RG 1996).

Metabolic whey protein. Protein supplementation has been used by fitness enthusiasts and athletes for many years. After exercise, when the body is in a catabolic state, protein supplementation can help protect the body's muscles from being metabolized for energy. Whey protein, in particular, is easily digestible and immediately available to the body. In a study comparing protein and carbohydrate supplements, participants in the protein group showed greater mechanical muscle function during resistance training than participants in the carbohydrate group (Andersen LL et al 2005).

Polyenylphosphatidylcholine and Phosphatidylcholine. Polyenylphosphatidylcholine (PPC) is a phospholipid that contains polyunsaturated fatty acids, including linoleic and linolenic acids. In addition to providing flexibility to the cell membrane, PPC can help maintain plasma choline levels during exercise. Choline, which is depleted during exercise, assists in acetylcholine formation. Acetylcholine is involved in the relay of muscle contraction signals across nerve synapses (Buchman AL et al 2000).

TESTOSTERONE REPLACEMENT

Testosterone, the male sex hormone that determines secondary sex characteristics in men, is important to capacity and endurance when exercising. As men age, they gradually lose testosterone in a process called andropause, which is somewhat similar to menopause among women. By age 70, as many as 40 percent to 50 percent of men have low testosterone levels (Anawalt BD et al 2001). Symptoms of andropause include the loss of bone and muscle mass, depression, loss of sexual function, and heart disease. At the same time testosterone is declining, growth hormone levels are dropping (Karakelides H et al 2005).

While it might seem obvious that testosterone and growth hormone supplementation would enhance exercise, study results have been conflicting and incomplete (Anawalt BD et al 2001). While a few small-scale studies have shown it is possible to temporarily boost growth hormone levels by taking supplements that naturally increase growth hormone and testosterone levels, there are not yet enough data to recommend hormone replacement in the context of increased exercise endurance and capacity (Anawalt BD et al 2001). Considering that some cancers are hormone dependent, testosterone supplementation should be approached with caution by aging men who want to boost their exercise capacity and endurance. Hormone replacement therapy should be done only under the supervision of a qualified physician and after comprehensive blood testing.

For More Information

The following chapters may also be of interest:

- Obesity and Weight Loss
- Trauma and Wound Healing

LIFE EXTENSION FOUNDATION RECOMMENDATIONS

There are many benefits to a program of regular exercise. In addition to enhanced self-esteem, exercise can promote weight loss and aid in the prevention of a number of diseases, including heart disease and diabetes. In addition, the following nutrients have been shown to enhance muscle function, promote quicker recovery after exercise, and increase strength:

- **Creatine**
- **Carnitine**—1000 to 2000 milligrams (mg) daily
- **Carnosine**—1500 to 3000 mg daily
- **Branched-chain amino acids**—containing at least 1200 mg L-leucine, 600 mg L-isoleucine, and 600 mg L-valine
- **Glutamine**—500 to 1000 mg daily
- **Whey protein**—consider taking 20 to 80 grams (g) whey protein daily. It is most important to consume whey protein before and immediately after your exercise session to make sure adequate protein is available to depleted muscles.
- **PPC**—900 to 1800 mg

In addition, bioidentical hormone therapy may be considered to balance levels of important sex hormones, including testosterone. For more information on hormone blood testing, call 1-800-544-4440.

FITNESS SUPPLEMENTATION SAFETY CAVEATS

An aggressive program of dietary supplementation should not be launched without the supervision of a qualified physician. Several of the nutrients suggested in this protocol may have adverse effects. These include:

Acetyl-L-Carnitine

- Acetyl-L-carnitine can cause gastrointestinal symptoms such as nausea and diarrhea.

L-Glutamine

- Consult your doctor before taking L-glutamine if you have kidney failure or liver failure.
- L-glutamine can cause gastrointestinal symptoms such as nausea and diarrhea.

Phosphatidylcholine

- Phosphatidylcholine can cause increased salivation, a metallic taste, headache, drowsiness, and gastrointestinal symptoms such as nausea and diarrhea.

For more information see the Safety Appendix

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