Dr. Murray's natural facts

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Focus on Magnesium

Introduction

Magnesium is second only to potassium in terms of concentration within the individual cells of the body. The functions of magnesium primarily revolve around its ability to activate many enzymes.

Magnesium deficiency is extremely common in Americans, particularly in the geriatric population and in women during the premenstrual period. Deficiency is often secondary to factors that reduce absorption or increase secretion of magnesium such as: high calcium intake, alcohol, surgery, diuretics, liver disease, kidney disease, and oral contraceptive use.

Signs and symptoms of magnesium deficiency can include fatigue, irritability, weakness, heart disturbances, mental confusion, muscle cramps, loss of appetite, insomnia, and a predisposition to stress.

Magnesium Supplementation in Cardiovascular Disease

Magnesium supplementation has been shown to be an extremely effective therapy or adjunctive measure in many common conditions especially cardiovascular disease. Magnesium is absolutely essential in the proper functioning of the heart. Magnesium's role in preventing heart disease and strokes is generally well-accepted. In addition, there is a substantial body of knowledge demonstrating that magnesium supplementation is effective in treating a wide range of cardiovascular diseases.

For example, magnesium was first shown to be of value in the treatment of ***cardiac arrhythmias*** in 1935. More than seventy years later, there are now numerous double-blind studies showing magnesium to be of benefit for many types of arrhythmias including atrial fibrillation, ventricular premature contractions, ventricular tachycardia, and severe ventricular arrhythmias.

Magnesium supplementation has also been shown to be helpful in ***angina*** due to either a spasm of the coronary artery or atherosclerosis. The beneficial effects of magnesium in angina relate to its ability improve energy production within the heart; dilate the coronary arteries resulting in improved delivery of oxygen to the heart; reduce peripheral vascular resistance resulting in reduced demand on the heart; inhibit platelets from aggregating and forming blood clots; and improve heart rate.

Magnesium supplementation is also critical in ***congestive heart failure*** (CHF). Studies have shown that CHF patients with normal levels of magnesium significantly live longer than those with lower magnesium levels. Many of the conventional drugs for CHF and high blood pressure (diuretics, beta-blockers, calcium channel-blockers, etc.) deplete body magnesium stores. Magnesium supplementation generally produces a modest impact in lowering ***high blood pressure*** (i.e., less than 10 mm Hg for both the systolic and diastolic).

Other Conditions Benefited by Magnesium Supplementation

Because of magnesium's critical role in many body processes, it is not surprising that research has demonstrated magnesium supplementation to benefit many other conditions. For example, since magnesium promotes relaxation of the bronchial smooth muscles, magnesium supplementation is a well-proven and clinically accepted measure to halt an acute ***asthma*** attack (via intravenous administration) as well as acute flare-ups of ***COPD***.

Magnesium is known to play a central role in the secretion and action of insulin. Several studies in patients with ***diabetes*** or impaired glucose tolerance have shown magnesium to be of significant value. Magnesium supplementation (usually 400 to 500 mg per day) improves insulin response and action, glucose tolerance, and the fluidity of the red blood cell membrane. In addition, magnesium levels are usually low in diabetics and lowest in those with severe retinopathy. Diabetics appear to have higher magnesium requirements.

An underlying magnesium deficiency can result in chronic fatigue and symptoms similar to the ***chronic fatigue syndrome*** (CFS). Low red blood cell magnesium levels, a more accurate measure of magnesium status than routine blood analysis, have been found in many patients with chronic fatigue and CFS. Double-blind studies in people with CFS have shown magnesium supplementation significantly improved energy levels, better emotional state, and less pain. Magnesium supplementation has also been shown to produce tremendous improvements in the number and severity of tender points in patients with ***fibromyalgia***.

Magnesium increases the solubility of calcium in the urine. Supplementing magnesium to the diet has demonstrated significant effect in preventing recurrences of ***kidney stones***. However, when used in conjunction with vitamin B6 (pyridoxine) an even greater effect is noted.

Magnesium supplementation is very important in preventing ***headaches***. There is now considerable evidence that low magnesium levels trigger both migraine and tension headaches. In individuals with chronic headaches that have low magnesium levels, magnesium supplementation has been shown to produce excellent results in double-blind studies.

Magnesium needs increase during ***pregnancy***. Magnesium deficiency during pregnancy has been linked to preeclampsia (a serious condition of pregnancy associated with elevations in blood pressure, fluid retention, and loss of protein in the urine), preterm delivery, and fetal growth retardation. In contrast, supplementing the diet of pregnant women with additional oral magnesium has been shown to significantly decrease the incidence of these complications.

Magnesium deficiency has also been suggested as a causative factor in ***premenstrual syndrome***. While magnesium has been shown to be effective on its own, even better results may be achieved by combining it with vitamin B6.

Available Forms:

Magnesium is available in several different forms. Absorption studies indicate that magnesium is easily absorbed orally, especially when it is bound to amino acids, aspartate, citrate, or malate. Inorganic forms of magnesium such as magnesium chloride, oxide, or carbonate are less well absorbed and are more likely to cause diarrhea at higher dosages.

Usual Dosage:

Many nutritional experts feel the ideal intake for magnesium should be based on

body weight (6 mg/2.2 pounds body weight). For a 110-pound person the recommendation would be 300 mg, for a 154-pound person 420 mg, and for a 200-pound person 540 mg.

Cautions and Warnings:

If you suffer from a serious kidney disorder or are on hemodialysis, do not take magnesium supplements unless directed to do so by a physician.
People with severe heart disease (such as high-grade atrio-ventricular block) should not take magnesium (or potassium) unless under the direct advice of a physician.

Possible Side Effects:

In general, magnesium is very well tolerated. Magnesium supplementation can sometimes cause a looser stool, particularly magnesium sulfate (Epsom salts), hyroxide, or chloride.

Drug Interactions:

There are many drugs that appear to adversely effect magnesium status. Most notable are many diuretics, insulin, and digitalis.

Nutrient Interactions:

There is extensive interaction between magnesium and calcium, potassium, and other minerals. High dosages of other minerals will reduce the intake of magnesium and vice versa. A high calcium intake and a high intake of dairy foods fortified with vitamin D results in decreased magnesium absorption. Vitamin B6 works together with magnesium in many enzyme systems.

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Magnesium: The Multi-Purpose Mineral

by Rehan Jalali

Magnesium is a versatile mineral that has some major implications with regards to athletes. It has been studied quite extensively in the research. This article tries to answer the question "Why is magnesium so important to athletes and what are its functions?" By exploring some general information on magnesium and then examining the research, it may be clear to see why this mineral is so important for proper metabolic function.

Magnesium in the human body ranks fourth in overall abundance, but intracellularly (within cells) it is second only to potassium. Between 60-65% of magnesium in the human body is found in bone. Magnesium that does not exist as part of bone, is mainly found within muscle intracellularly (1,2). About 1% of magnesium is found in the extracellular fluid. Inside cells, magnesium may be found bound to phospholipids. In animal studies, it has been shown that bone magnesium is used to maintain levels throughout the body and muscle magnesium is maintained (3), when magnesium intake is restricted. Magnesium absorption when ingested is carrier-mediated and is influenced by transit time through the gut, dietary intake of magnesium, and the amounts of phosphorous and calcium in the diet (4). These minerals compete for absorption sites in the intestinal mucosa. Excess magnesium that is not deposited in bone or retained in tissue is excreted through the urine.

This mineral is involved in over 300 enzymatic reactions in the body (5) including glycolysis, the krebs cycle, creatine phosphate formation, nucleic acid synthesis, amino acid activation, cardiac and smooth muscle contractability, cyclic AMP formation, and most importantly for strength athletes, protein synthesis. Some of the functions of this important macromineral are relevant to endurance and strength athletes. To fully understand the implications this mineral has on athletes, we must explore the roles of magnesium further.

ATP (adenosine triphosphate or energy) is always present as a magnesium: ATP complex. Magnesium basically provides stability to ATP. Magnesium binds to phosphate groups in ATP, thus making a complex that aids in the transfer of ATP phosphate. Since working muscles generally contain more ADP (adenosine diphosphate), allowing ATP to release a phosphate group is important to exercising individuals.

Magnesium is also a cofactor to the enzyme creatine kinase which converts creatine into creatine phosphate or phosphocreatine (which is the storage form of creatine). Since creatine monohydrate supplements are extremely popular and proven to be effective, magnesium may be an important mineral in helping to optimize creatine function. In active muscle, creatine kinase also helps phosphocreatine combine with ADP to resynthesize ATP in contractile activity. This process, which involves magnesium, basically increases anaerobic endurance. By the way, phosphocreatine possesses a higher

phosphate group transfer potential than ATP so it may be able to form ATP quickly and provide energy for muscular activity (6).

Magnesium also plays an important role in protein biosynthesis which is certainly applicable to athletes. It is necessary for the activation of amino acids and the attachment of mRNA to the ribosome. This process helps "make" proteins. In other words, protein synthesis depends on optimal magnesium concentrations. It is hypothesized that low magnesium levels may negatively affect protein metabolism, and may result in diminished strength gains in a structured workout regimen. It is important to note that increasing dietary protein intake may increase magnesium requirements because high protein intake may decrease magnesium retention (5).

To completely understand magnesium function, it is necessary to explore magnesium's relationship with calcium and potassium. Magnesium is needed for PTH (parathyroid hormone) secretion. PTH helps maintain calcium homeostasis. High magnesium or calcium levels actually inhibit PTH secretion. Magnesium may actually compete with calcium for nonspecific binding sites on myosin (7). Magnesium may also cause an alteration in calcium distribution by changing the flux of calcium across the cell membrane. It may also decrease intracellular calcium concentrations by inhibiting the release of calcium from the sarcoplasmic reticulum (7). In the process of blood coagulation, magnesium and calcium are actually antagonistic. Calcium basically promotes this process while magnesium inhibits it. If you take high amounts of calcium daily, you may have a magnesium deficiency. Most experts suggest that your calcium: magnesium ration should be 2:1. In other words, if you take 1500 mg of calcium daily through diet and supplementation, you should try to consume at least 750 mg of magnesium daily as well. this may help prevent an imbalance from occurring. Magnesium and calcium supplements should be taken at different times to allow for better absorption of each of these minerals.

Magnesium and potassium also have a close relationship. Magnesium is necessary for the function of the sodium/potassium pump. If a magnesium deficiency occurs, then pumping sodium out of the cell and pumping potassium into the cell may be impaired (5). Prescription diuretics tend to deplete magnesium and potassium. In this situation, magnesium intake can normalize both magnesium and potassium levels in the muscle (5).

Magnesium has also been implicated in the prevention of muscle cramps and muscle spasms. In a clinical study, 500 mg of magnesium gluconate relieved muscle spasms (within a few days) in an adult female tennis player who was complaining about having muscle spasms associated with prolonged outdoor exercise (8). This may be due to the fact that mineral losses through sweat and urine are increased during prolonged exercise. In specific, sweat losses of magnesium may increase during exercise (9). Increased loss of magnesium from the body have been seen during and after exercise. A shift in magnesium from the plasma into the erythrocytes was found (10). Basically , the more anaerobic the exercise (i.e. glycolytic), the greater the movement of magnesium from the plasma into the erythrocytes. This is why athletes may have a greater magnesium requirement.

People who sustain heart attacks are usually magnesium deficient. There are numerous studies which show that magnesium may be very important in cardiac function (11,12,13,14). For example, one study (11) showed that the early detection of magnesium deficiency is imperative for the prevention of abnormal cardiac metabolism and the maintenance of structural integrity of cardiac muscle during anaesthesia. The best way to get magnesium levels tested by your doctor is to get magnesium levels tested in red blood cells instead of serum. Testing magnesium levels in the serum will detect only the most severe deficiencies.

So what does the research on magnesium with athletes say? One 1992 study published in the Journal of the American College of nutrition entitled "Effect of Magnesium Supplementation on Strength Training in Humans" (15) studied the effects of a dietary magnesium supplement (magnesium oxide given in a ratio of 8 mg/kg/day including dietary magnesium) on strength development during a double-blind, 7 week strength training program in 26 untrained subjects. There was a magnesium supplemented group and a control or

placebo group. For example, a 200 lb. individual in the magnesium supplemented group would receive about 725 mg of magnesium daily. The results of the study showed that the oral magnesium supplementation group produced significantly greater results in strength than the control group. The researchers also concluded that magnesium's role in protein synthesis may be at the ribosomal level.

Magnesium is also an important mineral for endurance athletes. Endurance athletes may become magnesium deficient because of increased magnesium losses in sweat (16,17). Increased energy expenditure may also cause an increase in magnesium requirements. Magnesium supplementation has also been shown to improve cellular metabolism in competitive athletes (18). Another clinical trial which studied the effects of magnesium supplementation (360 mg/day) for 4 weeks in male competitive rowers showed a decrease in serum lactate concentration and oxygen consumption when compared to rowers receiving a placebo (18). In other words, the results of this study suggested that magnesium supplementation may have a beneficial effect on energy metabolism and work efficiency.

Other research studies show that serum magnesium levels may be reduced in response to strength training (19). Also, it has also been noted in research studies that maximal contraction of the quadriceps is positively correlated to serum magnesium status (20).

Alcoholism, renal disease, diabetes mellitus may all cause a magnesium deficiency to occur. Some of the signs and symptoms of a magnesium deficiency include nausea, vomiting, anorexia, muscle weakness, muscle spasms, and tremors (6). Poor magnesium status may be related to cardiovascular disease, hypertension, and heart attacks as mentioned earlier. Regular magnesium levels in the red blood cells should be tested for by a doctor every three months to help prevent any deficiency.

Magnesium toxicity is highly unlikely because normal kidneys can remove magnesium extremely rapidly. Toxicity is more likely to occur in individuals who have renal problems. One main effect of excess magnesium intake is diarrhea.

The best forms of supplemental magnesium seem to be the ones chelated to an amino acid (magnesium glycinate, magnesium taurate) or a krebs cycle intermediate (magnesium malate, magnesium citrate, magnesium fumarate). These forms seem to be better utilized, absorbed, and assimilated. Try to stay away from inorganic forms of magnesium like magnesium chloride or magnesium carbonate because they may not be absorbed as well and may cause gastric disturbances.

Dietary fiber impairs magnesium absorption to a small extent (1) so magnesium should not be consumed with any fiber source. Food sources of magnesium include nuts, legumes, and soybeans. Since it may be impractical for athletes to consume enough magnesium through dietary sources, supplemental magnesium may be used. Taking 500-1000 mg/day of magnesium may allow athletes to prevent any deficiencies as well optimize exercise performance.

Athletes need to recognize the vital importance of this macromineral since it plays a role in numerous bodily functions. So next time you experience muscle spasms and/or muscle cramps or just want a boost in strength, try magnesium supplementation and you may see some great results!

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