ALBION® HUMAN NUTRITION

Research Notes

A Compilation of Vital Research Updates on Human Nutrition

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Sports, Exercise, and Minerals (Part II)

The interest in the relationship between sports, exercise and mineral nutrition has been the subject of countless research studies, books, and consumer products for many years. Exercise can lead to an increased need for certain minerals in a couple of basic ways. Research has demonstrated that exercise can increase the rate of mineral loss via sweat and urine. In addition, exercise can increase the metabolic demand for certain minerals. The potential health hazard that can come from exercise induced mineral loss is further enhanced by the public's record for not consuming adequate amounts of many essential minerals. Additional findings have shown that many athletes, and female athletes, in particular, consume diets that have been found to be woefully inadequate for certain key minerals. The combination of strenuous exercise and compromised mineral status ultimately leads to low endurance capacity, depressed immune function, and the development of a variety of disease conditions. Minerals, such as zinc, magnesium, copper, and iron are the minerals most often impacted in the course of exercise, with, as it turns magnesium and zinc being the most prominent. Calcium and chromium have been seen to be affected by exercise, but not to the degree as seen with the others mentioned.

Magnesium (Mg)

Magnesium is needed for well over 300 biochemical reactions in the human body, and it helps maintain muscle and nerve function, steady heart rhythm, supports the immune system, and maintains bone strength. Magnesium helps regulate blood sugar levels, normal blood pressure, as well as being involved in protein synthesis - all of this in addition to its critical role in energy production (according to the Office of Dietary Supplements, NIH).

No other mineral has been more highly linked to what the body needs most in exercise and sports performance than has magnesium. All energy for muscle contraction is derived from the hydrolysis of ATP. Metabolic rates can be 20 times higher during aerobic activity and up to 50 times higher during intense anaerobic activity. Magnesium is intimately linked to the metabolic cycle of ATP production and hydrolysis. There are three overlapping and mutually supportive energy systems that provide the ATP needed for exercise: 1) immediate, 2) nonoxidative (glycolytic), and 3) oxidative. Exercise type determines which energy system is most activated, as seen in Table 1.

Table I

ATP Physical Activity Table

Energy Systems	Exercise Type	Representative Activity
Immediate	Anaerobic	Sprinting Weight Lifting
Nonoxidative (Glycolytic)	Most Sports Transitional Anaerobic	Tennis, Ballet, Circuit Training
Oxidative	Most Sports Aerobic	Jogging, Cycling, Hiking, Stair Climbing

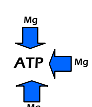
Most sports are of an interval nature, and they rely on the immediate and Nonoxidative energy systems heavily. However, even in short duration exercise, some oxidate energy may be involved.

Magnesium is a key catalyst in the cycling of ADP to ATP, and the subsequent hydrolysis of ATP to cleave the high energy phosphate bond of ATP, providing the energy needed for muscle contraction. As depicted in Table II, magnesium is a key component for all of these energy producing systems. Sport performance and exercise require a high supply of the energy produced by magnesium sparked reactions.

Table II

Magnesium: The key factor in all the components of these energy producing systems

Immediate Energy System
- Existing in scale sarcoplasm
- Myokinase reaction
- CPK reaction



Oxidative Energy System
- Mitochondrial electrontransport chain
- Citric acid (Krebs) cycle

Nonoxidative Energy Systems (Glycolytic)
- Glycolysis

Exercise and Magnesium Metabolism

The relationship between magnesium and muscle function, oxygen uptake, energy metabolism, and electrolyte balance has spurred researchers on in the study of exercise and magnesium. Plasma magnesium has been seen to decrease by about 10% following intense exercise, and the resulting low magnesium levels have been seen to last for up to 18 days. Part of this reduction is due to a redistribution of magnesium from the plasma pool to other areas of the body caused by exercise induced metabolic needs, including increased magnesium in exercising muscle, while an increased rate of urinary and sweat loss of magnesium caused by exercise accounts for the majority of the rest. Typically, magnesium loss due to sweat is on the order of 3 to 4 mg/liter, and under normal conditions it accounts for 12% of the total daily magnesium excretion. Urinary magnesium loss can increase by up to 30 percent following a session of strenuous exercise. The increased level of magnesium for exercising muscle may be a larger factor than commonly held. The energy for muscle contraction, of course comes from the cycling of ATP and ADP. Magnesium is a key part of this cycling having more than one role here.

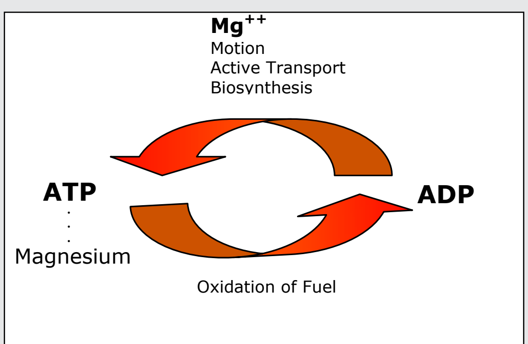
According to Biochemistry; Stryer L, 4th Edition, Fromm & Company 1995:

"ATP turnover is very high as demonstrated by the following examples:"

- An average human consumes 40 kg of ATP in 24 hours when resting
- During exercise 0.5 kg of ATP can be used per minute!

Thus, it is quite obvious that to maintain the body's normal activities a substantial amount of magnesium is required (see Figure 1).

Figure 1.



* From Biochemistry, Lubert Stryer, 4th edition*

Update On The Relationship Between Magnesium and Exercise

Nielsen FH, Lukaski HC.
Magnes Res, 2006:19(3):180-9.

Magnesium is involved in numerous processes that affect muscle function including oxygen uptake, energy production and electrolyte balance. Thus, the relationship between magnesium status and exercise has received significant research attention. This research has shown that exercise induces a redistribution of magnesium in the body to accommodate metabolic needs. There is evidence that marginal magnesium deficiency impairs exercise performance and amplifies the negative consequences of strenuous exercise (e.g., oxidative stress). Strenuous exercise apparently increases urinary and sweat losses that may increase magnesium requirements by 10-20%. Based on dietary surveys and recent human experiments, a magnesium intake less than 260 mg/day for male and 220 mg/day for female athletes may result in a magnesium-deficient status. Recent surveys also indicate that a significant number of individuals routinely have magnesium intakes that may result in a deficient status. Athletes participating in sports requiring weight control (e.g., wrestling, gymnastics) are apparently especially vulnerable to an inadequate magnesium status. Magnesium supplementation or increased dietary intake of magnesium will have beneficial effects on exercise performance in magnesium-deficient individuals. Magnesium supplementation of physically active individuals with adequate magnesium status has not been shown to enhance physical performance. An activity-linked RNI or RDA based on long-term balance data from well-controlled human experiments should be determined so that physically active individuals can ascertain whether they have a magnesium intake that may affect their performance or enhance their risk to adverse health consequences (e.g., immunosuppression, oxidative damage, arrhythmias).

Dietary Magnesium Depletion Affects Metabolic Responses During Submaximal Exercise In Postmenopausal Women

Henry C. Lukaski and Forrest H. Nielsen.
J Nutr; 2002; 132:930-935.

Magnesium is an essential mineral that is required for optimal biological function including energy metabolism. Although national nutritional surveys indicate that usual magnesium intakes do not meet recommendations, particularly among older women, diet-induced magnesium depletion is considered rare among humans without concurrent illness. We examined the effects of dietary magnesium restriction on biochemical measures of magnesium nutriture and physiologic responses during submaximal exercise in 10 postmenopausal women, 45-71 y old, not receiving hormone replacement therapy. The women consumed diets containing conventional foods with varying magnesium content totaling 112 mg/8.4 MJ (2000 kcal) supplemented with 200 mg magnesium daily for 35d (control), then 112 mg/8.4 MJ for 93d (depletion) followed by 112 mg/8.4 MJ supplemented with 200 mg magnesium/d for 49d (repletion) in a depletion-repletion experiment. RBC magnesium concentration ($P < 0.05$), magnesium retention ($P < 0.05$) and skeletal muscle magnesium concentration ($P < 0.05$) decreased when dietary magnesium was restricted. Peak oxygen uptake, total and cumulative net oxygen uptake determined by using indirect calorimetry and peak heart rate increased ($P < 0.05$) during standardized submaximal work with restricted compared with adequate dietary magnesium. These findings indicate that dietary magnesium depletion can be induced in otherwise healthy women; it results in increased energy needs and adversely affects cardiovascular function during submaximal work. This may also explain previous observations of increased energy cost during standardized exercise in physically active men and women considered to have reduced magnesium nutriture.

Effects Of Magnesium Supplementation On Blood Parameters Of Athletes At Rest And After Exercise

Cinar V, et al.
Biol Trace Elem Res; 2007; 115(3):205-12.

The effects of magnesium supplementation on blood parameters were studied during a period of 4 wk in adult tae-kwondo athletes at rest and exhaustion. Thirty healthy subjects of ages ranging in age from 18 to 22 yr were included in the study. The subjects were separated into three groups, as follows: Group 1 consisted of subjects who did not train receiving 10 mg/kg/d magnesium. Group 2 included subjects equally supplemented with magnesium and exercising 90120 min/d for 5 d/wk. Group 3 were subject to the same exercise regime but did not receive magnesium supplements. The leukocyte count (WBC) was significantly higher in groups 1 and 2 than in the subjects who did not receive any supplements ($p < 0.05$). There were no significant differences in the WBC of the two groups under magnesium supplementation. The erythrocyte, hemoglobin, and trombocyte levels were significantly increased in all groups ($p < 0.05$), but the hematocrit levels did not show any differences between the groups although they were increased after supplementation and exercise. These results suggest that magnesium supplementation positively influences the performance of training athletes by increasing erythrocyte and hemoglobin levels.

Supplementation of Magnesium – A Strong Consideration

The most recent US surveys on nutritional intake in our diet has found that the average intake of magnesium for men is at 75% of the RDA, and for women at 71 % of the RDA. Based on this data, 50% of the US populace has a magnesium intake that is at a level that puts us into a marginal deficiency status, at best. At this level, a number of important physiological functions are compromised. It is known that magnesium is a mineral of critical importance to the production of energy and muscle strength. Research has shown that the performance of exercise and sport performance causes an increased loss of magnesium that is proportional to the length and intensity level of that exercise or sport performance. The danger for a variety of adverse health consequences is real. Studies have shown a variety of these consequences. Cardiac problems, epileptic-like convulsions, immunosuppression, oxidative damage, and chronic fatigue have been seen in athletes due to a lack of proper magnesium intake, combined with exercise -induced magnesium loss. With this background, the consideration of employing a magnesium supplementation program by people who are involved with exercise is understandable. The development of an activity based RDA, as suggested by Dr. H.C. Lukaski (USDA) is a very good idea. The problem remains that the individual really doesn't know where their dietary magnesium intake stands. With the range of safety seen for magnesium, in terms of daily intake, a supplement program that provides the RDA of magnesium would seem to be a good start for any person engaged in strenuous exercise or athletic performance.

Bioavailability and tolerability of various albion manufactured organic magnesium sources compared to magnesium oxide.

CROWLEY D.

In a randomized double blind, crossover trial, three organic sources of magnesium were compared to magnesium oxide for bioavailability as determined by serum magnesium levels and tolerability as determined by adverse event reporting. Subjects were healthy adults (n=14) and they received 150 mg bolus dose of magnesium as either magnesium oxide, magnesium glycinate chelate, magnesium glycinate chelate buffered, or dimagnesium malate. Hourly serum samples were taken at 0-4 hours and again at 8 hours post treatment (see Figure 2). Subjects were interviewed for adverse events relating to treatment. It was found that each of the organic sources had significantly higher blood serums compared to magnesium oxide, and had higher total absorption as determined through area under the curve calculations (see Figure 3). It was also found that there were no adverse events reported that was a result of the treatments.

Figure 2. Serum magnesium levels. All treatments were significantly greater (p>0.05) than magnesium oxide.

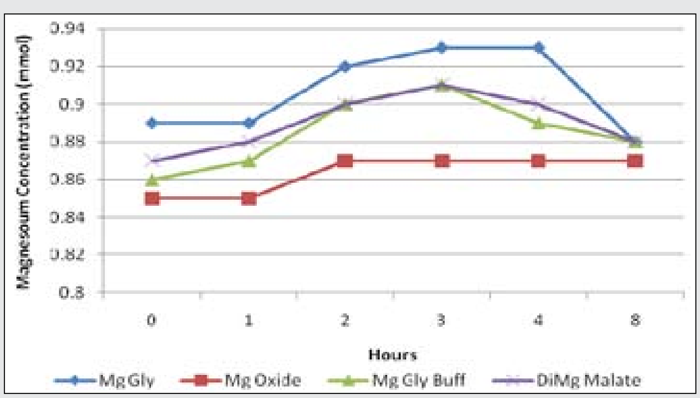
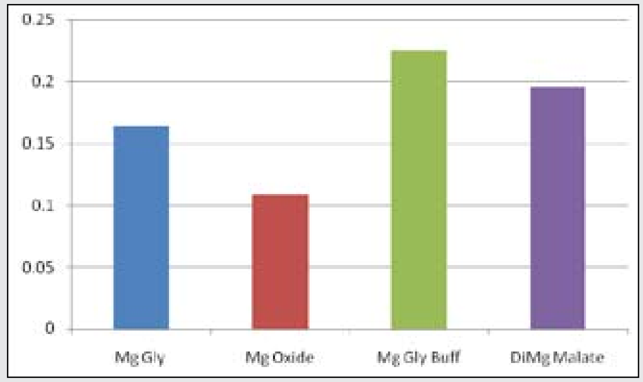


Figure 3. Area Under Curve (AUC) for 8 hours.



Best Magnesium to Select for Supplementation

In the study on bioavailablity for different forms of magnesium, the Magnesium Glycinate Chelate, Magnesium Glycinate Chelate Buffered, and the DiMagnesium Malate forms were all quite better absorbed than magnesium oxide, which is the magnesium salt form most often used as the standard for comparison in clinical trials on bioavailablity and magnesium supplement forms. The chelated forms of magnesium from Albion are the ones that will have the best absorption, when compared to any of the known salt forms. The non-buffered form of Magnesium Glycinate Chelate is the form that can be used in the highest dosage without worrying about laxation. Each of these three forms of Albion magnesiums has different advantages, and your Albion representative is the best one to help you in choosing the right one for your formulation needs. There is another Albion magnesium form that can be considered, as well, and it is Creatine MagnaPower® (magnesium creatine chelate), which supplies two ingredients that increase energy. Of course, it has differences in performance from Albion's other magnesium forms, and your representative can show you when each is best to use. All of Albion's magnesium ingredients have been clinically tested and found to be of excellent bioavailablity.

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