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HUMAN NUTRITION

Research Notes

A Compilation of Vital Research Updates on Human Nutrition

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Sports, Exercise, and Minerals

Research concerning the relationship between sports, exercise, and mineral nutrition has been ongoing for a few decades. An idea that is widely held is that strenuous exercise can increase the need for several minerals, which has lead to a perception that mineral supplements may be advantageous for people who engage in strenuous exercise or physically demanding sports. The rationale for the idea that exercise can increase the demand for certain minerals is due to the findings that heavy exercise can lead to an increased rate of mineral loss via urine and sweat, while others have found that exercise increases the metabolic demand for certain minerals. The physical danger for mineral deficiency is further compounded by a couple of other findings. First, in general, it has been shown that the U.S. populous does not consume the proper dietary intake of essential minerals. Additionally, certain athletes, and female athletes, in particular, have diets that are very low in some key minerals. Researchers have surmised that the inadequate intake of some minerals by people engaged in strenuous exercise could lead to the lowering of endurance capacity, depressed immune function, and the development of a variety of disease states. The interest in this area has resulted in literally thousands of reported clinical trials, surveys, and epidemiological studies devoted to sports, exercise, and mineral nutrition.

The complexity of the roles that minerals play in the human body makes it a dynamic that does not allow for any simple conclusions. Additionally, the impact on the functioning of the human body has been seen to differ depending on the type of exercise or sport one engages in, as well as the environment that it takes place in. Anaerobic or aerobic exercise? Hot weather or cold? High elevation or at sea level? Effort level, along with exercise duration plays a role here, as well. Despite all of these variables, certain trends can be seen for the interrelationship between mineral nutrition and exercise.

In reviewing the more recent research on minerals, sports, and exercise, the minerals magnesium, zinc, copper, and iron appear to be the prominent minerals impacted by exercise with magnesium and zinc being the most prominent. However, there are some mention of others, in different considerations, like calcium and chromium. Note that this review is on minerals and trace minerals, not electrolytes, which also play critical roles in the sports/exercise arena. The electrolytes potassium and sodium are long known needs in sport and exercise performance.

Zinc (Zn)

It is known that strenuous exercise can result in marked changes in zinc metabolism. The variations in plasma zinc levels can be related to the intensity of the exercise [Cordova A; Alvarez-Mon M; Neurosci Biobehav Rev. 1995; 19(3)]. Cordova and Alvarez state that it is clear that there are short term effects of exercise on zinc metabolism, and that a constant high level of exercise will give rise to other long term effects on zinc metabolism. Long term endurance training gives rise to lowered resting serum zinc levels in both males and females as compared to sedentary controls. Severe zinc deficiency can affect muscle function, since zinc is required for the activity of several enzymes in energy metabolism in muscle. A low muscle zinc will result in a reduction of endurance capacity. Several studies have shown that athletes involved in anaerobic exercise (short powerful movements, as in weight training, judo) exhibit higher plasma zinc levels than those who are involved in aerobic exercises like cycling or jogging.

The following two abstracts are included here, due to their classic findings on zinc and exercise.

Zinc metabolism in the athlete: influence of training, nutrition and other factors.

Couzy F ; Lafargue P ; Guezennec CY
Int J Sports Med. 1990; 11(4):263-6 (ISSN: 0172-4622)

Serum zinc was measured four times (October, January, March and May) in six young male athletes during a nine-month sporting season in relation to eleven other parameters. A significant decrease in serum zinc was observed after five months of intensive training (all values remaining in the normal range). This cannot be explained by changes in dietary habits, plasma protein concen trations, hormonal changes nor by the existence of minor infectious or inflammatory pathologies. The dietary intakes seemed adequate. These results support the hypothesis that zinc status may be slightly altered in the high-level athlete.

Effect of training on Zinc metabolism: changes in serum and sweat zinc concentrations in sportsmen.
Cordova A ; Navas FJ
Ann Nutr Metab. 1998; 42(5):274-82 (ISSN: 0250-6807)

The purpose of this research was to determine the effects of daily physical training on serum and sweat zinc concentrations in professional sportsmen between October and December, during the competing season. Twelve volleyball players and another 12 control subjects have participated in this study. Tests were made in October and December which consisted of a progressive bicycle ergometer test (increasing 30 W every 3 min to reach maximum tolerated power). Blood samples were obtained at rest and immediately after exercise. Total serum zinc increased significantly after maximal exercise in both sportsmen and control subjects. In athletes, the change after exercise was significantly higher in December than in October. The percentage of ultrafiltrable zinc (ZnUf) in October was similar in sportsmen and in controls. In December, however, after exercise, the percentage of ZnUf was higher in athletes. With respect to sweat zinc, it was in the same range both in controls and in sportsmen in October. In December, however, sweat zinc was significantly higher in athletes as compared with the situation in October and with respect to the control group. In October, the zinc concentration of urine was similar for sportsmen and controls. In December, the sportsmen showed an increase in urinary zinc excretion with respect to control subjects. Cortisol in athletes increased significantly after exercise in December. In conclusion, a daily and maintained practice of exercise is probably responsible for an alteration of zinc metabolism. The results suggest that ZnUf control, zinc supplementation and/or stress control appear to be indicated in athletes to prevent the diminution of active ZnUf. In our practical opinion we think that alterations in zinc metabolism with increases in zinc excretion and stress levels lead to a situation of latent fatigue with a decreased endurance.

There have been many other studies which have taken a look at the effect of exercise on zinc status. There are several rationales proposed for the cause of the hypozincemia seen resulting from training in athletes. These include 1.) the expansion of plasma volume 2.) increase zinc excretion (urinary and sweat) 3.) redistribution of zinc. Plasma zinc levels have been seen to decrease at a rate of from 12-33% during physical training, and only up to a 12% loss can be attributed to increase in plasma volume. Studies have found that urinary zinc loss increases by 10-45% after moderate exercise, and is higher in trained athletes than sedentary. Sweat zinc losses have been seen in males (0.65mg/hour) and females (0.4mg/hr) after one hour of moderate intensity exercise. Normal dermal losses of zinc have been rated as 0.76mg/day. It has also been shown that exercise will cause zinc to be redistributed to counteract some of the physiological impact of exercise. Some goes to the liver, forming enzymes and some to the erythrocytes. In particular, exercise has been shown to increase zinc erythrocyte levels in the endurance athlete. Plasma zinc increases and erythrocyte zinc decrease following high intensity exercise. Overall, exercise results in the loss of zinc, and exercise done on a regular basis can lead to a negative compromise in zinc status. It is of note that a study in 2006 (Kilic M, et al., Neuro Endocrinol Lett 2006;27(1-2): 247-252) examined the effect of exhaustive exercise in elite athletes, and its effect on thyroid and testosterone levels. The study determined that exhaustive exercise led to a significant inhibition of both thyroid and testosterone concentrations. Further, the researchers found that a 4 week course of oral zinc supplementation prevented this inhibition, and they concluded that physiological doses of zinc may benefit athletic performance. The relationship here could be a real key.

Research findings on zinc and its interplay with exercise and athletic performance will continue to bring in new and exciting findings. The physiological and biochemical changes related to zinc metabolism and exercise are complex, and the effect of exercise on any one compartmental level or enzyme level of zinc has been seen to vary by the type of exercise (aerobic or anaerobic), duration of exercise, intensity of exercise, as well as the repetition of certain exercise over long periods of time. Given the function of zinc in exercise, the zinc status of an individual prior to the start of exercise is an important element. As you will see in Table 1, the starting zinc status for the US population is low. Knowing that over the long haul, exercise programs demand zinc, and that marginal deficiencies in zinc will have a negative impact on the immune system and health, a dietary program to insure proper zinc intake is important to athletic success.

Table 1. Keep these numbers in mind on Zinc

Plasma levels of zinc drop from 12 to 33% during exercise or training (only a third of this is due to plasma expansion).
Urinary zinc loss increases 10 to 45% after moderate exercise.
Sweat loss of zinc after one hour of moderate exercise: **Males 0.65mg/hour** **Females 0.4mg/hour**
Normal dermal loss of zinc is 0.76mg/day.
NHANES III results on US zinc intake: 68% receive less than two thirds the RDA.

The Best Zinc to Supplement!

If you are thinking about putting together a dietary formulation aimed at taking care of the needs of people who are involved in exercise training programs, and other regular athletic performances, you need to use one that is of good bioavailablity and free of tolerance problems or adverse effects. In the recent published study, abstracted below, Albion's Zinc (Bis)Glycinate Chelate was demonstrated to be a zinc form that more than meets these parameters.

A Bioavailability Study Comparing Two Oral Formulations Containing Zinc (Zn Bis-glycinate vs. Zn gluconate) After a Single Administration to Twelve Healthy Female Volunteers.
Gandia P, et al.
Int J Vitam Nutr Res; 2007;77(4):243-8.

As the current nutritional zinc intake frequently falls outside the Dietary Reference Intake (DRI) and as zinc is an essential trace mineral involved in the function of many enzymes, zinc supplementation has been recommended to prevent or treat the adverse effects of zinc deficiency. The aim of the present study was to compare the oral bioavailablity of zinc bis-glycinate (a new formulation) with zinc gluconate (reference formulation). A randomized, cross-over study was conducted in 12 female volunteers. The two products were administrated orally at the single dose of 15mg (7.5 mg X 2), with a 7-day wash-out period between the two tests. Serum concentrations (Figure 1) of zinc were assayed by a validated inductively coupled plasma optical emission spectrometry (ICP-OES) method and C(max), T(max), and areas-under-the-curve (AUCs) were determined. The comparison between the two treatments was performed by comparing the C(max), AUC(t), and AUC(inf) using an analysis of variance followed by the calculation of the 90% confidence intervals of the ratio test/reference. Bis-glycinate administration was safe and well tolerated and bis-glycinate significantly increased the oral bioavailability of zinc (+43.4%) compared with the gluconate.

Table 2. Sum Increase in Plasma Zinc Concentration (↔g/ml).

Sum Increase Treatment	Mean
Zinc Picolinatemoderate exercise.	0.4661
Zinc Gluconate	0.8909
Zinc Glycine Chelate	1.4937
Zinc Oxide	0.464

In another zinc absorption study, by Dr. Robert DiSilvestro at Ohio State University (not yet published), Zinc (Bis)Glycinate Chelate was compared to zinc picolinate, zinc gluconate and zinc oxide. Table 2 lists the increase in plasma zinc seen with each zinc form. It can be seen from the data in this table that the Zinc Glycine Chelate (Albion) outperformed the other three forms of zinc by a wide and significant margin. The intestinal absorption rate of Zinc Glycine Chelate as compared to the other three forms came to:

- 3.2 times that of zinc picolinate
- 1.67 times that of zinc glyconate
- 3.22 times that of zinc oxide.

Figure 1. Mean concentrations curve: Comparison of 2 oral formulations containing zinc in human serum

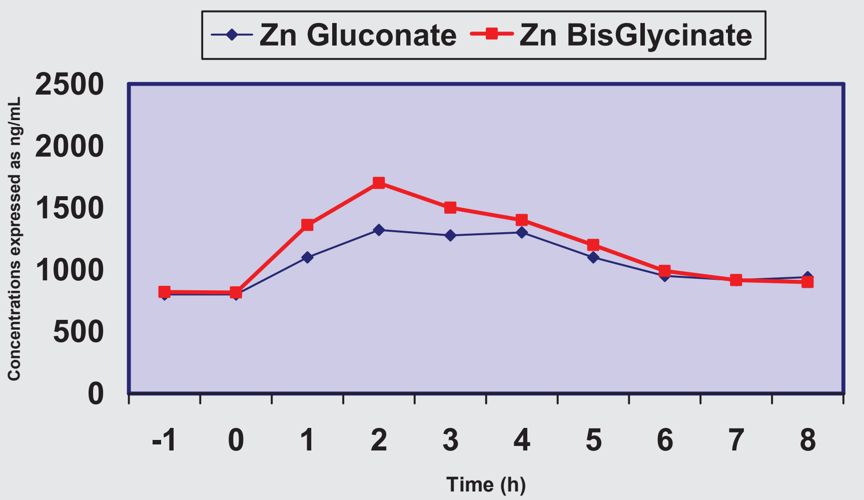

Figure 1. Mean of zinc serum concentrations vs. time measured after a single oral administration of 7.5mg x 2 zinc as gluconate (reference treatment) and bisglycinate-test treatment) in twelve healthy female volunteers.

In Conclusion

Exercise requires proper mineral status. No question about this. Exercise has been shown to increase the turnover of minerals. This issue of Albion's Research Notes has discussed some of the relationships between minerals, sports and exercise. The increased need for zinc that can be brought upon people involved in sport and physical training has been stressed. However, as we know, zinc is not the only mineral that is critical to exercise physiology. In the next issue of Albion's Research Notes, we will look into the relationship between sports, exercise, and magnesium

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- Zinc Glycinate Chelate
- Zinc Glycinate Chelate Taste Free®
- Zinc Arginate Chelate

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