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Original research article

The effect of different doses of zinc supplementation on serum element and lactate levels in elite volleyball athletes

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ABSTRACT

The present study aims to examine the effect of different doses of zinc administration on serum element metabolism and fatigue. The study registered 20 female elite athletes. The subjects were divided into two groups in equal numbers. Group supplemented with 220 mg/day zinc sulfate. Group supplemented with 440 mg/day zinc sulfate. Athletes who were already engaged in their daily training routines were put to a 20-m shuttle run test to create fatigue before and after supplementation. Blood samples were collected from the subjects for a total of 7 times, before and after zinc supplementation and during rest and after exercise within one-week intervals over the course of the 4-week supplementation. The blood samples collected as such were analyzed to determine serum magnesium, phosphorus and calcium, zinc, iron, copper, and selenium, and plasma lactate. Both exercise and zinc supplementations significantly elevated magnesium, calcium, and iron levels for 4 weeks. Pre-supplementation exercise elevated plasma lactate levels, while zinc supplementation led to a fall in plasma lactate. The results of the present study indicate that zinc-supplementation for 4 weeks may have a positive impact on athletic performance by delaying fatigue.

Introduction

Involved in the structure of more than 300 enzymes in the living organism and essential for a variety of metabolic reactions, zinc is an important trace element (Vallee and Falchuk, 1993). As a number of immune and endocrine functions depend on zinc, its deficiency is associated with problems in some physiological activities including cell proliferation, wound recovery, bone metabolism, growth and development, brain functions, regulation of nutrition, etc. (Prasad, 2009a, 2009b, 2013; Baltaci et al., 2004). Zinc, which is essential for carbohydrate, protein, and fat metabolisms, is integrally related to exercise (Vallee and Falchuk, 1993; Bicer et al., 2012). Its effects on tissue repair and protein synthesis, in particular, indicates the importance of zinc in post-exercise recuperation (Prasad, 1985; Kilic, 2007). In addition to the effects of zinc on exercise and performance, exercise has critical effects on zinc metabolism. Previous studies showed that not only low-intensity exercise produced short-term effects on zinc metabolism, but also high-intensity exercise performed for a prolonged period could do so (Cordova and Alvarez-Mon, 1995). These studies demonstrated a decrease in zinc levels after exercise (Haralambie, 1981; Couzy et al., 1990; Khaled et al., 1999). Low zinc levels may lead to a fall in muscle zinc concentrations. As zinc is required for the activity of a number of enzymes in the energy metabolism, reduced muscle zinc levels may bring about a decrease in endurance capacity (Cordova and Alvarez-Mon, 1995). It may be that the zinc deficiency observed in athletes performing endurance training is a factor triggering various functional changes in different systems and tissues that may be associated with the pathogenesis of fatigue (Cordova and Navas, 1998).

McDonald and Keen (1988) have reported that it is important known of relationship between interaction diet zinc and other elements for sportsperson health and performance. It has been postulated that zinc has significant effects on element distrubution in body (Eskici et al., 2016); especially has on positive affects on calcium-phosphor metabolism özellikle kalsiyum-fosfor metabolizması (Baltaci et al., 2014) and zinc supplementation has

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regulatory effects on magnesium, phosphor, calcium, iron, cupper and selenium levels (Sivrikaya et al., 2012). All of them mentioned references show posisble affects of zinc elements metabolism in sportsperson. The objective of the present study is to examine the effect of different doses of zinc supplementation on serum element metabolism and fatigue.

Materials and methods

Participants

The research included 20 female athletes who were on the volleyball team of Gazi University Sports Club and whose mean age, weight, and height were 15.1 ± 1.07 years (14–17), 59.9 ± 6.4 kg (50.4–72.2), and 175.3 ± 6.5 cm, respectively. The subjects (and/or their parents) who were verbally informed also signed copies of the Helsinki Declaration explaining who is conducting the study and why. The study protocol was approved by the Ethics Committee of Selcuk University School of Physical Education and Sports.

We have conducted the present research, each group of athletes's in resting and exhausting period lactate and serum element levels were determined; thereafter we postulated pre-measured periods as control levels. We have not used different control group.

The athletes in the study were divided into two groups:

Group 1 was supplemented with 220 mg/day zinc sulfate (Each 220 mg zinc sulphate has included 50 mg elemental zinc) and Group 2 was supplemented with 440 mg/day zinc sulfate (Each 440 mg zinc sulphate has included 100 mg elemental zinc). (Zinc sulfate capsules were supplied by Berko Drug and Chemicals Industry Inc. in the form of capsules each containing 220 mg zinc sulfate.) Mentioned doses were used previous search (Duchateau et al., 1981).

Procedures

The athletes who continued their routine daily training (6 days a week) were put to a 20-m shuttle run test before and after supplementation to induce fatigue (Gunay et al., 2006). 20 m shuttle run test, one of the aerobic power field test was performed in order to create just fatigue. Blood samples were collected from the subjects for 7 times before and after zinc supplementation and during rest and after exercise in one-week intervals over the course of 4 weeks. Blood samples (10 ml) were taken by specialist medical staff (nurse) from the forearm vein. Since the athletes were all females, the analyses were interrupted in the week they had their menstruation. The samples were stored at −80 °C until the time of analysis. The study was conducted during the 8- to 10-week general preparation period (consisting of 70–80% strength and 20–30% technical/tactical training) of the athlete group.

Serum zinc, magnesium, phosphorus, calcium, iron, copper, and selenium analyses

Blood samples put into Eppendorf tubes were centrifuged at 3000 rpm for 10 min to separate serum. Serum samples obtained as such were analyzed for magnesium, phosphorus, calcium (mg/dl), zinc, iron, copper, and selenium (μg/dl) levels in an atomic emission device (ICP-MS).

Plasma lactate analyses

Blood samples of 2 ml were put into tubes containing fluoride-oxalate anticoagulant. The tubes were kept in ice blocks for 15 min and then centrifuged at 3000 rpm at 4 °C for 5 min to separate plasma. Plasma lactate levels were determined in Rocher Cobas Mira Plus brand device (Lot number: W253088) (read at 556 nm wavelength) as mmol/l.

Statistical evaluations

Mann Whitney *U* test was employed to determine the differences between groups. The comparison of measurements at different times within the group tested with two-way repeated measures analysis of variance, which arise from timing differences to determine whether the Bonferroni test was used. Level of significance was taken to be $p < 0.05$.

Results

Pre-supplementation serum element levels of the groups (at rest and after exercise)

Serum Mg, Ca, Fe, Cu, Se, P, and Zn levels measured before supplementation (at rest and post-exercise) were not different between groups 1 and 2 (Table 1). Likewise, there was no significant difference between serum Mg, Ca, Fe, Cu, Se, P, and Zn levels measured at rest in weeks 1, 2, 3, and 4 after supplementation in groups 1 and 2 (Table 1).

Post-supplementation serum element levels of the groups after exercise

Serum Mg, Ca, Fe, Cu, Se, and Zn levels measured after exercise in the post-supplementation period in groups 1 and 2 were not different, whereas *p* level in group 1 was significantly higher than that in group 2 ($p < 0.05$, Table 1).

Comparison between pre- and post-zinc supplementation and pre- and post-exercise serum element levels

Exercises both before and after zinc supplementation increased magnesium, calcium, iron, copper, selenium, phosphorus, and zinc levels in both groups 1 and 2, in comparison to the levels measured in pre-exercise periods ($p < 0.05$, Tables 2 and 3).

Comparison between the weekly changes caused by zinc supplementation in serum element levels in groups 1 and 2

Zinc supplementation significantly elevated magnesium, calcium, iron, and zinc levels over the course of 4 weeks ($p < 0.05$, Tables 2 and 3).

On the other hand, zinc supplementation significantly reduced copper and selenium levels in one-week periods over the course of 4 weeks ($p < 0.05$), while it did not cause any change in phosphorus levels (Tables 2 and 3).

Comparison between plasma lactate values

Pre-supplementation exercise increased plasma lactate levels ($p < 0.05$, Table 4), while exercise after zinc supplementation decreased plasma lactate ($p < 0.05$, Table 4).

Discussion

Discussion of magnesium, calcium, and iron levels in the study groups

Both exercise and zinc supplementation significantly elevated magnesium, calcium, and iron levels for 4 weeks.

Despite the presence of contradicting results (Lukaski, 2000), magnesium (mg),

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