Original Article

EFFECT OF EXHAUSTING EXERCISE AND CALCIUM SUPPLEMENTATION ON POTASSIUM, MAGNESIUM, COPPER, ZINC AND CALCIUM LEVELS IN ATHLETES

Vedat Cinar[1], Abdulkerim Kasim Baltaci[2], Rasim Mogulkoc[3]

ABSTRACT

Objective: Present study was performed to determine four week calcium supplementation and athleticism exercise on plasma potassium, calcium, magnesium, cupper and zinc levels in resting and exhaustion.

Methodology: Research was carried out on 30 healthy male people. Group 1; Exercise, Group 2; Exercise + Calcium supplementation, Group 3; Sedentary+Calcium supplemented.

Results: All elements levels increased by exhausting exercise ($P<0.05$). Plasma K and Ca levels increased in exercise group after supplementation ($P<0.05$). Ca levels increased in exercise + supplemented group ($P<0.05$). This increase was much more in group three ($P<0.05$). Plasma Cu levels increased by Ca supplementation in sedentary ($P<0.05$). Exhausting exercise increased Zn levels in sedentary after supplementation ($P<0.05$).

Conclusion: The results of present study show that calcium supplementation for 4 week does not have clear affect on potassium and Mg. However, calcium levels were increased by supplementation and Cu after the supplementation. It was also exhausting exercise that caused increase in all parameters.

KEY WORDS: Athletes, Ca supplementation, K, Mg, Cu, Zn, Exhaustion.

Pak J Med Sci April - June 2009 Vol. 25 No. 2 238-242

How to cite this article:

Cinar V, Baltaci AK, Mogulkoc R. Effect of Exhausting Exercise and Calcium Supplementation on Potassium, Magnesium, Copper, Zinc and Calcium Levels in Athletes. Pak J Med Sci 2009;25(2):238-242.

1. Vedat Cinar,
Karaman High School of Physical Education and Sport,
Selcuk University, Karaman, Turkey.
2. Abdulkerim Kasim Baltaci,
3. Rasim Mogulkoc,
2-3: Departments of Physiology,
Meram Medical School,
Selcuk University,
Konya,
Turkey.

Correspondence

Dr. Vedat Cinar
Karaman High School of Physical Education and Sport,
Selcuk University,
Karaman,
Turkey.
E-mail: bsyovedat@yahoo.com.tr

* Received for Publication: September 13, 2008

* Accepted: January 25, 2009

INTRODUCTION

In human body, many trace elements take part in numerous physiological and biochemical events.[1] The changes in the element levels changes depending on the type, length and intensity of the exercise, as well as the nutritional behavior.[2] In parallel to the factors mentioned above, the changes at the levels of the trace elements inevitably affect the performance in athletes as well. In recent years, relationships between the type of the nutrition in the athletes and the performance in sports have begun to be researched extensively.[3,4] In exercises performed at top levels, the trace element intake is affected.[5] Intake of energy

into the body is also related to a great extent with the magnesium, phosphorus, iron, the vitamins and VO_2Max.[6]

The nutritional behaviors are different for the sports men and women and the amounts of the trace element taken can vary.[7,8] While the low intakes of calcium lessen the bone intensity, the low intakes of iron can affect the performance as well.[9] The intake of zinc and copper in adequate levels has an important role in the antioxidant response of the body to exercise.[10] The trace elements such as magnesium and zinc needs to be present in the normal levels for maintain of the health and the normal physiological functions.[11] As a result of exercise performed, the athletes can lose a certain amount of calcium with the sweat. However, the deficiency of calcium emerging due to this can be compensated by means of the commercial calcium preparations or calcium-rich foods.[12] The most common ones among the low-level micro-nutrients are calcium, which constitutes the bones, iron and zinc.[13]

The purpose of this study was to investigate the effects of a four-week calcium support and running exercise on the serum calcium, potassium, magnesium, cupper and zinc levels.

METHODOLOGY

Subjects: Thirty healthy male athletes of ages between 17–21 years voluntarily enrolled in the study. Before the start of the research protocol, all the subjects gave their informed consent for participation in the study. The participants were divided into three groups of ten subjects each, kept under distinct regimes for four weeks as follows:

Group 1: Athletes performing training routines for 90 min/day, five days a week.

Group 2: Athletes performing training routines for 90 min/day, five days a week while receiving 35 mg /kg/day of a calcium gluconate supplement.

Group 3: Athletes receiving 35 mg/kg/day calcium gluconate supplement, no training. All participants tolerated dose and produced any side-effects or affected general well-being.

Before and after four week calcium supplementation and athletics exercise, total four times blood samples were taken and plasma Ca, K, Mg, Cu and Zn levels were analyzed in Atomic absorption spectrofotometry. Levels were gives as mg/dl for Ca and Mg, mEq/l for K, Zn ug/dL for Zn and umol/L for Cu. The training routines have been described in a previous paper.[14]

Statistics Analysis: The results are expressed as means ± SD. The statistical analysis was carried out with the SPSS statistical program. The Kruskal-Wallis analysis of variance was used for comparison between groups and the Mann-Whitney U-test was applied to those with $p<0.05$.

RESULTS

When the plasma calcium levels prior to the supplementation are examined, there was no difference among the groups for the levels in the rest and exhausted situations. However, when the values are evaluated within the groups, it was found out that the exhaustion changed the plasma calcium levels ($P<0.05$).

When the rest values following the support are examined, it was seen that only the groups the support had been given had higher levels than the training groups. Similar findings were obtained for the post-support exhaustion levels as well ($P<0.05$).

It was also found out that the potassium levels had also increased in the exhausted state in the trained groups both before and after the support ($P<0.05$). Similar increase were observed in the sedentary group to whom a calcium support had been applied ($P<0.05$). When the plasma calcium levels were evaluated, it was seen that the exhaustion levels before the support were higher than the rest values in all groups ($P<0.05$). Similar findings were obtained after the four-week application as well ($P<0.05$). Plasma Cu levels increased in exercise + Ca supplemented group after the exhausting exercise ($P<0.05$). Resting Cu levels after the supplementation increased in sedentary group (group 3, $P<0.05$). The highest Cu levels were determined in exercise plus Ca

Table-I: Plasma Elements in Groups

	Measurement	*Exercise*	*Exercise + Ca*	*Ca*
Ca (mg/dl)	I.	8.80±0.88 b	8.92±0.78 c	9.56±1.72 c
	II.	9.99±0.72a	10.21±0.82ba	13.09±1.08a
	III.	10.02±1.20a	10.18±1.06b	11.55±1.86b
	IV.	10.21±0.71ax	13.56±1.23ay	14.04±1.12az
K (mEq/l)	I.	3.67±0.81b	3.65±1.08b	3.99±0.86
	II.	4.26±0.69a	4.15±0.88a	3.99±0.78
	III.	4.13±0.51a	3.69±0.78b	4.24±1.02
	IV.	4.20±0.77a	4.23±0.58a	4.04±0.92
Mg (mg/dl)	I.	1.87±0.27b	1.87±0.21b	1.89±0.23b
	II.	2.10±0.31a	2.03±0.53ba	2.03±0.47a
	III.	1.90±0.23b	1.91±0.67b	1.87±0.32b
	IV.	2.16±0.17a	2.16±0.18a	2.01±0.41a
Cu (umol/L)	I.	8.68±0.84	9.58±1.56b	9.95±1.54b
	II.	9.94±0.91	10.00±1.81a	9.81±1.21b
	III.	9.35±1.21	9.33±0.86b	13.92±1.62a
	IV.	9.69±0.76xy	10.18±1.21ax	8.93±0.89by
Zn (ug/dL)	I.	78.80±4.98b	76.50±4.81b	78.30±5.87b
	II.	86.30±5.87ba	85.60±5.65a	84.80±4.98b
	III.	81.00±6.20b	78.90±6.41b	78.70±5.71b
	IV.	91.90±5.10a	94.30±5.87a	91.00±6.50a

a, b, c different letters are significant in same column (P<0.05)
x, y, z different letters are significant in same line (P<0.05)

I. Resting before supplement (Rbs)
II. Exhaustion before supplement (Ebs)
III. Resting after supplement (Ras)
IV. Exhaustion aftersupplement (Eas)

supplemented group (P<0.05). Exhausting plasma Zn levels increased before supplement (P<0.05).

DISCUSSION

The most important finding of the present study is that the four-week calcium support increased the plasma calcium and potassium and copper levels in athletes. Besides this, even though not statistically significant, certain increase occurred in the magnesium levels as well. It is known that different types of exercise and different mineral supports affect the body trace elements in different ways. Besides, a certain amount of trace elements are lost by means of perspiration during the training workouts or by means of urination.[15,16] In order to allow bone formation and prevent osteoporosis, it is necessary to intake adequate amounts of calcium. However, since the athletes lose calcium through perspiration as well, they need to compensate the resulting deficit by means of their diet or by means of calcium-rich commercial preparations.[12]

In the present study, though the plasma calcium levels increased after the support, this increase was found to be less in the group which performed training together with the support. These findings show that the four-week athletics training caused a certain loss in calcium. In fact, some previous studies have also shown that different branches of sports cause differences in calcium levels.[9,13] In our study, the fact that the plasma calcium levels in the trained groups was found to be lesser than only the sedentary group which took

support shows that a certain rate of deficit occurs with training. When the plasma levels of magnesium are evaluated, it is seen that this parameter is not influenced by the calcium support neither in the athletics group nor in the sedentary group. However, it was found out that the exhaustion increased the Mg levels both before and after the support. In the studies in which the Mg levels in exercise are investigated, the Mg levels are generally found to have increased.[17-19] In these studies, the increase in the Mg levels are generally determined immediately after the exercise and are in parallel to the findings obtained in our study regarding the exhaustion. The changes in the serum and plasma Mg levels are at the same time related to the type of the exercise.[20] While these levels generally increase with the short-period exercises performed until the exhaustion, they are reported to be decreasing in the long-period exercises.[21] These results are also in parallel to the results obtained in our present study. It was seen that this potassium increased with the four-week athletics training. In a way similar to the plasma Mg levels, the exercise performed up to the point of exhaustion was seen to increase the plasma potassium levels. In the studies carried out on the subject, different results have been obtained. It was reported that losses does occur in different elements in the body through perspiration in the long-period exercises.[22] It was also reported that the decrease emerging in the plasma potassium levels during the exercise resulted from the increase in the muscle sodium-potassium pumping action and the decrease in the cellular potassium loss.[23] However, in another study it was seen that the repeated maximal exercises caused an approximately 50% increase in the potassium levels.[24] The function of the erythrocytes emerges as an important factor in the regulation of this ionic balance.

In another study, it was reported that while the arterial erythrocyte potassium levels increased the venous erythrocytes potassium levels are not significantly affected by the exercise, in a way similar to the one mentioned above.[25] It has been suggested that a certain concentration difference between the plasma and muscles are maintained since the potassium and the molecules such as lactate and chlorine by the erythrocytes. In our present study, however, it was found out that though the finding that the long-period (four-week) athletics training causes an increase in plasma potassium levels is contrary to some studies,[22,23] it is in parallel to the other study.[24,25] But, it was found out that the calcium support carried out additional to the athletics training has not a significant effect on this parameter. The increases in the plasma potassium levels which we found out in the present study may have resulted from two reasons. The first of these reasons is the liquid losses occurring during the exercise, and the second is the inadequacy in the mechanisms which are effective in the changes in the interstitial liquid. Plasma Cu and Zn levels increased after the exhausting exercise in our research. In similar studies it has been reported that whole-body sweat losses of calcium, copper and magnesium occurred after the exercise.[26,27] In our study, especially after the exercise these parameters increased. However, we found that plasma Cu levels increases in much more sedentary group. Consequently, it was found out that the four-week running training and calcium support do not affect the plasma magnesium levels, but cause a certain increase in the calcium and potassium and copper levels. However, plasma zinc levels increased by exhausting exercise after the Ca supplementation.

REFERENCES

1. Cordova A, Alvarez-Mon M. Serum Magnesium and immune parameters after maximal exercise in sportsmen. Magnes Bulletin 1996;18:66-70.
2. Haymes EM. Nutritional concerns: need for iron. Med Sci Sports Exerc 1987;19:197-200.
3. Brotherhood JR. Nutrition and sports performance. Sports Med 1984;1:350-89.
4. Clark M, Reed DB, Crouse SF, Armstrong RB. Pre- and post-season dietary intake, body composition, and performance indices of NCAA division I female soccer players. Int J Sport Nutr Exerc Metab 2003;13:303-19.
5. Couzy F, Lafargue P, Guezennec CY. Zinc metabolism in the athlete: influence of training, nutrition and other factors. Int J Sports Med 1990;11:236-63.

6. Chatard JC, Boutet C, Tourny C, Garcia S, Berthouze S, Guézennec CY. Nutritional status and physical fitness of elderly sportsmen. Eur J Appl Physiol Occup Physiol 1998;77:157-63.
7. Cupisti A, D'Alessandro C, Castrogiovanni S, Barale A, Morelli E. Nutrition knowledge and dietary composition in Italian adolescent female athletes and non-athletes. Int J Sport Nutr Exerc Metab 2002;12:207-19.
8. Fogelholm M, Rankinen T, Isokääntä M, Kujala U, Uusitupa M. Growth, Dietary intake and trace element status in pubescent athletes and schoolchildren, Med Sci Sports Exerc 2000;32:738-46.
9. Haymes EM. Vitamin and mineral supplementation to athletes. Int J Sport Nutr 1991;1:146-69.
10. Coury JC, de Olilveria AV, Portella ES, de Olilveria CF, Lopes GC, Donangelo CM. Zinc and copper biochemical indices of antioxidant status in elite athletes of different modalities. Int J Sport Nutr Exerc Metab 2004;14:358-72.
11. Lukaski HC. Magnesium, zinc, chromium nutriture and physical activity. Am J Clin Nutr 2000;72:585S-93S.
12. Kunstel K. Calcium requirements for the athlete. Curr Sports Med Rep 2005;4:203-6.
13. Manore MM. Dietary recommendations and athletic menstrual dysfunction. Sports Med 2002;32:887-901.
14. Léger LA, Lambert J. A maximal multistage 20-m shuttle run test to predict VO2 max. Eur J Appl Physiol Occup Physiol 1982;49:1-12.
15. Shirreffs SM, Armstrong LE, Cheuvront SN. Fluid and electrolyte needs for preparation and recovery from training and competition. J Sports Sci 2004;22:57-63.
16. Shirreffs SM. Restoration of fluid and electrolyte balance after exercise. Can J Appl Physiol 2001;26:S228-35.
17. Stendig-Lindberg G, Shapiro Y, Tepperberg M, Moran D. Not only strenous but also sustained moderate physical effort causes magnesium deficiency. Magnes Bull 1996;18: 66-70.
18. Liu L. Hypomagnesemia in a tennis player. Physician Sports Med 1983;11:79-80.
19. Marella M, Guerrini F, Solero PL, Tregnaghi PL, Schena F, Velo GP. Blood copper and zinc changes in runners after a marathon. J Trace Elem Electrolytes Health Dis 1993;7:248-50.
20. Bohl CH, Volpe SL. Magnesium and exercise. Crit Rev Food Sci Nutr 2002;42:533-63.
21. Rayssiguier Y, Guezennec CY, Durlach J. New experimental and clinical data on the relationship between magnesium and sport. Magnes Res 1990;3:93-102.
22. Montain SJ, Cheuvront SN, Lukaski HC. Sweat mineral-element responses during seven hour of exercise-heat stress. Int J Sport Nutr Exerc Metab 2007;17:574-82.
23. McKenna MJ, Heigenhauser GJ, McKelvie RS, MacDougall JD, Jones NL. Sprint training enhances ionic regulation during intense exercise in men. J Physiol 1997;15:687-702.
24. Lindinger MI, Heigenhauser GJ, McKelvie RS, Jones NL. Blood ion regulation during repeated maximal exercise and recovery in humans. Am J Physiol 1992;262:R126-36.
25. McKelvie RS, Lindinger MI, Heigenhauser GJ, Jones NL. Contribution of erythrocytes to the control of the electrolyte changes of exercise. Can J Physiol Pharmacol 1991;69:984-93.
26. Chinevere TD, Kenefick RW, Cheuvront SN, Lukaski HC, Sawka MN. Effect of heat acclimation on sweat minerals. Med Sci Sports Exerc 2008;40:886-91.
27. DeRuisseau KC, Cheuvront SN, Haymes EM, Sharp RG. Sweat iron and zinc losses during prolonged exercise. Int J Sport Nutr Exerc Metab 2002;12:428-37.