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Full Length Research Paper

Effect of a three-month football training program on trace element metabolism of boys in the eight to twelve age group

Ersan Kara

Karabuk University, Hasan Dogan High School of Physical Education and Sports, Karabuk-Turkey.
E-mail: kara74@gmail.com.

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This study was conducted to examine the effects of a three-month football training program on some trace elements in the serum in male kids aged between eight and twelve years. The study registered eight boys whose mean age was 10.25 ± 0.75 years, mean height was 138.63 ± 3.28 cm and mean weight was 32.13 ± 2.72 kg. The subjects were regularly trained in the accompaniment of coaches for three months (four to five days a week). Blood samples of 5 ml each were taken into plain tubes from the subjects twice, once at the beginning of the study and the other at the end of the three-month training sessions, after 12 h of nocturnal fasting. Serum cobalt (Co), cadmium (Cd), nickel (Ni), molybdenum (Mo), manganese (Mn), aluminum (Al), copper (Cu), zinc (Zn) and iron (Fe) levels were measured using an atomic absorption spectrophotometer. The results were expressed in mg/L. Cadmium, molybdenum, copper and zinc ($p<0.05$) values were measured after the study and were found significantly lower than those before the study. Results of this study demonstrate that three-month football training significantly reduced cadmium, molybdenum, copper and zinc values in eight to 12-year-old boys. The decrease in zinc levels in particular may be critical for the athletes health and performance.

Key words: Football, boys, cadmium, molybdenum, copper, zinc.

INTRODUCTION

Participation of children in youth sport is rapidly growing in the United States and around the world (VanHeest and Cappaert, 2004). Although, the participation of children in sport from the age of six to 11 differs from one country to another in Europe, it is considered to be between 53 and 98% (Petrie et al., 2004). Football is the most common sport branch which is played by 7 million children between the ages of six to 11. Football plays an important role in terms of both supporters and players in Turkey. Football is the most favorite sport branch for primary and secondary schools student and it is widely watched by adults in Turkey (Bozkurt, 2000). As children become involved in sport, the risks and benefits of participation must be evaluated (VanHeest and Cappaert, 2004). The lack of calcium and iron is observed frequently in young players, their health and physical performance are badly affected (Juzwiak, 2000). Many of the trace elements play a part in the physiological events in the organism. Most notably, trace elements like zinc and copper are involved in carbohydrate, protein and fat metabolisms (Campbell and Anderson, 1987). Therefore, it is important to show whether exercise affects the functions of these trace elements (Campbell and Anderson, 1987).

Several researchers reported that post-exercise decreases the levels of trace elements in the blood and tissues (Bordin et al., 1993; Campbell and Anderson, 1987; Konig et al., 1998). It is accepted that these decrease may depend on the type and severity of exercise, as well as factors like individual regulation status and nutrition (Konig et al., 1998). That physical exercise causes a re-distribution of various trace elements between body reserves, blood and tissues, and that the increased metabolism results in trace element deficiencies suggest a possible correlation between sportive performance and trace element metabolism (Bordin et al., 1993). It was noted that athletes might particularly suffer from zinc and copper deficiencies, which might result from insufficient dietary intake, as well as loss of trace elements through perspiration and urine due to physical activity (Clarkson, 1991). It was stated that zinc and magnesium are important in increasing muscle strength and metabolism (Lukaski, 2000), while copper and selenium are associated with antioxidant activity, and consequently that trace element-mineral supple-mentation could contribute to the health of athletes (Clarkson, 1991). However, it should be borne in mind regarding trace element-mineral supplementation, and zinc and iron support in particular, that excessive supplementation can also be harmful (Gleeson and Bishop, 2000). Consequently, it may be argued that there is a bidirectional and inevitable relationship between physical exercise and trace element metabolism (Marrella et al., 1993; McDonald and Keen, 1988). It is seen that studies about physical activity and trace element meta-bolism generally focuses on elite athletes (Bordin et al., 1993; Campbell and Anderson, 1987; Konig et al., 1998; Marrella et al., 1993). It has been suggested that blood and tissue deficiency of trace elements particularly zinc causes retarded growth and hypogonadizm in young males (Baltaci et al., 2006; Ozturk et al., 2003; Ozturk et al., 2005). Especially, the zinc-dependency on dihydro-testosteron, the active form of testosteron , 5 α-reductase and type 1,5'-deiyodinaz which converts T_3 (Triiyodotronin) to T_4 (Tyroxin) highlights the importance of zinc metabolism in young male children (Baltaci et al., 2003; Baltaci et al., 2004).

This study aimed at investigating how a three-month football training program affects trace element meta-bolism in eight to 12-year-old boys.

MATERIALS AND METHODS

Subjects

The study was performed at Karabuk Youth Sport Directorship facilities on male children attending sport schools. The study included eight male children aged between eight and 12. The mean age of the subjects was 10.25 ± 0.75 years, mean height was 138.63 ± 3.28 cm and mean weight was 32.13 ± 2.72 kg. The subjects were regularly trained (four to five days a week) by coaches for three months. Football technique and tactic training sessions were of medium intensity, endurance training was of 60 to 70% intensity, while strength and speed training sessions were of 80 to 90% intensity. Exercise intensity was determined by Karvonen methods [(220 – age = maximum heart rate/ training heart rate: (maximum heart rate – resting heart rate) x (density + resting heart rate)] (De Geus et al., 2004). The family of the subjects was informed about the study protocol before enrolment and family approval was obtained, medical check of exercise suitability was also obtained. The study protocol was approved by the local ethics committee.

Collection of blood samples

Blood samples of 5 ml were taken after 12 h of fasting from all subjects into plain tubes. The samples were collected twice, one at the beginning of the football training program and the other at the end of the three-month training. Blood samples were obtained by a nurse under supervision of physician in charge at Karabuk Youth Sport Directorship. After the blood samples clotted, they were centrifuged at 3000 rpm for 10 min to separate serum. Separated sera were kept at -80°C until analysis time.

Determination of serum cobalt (Co), cadmium (Cd), nickel (Ni), molybdenum (Mo), manganese (Mn), aluminum (Al), copper (Cu), zinc (Zn) and iron (Fe)

Levels of cobalt, cadmium, nickel, manganese, molybdenum, copper, iron and zinc in the sera were determined using an atomic absorption spectrophotometer device.

Levels of serum Cu, Zn and Fe were determined by using a Varian AA240FS (Australia) model atomic absorption spectro-photometer found in the Analytical Chemistry Department of Gazi University, Faculty of Arts and Sciences. The measurements were conducted twice for each sample, using light at 2139 wavelength according to flame atomization method. Levels of serum copper, zinc and iron were determined as mg/L. Serum Mo, Co, Cd, Ni, Sb, Mn, Al levels were measured twice for each sample, using the Varian AA240 (Zeeman) electrothermal atomic absorption spectrometer found in the Analytical Chemistry Department of Gazi University, Faculty of Arts and Sciences. The results were presented as mg/L. No financial support was obtained for the analysis performed during the study.

Statistical evaluations

SPSS 15.0 computer software was used in the statistical evaluation of the results. Arithmetic means and standard deviations of all parameters were calculated. The differences between the parameters were obtained by use of repeated measures and ANOVA test. Normality was tested by (K – S), and it was found that the data was evenly distributed ($p<0.05$). Differences for $p<0.05$ were considered significant. The results were expressed as mean ± standard error.

RESULTS AND DISCUSSION

It was observed that cadmium, molybdenum, copper and zinc values of the subjects measured at the end of 3-month training and were significantly lower than those at the beginning of the football training program ($p<0.05$, Table 1). Serum cobalt, nickel, manganese, aluminum and iron levels were determined after the study, however, it did not differ from those before the study (Table 1).

Three months of football training caused a significant decrease in serum zinc levels of children. Several researchers have reported that training affects the trace element metabolism in athletes (Arikan et al., 2008; Baltaci et al., 2009; Baltaci et al., 2010). It was noted that physical exercise affects serum zinc levels in particular, but that this correlation was associated with the duration of exercise (Khaled et al., 1997). Short-term and medium-intensity exercises elevate zinc levels due to the passage of fluid to the intracellular space (Khaled et al., 1997) whereas, long-term exercises and regular training reduce the zinc in the plasma and body reserves (Cordova and Alvarez-Mon, 1995). Consequently, zinc deficiency is more common in athletes and training people, than in

Table 1. Serum trace element levels of subjects before and after the study (mg/L).

Parameter (mg/L)	Beginning of the football training program	The end of 3-month training
Cobalt	0.51±0.18	0.35±0.06
Cadmium	0.24±0.02	0.17±0.02*
Nickel	0.25±0.05	0.23±0.04
Molybdenum	1.03±0.05	0.91±0.05*
Manganese	1.23±0.14	1.44±0.09
Aluminum	6.43±1.91	3.59±0.20
Copper	0.93±0.02	0.57±0.03*
Zinc	0.93±0.07	0.66±0.04*
Iron	0.30±0.02	0.30±0.03

*Lower, relative to the level before the study ($p<0.05$).

sedentary individuals (Lukaski, 1995; Singh et al., 1994). These results may be critical in the practice of sports, as depleted zinc reserves have been suggested to be associated with impaired immune functions and decreased performance (Gleeson et al., 2004; Kilic et al., 2006). That three-month football training was found to have decreased serum zinc values significantly in child footballers in our study is consistent with the findings of the researchers cited above. However, it is known that studies on this topic usually focus on elite and adult athletes. Our study concerns the effects of a three-month football training program on the trace element metabolism of male subjects in the eight to 12 age group. This finding of decreased zinc levels we obtained in male children may be very important, as zinc is involved in various clinical and physiological functions such as growth, sexual maturation, development and immune functions (Baltaci et al., 2005; Baltaci et al., 2006). In this respect, it can be suggested that zinc levels in child athletes should be continuously followed and zinc support should be provided in case of deficiency.

Marathon runners were reported to experience a decrease in erythrocyte copper content and an increase in plasma copper (Marrella et al., 1993), while Cordova et al. (1990) reported significantly elevated plasma copper levels after 2 h exercise. However, there are also studies arguing that acute submaximal exercise lowered copper levels (Savas et al., 2007), and those claiming that plasma copper levels remained unchanged in elite female judoists (Koury et al., 2007). In our study, three month football training led to a significant decrease in copper levels in male kids. It was reported that there was an inverse relation between zinc and copper, whereby excess zinc might impair copper absorption and vice versa (Fischer et al., 1984). Thus, the decreased levels of copper we obtained in the study comprise an interesting finding. That copper, like zinc, is involved in various physiological events like antioxidant events (Clarkson, 1991; Cordova et al., 1990) lends significance to the decreased copper levels we found in boys. It demonstrates that trace element support may be crucial in male kids involved in sporting activities.

The three months football training in our study also reduced the levels of serum cadmium and molybdenum in male children. We have not encountered any study focusing specifically on the one-to-one relation between exercise and serum cadmium and molybdenum levels. However, the physical exercise reported to lead to a redistribution of various trace elements between body reserves, blood and tissues (Bordin et al., 1993) might explain the decrease in cadmium and molybdenum values we found in the boys. The three month football training did not significantly alter serum cobalt, nickel, manganese, aluminum and iron levels in the male kids.

Conclusion

Results of this study indicate that three months of football training caused a significant decrease in serum zinc levels of the children. Considering the critical physiological roles of zinc in growth, sexual maturation, development and immune functions, it can be suggested that it is necessary to monitor and if necessary supplement a physiological doses of zinc to the eight to 12 age group young male children.

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