The Acute Effect of Maximal Strength, Power Endurance and Interval Run Training on Levels of Some Elements in Elite Basketball Players

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Abstract: The aim of the study was to investigate the acute effects of different types of training models (maximal strength, power endurance, interval running) on the magnesium (Mg), calcium (Ca) and iron (Fe) levels in blood. Twenty four male basketball players voluntarily served as subjects for this study. Subjects were divided into three groups as maximal strength (MS) (n=8), power endurance (PE) (n=8) and interval run (n=8). Serum Mg, Ca and Fe levels were determined according to atomic emission method in blood samples collected from the groups after and before the exercise program. In results of this study, there was no significant change in Fe, Mg and Ca levels in PE and there was a significant decrease in Mg and a significant decrease in Ca in MS and while there was no significant change in Mg, there was a significant increase in Fe levels in IR exercise. In light of the study results; when the acute effects of the different training types were examined, it was determined that these effects would cause increases and decreases in the concentrations of some elements in blood.

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1. Introduction

Minerals assume an important role during strenuous physical activity, as the energy requirement in the energy metabolism and the skeletal muscle increases by 20 to 100 times the requirement in resting conditions is much lower than during exercise. Exercise training with regular density increases both the reduction levels and the levels body loss, thus increasing the mineral requirement(Maughan, 1999). Cases of marginal inadequacy may have a reduced effect on sedentary individuals, but minor deficiencies in the exercise capacity may result in serious conditions in elite sportsmen (Williams, 2005). Speich and colleagues recently reviewed the physiological roles of minerals important to athletes, noting that minerals are involved in muscle contraction, normal heart rhythm, nerve impulse conduction, oxygen transport, oxidative phosphorylation, enzyme activation, immune functions, antioxidant activity, bone health, and acid-base balance of the blood (Maughan et al., 2000; Speich et al., 2001). Because many of these processes are accelerated during exercise, an adequate amount of minerals is necessary for optimal functioning . Magnesium, calcium and iron are the prominent minerals for bodily functions for both under the normal circumstances and during the elevated sport performance. (Maughan et al., 2000).

Iron is one of the most critical minerals with implications for sports performance. Iron is a component of hemoglobin, myoglobin, cytochromes, and various enzymes in the muscle cells, all of which are involved in the transport and metabolism of oxygen for aerobic energy production during endurance exercise (Williams, 2005). Exercise may cause changes in iron levels of the body. It is important whether or not it impairs the sportsman's health and performance(Cook, 1994). Williams (2005) has stated that iron deficiency impairs the muscular performance (Williams, 2005), while Hass and Brownlie have stated that iron deficiency reduces the work capacity in humans and animals (Haas and Brownlie, 2001).Magnesium is a ubiquitous element that plays a fundamental role in many cellular reactions. More than 300 metabolic reactions require magnesium as a cofactor. Some of these activities include glycolysis, fat and protein metabolism. Magnesium also serves as a physiologic regulator of membrane stability and neuromuscular, cardiovascular, immune, and hormonal functions (Wilborn et al., 2004; Williams, 2005). Another mineral that is also important for the health and performance of sportsmen is calcium. Calcium also involves a number of physiological processes relating to energy metabolism and muscular cramps (Williams, 2005). Calcium is especially important for growth, the protection and regeneration of bone tissue, protection of blood calcium levels, regulation of muscular cramps, nerve conduction and normal blood flow (Association, 2009; IOCPS, 2009; Nattiv et al., 2007; Nickols-Richardson et al., 2006). The macro elements calcium and magnesium are generally integrated into anatomic structures (Lukaski, 2004). In active form, they are of particular importance for metabolic balance in sports and during physical exercise (Maughan, 1999). The magnesium and calcium are involved in the propagation of nerve impulses and in muscle and heart contraction. Calcium controls vascular tonicity and coagulation of the blood.(Lehninger et al., 2005). Thus, magnesium may be considered a potentially limiting element for human performance (Lukaski, 2004). 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 (Nielsen and Lukaski, 2006).

In recent years, researchers have become increasingly interested in the effects of these minerals on the health and physical performances of sportsmen and have focused their studies on this field (Williams, 2005). Therefore, it can be said that there has been a growing interest in research into the relation between exercise, minerals, and elements (Finstad et al., 2001).

The aim of this study is to determine the acute effects in calcium, magnesium and iron levels in the plasma concentration of sportsmen in training types of Maximal Strength (MS), Power Endurance (PE) and Interval Run (IR), to find out the mineral requirements of professional sportsmen after exercising with different types of training.

2. Material and Methods

2.1. Subjects

The study included 24 male professional basketball players with the mean age of 22 years, height of 191.92 centimeters and weight of 87.38 kilograms. In order to examine the effects of different training models, participants were divided into 3 groups (n=8 in each group); maximal strength (MS), power endurance (PE) and interval run (IR). Mean age, height, weight and body mass index (BMI) values are 24 years, 193.5 centimeters ,89.5 kilograms and 24.91 kg/m^2 for the MS group; 23 years, 191.13 centimeters, 91.25 kilograms and 23.73 kg/m^2 for the PE group; and 19 years, 191.13 centimeters, 81.38 kilograms and 22.13 kg/m^2 for the IR group.

2.2. Training Models

For preparation of training programs, difference between percentage and repetations are determined in such a way that there is a minimum difference between training programs from the literature. Based on the literature, the training programs were prepared so that the specified percentage and reps produced the minimum variation between the participants' personal training programs. Eight different exercises were used in training. Bench press, biceps, shoulder press and triceps moves were used for the upper body and squat, leg extension and step up with weight exercises were used for the lower body.

Maximal Strength (MS)

MS training is based on 80-95% of MS and made of 3 sets: 80% of MS with 8 reps, 85% of MS with 7 reps, and 90% of MS with 6 reps. The length of the resting period was the same as the working period.

Power Endurance (PE)

PE training was based on 20-35% of MS data. The program consists of 3 sets: 25% of MS with 24 reps, 30% of MS with 22 reps and 35% of MS with 20 reps.

Interval Running (IR)

5x86 m running and 43m jogging
4x86 m running and 43m jogging
3x86 m running and 43m jogging
2x86 m running and 43m jogging
1x86 m running and 43m jogging
2x86 m running and 43m jogging
3x86 m running and 43m jogging
4x86 m running and 43m jogging
5x86 m running and 43m jogging

Interval running was implemented with two sets and a break of five minutes was given.

For the IR training, the 86-meter length of the basketball court was used as running track and the participant's hearth rate was kept between 160-180 beats/sec. During the resting period, the hearth rate was kept between 120 beats/sec and between sets it was kept between 120-140 beats/sec with jogging exercise. The heart rate was recorded during the whole IR by the use of Polar vantage NV Telemeters (Polar Electro Oy, Kempele, Finland).

2.3. Biochemical Methods

There were 5 cc blood samples taken from the participants before and after they had been subjected to exercises loading process. Blood samples were obtained by venipuncture and analyzed for iron, magnesium and calcium concentration in the three groups. The serum was separated by centrifugation at 3000 × g, for 10 minutes and kept under refrigeration at -80 °C until analysis. Plasma iron, magnesium and calcium were measured by flame atomic absorption spectrometry (FASS) (Shimadzu 680 AA, Tokyo, Japan)(Burtis, 2009).

2.4. Statistical Evaluations

The statistical evaluation of data was performed using a statistical package with Wilcoxon Signed Ranks Test (SPSS 18.0, USA). Arithmetic means and standard errors of all parameters were calculated. The blood Fe, magnesium and calcium levels were correlated with each different training type at a significance level of $p<0.05$.

3. Results

Table 1: Comparison of pre and post training values of Iron (Fe) (µg/dl), Magnesium (Mg) (µg/dl) and Calcium (Ca) (µg/dl) levels at the end of 8-week Interval Running, Maximal Strength and Power Endurance training.

Variables			Mean	S.D	Min.	Max.	X_2-X_1	Z Value	P
INTERVAL RUNNING (N=8)	Iron (Fe)	Pre-exercises	122.14	38.80	81.00	175.00	14	-2.197	.028*
		Post- exercises	136.14	35.95	80.00	181.00			
	Magnesium (Mg)	Pre-exercises	2.05	0.15	1.74	2.16	-0,09	-1.859	.0.63
		Post- exercises	1.96	0.12	1.79	2.13			
	Calcium (Ca)	Pre-exercises	9.77	0.36	9.40	10.50	0,44	-2.379	.017*
		Post- exercises	10.21	0.31	9.70	10.70			
MAXIMAL STRENGTH (N=8)	Iron (Fe)	Pre-exercises	96.62	42.43	47.00	167.00	-0,75	-.530	.596
		Post- exercises	95.87	44.28	40.00	167.00			
	Magnesium (Mg)	Pre-exercises	2.13	0.13	2.00	2.40	-0,08	-1.975	.048*
		Post- exercises	2.05	0.09	1.97	2.24			
	Calcium (Ca)	Pre-exercises	9.56	0.37	9.20	10.30	0,15	-2.460	.014*
		Post- exercises	9.71	0.37	9.40	10.50			
POWER ENDURANCE (N=8)	Iron (Fe)	Pre-exercises	125.87	47.78	52.00	182.00	-1	-0.423	.673
		Post- exercises	124.87	42.67	60.00	175.00			
	Magnesium (Mg)	Pre-exercises	2.18	0.157	1.99	2.40	-0,03	-0.421	.674
		Post- exercises	2.15	2.53	2.01	2.53			
	Calcium (Ca)	Pre-exercises	9.67	0.36	9.10	10.40	0,21	-1.869	.062
		Post- exercises	9.88	0.39	9.30	10.70			

**$P<0.01$, *$P<0.05$

In blood samples collected after different types of training, Fe and Calcium levels in IR decreased while, in MS, Fe level decreased and calcium level increased (Table 1).

4. Discussion

In this study, increases and decreases were observed in different minerals in blood serum concentration after different trainings.

At the end of study was found that blood iron levels varied by types of training when the findings before and after the training were compared and we also observed that Power Endurance (PE) caused a minor increase, Maximal Strength (MS) a minor decrease and Interval Running (IR) a significant increase in blood iron levels (Table 1). It is also important to delineate whether exercise itself may alter iron status and whether such alterations are detrimental to athletic performance or to the health of an athlete (Beard and Tobin, 2000). It has been reported that iron deficiency ranges from 20% to 80% in the sportsmen. It has also been reported that certain sports branches cause iron deficiency in the body which continued in long-distance runners on an increasing level during the run (Üstüner Z, 1998). The acute effects of training upon some elements were investigated among 26 male wrestlers aged 17-20 and it was determined that the most decreased element was Fe among the 5 minerals (Saraymen et al., 2004). In a study on the acute effects of different physical activities upon Fe concentration with the three groups of 39 subjects; the first group (no training) and the second group (moderate training) received running to exhaustion and fast running at %70 VO_2 max for 45 minutes while the third group (high training) received aerobic bicycle exercises at %50-70 VO_2 max for 4 days. At the end of the study; it was seen that the groups with trainings and without trainings had insignificant increases in Fe levels after both running exercises and bicycle exercises. In another study which investigated the effects of 5-day matches on electrolyte levels in the blood in handball players, blood samples were taken from 12 handball players before and after the match and a statistically insignificant increase was observed in blood iron levels (Koc, 2011). In the studies of literature; it was reported that Fe amount in blood decreased with anaerobic exercises while increased with aerobic exercises. Our study results were in line with the literature. Fe increases in IR depend on the type of the exercises because body must increase O_2 transportation in order to supply O_2 need caused by aerobic exercises. As the physiologic result of this; it may be argued that body increases Fe.

In the study, it was detected that Mg levels in blood decreased after each of IR, MS and PE training models. Several studies have reported that athletes may be deficient in magnesium studied

(Nielsen and Lukaski, 2006). In a study, it was observed that magnesium concentrations were significantly reduced following a marathon race (Kawabe et al., 1999). Other researchers have also observed similar reductions in serum magnesium not only during the endurance race but also during other endurance activities including the bicycle ergometer test, swimming and treadmill exercises (Olha et al., 1982). With respect to blood extracellular magnesium, various authors have indicated that high intensity exercise leads to hypermagnesemia as a consequence of the decrease in plasma volume (Monteiro, 2006). Some researchers found that exercises resulted in a redistribution of magnesium in the body and type of exercises and magnesium status influenced the nature of this redistribution (Laires and Monteiro, 2008; Lukaski, 2001).. In another study, the relationship between magnesium and strength was investigated in basketball, volleyball and handball players, the sportsmen were put to strength tests and at the end of the study, it was observed that there was a positive significant relationship between the muscular strength of the sportsmen (Santos et al., 2011). 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 magnesium requirements by 10-20% (Nielsen and Lukaski, 2006). Current study showed that the reduction in the blood magnesium level was no significant after IR and PE trainings and significant after MS training which was similar to the results of some studies in the literature. However; there are also some studies that indicate that Mg levels in blood may increase after acute exercises. For example, short-term high intensity (anaerobic) exercises increased serum magnesium concentration. Instead of decreased plasma volume , muscle breakdown was suggested as the cause of increased serum magnesium found shortly after exercise (Meludu, 2002)

In study, we observed an insignificant increase in blood serum calcium concentrations after the training in Power Endurance (PE) exercise and significant increases in Interval Running (IR) and Maximal Strength (MS) exercises. Exercise may increase calcium losses (Williams, 2005). In a study where the effect of 1-day anaerobic exercise on the serum mineral concentration was investigated, it was observed that while there was a significant decrease in serum magnesium concentration, there was no statistically significant change in the serum calcium level (Meludu, 2002). In a study on the acute effects of interval running trainings upon trace elements among the sedentary people; it was seen that Ca levels significantly decreased after exercises in blood samples taken before and after exercises. (Kara, 2011). The studies in literature points out that Ca levels after exercises may decrease after exercises while in our study it was seen that Ca increased in the three different trainings.

5. Conclusions

As a conclusion; it was discovered that IR trainings may increase Fe in blood, MS may decrease in Mg and IR and MS trainings may significantly increase Ca. In this sense, when the effects of different training types (IR,MS,PE) were examined, it was determined that acute exercises may lead to increases and decreases in the concentrations of some elements in blood.

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