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Acute Effects of Maximal Strength, Power Endurance and Interval Run Training on Na, K and Cl Levels in Elite (Professional) Basketball Players

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Abstract

The aim of this study is to determine the acute effects in sodium, potassium and chlorine 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. The study included 24 male professional basketball players with the average of 22 years. In order to examine the effects of different training models, participants were divided into three groups (n=8 in each group); maximal strength (MS), power endurance (PE) and interval run (IR). In blood samples collected after different types of training, in IR and MS while Na and Cl levels were increasing, K levels decreased, only the increase at NA level in IR found out significant. While in PE, all of parameters (Na, K and Cl levels) were increasing, only the increase at C1 level observed significant. Besides, Na and C1 levels increased after each of the three training type (IR, MS and PE), while the K level (PE) was increasing in the training group, decreased in (MS) and (IR) group.

Keywords: Endurance; Running; Some elements; Strength

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1. Introduction

Minerals are essential for a wide variety of metabolic and physiologic processes in the human body (Williams, 2005). Minerals are inorganic substances, present in all body tissues and fluids and their presence is necessary for the maintenance of certain physicochemical processes which are essential to life. Minerals are chemical constituents used by the body in many ways. Although they yield no energy, they have important roles to play in many activities in the body (Malhotra, 2011; Soetan, Olaiya & Oyewole, 2010). Minerals may be broadly classified as macro (major) or micro (trace) elements. Such as sodium (Na), chlorine (Cl) and potassium (K) which are the macro elements consumed more than microelements in body (Eruvbetine, 2003; Perveen, Bokhari, Siddique, Siddiqui & Soliman, 2012; Sharma, et al., 2011).

It is unquestionable that physical activity has positive effects on health (De Oliveira & Burini, 2011). The physiological, psychological and social benefits of regular exercise are plentiful and profound. Examples of such benefits include positive effects on weight, bone strength, metabolic factors (such as glucose and cholesterol), organ function, sleep, mood and self-image (De Oliveira & Burini, 2011). Especially in equilibrium of water and electrolytes that have indispensable roles in vital reactions of the body are very important and remarkable (Banaei, Ghahramani & Boostani, 2014). Na, K and Cl body liquids and their osmatic pressure are necessary electrolytes for acid-base balance, nerve stimulations and blood tissue (Yılmaz, 2000). Because many of these processes are accelerated during exercise, an adequate amount of these minerals is necessary for optimal functioning (Speich, Pineau & Ballereau, 2001). Mineral deficiency may impair optimal health, and health impairment may adversely affect sport performance (Williams, 2005).

Na is a critical electrolyte, particularly for athletes with high sweat losses (Sawka et al., 2007; Sharp, 2006). It is not exaggeration saying that the concentration of plasma/serum Na is affected during exercise (Speich et al., 2001). Many endurance athletes require much more than the UL for Na (2.3 $g{\cdot}d^{-1}$) and Cl (3.6 $g{\cdot}d^{-1}$) (Palmer & Spriet, 2008). Na requirement is important for the body for stimulated ability of nerves and muscles. K causes increase in heart tone and contraction in muscles (Yılmaz, 2000). K also interacts with both Na and Cl to control fluid and electrolyte balances and assists in the conduction of nerve impulse (Emenike, Ifeanyi, Kingsley, Chinedum & Chineneye, 2014; Epstein & Armstrong, 1999). The physical activity induced urinary levels of Na and K electrolytes would affected by different intensities, spans and types of the physical trainings (Mooren et al., 2001). During intense exercise, plasma K concentrations tend to decline to a lesser degree than Na (Sawka et al., 2007). Cl is very important for human metabolic processes, “To function properly, organisms must actively pump sodium and chlorine out of cells and actively take in potassium” (Selinus et al., 2005). Chlorine is involved in fluid and electrolyte balance. Chlorine is the principal anion in extracellular fluid. It helps in the regulation of extracellular osmotic pressure and makes up over 60 percent of the anions in this fluid compartment and is thus important in acid-base balance (Soetan et al., 2010). Another role of chlorine in the body is to combine with hydrogen to form HCl, which breaks down proteins for absorption of other metallic minerals. It also maintains the electrical neutrality across the stomach membrane. With Na and K, Cl works well to keep all of our biological systems running smoothly (Ila, 2006).

For sportsmen, adequate amounts of these minerals are required for physical training and performance. Studies of sportsmen during training, as compared to non-training control subjects, indicate the potential for increased losses of minerals in sweat and urine (Lukaski, 1995). 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, Newhouse, Lukaski, McAuliffe & Stewart, 2001).

The aim of this study is to determine the acute effects in Na, K and chlorine 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.

2. Methods

2.1. Subjects

The study included 24 male professional basketball players with an average age of 22 years, height of 191.92 centimeters and weight of 87.4 kilograms. In order to examine the effects of different training models, participants were divided into three groups (n=8 in each group); MS, PE and IR. Mean age, height, weight and body mass index (BMI) values are 24 years, 193.5 centimeters, 89.5 kilograms and 24.9 kg/m^2 for the MS group; 23 years, 191.1 centimeters, 91.3 kilograms and 23.7 kg/m^2 for the PE group; and 19 years, 191.1 centimeters, 81.4 kilograms and 22.1 kg/m^2 for the IR group. There was no significant difference among groups in age, height, weight or body mass index ($p>0.05$).

2.2. Training Models

For preparation of training programs, difference between percentage and repetitions 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.

2.3. Maximal Strength (MS)

MS training is based on 80-95 percent of MS and made of three sets: 80 percent of MS with eight reps, 85 percent of MS with seven reps, and 90 percent of MS with six reps. The length of the resting period was the same as the working period.

2.4. Power Endurance (PE)

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

2.5. 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).

2.6. 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 venepuncture and analysed for Na, K and chlorine concentration in the three groups. The serum was separated by centrifugation at 3000 × g, for 10 minutes and kept under refrigeration at -80 degree Celsius until analysis. Plasma Na, K and chlorine were measured by flame atomic absorption spectrometry (FAAS) (Shimadzu 680 AA, Tokyo, Japan) (Burtis and Ashwood, 2009).

2.7. Statistical Evaluations

The statistical evaluation of data was performed using a statistical package Wilcoxon Signed Ranks Test (SPSS 18.0, USA). Arithmetic means and standard errors of all parameters were calculated. The blood Na, K and chlorine 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 sodium (Na) (µg/dl), potassium (K) (µg/dl) and chlorine (Cl) (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)	Sodium (Na)	Pre-ex.	139.57	2.63	137.00	144.00	3.85	-2.214	.027*
		Post- ex.	143.42	2.50	141.00	147.00			
	Potassium (K)	Pre-ex.	4.12	0.306	3.60	4.48	-0.09	-.338	.735
		Post- ex.	4.03	0.322	4.03	4.52			
	Chlorine (Cl)	Pre-ex.	101.57	2.507	98.00	105.00	1.71	-1.933	.053
		Post- ex.	103.28	2.49	100.00	107.00			
Maximal Strength (N=8)	Sodium (Na)	Pre-ex.	139.62	1.505	138.00	142.00	1.38	-1.594	.111
		Post- ex.	141.00	0.925	140.00	142.00			
	Potassium (K)	Pre-ex.	4.30	0.235	3.88	4.70	-0.03	-.140	.889
		Post- ex.	4.27	0.221	3.87	4.55			
	Chlorine (Cl)	Pre-ex.	102.87	2.69	97.00	106.00	1.25	-1.452	.146
		Post- ex.	104.12	3.136	98.00	109.00			
Power Endurance (N=8)	Sodium (Na)	Pre-ex.	140.12	2.587	136.00	145.00	1.50	-1.590	.112
		Post- ex.	141.62	1.99	138.00	144.00			
	Potassium (K)	Pre-ex.	4.01	0.192	3.70	4.20	0.20	-1.951	.0,51
		Post- ex.	4.21	0.328	3.70	4.66			
	Chlorine (Cl)	Pre-ex.	102.12	2.35	98.00	106.00	1.13	-2.060	.039*
		Post- ex.	103.25	1.38	102.00	106.00			

**P<0.01, *P<0.05

In blood samples taken after different types of training, in IR (Interval Running) and MS (Maximal strength) Na and Cl levels increased while, K levels decreased. Only the increase at IR Na level identified significant. While in PE (Power Endurance), all of parameters (Na, K and Cl levels) increasing, only the increase at Cl level observed significant (Table 1).

4. Discussion

Although the literature examined in sportsmen having adequate and balanced food consumption expressed that mineral deficiency will not be and there is no need to use mineral tablets, stated that in cases minerals taken insufficient the physical performance adversely affected and especially sportsmen should take the necessary measures against mineral deficiencies (Bagchi, Nair, & Sen, 2013; Insel, RE, & Ross, 2004; Maughan, 1999; Ozdemir, 2010; Rodriguez, DiMarco, & Langley, 2009; Uzun, 2013). In this study, increases and decreases were observed in different minerals (Na, K and Cl) in blood serum concentration after different trainings.

In our study, in training in the different types, when compared serum sodium levels pre training and post training, while the increase was insignificant in the MS and PE group, the increase at Na level identified significant in interval running (IR) group (Table 1).

Hazar, Sever, Gurkan, Er, and Erol (2013), in the study 13 female footballers joined, footballers applied submaximal aerobic exercise protocol (Shuttle-Run Test) and blood Na values were examined before the test, immediately after and after 1 hour. They stated that an insignificant increase was in the Na value of female footballers as a result of the study. McKenna, Heigenhauser, McKelvie, MacDougall, and Jones (1997), make six healthy male participants who did not joined regular physical activity before do sprint training three days per week for seven weeks. Subjects pedalled at maximum intensity for 30 sec on a cycle ergometer pre training and post training and before and immediately after installing collected blood samples. While seven weeks before the sprint training program Na values found average respectively 140,5±0,3 mmol/l, 155,8± 1,4 mmol/l pre and post training, after sprint training found respectively 139,3±0,6 mmol/l,152,8±1,8 mmol/l. They stated that a significant increase found in Na values pre and post sprint training at the end of study. In a similar study, in the study on 16 male university students, performed 10 * 30 m in sets of sprint training three days a week for five weeks and evaluated the possible effects of sprint training on acute fatigue process. Special planned bicycle test to create fatigue was applied. In the blood samples taken pre-test and post-test before and after training, serum Na concentration of fatigue significantly increased was observed (Aslankeser, 2010). In other studies that taekwondo athletes applied anaerobic training and male university students applied resistance training identified significant increases at the Na values pre training and post training (Kan, 2009; Kasap, 2014). In our study the increases at the Na values pre training and post training are consistent with studies. When the literature examined, in Na levels being compared pre and post training observed also decreases in contrast to the above studies (Kutlu, Dıramalı, Temiz, Onur, & Miskioglu, 2011). It was stated that there was a significant decrease at Na values as a result of 3-hour exercise done in a 65 percent moist environment and 10 male endurance athletes joined maximum of 55 percent of O_2 consumption, 34 degree Celsius (Weschler, 2006). In another study, they made 13 female endurance athletes do four hours of running exercise and they applied athletes three different fluids containing high sodium-containing liquid, low sodium-containing liquid and only water. At the end of the study, significant decreases observed at the Na levels of all groups (Twerenbold et al., 2003). In the study increase of Na concentration observed after exercise as a result of all the training practices. This is because water intake during exercise, even though the intracellular fluid volume reduction might depend on the concentration of Na ion as a result of water loss from extracellular fluids.

In this study, when serum K levels compared pre and post training, while an unimportant decrease was observed in IR and MS groups, an unimportant increase found in PE group (Table 1).

When literature searched, observed that there were similar studies like unimportant increase determined at K levels pre training and post training of PE group athletes (Aslankeser, 2010; Kan, 2009; McKenna et al., 1997; Ocal, 2007). In the study done with 10 female participants of age group 18-23 having sedentary life style, shuttle-run test applied in order to exhaust the subjects by monitoring heart rate of them. When K levels in the blood samples taken pre-test and post-test evaluated, a significant increase observed after test (Baydil, 2013). In another study 18 male professional footballers applied eight weeks and six days a week and 90 minutes per day during the period of preparatory training. Blood samples taken pre and post 8 week training and an unimportant increase found in K values (Pakdil, 2013). These results are consistent with the results of our study. In the study unlike unimportant increase of the sportsmen in PE group, an unimportant decrease observed in K values of sportsmen in IR and MS group Koc (2011), investigated the effect of acute exercise on blood electrolytes. In the K values of 12 male handball players participated in Inter University group competitions found an unimportant decrease five days pre-tournament and post-tournament. In another study 10 men and 10 women a total of 20 participants having sedentary life style and has not done sports before, the average age is 26,9±2,1 aerobic exercise program applied for 10 weeks and investigated the effects on the physical fitness levels of subjects and blood parameters as a result of study. When compared the K values pre and post 10 week exercise, an unimportant decrease observed at the K levels (Goksu, Harutoglu, & Yigit, 2003). Alike in blood samples pre and post-test taken from 18 male and 13 female footballers joining test and doing aerobic exercise (shuttle-run) while observing an unimportant increase at K levels of male footballers, observed an unimportant decrease in female footballers (Hazar et al., 2013).

Studies done before observed to match with our findings. Stated that the K concentration tends to decrease during intense exercise. Similarly, in the study of researchers at K levels the decrease in PE group unlike the increase in IR and MS group may be due to the low intensity of training. In our study when compared the blood serum levels of chlorine pre and post training, while observing an unimportant increase in IR and MS group, found a significant increase at C1 level in PE group (Table 1). Kan (2009), 10 male taekwondo athletes whose age were 14,30 anaerobic exercise program applied four days a week and 2 hours a day for 12 weeks, blood samples taken at the beginning and after 12-week training period also pre and post exercise. At the beginning of 12-week training period while C1 levels found respectively average 104,6±2,06 mmol/l, 104±2,83 mmol/l pre and post exercise, after 12-week training program C1 levels found respectively average 108,6±1,71 mmol/l and 110,6±1,71 mmol/l pre and post exercise.

After 12-week training program post exercise C1 value stated significantly higher than pre exercise value. When literature examined, there are studies parallels with the findings in the researchers' study (Finstad et al., 2001; Hazar et al., 2013; Koc, 2011), also rarely decreases in the chlorine level observed pre and post exercise. Ozdemir (2010), stated that the long lasting and intense interval training program resulted in significant decreases in Cl level in the blood as a result of the study with 31 swimmers at the age of 13-16 years (9 female, 22 male). In another study done on male footballers a significant decrease found at C1 level after 8-week preparatory training period (Rodriguez et al., 2009). Many studies in the literature shows that the increase at the C1 levels in blood was more dominant than decrease and it is important to support the researchers' study results. There are a lot of studies about the decrease at Na and C1 level post exercise as a result of duration of exercise and depletion of body (Baydil, 2013; Goksu et al., 2003; Koc, 2011; Noakes et al., 2005; Pakdil, 2013; Sharp, 2006), increasing Na and C1 levels in the researchers' study may be derived from no loss water as a result of lack of training duration long enough.

In this study done on elite basketballers identified that Na and C1 levels increased after each of the three training type (IR, MS and PE), while increasing K level (PE) in training group, decreased in (MS) and (IR) group. In this regard in blood serum concentrations of acute exercise in different types of training has effects on Na, K and C1 levels. Consequently, the reason of the increases and decreases in blood serum mineral levels post-acute exercise may be shown as differences about duration, type, severity and extent of training.

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