Physiologic Responses of Macro Elements to Maximal Aerobic Exercise in Male and Female Footballers

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Abstract: Aim: This study aimed to detect changes in calcium, magnesium, potassium, sodium and chlorine levels in male and female footballers before, immediately after and 1 hour after aerobic exercise and to compare the mineral levels detected after the exercise by taking the gender into account. **Method:** Blood samples were taken before, immediately after and 1 hour after a 20-meter shuttle run test. Macro elements were detected by using the plasma emission spectroscopy method, and the significance level was accepted as P<0.05. **Findings:** A statistically significant difference was not observed in macro element levels in male and female footballers before, immediately after and 1 hour after the training. In females, the chlorine level in all three periods and the potassium level 1 hour after the training was found higher than males. **Conclusion:** It is thought that the duration of exercise does not cause a loss of liquid which may result in liquid imbalance; and the haemostatic balance which is strongly controlled by the body prevented the mineral levels from changing after the aerobic exercise.
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1. Introduction

Minerals are important for a variety of metabolic and physiologic processes in human body. [1] Physiologic changes accelerated by exercise and mobility can cause mineral levels in the body to change. Because minerals have an important role in cellular energy metabolism and energy formation, intra-tissue levels should be monitored closely. [2] However, since the direct measurement methods are not practical, the relevance of body mineral levels is determined by taking blood mineral levels and comparing them by using interval values that are set according to gender-age factors. [2] Doing sport and exercise may make acute or chronic changes in these values. Considering this fact, it is important for athletes to know the body mineral levels and supplement them with relevant diets.

Studies have proved that mineral levels change according to the exercise duration and intensity. That's why it is important to know beforehand how the exercises with different durations and intensities in different sport branches will affect mineral levels and what short term or long term effects they will have. Sodium, potassium and chlorine body liquids and their osmatic pressure are necessary electrolytes for acid-base balance, nerve stimulations and blood tissue. [3] Magnesium is necessary for more than 300 enzymes in metabolism to work. [2] Particularly, the enzymes that organise reactions of phosphorus addition to molecules in energy metabolism require the existence of magnesium. [3] Chlorine helps carbonate to form, which removes hydrochloric acid –a gastric fluid- and carbon dioxide from blood. [1] Calcium is necessary for muscle tone, nerve conduction and hormonal activities. [4,5,6,3] Macro minerals, with all these features, should be carefully monitored for athlete performance and health. In this study, macro minerals in male and female footballers were measured in three periods; before, immediately after and 1 hour after the training, and the change was monitored. Additionally, male and female mineral levels were compared in each period.

2. Materials and Methods

Workgroup and Experimental Protocol

18 male and 13 female footballers are subjects to the study. Athletes' physical characteristics, sports experiences, before training (BT), immediately after training (AT) and 1 hour after training (1hAT), blood pressure and heart rate numbers are shown in Table 1. The study protocol was confirmed by the ethic committee. All athletes were informed about the aim and risks of the study before they sign a written confirmation, and the study was held in compliance with the Helsinki Declaration. The athletes were applied submaximal aerobic exercise protocol (Shuttle-Run Test).

Taking Blood Samples

Blood samples were taken and kept in sorted BT, AT and 1hAT vacutainer tubes (Becton Dickinson, Franklin Lakes, NJ, USA) and centrifuged at 1500 g for 15 minutes. They were kept at -86^{0}C and thawed only once before the study was carried out.

Measurements for Minerals

Blood samples (1 ml) were mixed with 2 ml of $HN0_3$ and this mixture was cut with Bergrof/Microwave Digestion system MW-3 device. They were subjected to microwave at 160^{0}C for five minutes and at 190^{0}C, 100^{0}C and 80^{0}C for ten minutes. Fully cut samples were completed to 10 ml by adding deionised water. Analyses were made by inductively coupled plasma (optic emission) atomic emission spectrography (ICP-OES Perkin Elmer, Optima 5300 DV, USA). Mg value for females could not be acquired due to a malfunction in the lab. Mg value for females was not used in the study.

Statistical Analysis

Complementary statistics data regarding male and female athletes was given as average and standard deviation values as seen in Table 1. Average difference between genders was found by using independent single sample test. The changes related to BT, AT and 1hAT macro element levels were tested for both genders separately and repeatedly with ANOVA test, and mutual comparisons were made by Bofforoni test. Statistical significance was accepted as P<0.05.

3. Results

Table 2 compares the changes in mineral blood serum levels in males and females separately at BT, AT and 1hAT periods. No change was observed in mineral serum levels between periods.

BT, AT and 1hAT mineral levels between genders are compared in Table 3. In all chlorine values and 1hAT potassium values observed a statistically significant difference between genders. Chlorine levels of female footballers in all three periods and 1h AT potassium levels for male footballers were detected high.

Table 1. Descriptives of man and woman football players.

	Man		Woman	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**
Age	23.5	2.506	18.7	1.215
Height(cm)	178.1	4.606	163.4	5.035
Weight(kg)	74.3	4.990	55.4	5.775
Years of Sportmanship	12	4.944	4.8	1.467

Table 2. Comparison analysis of BT, AT and 1hAT macro element levels within man and woman groups.

		Ca(mg/dl)	**Na(mmol/l)**	**K(mmol/l)**	**Cl(mmol/l)**	**Mg(mg/dl)**
	Period	$\bar{X} \pm Sd$	$\bar{X} \pm Sd$	$\bar{X} \pm Sd$	$\bar{X} \pm Sd$	$\bar{X} \pm Sd$
Man	**BT**	9.88 ± 0.45	137.7 ± 6.89	4.37 ± 0.25	96.1 ± 4.81	2.33 ± 0.09
	AT	9.89 ± 0.99	136.2 ± 11.24	4.08 ± 0.38	93.7 ± 8.52	2.27 ± 0.22
	1hAT	9.54 ± 0.77	136.4 ± 17.74	4.20 ± 0.37	89.4 ± 9.86	2.23 ± 0.44
	F	0.752	0.040	1.524	1.993	0.279
	P	0.486	0.961	0.245	0.165	0.760
Woman	**BT**	9.06 ± 0.56	139.7 ± 3.52	3.90 ± 0.23	102.6 ± 3.82	-
	AT	9.23 ± 0.43	140.3 ± 2.46	3.82 ± 0.19	102.2 ± 1.11	
	1hAT	9.31 ± 0.36	140.0 ± 1.24	3.87 ± 0.25	102.7 ± 1.77	
	F	2.134	0.195	0.601	0.210	
	P	0.142	0.825	0.557	0.812	

*: Difference is statistically significant within groups. (P < 0.05)

Table 3. Comparison analysis of BT, AT and 1hAT macroelement levels of the man and woman groups.

	Period	Mean		Mean Diff.	t	P
		Man	Woman			
Ca(mg/dl)	**BT**	9.540	9.067	0.473	1.664	0.112
	AT	9.890	9.233	0.656	2.070	0.052
	1hAT	9.540	9.308	0.231	0.926	0.366
Na(mmol/l)	**BT**	137.70	139.67	-1.967	-0.864	0.398
	AT	136.20	140.33	-4.133	-1.140	0.282
	1hAT	136.40	140.08	-3.683	-0.655	0.529
K(mmol/l)	**BT**	3.9100	3.9000	0.010	0.097	0.923
	AT	4.0510	3.8183	0.232	2.005	0.059
	1hAT	4.2010	3.8725	0.328	**2.471***	**0.023**
Cl(mmol/l)	**BT**	89.40	102.58	-13.183	**-3.983***	**0.002**
	AT	93.70	102.17	-8.467	**-3.118***	**0.012**
	1hAT	89.40	102.67	-13.267	**-4.195***	**0.002**

4. Discussion and Conclusion

There was not any change in Ca levels for both genders between periods (Table 2). Similarly, Ca levels do not vary between genders (Table 3). Hazar and et al did not find any significant change in BT, AT and 1hAT Ca levels. [7] Kara and et al did not detect any change in Ca levels during their study in which they analysed the chronic effects of three-month long football training on mineral serum levels. [8] The body retains the Ca level by regulating calcium emission and excretion with parathyroid and calcitonin hormones. As a result, it is thought that there is no change in serum calcium levels during and after the exercise.

There was not a significant difference in BT, AT and 1hAT serum levels considering Na, Cl and K minerals (Table 2). It can be seen that female footballers' chlorine levels in all three periods and male footballers' potassium levels in 1hAT period were found high (Table 3). Similar studies show that K levels can increase during training. [9,10,11,12] It is estimated that this increase is caused by potassium; leaving vascular, muscular and blood cells and disseminate into intracellular liquid. [9,11,13,14] Similarly, regarding the duration of the exercise, serum sodium and chlorine levels decrease after the training as a result of urinary excretion. [15,16,17,18,19,20] The study shows that a training which is not long enough to cause dehydration can keep sodium and chlorine body levels; and the potassium level goes back to normal as it is reuptaken in the cells during the measurement after training.

Considering Mg levels for male athletes, there is no change between periods. Studies show the importance of magnesium during exercise and muscle contraction. Mg declines particularly with exercise [9,21,22,23,7,21], and this decline is caused by magnesium transmit to erythrocytes. Mg is not transmitted to intracellular environment from extracellular environment during exercise. [21] There was a decline in mg averages in periods, nevertheless; this decline is not statistically significant (p>0.05).

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