Alteration in Body Composition of Elite Professional Female Players in a Premier League Volleyball Bout

Suat Cerit[1], M.Zulkuf Akdag[2], Suleyman Dasdag[2], Yunus Karakoc[3], Mehmet Celik[4]*

[1]Department of Physical Training and Sport, Dicle University, 21280 Diyarbakir, Turkey
[2]Department of Biophysics, Dicle University Faculty of Medicine, 21280 Diyarbakir, Turkey
[3]Department of Physiology, Inonu University Faculty of Medicine, 44280 Malatya, Turkey
[4]Teacher of Physical Training, D.U. Lojmanlari No:50 , Diyarbakir, Turkey

Abstract

In this study, we aimed to investigate the effects of single bout of volleyball on body composition in elite professional female players. Sixteen elite professional female players that play volleyball in a club in Turkish Premier League were enrolled in the study. Prior to one league match (pre-exercise) bioelectric impedance analyzes were performed using a bioelectric impedance analyzer. After the final period (3rd set) of match was ended, bioelectric impedance analyzes were repeated (post-exercise). There were no significantly changes in body mass index, body cell mass, body capacitance, lean body mass, and basal metabolic rate at post-exercise time. Body resistance, reactance and fat mass were all significantly lower than pre-exercise time ($p<0.01$). On the other hand, extracellular mass increased at post-exercise time, and that significances were found to be $p<0.05$. As an intense aerobic exercise, single bout of volleyball (three sets) decreases body fat mass at post-exercise time. This change is associated with decreases in body resistance and reactance. Excess lost of body fat may be related to frequently using anaerobic process for energy requirement in volleyball players and prolonged exercise for competition.
(*Journal of International Dental and Medical Research 2009; 2: (1), pp. 33-36)*

Keywords: Volleyball, sports, exercise, body composition, bioelectric impedance.

Received date: 10 October 2008 **Accept date: 03 February 2009**

Introduction

Contemporary sports imply huge training volumes, with thus an increasing danger of overloading. The timely detection of the state of overloading in the organism as a whole or in skeletal muscles presents a difficult and complicated problem.[1] In the last decades, the sport of volleyball has become popular all over the world. The increasing number of high-quality professional teams has made official matches more and more spectacular but also more intense and longer-lasting. Today, competitions such as the World Championship, the Word League and the Olympic Games entail several exhaustive matches played very close to one another.[2]

Corresponding author:

Suleyman Dasdag, PhD
Department of Biophysics
Dicle University
Faculty of Medicine
(21280) Diyarbakir
Turkey

E-mail: dasdag@dicle.edu.tr

During the normal conditions or exercise, body water and electrolyte balance are essential to optimal physiological function and health.[3] Bioelectric impedance analyze (BIA) is commonly used in clinical settings and field studies for estimating body composition parameters such as total extracellular, intracellular water compartments, fat mass, body mass, resistance, reactance, body capacitance and basal metabolic rate.[4-9] Recently, great advances were made in the art of accurately measuring the electrical properties of matter.[7]However, giving the definition of some BIA parameters such as resistance, reactance, phase angle, body capacitance and basal metabolic rate would help to understand physics of BIA.

Resistance and reactance are terms from physics which are part of the complex field of materials and their effects on electricity. Resistance is the ratio of electrical potential (voltage) to the current in a material. A material with low resistance conducts well, while a material with high resistance conducts poorly. In the human body, low resistance is associated with large amounts of fat-free mass. High resistance is associated with smaller amounts of fat-free mass. Reactance is the effect on an electrical current caused by a material's ability to

store energy. Reactance is seen as a time delay between an applied electrical potential and current. A material that stores energy readily has high reactance, and causes a large delay in the current. A material that stores energy poorly has low reactance and causes a small delay in the current. In the human body, high reactance is associated with large amounts of body cell mass (intracellular mass).

Low reactance is associated with smaller amounts of body cell mass. Phase angle is proportional to the ratio of reactance and resistance. Phase angle is an indicator of cellular health and integrity. Research in humans has shown that the relationship between phase angle and cellular health is increasing and nearly linear. A low phase angle is consistent with an inability of cells to store energy and an indication of breakdown in the selective permeability of cellular membranes. A high phase angle is consistent with large quantities of intact cell membranes and body cell mass.[10]

Body capacitance is the total energy storage capacity of the body cell mass compartment. A high capacitance is an indicator of large quantities of intact cellular membranes. A low capacitance indicates lower quantities of intact cellular membranes. Capacitance is determined by the number and quality of cell membranes contained within the body cell mass compartment. Basal metabolic rate (BMR) is the number of calories metabolized at rest during 24 hours.[10] Bioelectric impedance analyze has also potential use in the area of sports and exercise.[11] Fornetti et al showed that the method of BIA was extremely reliable and valid for estimating body composition values in female collegiate athletes.[12] As an aerobic exercise, long-time training of volleyball can lead to some alterations in the body shape and functions.[13-15] Single bout of volleyball can also force the body functions for some skilled manner and maintaining of match performance. In this study, we aimed to investigate the effects of single bout of volleyball on body composition in elite professional female players.

Material and Methods

Sixteen elite professional female players that play volleyball in a club in Turkish Premier League were enrolled in the study. Informed consent was taken from each subject and, Helsinki Recommendations was regarded**.** These subjects were questioned about the performance and the health problems.

Physical parameters such as age and height were noted. Prior to one league match (pre-exercise) bioelectric impedance analyzes were performed using a portable bioelectric impedance analyzer (Bioimpedance Analyzer, BIA 450, BIODYNAMICS, USA). After the final period (3rd set) of match was ended (post-exercise), bioelectric impedance analyzes were repeated for all subject that they participated in a period of match by substitution with each other. Just before impedance analyzes, subjects were weighed and then they lied face up on a bench in a supine position. Two pairs of sensor electrodes (ecg pads) were placed on the subject's right hand and wrist, and right foot and ankle. A cable was connected between the analyzer and the sensor electrodes. Using the analyzer's keypad, the patient's gender, age, height, and weight (determined at this time) are entered. 50 kHz alternating electric current was applied to current electrodes and, bioelectric impedance parameters were recorded by means of voltage electrodes in accordance with the manufacturer's instructions.[10,16]

When a test was performed, a printout was generated. From the recorded parameters, body mass index (kg/m^2), body capacitance (pF), resistance (Ohm), reactance (Ohm), body cell mass (kg), etracellular mass (kg), lean body mass (kg), fat mass (kg), and basal metabolic rate (cal) were evaluated. All players had free access to water intake at the break times of match.

SPPS for Windows 13.0 version was used to analyze of data. Normality of data was analyzed by Shapiro Wilks normality test. Because of the not normal distribution of all variables ($p<0.05$), Wilcoxon test was used to compare variables between pre- and post-exercise periods. $p < 0.05$ was regarded to be statistically significant.

Results

Average age of these volleyball players was 22.6±5.2 years and their body mass indexes (BMIs) were 21.6±1.05 and 21.4±1.06 at pre-exercise and post exercise periods, respectively. All subjects were in good health and had no noteworthy health or traumatic problems within the last one month. Pre-exercise and post-exercise parameters determined by bioelectric impedance analyze were shown on Table 1.

	Pre-exercise	Post-exercise	P
Body capacitance (pF)	610.6±55,4	625.1±50.5	NS
Resistance (Ohm)	592.8±39.5	565.3±32.0	0.003
Reactance (Ohm)	68.3±8.8	63.7±7.8	0,001
Body cell mass (kg)	27.4±2.2	26.7±1.8	NS
Extracellular mass (kg)	28.7±2,6	29.8±3.2	0.015
Lean body mass (kg)	56.3±4,3	56.5±4.3	NS
Fat mass (kg)	14.4±2.1	13.4±2.0	0.002
Basal metabolic rate (cal)	1756.4±130.3	1764.0±135.7	NS

NS: Not significant

Tab. 1 Pre-and post-exercise parameters determined by bioelectric impedance analyze (Mean±SD).

There were no significantly changes in body mass index, body capacitance, body cell mass, lean body mass and basal metabolic rate (Table 1). Body resistance, reactance and fat mass were all significantly lower than pre-exercise time ($p<0.01$). On the other hand, extracellular mass increased at post-exercise time, and that significances were found to be $p<0.05$.

Discussion

In human body, several functions and parameters such as cardiac function and metabolic rate change at any time of exercise, and these changes are depending on type and duration of exercise.[17, 18]

It is generally accepted that exercise is beneficial for young women, since it increases cardiovascular fitness and reduces adiposity. Too much exercise can have negative effects on the reproductive and skeletal systems.[19, 20] During exercise, work, or high temperatures, a significant level of dehydration can develop, and the ratio of extracellular to intracellular fluid can change, despite an ample supply of water. Physical and cognitive performances are impaired at 1-2% dehydration, and the body can collapse when water loss approaches 7%. [3]

In our study, we revealed that single bout of volleyball altered the body composition of these trained female players. Increase in extracellular mass at post-exercise time seems to be related to increase in extracellular water volume. Excess amount of sweating can cause water loss and then fluid shift from intracellular area to extracellular area, and the later causes redistribution of body water in the body compartments.[21]

The ability of the body to redistribute water within its fluid compartments provides a reservoir to minimize the effects of water deficit. Each body water compartment contains electrolytes, the concentration and composition of which are critical for moving fluid between intracellular and extracellular compartments and for maintaining membrane electrochemical potentials.[22]

At the post-exercise time, increase in extracellular mass (probably water) and decrease in fat mass may help to decrease in body resistance and reactance. The resistance of tissues to electrical current is directly related to their fluid content: the highly hydrated fat-free mass is a good electrical conducting medium, whereas the poorly hydrated adipose tissue is a good electrical insulator.

In normal and ill subjects, Bioelectric impedance analyze is correlated with total body water, and the variations of both are also correlated.[23] In the present study, resistance and reactans decreased after the bout. As it is known, low resistance is associated with small amounts of fat mass and low reactance is associated with smaller amounts of body cell mass. Therefore, decreasing of resistance and reactance has an agreement with decreasing of fat mass and body cell mass measured in this study.

In our study, body fat mass markedly decreases after three sets of volleyball match. This result may be a consequence of the hardness of this sport. In a previous study, it was reported that beach volleyball players had lost their body weight at about 750 g ranging from 200 to 1800 g during one tournament.[24] Volleyball players, like high jumpers, exhibit the highest values for mechanical power of the leg extensor muscles on the force-platforms when compared to athletes in other sports. During ball-in-play time, the energy needs are almost exclusively provided by the anaerobic alactic energy sources, namely by the breakdown of muscle ATP and phosphocreatine.[2] This process may cause to deplete too much substance for ATP synthesis and leads to body fat lost.

In conclusion, as an intense aerobic exercise, single bout of volleyball (three sets) decreases body fat mass at post-exercise time. This change is associated with decreases in body resistance and reactance. Excess lost of body fat may be related to frequently using anaerobic process for energy requirement in volleyball players and, intensity and long-lasting periods of volleyball competition. Finally, it can be said that a premier league volleyball match (three set) can alter the body composition parameters of female players.

Conclusions

In conclusion, as an intense aerobic exercise, single bout of volleyball (three sets) decreases body fat mass at post-exercise time. This change is associated with decreases in body resistance and reactance. Excess lost of body fat may be related to frequently using anaerobic process for energy requirement in volleyball players and, intensity and long-lasting periods of volleyball competition. Finally, it can be said that a premier league volleyball match (three set) can alter the body composition parameters of female players.

References

1. Ferretti A, Zeppill P. Volleyball: description, injuries, physiology, training. Available at: http://www.sportsci.org/encyc/drafts/Volleyball.doc; 2003 [Accessed March 03, 2009].

2. Varlet-Marie E, Maso F, Lac G, and Brun J.F. Hemorheological disturbances in the overtraining syndrome. Clin. Hemorheol. Microcirc. 2004; 30: 211-218.
3. Armstrong L.E, and Epstein Y. Fluid-electrolyte balance during labor and exercise: concepts and misconceptions. Int. J. Sport Nutr. 1999; 9:1-12.
4. Bedogni G, Severi S, Manzieri A.M, Trunfio O, Poli M, and Battistini N. Use of bioelectric impedance analysis (BIA) in children with alterations of body water distribution. Applied Radiation and Isotopes. 1998; 49: 619-620.
5. Martinoli R, Mohamed E.I, Maiolo C, Cianci R, Denoth F, Salvadori S, and Iacopino L. Total body water estimation using bioelectrical impedance: a meta-analysis of the data available in the literature. Acta. Diabetol. 2003; 40:203-206.
6. Pietrobelli A, Andreoli A, Cervelli V, Carbonelli M.G, Peroni D.G, and De Lorenzo A. Predicting fat-free mass in children using bioimpedance analysis. Acta. Diabetol. 2003; 40: 212-215.
7. Lafargue A.L, Cabrales L.B, Larramendi R.M. Bioelectrical parameters of the whole human body obtained through bioelectrical impedance analysis. Bioelectromagnetics. 2002; 23:450-454.
8. Dasdag S, Akdag M.Z, Celik M.S. Bioelectrical parameters of people exposed to radiofrquency in workplace and houses provided to workers. Biotechnol. and Biotechnol. Eq. 2008; 22:859-863.
9. Sert C, Altindag O, Dasdag S and Akdag M.Z. Bioelectrical impedance analyses of patients with postmenopausal osteoporosis. Journal of Back and Musculoskeletal Rehabilitation. 2008;21:29–33.
10. Biodynamics Corp. (2007). Handbook of BIA 450, http://www.biodyncorp. com/product/ 450/bmr_450.html.
11. Segal K.R. Use of bioelectrical impedance analysis measurements as an evaluation for participating in sports. Am. J. Clin. Nutr. 1996; 64: 469-471.
12. Fornetti W.C, Pivarnik J.M, Foley J.M, and Feichtner J.J. Reliability and validity of body composition measures in female athletes. Journal of Applied Physiology. 1999; 87:1114-1122.
13. Fleck S.J, Case S, Puhl J, and Van Handle P. Physical and physiological characteristics of elite women volleyball players. Can. J. Appl. Sport Sci. 1985; 10:122-126.
14. Johnson, G.O., Nebelsick-Gullett, L.J., Thorland, W.G., & Housh, T.J. The effect of a competitive season on the body composition of university female athletes. J. Sports Med. Phys. Fitness, (1989), 29(4), 314-20.
15. Tsunawake N, Tahara Y, Moji K, Muraki S, Minowa K, and Yukawa K. Body composition and physical fitness of female volleyball and basketball players of the Japan inter-high school championship teams. J. Physiol. Anthropol. Appl. Human Sci. 2003; 22: 195-201.
16. Singhal A, Farooqi I.S, O'Rahilly S, Cole T.J, Fewtrell, M, and Lucas A. Early nutrition and leptin concentrations in later life. Am. J. Clin. Nutr. 2002; 75: 993-999.
17. Perini R, and Veicsteinas A. Heart rate variability and autonomic activity at rest and during exercise in various physiological conditions. Eur. J. Appl. Physiol. 2003; 90: 317-325.
18. Green D.J, Maiorana A, O'Driscoll G, and Taylor R. Physical activity and resting metabolic rate. J. Physiol. 2004; 561:1-25.
19. Warren M.P, and Stiehl A.L. Exercise and female adolescents: effects on the reproductive and skeletal systems. J. Am. Med. Womens Assoc. 1999; 54: 115-120.
20. Warren, M.P, and Goodman L.R. Exercise-induced endocrine pathologies. J. Endocrinol. Invest. 2003; 26: 873-878.
21. Sato K, Kang W.H, Saga K, and Sato K.T. Biology of sweat glands and their disorders. I. Normal sweat gland function. J. Am. Acad. Dermatol. 1989; 20:537-563.
22. Sawka M.N, and Montain S.J. Fluid and electrolyte supplementation for exercise heat stress. Am. J. Clin. Nutr. 2000;72:564-572.
23. Kushner R.F. Bioelectrical impedance analysis: a review of principles and applications. J. Am. Coll. Nutr. 1992;11: 199-209.
24. Zetou E, Giatsis G, Mountaki F, Komninakidou A. Body weight changes and voluntary fluid intakes of beach volleyball players during an official tournament. J Sci Med Sport. 2008;11:139-45.