Body Composition and Segmental Bioimpedance Phase Angle in Elite Volleyball Players

Olivia Di Vincenzo[1], Maurizio Marra[1], Rosa Sammarco[1], Enza Speranza[1] and Luca Scalfi[2]
[1]*Department of Clinical Medicine and Surgery, Federico II University of Naples, Via S. Pansini 5, 80131, Naples, Italy*
[2]*Department of Public Health, Federico II University of Naples, Via S. Pansini 5, 80131, Naples, Italy*

Keywords: Anthropometry, Body Composition, Bioimpedance, Muscular Strength, Athletes.

Abstract: Because of the great interest in the evaluation of body composition (BC) in athletes, this study aimed to estimate BC variables like fat-free mass (FFM) and fat mass (FM) of volleyball players compared to a group of healthy subjects. 12 female volleyball players (VP, age 23.8 ± 3.6 years; weight 63.0 ± 5.1 kg; stature 170 ± 4 cm; BMI 21.9 ± 1.3 kg/m^2) and 22 healthy females as control group (CG, age 23.6 ± 2.0 years; weight 60.7 ± 4.8 kg; stature 167 ± 5 cm; BMI 21.9 ± 1.3 kg/m^2), participated to the study. BC was evaluated by skinfold thickness and whole-body and segmental bioimpedance analysis (BIA) measurements were assessed. BC resulted significantly different in VP than CG (FM (kg) = 15.7 ± 2.7 vs. 18.0 ± 3.0, p=0.036; FM (%) = 24.8 ± 3.0 vs. 29.5 ± 3.8, p=0.001; FFM (kg) = 47.4 ± 3.5 vs. 42.8 ± 3.6, p=0.001). These data confirm previous observations on FM % in VP. Moreover, assessing segmental BIA-derived phase se angle (PhA) appears to be sensible in these evaluations.

1 INTRODUCTION

Body composition (BC) assessment plays an important role in monitoring athletes' nutritional status and the effects of training (Brocherie, 2014). Bioelectrical impedance analysis (BIA) and skinfold thickness measurement are field methods for assessing BC that are portable and easy to use. Raw BIA variables are widely used to evaluate cellular function and hydration status. Resistance (R) is the pure opposition of tissues to the flow of the electric current, while reactance (Xc) is related to the capacitance of cell membranes, tissue interfaces, etc. Phase angle (PhA) is the shift between current and voltage (Norman, 2012), is widely used in clinical practice to monitor nutritional status, the effectiveness of nutritional intervention and to predict mortality (Santarpia, 2009; Norman, 2015; Lukaski 2017; Mundstock 2018). There is increasing interest in the use of PhA in athletes as an index of muscle quality, especially with respect to body water distribution, but data are not yet consistent when different sport specialities are compared to each other, and its association with sport performance is still uncertain. In healthy subjects, the PhA ranges from 5 to 7 degrees (Barbosa-Silva, 2005), whereas in trained athletes it may reach 8.5 degrees (Marra, 2009). Several studies (Carrasco-Marginet, 2017; Mascherini, 2015) described that PhA increases after an athletic season, whereas a study by Marra (Marra, 2014) has shown in a team of elite endurance cyclists, during a three-week stage race, a significant and progressive reduction of PhA, especially for lower-limbs, probably due to a loss of intracellular water (ICW) because of continuous vigorous exercise during a long-lasting competition.

Several studies have evaluated the BC of volleyball players (VP) in comparison with other athletes practicing different sport games (Mala, 2015; Valente-Dos Santos, 2018; Fields, 2018; Fields, 2018;) or among groups of VP (Mala, 2010; Maly, 2011) but none of them compared BC of VP to a control group with similar anthropometric characteristics.

The aim of this study was to evaluate BC and BIA-derived PhA (for the whole-body or limbs) in 12 elite female VP compared to a group of 22 healthy-controls.

2 METHODS

Twelve elite female volleyball players (VP, age 23.8±3.6 years; weight 63.0±5.1 kg; stature 170±4

Di Vincenzo, O., Marra, M., Sammarco, R., Speranza, E. and Scalfi, L.
Body Composition and Segmental Bioimpedance Phase Angle in Elite Volleyball Players.
DOI: 10.5220/0007945701130116
In *Proceedings of the 7th International Conference on Sport Sciences Research and Technology Support (icSPORTS 2019)*, pages 113-116
ISBN: 978-989-758-383-4

cm; BMI 21.9±1.3 kg/m^2) and 22 control young-women with similar characteristics (control non-athletic=C-NA, age 23.6±2.0 years; weight 60.7±4.8 kg; stature 167±5 cm; BMI 21.9±1.3 kg/m^2) participated in the study. Data were collected during the regular season of the 2015/2016 Italian Women's Volleyball *Serie B* League. Athletes trained to Monday to Saturday four hours/day. Control women did not follow regular exercise regimes.

Participants were studied in the morning (9.00 a.m.) by the same operator, following standard procedures, at the BC and energy expenditure laboratory, Clinical Nutrition Unit, Department of Clinical Medicine and Surgery. "Federico II" University Hospital of Naples. Weight was measured to the nearest 0.1 kg using a platform beam scale and stature to the nearest 0.5 cm using a stadiometer (Seca 709; Seca, Hamburg, Germany). BMI was then calculated as weight (kg)/stature^2 (m^2).

BC was estimated by skinfold thickness (biceps, triceps, subscapular and suprailiac sites), measured on the left side of the body, in triplicate to the nearest 0.2 mm, using an appropriately calibrated Harpenden calibre by the same operator (MM). Body density was estimated from the sum of these four subcutaneous skinfolds values by Durnin and Womersley equation (Brozek, 1963; Durnin, 1974). Bioimpedance analysis (BIA) was performed at 50 kHz on the non-dominant side of the body (Human Im Plus II, DS Medica S.r.l., Milan, Italy) to collect data on R and PhA.

Fat-Free Mass (FFM) and Fat Mass (FM) was determined using the Siri Equation (Siri, 1961).

Statistical Analysis

Results are expressed as mean±standard deviation. The independent samples t-test was used to assess the association between variables (SPSS. 19.0 vers., Chicago, USA). Statistical significance was pre-determined as $p<0.05$.

3 RESULTS

Anthropometric characteristics of the participants are described in Table 1. Age, weight, stature and BMI were similar between the two groups. FM both in absolute and percentage values resulted significantly lower and FFM resulted higher in VP than in control group.

BIA-derived PhA values resulted significantly higher in VP, both for the whole body ($p=0.001$) and limbs, and especially for lower limbs ($p<0.001$) (Table 1).

Table 1: Anthropometric characteristics, body composition and phase angle of volleyball players and controls.

		Volleyball Players (n = 12)	**Control Group** (n = 22)	p
Age	yrs	23.8±3.6	23.6± 2.0	NS
Weight	kg	63.0±5.1	60.7± 4.8	NS
Stature	cm	170±4	167± 5	NS
BMI	(kg/m²)	21.9±1.3	21.9±1.3	NS
Fat mass	kg	15.7±2.7	18.0±3.0	=0.036
Fat mass	%	24.8±3.0	29.5±3.8	<0.001
Fat-free mass	kg	47.4±3.5	42.8±3.6	<0.001
Phase angle	degrees			
Whole-body		6.8±0.43	6.0±0.66	<0.001
Upper-limb		5.1±0.53	4.7±0.72	=0.080
Lower limb		8.6±0.86	6.3±0.98	<0.001

SD= standard deviation;
BMI= Body Mass Index
NS=not significant;

4 DISCUSSION

Several studies agree that appropriate BC is of crucial importance for volleyball performance because of the characteristics of this sport speciality. Usually, high ratios of FFM to FM and low FM% are auspicious for training and competitive athletes. In the present study, BC of VP has been compared to that of a group of healthy control subjects, matched for anthropometric characteristics (weight, stature, BMI). Our results underline that VP presented different BC than a healthy non-athletic population. Specifically, VP showed a lower FM both in absolute values and in percentage as well as a higher FFM than C-NA females. Additionally, this study compared PhA of VP group (whole-body and limbs) to that of the C-NA group clearly showing that both whole-body and lower-limb values were significantly higher in VP.

In conclusion, this study confirms previous observations on lower FM in VP. Moreover, highlights that BIA (especially with regard to segmental assessment) appears to be helpful in qualitative evaluations of muscle mass and possibly in assessing changes due to training.

REFERENCES

Barbosa-Silva MC, Barros AJ. Bioelectrical impedance analysis in clinical practice: a new perspective on its use beyond body composition equations. *Curr Opin Clin Nutr Metab Care*. 2005 May;8(3):311-7.Marra

M, Da Prat B, Montagnese C, Sgroi M, Sicilia G, Caldara A, Santarpia L, Corsetti R. Body composition changes in professional cyclists during the 2011 Giro d'Italia, a 3-week stage race. *Nutr Therapy & Metab* 2014, 32, 31-34. /37/7/1035.

Brocherie F, Girard O, Forchino F, Al Haddad H, Dos Santos GA, Millet GP. Relationships between anthropometric measures and athletic performance, with special reference to repeated-sprint ability, in the Qatar national soccer team. *J Sports Sci*. 2014;32(13):1243-1254.

Brozek, J, Grande, F, Anderson, JT, & Keys A. (1963). Densitometric analysis of body composition: Revision of some quantitative assumptions. *Annals of the New York Academy of Sciences,* 110, 113-140.

Carrasco-Marginet, M.; Castizo-Olier, J.; Rodríguez-Zamora, L.; Iglesias, X.; Rodríguez, F.A.; Chaverri, D.; Brotons, D.; Irurtia, A. Bioelectrical impedance vector analysis (BIVA) for measuring the hydration status in young elite synchronized swimmers. *PLoS One* 2017, Jun 7;12(6):e0178819.

Durnin JV, Womersley J. Body fat assessed from total body density and its estimation from skinfold thickness: measurements on 481 men and women aged from 16 to 72 years. *Br J Nutr*. 1974 Jul;32(1):77.

Fields JB, Merrigan JJ, White JB, Jones MT. Body Composition Variables by Sport and Sport-Position in Elite Collegiate Athletes. *J Strength Cond Res*. 2018 Sep 19.

Fields JB, Metoyer CJ, Casey JC, Esco MR, Jagim AR, Jones MT. Comparison of Body Composition Variables Across a Large Sample of National Collegiate Athletic Association Women Athletes From 6 Competitive Sports. *J Strength Cond Res*. 2018 Sep;32(9):2452-2457.

Lukaski HC, Kyle UG, Kondrup J. Assessment of adult malnutrition and prognosis with bioelectrical impedance analysis: phase angle and impedance ratio. *Curr Opin Clin Nutr Metab Care*. 2017 Sep;20(5):330-339.

Malá L, Malý T, Zahalka F, Bunc V, Kaplan A, Jebavy R, Tuma M. Body Composition of Elite Female Players in Five Different Sports Games. *J Human Kinetics* 2015 *45(1),* 207-215.

Malá L, Malý T, Záhalka F, Bunc V. The profile and comparison of body composition of elite female volleyball players *Kinesiology* 2010**,** *42* 90-97.

Malý T, Malà L, Zahalka F, Balas J, Cada M. Comparison of body composition between two elite women's volleyball teams. *Acta Universitatis Palackianae Olomucensis, Gymnica* 2011**,** *41 (1)*, pp. 15-22.

Mascherini, G.; Gatterer, H.; Lukaski, H.; Burtscher, M.; Galanti, G. Changes in hydration, body-cell mass and endurance performance of professional soccer players through a competitive season. *J Sports Med Phys Fitness* 2015, Jul-Aug;55(7-8):749-55.

Mundstock E, Amaral MA, Baptista RR, Sarria EE, Dos Santos RRG, Filho AD, Rodrigues CAS, Forte GC, Castro L, Padoin AV, Stein R, Perez LM, Ziegelmann PK, Mattiello R. Association between phase angle from bioelectrical impedance analysis and level of physical activity: Systematic review and meta-analysis. *Clin Nutr,* 2018 Sep 4, S0261-5614(18) 32425-7.

Norman K, Stobaus N, Pirlich M, Bosy-Westphal A. Bioelectrical phase angle and impedance vector analysis – clinical relevance and applicability of impedance parameters. *Clin Nutr* 2012; 31:854–861.

Norman K, Wirth R, Neubauer M, Eckardt R, Stobäus N. The bioimpedance phase angle predicts low muscle strength, impaired quality of life, and increased mortality in old patients with cancer. *J Am Med Dir Assoc*. 2015 Feb;16(2): 173.e17-22.

Santarpia L, Marra M, Montagnese C, Alfonsi L, Pasanisi F, Contaldo F. Prognostic significance of bioelectrical impedance phase angle in advanced cancer: preliminary observations. *Nutrition*. 2009 Sep;25(9):930-1.

Siri WE (1961). Body composition from fluid space and density. In J. Brozek & A. Hanschel (Eds.), Techniques for measuring body composition (pp. 223-244). Washington, DC: National Academy of Science.

Valente-Dos-Santos J, Tavares ÓM, Duarte JP, Sousa-E-Silva PM, Rama LM, Casanova JM, Fontes-Ribeiro CA, Marques EA, Courteix D, Ronque ERV, Cyrino ES, Conde J, Coelho-E-Silva MJ. Total and regional bone mineral and tissue composition in female adolescent athletes: comparison between volleyball players and swimmers. *BMC Pediatr*. 2018 Jul 3;18(1):212.