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BIOELECTRICAL IMPEDANCE ANALYSIS IN KARATE ATHLETES: BIA PARAMETERS OBTAINED WITH INBODY720 REGARDING THE AGE

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Abstract

The basic purpose of this paper is to make recognizable analysis of body composition with bioelectrical impedance analyzer, (especially with InBody 720) to the sports scientific public. To fulfill this assignment we would like to present numerous parameters of body composition obtained with InBody 720, in subjects younger than 18 years and older than 18years, because of fact that this BIA device gives different final result sheets regarding the age limit of 18 years. We investigated 21 karate athletes, members of karate national team of Republic Macedonia, age span from 15 to 22 years. They were divided in two age different groups, up to 18 (U18) and over 18 years old (18+). The final result sheets for person younger than 18 years consists considerably less parameters than for subjects older than 18 years. Comparison of parameters common for both groups showed that U18 karate athletes had significantly lower mean values for following parameters: height (176.8 ± 4.26cm vs. 179.8 ± 5.35cm), body weight (69.05 ± 7.4 kg vs. 77.43 ± 8.71 kg), skeletal muscle mass (35.38 ± 4.43 kg vs. 38.34 ± 2.97 kg) and body mass index, BMI (21.8 ± 1.31 kg/m^2 vs. 23.97 ± 2.26 kg/m^2) than 18$^+$ karate athletes. Younger athletes also had significantly lower parameters of obesity diagnose: body fat mass (6.73 ± 1.98 kg vs 10.31 ± 5.02 kg) and body fat percent (9.8 ± 2.65% vs. 12.91 ± 5.14%). The data from this paper could allow the health professionals, sport scientists, sport expert and athletes to get useful information about plenty of parameters of body mass analysis obtained with bioelectrical impedance analyzer.

Keywords: *body composition, bioelectrical impedance, InBody 720, karate*

Introduction

The main role of body mass analysis in sport anthropometry is to indicate if there is need of correction of body components which will help the sports experts to plan the training system and nutritional regime of athletes. The validity and reliability of body components assessment will depend on the choice of the appropriate methodology.

The bioelectric impedance analyzes (BIA) employs the principles that an electric current flows more rapidly through materials that content ionized water. The tissues consist of abundance of water and electrolytes, such as muscles, offer less resistance and conduct the current easier than tissue poor with water, such as adipose tissue. Thus the resistance or impedance to electric current, directly relates to the amount of fat free mass. (Nichols, Going, Loftin, Stewart, Nowicki, & Pickrel. 2006). BIA methodology is present in sports anthropometry since 1980, but it is still not acknowledged enough between sports practitioners. Bia technology is drastically improved since first time occurred and become more reliable and acceptable method for measuring body composition. Presence of various manufacturers on market gains plenty devices and software's solutions for body mass assessment (Ackland, Lohman G, Sundgot-Borgen J, et al., 2012).

The aim of this paper is to show which parameters could be obtained by BIA methodology employing the InBody 720 apparatus in karate athletes bellow and over age limit of 18 years old. We believed that these are the first published data in sports population obtained with BIA in our country and our scope is to make this modern methodology for evaluation of body composition familiar and recognizable to our health and sport practitioners.

Methods

Study sample

The study sample was consisted of 21 male karate athletes, members of karate national team of Republic Macedonia, age span 15 to 22 years. Subjects were divided in two age different groups, up to 18 (U18) with mean age 16.48±1.22 years and over 18 years old (18+), mean age = 19.47±1.51 years. The measurements were made during the regular sports medical checkups, before preparation period.

Assessment of body composition

Measurements of body composition were performed using bioelectrical impedance analysis (BIA), with the InBody 720 Tetrapolar 8-Point Tactile Electrode System (Biospace Co., Ltd.). The InBody 720 apparatus utilizes the latest technology of measuring body composition using the method of Direct Segmental Multifrequency Bioelectrical Impedance Analysis (DSM-BIA). Using the frequency range from 1kHz to 1MHz, the quantity / weight of all four major body components-water, proteins, minerals and fats-is measured with a high level of accuracy [10]. All measurements were carried out in the period July-August 2015, during the regular seasonal training preparation.

The manufacturer's recommendations [Biospace, Kinesiology] were followed fully: the measurements were taken in the morning (between 8:30 and 10:00 a.m.); the respondents did not eat after 9:00 p.m. the evening before, and on the day of the measurement they neither ate nor drank before the end of the procedure; the respondents were not submitted to any great physical exertion during practice 12 hours before the measurement; the respondents did not consume alcohol 48 hours before the measurement; the respondents were asked to empty their bowels and bladder before the measurement; the respondents were in the standing position for at least 5 minutes before the measurement to redistribute the tissue fluids; the measurement was performed in the standing position by the procedure recommended by the manufacturer (hands aside placed 15 cm laterally from the body)

Statistical analysis

All results were first subjected to descriptive statistical analysis to define the basic measures of central tendency and dispersion of data (MEAN, SD, cV%, 95% confidence interval-lower and upper bound). To analyse the significance of differences between selected body composition parameters in two aged different groups of karate athletes, the analysis of mean, standard deviation and 't' test was applied at 0.05 level of significance.

Explanation of InBody 720 sheet result

InBody's results sheet for person younger than 18 years offer a set of parameters, regarding components that made the body: body water, protein, mineral and body fat. These parameters from nutritional evaluation point of view are described as "enough" or "too little". Second part of result sheet gives data about weight, muscle mass and body fat, expressed as absolute value in kilograms and as percentile values, not as part of the body weight, but compared with reference values. There is is graphical presentation of his/hers height and weight compared with "their friends" or siblings. The growth score (in points) is also given. The fourth part of results sheet for up to 18 years subjects is called "evaluation of my body". It gave us information which is the ideal weight for the tested subject, how much kilograms he/she needs to change in total, and partially for muscle mass and body fat. Additional data in this part of result sheet are body mass index (BMI), percentage body fat (PBF), obesity degree (OD), and basal metabolic rate (BMR). At the end of the sheet is note where the impedance (Z) values, for different frequencies (1kHz, 5kHz, 50kHz,250kHz, 500kHz, 1MHz) for all limbs and trunks are given.

InBody's results sheet for person older than 18 years old is comprised of four (4) main sets of analysis and several additional descriptive information sets. After general data, name, height, gender and date of testing follows body composition fourth compartments analysis. The total water compartment, consist of intracellular (ICW) and extracellular water (ECW). The protein compartment is part of soft lean mass (SLM) and consecutively of fat free mass (FFM). The mineral compartment is divided into two subcompartments: non-osseous part which is part of SLM and osseous which is part of FFM. The fourth compartment is body fat mass.

Muscle-Fat analysis showed us the measured body weight and calculated values for skeletal muscle mass and body fat mass, and their reference values. The graphical presentation of obtained values is qualified as under, normal or over regarding the normal range.

Obesity diagnoses presents body mass index- BMI (kg/m^2), percent body fat-PBF (%) and waist to hip ratio (WHR) in same manner as above mentioned parameters.

The last analysis is Lean balance analysis or segmental analysis for right arm, left arm, trunk, right leg and left leg expresses in three (3) way: as kilogram of muscle for each part; as percentile value obtained from ratio of lean to lean ideal multiply with 100 (lean/lean ideal*100); fat mass percentile for each body segment. Part of lean balance analysis are segmental edema data for limbs and trunk.

Results

The data obtained by bioelectrical impedance are divided to two age different groups, regarding the age limit of 18 years. InBody 720 as bioelectrical analyzer generated different final results depending on subject's age, if he/she is younger or older than 18 years.

Descriptive statistics for general parameters and BIA obesity diagnose parameters for U18 athletes and for athletes older than 18 years are shown ii the table 1.

Table 1. General characteristics and obesity diagnose BIA parameters in karate athletes (U18=younger than 18 years; 18$^+$= older than 18 years)

		mean	SD	min	max
Age (year)	U18	16.48	1.22	15	17.9
	18$^+$	19.47	1.51	18	22
Height (cm)	U18	176.8	7.26	172	181
	18$^+$	179.8	5.35	171	187.5
Weight (kg)	U18	69.05	7.4	59	77.3
	18$^+$	77.43	8.71	66.7	94.3
BMI (kg/m$^{2)}$	U18	21.8	1.31	19.9	23.3
	18$^+$	23.97	2.26	21.5	29.8
Body fat mass (kg)	U18	6.73	1.98	5	10.4
	18$^+$	10.31	5.02	4.6	19.4
Body fat percent (BF%)	U18	9.8	2.65	6.6	13.4
	18$^+$	12.91	5.14	6.6	21.7
Waist-to-hip ratio	U18	#	#	#	#
	18$^+$	0.82	0.04	0.75	0.90

this parameter is not available for younger than 18 years

Table 2. Body fluids and body components in karate athletes (U18=younger than 18 years; 18$^+$= older than 18 years)

All variables are in kg		mean	SD	min	max
Total Body Water (TBW)	U18	45.73	5.3	38.6	52.1
	18$^+$	48.78	5.76	38.6	69.4
Intracellular water (ICW)	U18	#	#	#	#
	18$^+$	31.19	3.51	26.4	43.4
Extracellular water (ECW)	U18	#	#	#	#
	18$^+$	18.42	2.23	15.9	26.0
Fat Free Mass (FFM)	U18	#	#	#	#
	18$^+$	67.65	7.75	58.0	94.6
Soft Lean Mass (SLM)	U18	#	#	#	#
	18$^+$	63.91	7.32	54.7	89.3
Skeletal muscle mass (SMM)	U18	35.38	4.43	29.4	40.7
	18$^+$	38.34	2.97	34	43.7
Protein	U18	12.4	1.49	10.4	14.2
	18$^+$	10.09	1.56	10.4	18.8
Mineral	U18	4.18	0.56	3.43	4.95
	18$^+$	4.47	0.55	3.43	6.43
Osseous	U18	#	#	#	#
	18$^+$	3.74	0.44	3.26	5.31

this parameter is not available for younger than 18 years

BIA variables which express body fluids compartments and components of fat free part of body weight are shown in table 2 for both age different groups. It is noticeable that several parameters are missed for

the U18 group, because they are not a part of their body composition analysis. Comparison of parameters common for both groups showed that U18 karate athletes had significantly lower mean values for following parameters: height (176.8 ± 4.26cm vs. 179.8 ± 5.35cm), body weight (69.05 ± 7.4 kg vs. 77.43 ± 8.71 kg), skeletal muscle mass (35.38 ± 4.43 kg vs. 38.34 ± 2.97 kg) and body mass index, BMI (21.8 ± 1.31 kg/m^2 vs. 23.97 ± 2.26 kg/m^2) than 18$^+$ karate athletes. Younger athletes also had significantly lower parameters of obesity diagnose: body fat mass (6.73 ± 1.98 kg vs 10.31 ± 5.02 kg) and body fat percent (9.8±2.65% vs. 12.91±5.14%).

Discussion

Modern sports anthropometry employs many methods for describing the body mass components in athletes and generally they are divided into reference, laboratory and field methods. Beside this approaches these methods are categorized in direct (via cadaver dissection); indirect when surrogate parameter are measured to estimate certain tissue or body components and double indirect when one indirect parameter is used to estimate other indirect parameter (via regression analysis) (Ackland et al., 2012). Bioelectrical impedance analysis (BIA) is classified as double indirect and field method. The most accurate measures of body composition are obtained from laboratory-based procedures based on multi-component models or the use of dual energy X ray absorptiometry (DEXA) which allows independent estimates of fat, muscle and bone density. These methods are expensive and not readily available in field and clinical settings (Goran, Driscol, Johnson, Nagy, & Hunter.1996).

Bioelectrical impedance analysis(BIA) exists almost thirty years on anthropometry scene but still it is not affirmed enough in sports anthropometry. BIA techniques requires inexpensive, portable equipment, making it appealing alternative to asses body composition in practice. The disadvantage of using BIA are the diversity of formulas used to predict fat mass and fat free mass. These formulas use factors like gender, height and weight combined with values of resistance and/or reactance to predict FM and FFM. (Bucholz, Bartok, & Schoeller, 2004; Deurenberg, & Derrenberg-Yap,2003). Until a generalized athlete-specific BIA equation developed from a multiple-compartment is published, it is recommended that generalized equations such as those published by Lukaski and Bolonchuk and Lohman be used in athletes. [Ackland et al., 2012) BIA equations developed for specific athletes may also produce acceptable values and are still acceptable for use until more research is conducted. In spite of ambiguity of validity of predicted body mass components the reproducibility of BIA is high, which made the monitoring individual changes in body composition possible (Deurenberg, 1992).

In the current paper were presented the BIA parameters of body composition in karate athletes, member s of national karate team of Republic of Macedonia, regarding the age limit of 18 years. The comparison of mean values showed that karate athletes under 18 years had significantly lower values for general anthropometric parameters and main body components (body fat and skeletal muscle mass) than their older team colleagues. We would like to emphasize that the purpose of this study was to introduce the BIA methodology to our sports scientific public. In order to achieve that purpose we will shortly discussed about pros and contras for BIA methodology.

In a critical review of the use of bioelectrical impedance analysis, Mialich et al. conclude that BIA is an important instrument for health professionals and that its use can provide safe data about body composition (Mialich, Faccioli Sicchieri, &Jordao, 2014).

In the systematic review of scientific papers which investigated the reliability of BIA method in the estimation of body composition of athletes by performing a comparative analysis of %BF obtained by this and other relevant laboratory techniques, (DXA, hydrodensitometry, deuterium dilution method and plethysmography) Mazic S. et al have reviewed sixteen studies (Mazic et al., 2014). The results obtained in 13 out of 16 studies indicate the relative unreliability of BIA method in the estimation of body composition in athletes. Five studies declared that BIA overestimated %BF, while one study indicated that these values were underestimated. Only three studies highlighted the relative reliability of this body composition assessment method. Obviously BIA is a quick, relatively inexpensive and noninvasive method for the body composition evaluation, the results are conflicting.

The main notifications found in the studies of BIA accurateness and validity are that conditions during BIA procedure must be precisely controlled and regarding overestimation or underestimation of body components (Lukaski, 1987; Andreoli et al.,2004; Knechtle et al., 2011). There may be an intrinsic bias in the use of BIA in athletes because of a generally lower BF percentage in athletes than in the normal population such that fatness tends to be overestimated at the lower end of BF values (Segal, 1996). As a

general rule, there are larger regression artifact on extreme leanness or obesity ends of regression curve, whereas at the extreme of obesity predictive equations tend to underestimate fatness (Kao, Lu, Jang, Yang, Chen, Chen, & Hsieh, 2010)

BIA is considered reasonably accurate for measuring groups, or for tracking body composition in an individual over a period of time, but is not considered sufficiently accurate for recording of single measurements of individuals.[8] The bioelectrical impedance technology may be acceptable for determining body composition of groups and for monitoring changes in body composition within individuals over time (Buchholz, Bartok, & Schoeller, 2004; Dehghan, & Merchant, 2008; Kushne, Gudivak, & Schoeller, 1996). In general, majority of literature concur that the BIA method shows promise for estimating body composition in athletes, but future research should focus on the development of general athlete-specific equations using. **(**Moon, 2013).

Conclusions

The application of BIA technique in sports anthropometry is attractive for multiple reasons: simple and easy routine for athlete and for practitioner, short time consuming, inexpensive, absolutely noninvasive and harmful, produce a plenty of parameters and data about body composition. The main deficiency of BIA technique is a certain ambiguity concerning accuracy of body fat component (overestimation or underestimation) which is caused because of lack of standardized and generally accepted athlete specific equation. We should bear on mind that body composition parameters are not diagnostic physiological parameters for athlete's health status, they are indicators of temporarily body composition status. Considering the fact that there is no gold criterion field method, we suggest that BIA as cost-effective method which could be helpful to asses and follow the changes in athlete's body composition concerning the nutrition regime, training routine and sports events and performance.

References:

Ackland, T.R., Lohman, T.G., Sundgot-Borgen, J., Maughan, R.J., Meyer, N.L., & Muller, W. (2012). Current status of body composition assessment in sport: Review and position statement on behalf of the ad hoc research working group on body composition health and performance under the auspices of the I.O.C. Medical Commission. *Sports Medicine*, **42**, 227-49.

Andreoli, A., Melchiorri, G., Volpe, S.L., Sardella, F., Iacopino, L., & De Lorenzo, A.(2004). Multicompartment model to assess body composition in professional water polo players. *Journal of Sports Medicine and Physical Fitness*, **44**(1): 38-43.

Biospace. (2012). *InBody 720 -The precision body composition analyzer*. Retrieved January 21, 2016 from www.e-inbody.com.

Bucholz, A.C., Bartok, C., & Schoeller, D.A. (2004). The validity of biolecterical impedance models in clinical populations. *Nutrition Clinical Practice*, **19**,433-446;

Dehghan, M., & Merchant, A.T. (2008). Is bioelectrical impedance accurate for use in large epidemiological studies? *Nutrition Journal,* **7**, 26.

Deurenberg, P. (1992). The assessment of body composition: Uses and misuses. Annual report, Lausanne, Switzerland, Nestle Foundation, pp 35-72.

Deurenberg, P., & Derrenberg-Yap, M. (2003). Validity of body composition methods across ethnic population groups. *Forum Nutrition,* **56**,299-301.

Goran, M.I., Driscol,l P., Johnson, R., Nagy, T.R., & Hunter, G. (1996).Cross-calibration of body-composition techniques against dual-energy X-ray absorptiometry in young children. *American Journal of Clinical Nutrition*,**63**, 299–305

Kao, M.F., Lu, H.K., Jang, T.R., Yang, W.C., Chen, C.H., Chen, Y.Y., Hsieh, K.C. (2010). Comparison of diferent measurement equations for body composition estimation in male athletes. *International Journal of Sport ans Exercise Science,* **3**(10),11-16

Knechtle B, Wirth A, Knechtle P, Rosemann T, Rüst CA, Bescós R. (2011). A comparison of fat mass and skeletal muscle mass estimation in male ultra-endurance athletes using bioelectrical impedance analysis and different anthropometric methods. *Nutritional Hospital*, **26**(6), 1420-1427.

Kushne, R.F., Gudivak, R., & Schoeller, D.A. (1996). Clinical characteristics influencing bioelectrical impedance analysis measurements. *American Journal of Clinical Nutrition,* **64,** (3), 423–427.

Lukaski, H.C. (1987). Methods for the assessment of human body composition: traditional and new. *American Journal of Clinical Nutrition*, **46**, 537-56.

Mazic, S., Lazovic, B., Djelic, M., Suzic-Lazic, J., Acimovic, T., & Brkic, P. (2014). Body composition assesemnt in athletes: systematic review. *Medicinski pregled*, **67**(7-8), 255-260.

Mialich, M.S., Faccioli Sicchieri, J.M., & Jordao, J.A.A. (2014). Analysisi of Body Composition: A critical review of the use of bioelectrical impedance analysis. *Internationa Journal of Clinical Nutrition*, **2**(1),1-10

Moon, J.R. (2013). Body composition in athletes and sports nutrition: an examination of the bioimpedance analysis technique. *European Journal of Clinical Nutrition*, **67**, 554-559.

Nichols, J., Going, S., Loftin, M., Stewart, D., Nowicki, E., & Pickrel, J. (2006). Comparison of two bioelectrical impedance analysis instruments for determining body composition in adolescent girls. *Internationa Journal of Body Composition Researches,* **4**(4), 153-160.

Segal, K.R. Use of bioelectrical impedance analysis measurements as an evaluation for participating in sports. (1996). *The American Journal of Clinical Nutrition*, **64**, 469-471