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Comparative analysis of measuring the body fat percentage by anthropometric methods and bioimpedance

Упоредна анализа одређивања процента масти у телу антопометријским методама и биоимпеданцом

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Упоредна анализа одређивања процента масти у телу антопометријским методама и биоимпеданцом

SUMMARY

Introduction/Objective Body fat percentage (BFP) is the most reliable indicator of a nutritional status. For clinical practice it is important but scarcely investigated whether to exclusively use contemporary methods of BFP measurement, or classic anthropometric methods are also reliable.

The aim was to investigate the correlation between the results of BFP measuring using a contemporary method of bioimpedance (Bio) and classic methods of skin fold thickness (SFT) and body mass index (BMI).

Method There were 279 patients of the Dietetic Counseling Center of the Institute for Public Health in Niš who were included in the research during 2015. Body fat percentage was determined using three classic anthropometric methods of ST over the triceps, and the scapula and BMI. Apparatus OMRON BF 302 was used for BFP measuring with bioimpedance method.

Results Using a one factorial analysis of variance we found a statistically significant difference between the mean values of the BFP obtained with bioimpedance and with anthropometric methods ($F = 24.19$, $p < 0.05$). Post hoc analysis revealed a statistically significant difference between the BFP determined with bioimpedance and SFT over the triceps and the scapula, while the anthropometric method based on BMI gave the results similar to those from bioimpedance.

Conclusion We show that the most reliable anthropometric method of determination of BFP is that based on BMI, as its results correlate best with those obtained with a contemporary method of bioimpedance.

Keywords: body fat percentage, BMI, bioimpedance

САЖЕТАК

Увод/Циљ Проценат масти у телу је најпоузданији показатељ степена ухрањености. За клиничку праксу важно је али и недовољно испитано да ли се у одређивању процента телесне масти треба ослањати искључиво на најсавременије методе или су поуздане и класичне антропометријске методе.

Циљ истраживања био је да се испита корелација између резултата мерења процента масти у телу савременом методом биоелектричне импеданце и класичним антропометријским методама дебљине кожног набора (ДКН) и индекса телесне масе (*BMI*).

Методе У истраживање је укључено 279 пацијената Саветовалишта за дијететику у Институту за јавно здравље Ниш током 2015. године. Проценат телесне масти класичним антропометријским мерењима одређен је на три начина: на основу ДКН над трицепсом; на основу ДКН над скапулом и на основу BMI. Такође свим испитаницима је апаратом ОМРОН БФ 302 на бази биоимпеданце одређен проценат телесне масти.

Резултати Једнофакторском анализом варијансе поновљених мерења утврђена је статистички значајна разлика између средњих вредности процента масти добијених биоимпеданцом и помоћу три антропометријске методе (F (24,19), $p < 0,05$). Даљом пост хок анализом утврдили смо да постоји статистички значајна разлика између процента масти одређеног биоимпеданцом и на основу ДКН над трицепсом и над скапулом, док антропометријска метода на основу BMI даје резултате сличне резултатима биоимпеданце.

Закључак У нашем истраживању показали смо да је за одређивање процента масти најпрепоручљивија антропометријска метода она на основу BMI, јер најбоље корелира са савременом методом биоимпеданце.

Кључне речи: проценат масног ткива, *BMI*, биоимпе

INTRODUCTION

Body fat percentage (BFP) as a part of the overall body weight gives the most reliable assessment of nutritional status [1]. There are several modern methods of determining BFP: Bioimpedance (Bio) [2,3,4], hydro densitometry [5], air-displacement plethysmography [6], Dual – Energy X-ray Densitometry (DEXA)[7], Computerized Tomography [8], Nuclear Magnetic Resonance [9] and Near Infra-Red [10].

For this research we use a Bioimpedance method as non-invasive, relatively simple electrical conductivity method based on tissue properties to provide resistance to low-intensity electric current flow. Under the influence of impulses of a low-dose safe alternating current (800μA), the cells and tissues provide resistance or an electrical bio-impedance that depends on a tissue structure and the frequency of used signal. Therefore, the frequency response of the electrical impedance of biological tissues is under the great influence of their physiological and physicochemical status and varies from a subject to a subject. It varies from tissue to tissue in a particular subject and also varies with a change in the health status depending on the physiological and physicochemical changes, which occur in the tissue. Non-fatty tissue rich in electrolytes and water (73%) is a good electrical conductor, whereas fatty tissue poor in electrolytes and water (14%) shows a great resistance and it is a weak conductor [2,3,4]. The Bioimpendance analysis could be also useful in the planning of the physical activity for overweight/obese children and adolescents [11]. The coronavirus disease of 2019 (COVID-19) pandemic has been showing that the timely identification and correction of undernutrition also have the potential to improve outcomes of the disease cost-effectively. Practical steps to improve nutritional status at a time when hospital services are particularly stretched are also important [12]. The clinical relevance of the anthropometric data on patients obtained by the Bioimpendance is also confirmed [13].

Contemporary methods of BFP measurements are accurate but expensive as well, and the research question is whether classic methods based on skin fold thickness (SFT) and on BMI should be abandoned in a clinical practice.

The aim of this investigation is to examine the correlation between the results of BFP measurements with classic anthropometric methods of SFT and BMI and one contemporary method - Bioimpedance. The working hypothesis of the research is that some of the classic

methods of BFP measurement correlate strongly and positively with the contemporary method of bioimpedance and that it can be further recommended for clinical practice.

MATERIALS AND METHODS

Sample

There were 279 patients of the Dietetic Counseling Center of the Institute for Public Health in Nis who were included in the research during 2015. The inclusion criteria for the study were: age between 18 and 59 years , BMI greater than 25, and the absence of chronic illnesses. This information was obtained from the patient's medical records.

Body fat percentage measurements

Body height and body weight and skin fold thickness (SFT) over the triceps and the scapula were measured. The SFT was determined using a mechanical caliper (John-Bull). Also, BFP was determined in all examinees using the OMRON BF 302 ("Prizma" from Kragujevac) apparatus based on bioimpedance. Trained personnel performed all measurements, using three times and the mean values were calculated. Examinees were advised not to drink diuretics seven days before the measurement, not to drink alcoholic drinks two days prior to measurements, not to exercise intensively 24 hours prior to measurement and not to drink any fluids four hours before measurement.

The BFP determination using classic anthropometric measurements was calculated in three ways: 1) based on SFT over the triceps; 2) based on SFT over the scapula and 3) based on the BMI. For these three methods, we used the following formulas:

1) $D1=1.0923-0.0202 \cdot SFT_t$; $F1= (4.201/D1-3.813) \cdot 100$ [1]

SFT_t – skin fold thickness over triceps

D1 – specific body density based on STy

F1– BFP based on D1

2) $D2=1.089-0.0179 \cdot SFT_s$; $F2= (4.201/D2-3.813) \cdot 100$ [1]

SFT_s – skin fold thickness over the scapula

D2 – specific body density based on STs

F2– BFP based on D2

3) BMI is calculated using formula

$BMI = Weight (kg)/ [Height (m)]^2$

$F3= 1.2 \cdot BMI+0.23 \cdot years - 10.8 \cdot gender -5.4$ (male = 1; female= 0) [14]

F3 - BFP based on BMI

The measurement of BFP using bioimpedance method was carried out with the instrument OMRON BF 302, which performs measurements in the upper body part. Before measurement, data on patient's body height, body weight, age, and gender were entered. The device is held with extended arms at an angle of 90º in relation to the body. The elbows are held straight, and the body is not moved during the measurement. The ring finger and little finger are laid around the lower part of the electrode and the middle finger around the dents on the holder between the electrodes. With the thumb and forefinger, a patient firmly tightens the upper part of the electrode.

After taking the right position a patient tightens the electrodes firmly with hands. The measurement takes about 20 seconds. The BFP value is seen on the display of the device. Each patient was precisely explained how to stand and to hold the device properly. All patients were informed about the nature of the study and were asked to sign a written consent form. They had the opportunity to end the monitoring at any time. The authors also followed the latest version of the Declaration of Helsinki given by World Medical Association and the study was done in accordance with standards of the institutional Committee on Ethics (Ethics Committee of the Public Health Institute, Niš; No. 12-3785/5).

Statistical methods

The primary data were analyzed by descriptive statistical methods, methods for testing the difference of mean values, and the method for determining the correlation between variables. From the descriptive statistical methods, the measure of central tendency (mean) and measurement of variability (standard deviation) were used. To test the difference in numerical data, Student's t-test and ANOVA repeated measurements were used with the Bonferroni post hoc analysis. For the correlation of the tested values, the Spearman's coefficient of correlation was used. Statistical hypotheses were tested at a significance level of 0.05.

RESULTS

There were 279 participants included in the research (159 (57%) females and 120 (43%) males). The average age was 36.09 ± 14.26 years.

Men had higher body mass and body height than women. Concerning anthropometric indexes, women had higher BFP than men (Table 1).

Using One way ANOVA for repeated measurements we determined a statistically significant difference between the mean values of fat percentage obtained by bioimpedance and three anthropometric methods (F (24.19), $p < 0.05$). By a further post-hoc analysis, we found that there was a statistically significant difference between the percentage of fat determined by bioimpedance and indexes F1 and F2. There is no statistically significant difference between the values of F1 and F2. Also, there were no statistically significant differences between the percentage of fat determined by bioimpedance and index F3 (Table 2).

All the correlation coefficients between the BFP obtained by bioimpedance and other measurements by indexes F1, F2, and F3 were positive and significant. The strongest correlation is between index F3 and bioimpedance in both genders (Table 3).

The correlation analysis in relation to age showed that all BFP determined by bioimpedance and anthropometrics were significantly and positively related. At the age of 18-25, the strongest correlation is between the BFP determined by bioimpedance and the F1 index (BFP based on SFT over triceps). In all other age groups, the strongest correlation was between BFP based on bioimpedance and an BMI (Table 4).

Correlation analysis stratified in relation to BMI showed a significant positive correlation between the BFP based on bioimpedance and three used indexes with the exception of the F2 index for BMI ≥ 35 (our measurement of skin thickness may not have been precise enough due to the large amount of fat tissue above the scapula). In the group of the examinees whose BMI is in the range 30-34.9 the strongest correlation is between BFP based on bioimpedance and F1 index. However, this connection is weak. In the other two groups, the correlation of BFP based on bioimpedance and the F3 index is the strongest, and this is a strong association (Table 5).

DISCUSSION

In our research, we show that the most appropriate anthropometric method for BFP measurement is based on BMI, because it gives the closest results and it correlates best with the modern Bioimpedance method.

Today, in clinical practice and in a scientific work, BMI and different indexes for determining BFP are used, but WHO officially recommends only BMI as anthropometric method of BFP determination [15]. Some countries have developed their own standards N1,N2 [16,17,18]. However, there are shortcomings of this method which have been proven in

various studies [19,20,21]. That is why there is a need to use some other anthropometric method of BFP determination, together with BMI. However, there is a problem of how to choose the appropriate index. The practice, which has been proven as successful, is that each country should determine the combination of indexes for BFP. It seems that body fat schedule may be country or nation specific [17, 22]. In our research, we compared different anthropometric indicators and, to our knowledge the results presented here are the first of a kind in Serbia.

From all indexes, which follow the percent of fat in the body the highest mean value in the sample, was determined using index based on SFT_s, whereas the lowest percent of fats was determined using Bioimpedance method, and this method showed the lowest standard deviation. It indicates that this index was the most stable throughout the entire research. However, the method based on BMI has also a small standard deviation which is also in favor of its stability throughout the measurements. These results are similar to the findings of previous studies which showed that the calculation of BFP based on SFT was error prone and with considerable variation across age, gender and ethnicity [23]. High standard deviations with indexes based on SFT_s and based on SFT_t speak about the insufficient precision of the method.

Earlier research demonstrated a good correlation between BMI and BFP calculated or measured by different methods [24]. Nevertheless, some inconsistencies were found, most likely due to the fact that the calculation of BMI does not include age and gender. However, BFP based on BMI in our study takes into account gender and age [25,26].

Due to this it is highly expected that the strong correlation between the results of BFP measurer using Bioimpedance and index based on BMI was found in the whole sample but also according to gender and in different age and BMI categories.

That is why the method of determining BFP using BMI can be recommended both in epidemiological studies and in a clinical practice. This is important since there is limited access to the advanced methods of BFP measuring in Serbia

CONCLUSION

The only anthropometric method of BFP measurement suitable for clinical practice and research is that based on BMI because its results strongly correlate with the results based on Bioimpedance method. Anthropometric methods based on SFT over the triceps and the scapula significantly vary in the results from the method of Bioimpedance and they are of a low precision.

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Conflict of interest: None to declare

REFERENCES

1. Radovanović M, Jevtić. Udžbenik higijene. Beograd: Medicinska knjiga Beograd; 1992.
2. Brantlov S, Jødal L, Lange A, Rittig S, Ward LC. Standardisation of bioelectrical impedance analysis for the estimation of body composition in healthy paediatric populations: a systematic review. J Med Eng Technol. 2017Aug;41(6):460-79. DOI: 10.1080/03091902.2017.1333165. PubMed PMID: 28585459.
3. Kyle UG, Bosaeus I, De Lorenzo AD, Deurenberg P, Elia M, Gomez JM, et al. Bioelectrical impendance analysis – part I:review of principles and methods. Clin Nutr. 2004 Okt;23(5):312-9. DOI: 10.1016/j.clnu.2004.06.004; PubMed PMID:15380917.
4. Fang H, Berg E, Cheng X, Shen W. How to best assess abdominal obesity. Curr Opin Clin Nutr Metab Care. 2018 Sep;21(5):360-65. DOI: 10.1097/MCO.0000000000000485; PubMed PMID:29916924.
5. Kuriyan R. Body composition techniques. Indian J Med Res. 2018 Nov;148(5):648-58. DOI: 10.4103/ijmr.IJMR_1777_18. ; PubMed PMID: 30666990; PubMed Central PMCID: PMC6366261.
6. Kendall KL, Fukuda DH, Hyde PN, Smith-Ryan AE, Moon JR, Stout JR. Estimating fat-free mass in elite-level male rowers: a four-compartment model validation of laboratory and field methods. J Sports Sci. 2017 Apr;35(7):624-33. DOI:10.1080/02640414.2016.1183802; PubMed PMID: 27159216.
7. Ren J, Brann LS, Bruening KS, Scerpella TA, Dowthwaite JN. Relationships among diet, physical activity, and dual plane dual-energy X-ray absorptiometry bone outcomes in pre-pubertalgirls. Arch Osteoporos. 2017 Dec;12(1):19. DOI:10.1007/s11657-017-0312-9; PubMed PMID:28197890.

8. Gómez-Ambrosi J, González-Crespo I, Catalán V, Rodríguez A, Moncada R, Valentí V, et al. Clinical usefulness of abdominal bioimpedance (ViScan) in the determination of visceral fat and its application in the diagnosis and management of obesity and its comorbidities. Clin Nutr. 2018 Apr;37(2):580-89. DOI: 10.1016/j.clnu.2017.01.010; PubMed PMID: 28187933.
9. Jones TA, Wayte SC, Reddy NL, Adesanya O, Dimitriadis GK, Barber TM, et al. Identification of an optimal threshold for detecting human brown adipose tissue using receiver operating characteristic analysis of IDEAL MRI fat fraction maps. Magn Reson Imaging. 2018 Sep;51:61-8. DOI: 10.1016/j.mri.2018.04.013; PubMed PMID: 29704560.
10. Fthenakis ZG, Balaska D, Zafiropulos V. Uncovering the FUTREX-6100XL prediction equation for the percentage body fat. J Med Eng Technol. 2012 Oct;36(7):351-7. DOI: 10.3109/03091902.2012.708382; PMID: 22953764.
11. Radovanović D, Ignjatović A. The Planning of Physical Activities for Overveight/Obese Children and Adolescents: Principles, Guidelines and Recommendations. Prev Ped. 2018; 4(1-2): 22 -5.
12. Mehta S. Nutritional status and COVID-19: an opportunity for lasting change?Clin Med (Lond). 2020 Apr 27;20(3):270-3.
DOI: 10.7861/clinmed.2020-0187.)
13. Moriwaki EI, Enomoto H, Saito M, Hara N, Nishikawa H, Nishimura T, Iwata Y, Iijima H, Nishiguchi S. The Anthropometric Assessment With the Bioimpedance Method Is Associated With the Prognosis of Cirrhotic Patients.In Vivo. 2020;34(2):687-93. DOI: 10.21873/invivo.11825.
14. Deurenberg P, Weststrate JA, Seidell JC. Body mass index as a measure of body fatness: Age- and sex-specific prediction formulas. British Journal of Nutrition. 1991 Mar; 65(2): 105–14. PubMed PMID: 2043597.
15. WHO (World Health Organization). Physical Status: the use and inetpretation of anthropometry. 1997. Who Tehnical Raport Series no.854. Geneva: WHO.
16. Gallagher D, Heymsfield SB, Heo M, Jebb SA, Murgatroyd PR, Sakamoto Y. Healthy percentage body fat ranges: an approach for developing guidelines based on body mass index. Am J Clin Nutr. 2000 Sept;72(3):694-701. DOI:10.1093/ajcn/72.3.694; PubMed PMID:10966886.
17. Dasgupta R, Anoop S, Samuel P, Kurian ME, Inbakumari M, Finney G, et al. Bioimpedance analysis with a novel predictive equation - A reliable technique to estimate fat free mass in birth

weight based cohorts of Asian Indian males. Diabetes Metab Syndr. 2019 Jan - Feb;13(1):738-42. DOI: 10.1016/j.dsx.2018.11.070; PubMed PMID: 30641798.
18. Costa-Urrutia P, Vizuet-Ga´mez A, Ramirez-Alca´ntara M, Guillen-Gonza´lez MA´ , Medina-Contreras O, Valdes-Moreno M, et al. Obesity measured as percent body fat, relationship with body mass index, and percentile curves for Mexican pediatric population. PLoS One. 2019 Feb 25;14(2):e0212792. DOI: 10.1371/journal.pone.0212792; PubMed PMID:30802270; PubMed Central PMCID: PMC6388924.
19. Takesian M, Santo MA, Gadducci AV, Santarém GCF, Greve J, Silva PR, et al. Trunk body mass index: a new reference for the assessment of body mass distribution. Arq Bras Cir Dig. 2018 Jun 21;31(1):e1362. DOI: 10.1590/0102-672020180001e1362.; PubMed PMID: 29947696; PubMed Central PMCID: PMC6050002.
20. Ahima RS, Lazar MA. Physiology. The health risk of obesity–better metrics imperative. Science. 2013 Aug 23;341(6148):856–58. DOI: 10.1126/science.1241244; PubMed PMID: 23970691.
21. Krakauer NY, Krakauer JC. A new body shape inde x predicts mortality hazard independently of body mass index. PLoS ONE. 2012:7:e39504. DOI: 10.1371/journal.pone.0039504; PubMed PMID: 22815707.
22. Rahman M, Berenson AB. Accuracy of current body mass index obesity classification for white, black, and Hispanic reproductive-age women. Obstet Gynecol. 2010 May;115:982-88. DOI: 10.1097/AOG.0b013e3181da9423; PubMed PMID:20410772
23. Dagenais GR, Yi Q, Mann JF, Bosch J, Pogue J, Yusuf S. Prognostic impact of body weight and abdominal obesity in women and men with cardiovascular disease. Am Heart J. 2005 Jan;149(1):54-60. DOI:10.1016/j.ahj.2004.07.009; PubMed PMID:15660034.
24. Fedewa MV, Nickerson BS, Esco MR. Associations of body adiposity index, waist circumference, and body mass index in young adults. Clin Nutr. 2019 Apr;38(2):715-20. DOI: 10.1016/j.clnu.2018.03.014; PubMed PMID:29653863.
25. Freedman DS, Thornton JC, Pi-Sunyer FX, Heymsfield SB, Wang J, Pierson RN, et al. The body adiposity index (hip circumference ÷ height(1.5)) is not a more accurate measure of adiposity than is BMI, waist circumference, or hip circumference. Obesity (Silver Spring). 2012 Dec;20(12):2438-44.DOI:10.1038/oby.2012.81;PubMed PMID:22484365 PubMed Central PMCID: PMC3477292.
26. Cerqueira MS, Santos CAD, Silva DAS, Amorim PRDS, Marins JCB, Franceschini SDCC. Validity of the Body Adiposity Index in Predicting Body Fat in Adults: A Systematic Review. Adv Nutr. 2018 Sep 1;9(5):617-24. DOI:10.1093/advances/nmy043; PubMed PMID:30239583; PubMed Central PMCID:PMC6140443

Table 1. Anthropometric indicators of examinees related to the gender (mean value ± standard deviation)

Characteristics	Whole sample (n= 279)	Men (n=120)	Women (n=159)	t	p
Body mass (kg)	88. 65 ± 15.96	96.37 ± 13.80	82.89 ± 15.03	t = - 8.311	< 0.05
Body height (m)	1.68 ± 0.1	1.75 ± 0.09	1.63 ± 0.07	t = - 12.48	< 0.05
BMI	31.35 ± 4.54	31.68 ±3.76	31.1 ± 5.06	t = -1.54	0.297
Bio (%)	31.78 ± 7.57	28.84 ±7.01	33.99 ± 7.23	t =11.05	< 0.05
F1 (%)	39.06 ± 26.59	32.23 ± 20.76	44.22 ± 29.28	t = 4.09	< 0.05
F2 (%)	41.44 ± 23.91	40.22 ± 23.59	42.36 ± 24.19	t = 0.52	0.433
F3 (%)	32.88 ± 9.04	29.5 ± 6.26	35.58 ± 8.42	t = 12.88	< 0.05

BMI – Body Mass Index; Bio – percent of fats determined by bioimpedance; F1 – percent of fats in the body determined based on ST over the triceps; F2 – percent of fats in the body determined based on ST over the scapula; F3 – percent of fats in the body based on body mass index

Table 2. Difference between mean values of the body fat percentage based on bioimpedance (Bio) and those based on the anthropometric indicators

Method	Method	p*
Bio	F 1	< 0.05
	F 2	< 0.05
	F3	0.09
F1		
	F2	0.34
	F3	< 0.05
F2		
	F3	< 0.05

One way ANOVA for repeated measurements, post- hoc method Bonferroni; F1 – percent of fats in the body determined based on ST over the triceps; F2 – percent of fats in the body determined based on ST over the scapula; F3 – percent of fats in the body based on body mass index

Table 3. Correlation (Spearman-Brown's correlation coefficient) between body fat percentage based on bioimpedance and anthropometric indicators in relation to gender

Method	**Whole sample (n = 279)**	**Men (n = 120)**	**Women (n = 159)**
F1	0.658*	0.654*	0.659*
F2	0.642*	0.638*	0.646*
F3	0.701*	0.682*	0.726*
*p< 0.05			

F1 – percent of fats in the body determined based on ST over the triceps; F2 – percent of fats in the body determined based on ST over the scapula; F3 – percent of fats in the body based on body mass index

Table 4. Correlation (Spearman-Brown's correlation coefficient) between body fat percentage based on bioimpedance and anthropometric indicators in relation to age

Method	**Age**			
	18–25	26–35	36–45	≥ 46
F1	0.676*	0.710*	0.419*	0.667*
F2	0.615*	0.631*	0.433*	0.676*
F3	0.429*	0.851*	0.618*	0.731*
*p< 0.05				

F1 – percent of fats in the body determined based on ST over the triceps; F2 – percent of fats in the body determined based on ST over the scapula; F3 – percent of fats in the body based on body mass index

Table 5. Correlation (Spearman-Brown's correlation coefficient) between body fat percentage based on bioimpedance and anthropometric indicators in relation to body mass index (BMI)

Method	BMI		
	25–29.9	30–34.9	≥ 35
F1	0.558*	0.391*	0.541*
F2	0.465*	0.272*	0.222
F3	0.610*	0.285*	0.676*
*p < 0.05			

F1 – percent of fats in the body determined based on ST over the triceps; F2 – percent of fats in the body determined based on ST over the scapula; F3 – percent of fats in the body based on body mass index

