Journal of Clinical Densitometry: Assessment & Management of Musculoskeletal Health, vol. ■, no. ■, 1−8, 2014

1094-6950/■:1−8/$36.00
http://dx.doi.org/10.1016/j.jocd.2014.07.002

Original Article

Accuracy of Segmental Bioelectrical Impedance Analysis for Predicting Body Composition in Pre- and Postmenopausal Women

Noriko I. Tanaka,[*,1] *Satoshi Hanawa,*[2] *Haruka Murakami,*[1] *Zhen-Bo Cao,*[3] *Michiya Tanimoto,*[4] *Kiyoshi Sanada,*[2] *and Motohiko Miyachi*[1]

[1]*Division of Health Promotion and Exercise, National Institute of Health and Nutrition, Shinjuku-ku, Tokyo, Japan;* [2]*College of Sport and Health Science, Ritsumeikan University, Kusatsu-shi, Shiga, Japan;* [3]*Faculty of Sport Sciences, Waseda University, Tokorozawa-shi, Saitama, Japan; and* [4]*Faculty of Biology-Oriented Science and Technology, Kinki University, Kinokawa-shi, Wakayama, Japan*

Abstract

This study aimed to compare the accuracy for predicting body composition using single-frequent segmental bioelectrical impedance analysis (BIA) between pre- and postmenopausal women. A total f 559 Japanese women aged 30−88 yr were divided into 4 groups by questionnaire: natural menopause, pathological menopause, regular menstruation, or irregular menstruation. The measurement values by dual-energy X-ray absorptiometry were used as a reference of the body composition. In terms of the results, regardless of the menopausal status, BIA slightly but significantly overestimated the percentage of body fat (standard error of estimate: 5.3%−6.7%) and the leg lean soft tissue mass (LSTM; 5.1%−6.1%), and underestimated the LSTM in the whole body (6.2%−7.6%) and arm (2.8%−3.7%). The absolute values of the predictive error for leg LSTM were significantly higher in postmenopausal groups than in the premenopausal ones. The corresponding values for the whole body and arm LSTM, and the percentage of body fat were higher in premenopausal groups than in postmenopausal ones. In conclusion, the predictive accuracy of BIA for postmenopausal women is not inferior to that for premenopausal ones, unless we target the leg LSTM.

Key Words: Bioelectrical impedance analysis; body composition; dual-energy X-ray absorptiometry; estimation; menopause.

Introduction

Natural menopause occurs between the ages of 42 and 56 yr, with an average of 51 yr. In general, the body composition of perimenopausal (during menopause transition) and postmenopausal women changes dramatically. For example, loss of total body potassium (associated with muscle and viscera) is greatest in the first 3 yr after menopause *(1)*. The ratio of body fat to weight also increases in postmenopausal women compared with that in premenopausal ones *(2)*. These factors would accelerate ‘‘sarcopenic obesity,’’ which is defined as a combination of excess adiposity and low muscle mass or strength *(3)*. Many recent studies have reported that menopause and/or sarcopenic obesity increase the risk of coronary artery disease, diabetes, osteoporosis, and changes in lipid profiles and inflammatory markers *(4−7)*. Therefore, qualitative assessment of the body composition of postmenopausal women is particularly important.

In general, a dual-energy X-ray absorptiometry (DXA) is the gold standard method for measuring the body composition. However, DXA includes slightly exposure to radiation and cannot be used for the field test. On the other hand, there is increasing interest in the use of bioelectrical impedance analysis (BIA) to estimate body composition because it is safe,

Received 05/06/14; Revised 06/24/14; Accepted 07/03/14.
*Address correspondence to: Noriko I. Tanaka, PhD, Division of Health Promotion and Exercise, National Institute of Health and Nutrition, 1-23-1 Toyama, Shinjuku-ku, Tokyo 162-8636, Japan. E-mail: tanaka-n@nih.go.jp

Table 1
Descriptive Data of the Subjects

Variables	Regular menstruation		Irregular menstruation		Natural menopause		Pathological menopause	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
N	176		38		288		57	
Age (yr)	41.4	6.5	48.1[a]	5.2	62.8[a,b]	6.8	61.3[a,b]	8.4
Height (cm)	158.7	5.9	159.1	4.9	154.8[a,b]	5.4	155.4[a,b]	6.0
Body mass (kg)	55.7	9.1	55.6	8.2	53.5[a]	7.2	55.0	7.7
Body mass index (kg/m^2)	22.2	3.6	21.9	2.8	22.4	2.9	22.8	3.0
Bone mineral content (g)	2099.5	277.0	1991.3	218.9	1629.9[a,b]	255.2	1651.4[a,b]	300.6
Bone mineral density (g/cm^2)	1.129	0.084	1.088	0.080	0.962[a,b]	0.091	0.962[a,b]	0.102
Estradiol (pg/mL)	90.94	69.76	68.81	72.72	12.02[a,b]	5.71	22.16[a,b]	40.63
Lean soft tissue mass by DXA (kg)								
Whole body	38.9	4.8	38.0[a]	3.9	36.2[a,b,c]	3.6	37.0[a,b]	4.3
Right arm	1.9	0.3	1.8	0.2	1.8	0.2	1.8	0.3
Left arm	1.8	0.3	1.7	0.2	1.7	0.2	1.7	0.2
Right leg	6.3	0.9	6.2	0.7	5.7[a,b]	0.7	5.9[a,b]	0.9
Left leg	6.3	0.9	6.2	0.8	5.8[a,b]	0.7	5.9[a,b]	0.9
Fat by DXA (%)								
Whole body	26.8	6.6	28.3	5.8	29.8[a]	5.3	30.4[a]	5.3
Right arm	31.3	9.0	32.1	8.4	34.3[a,b]	6.8	35.6[a,b]	7.3
Left arm	31.3	9.0	32.1	8.4	34.3[a,b]	6.8	35.5[a,b]	7.3
Right leg	31.4	6.3	32.2	5.8	31.6	5.7	31.8	5.7
Left leg	30.8	6.2	31.7	5.9	31.1	5.5	31.3	5.4
Trunk	23.6	8.4	25.9	7.6	29.2[a,b]	7.0	29.9[a,b]	7.0

Abbr: DXA, dual-energy X-ray absorptiometry; SD, standard deviation.
[a]Significantly different between regular menstruation ($p < 0.05$).
[b]Significantly different between irregular menstruation ($p < 0.05$).
[c]Significantly different between pathological menopause ($p < 0.05$). Note that the muscle mass of arm and leg is only in right side.

noninvasive, convenient, easy to perform, and inexpensive *(8)*. The periodic assessment of the body composition by BIA would provide the preservation and/or increase in skeletal muscle, and leads up to contribute the skeletal health. However, there is little information on the validity of BIA for estimating the body composition of perimenopausal and postmenopausal women. To our knowledge, for postmenopausal women, BIA systematically underestimates lean soft tissue mass (LSTM) and overestimates body fat mass *(9,10)*. Then, most of the commercially available BIA system in Japan refers to estimated body composition value for the postmenopausal women only as a guide. However, these previous studies did not directly compare the accuracy between premenopausal and postmenopausal women. Moreover, the electrodes' placement and/or the predictive equation differed among studies, so we cannot directly compare the previous results. Therefore, it is unknown whether the predictive accuracy of body composition changes depending on the menopausal status. That is, the under- or overestimation mentioned above might reflect the characteristics of the BIA per se.

The purpose of the present study is thus to confirm the validity for predicting the body composition with the BIA system commonly applied in Japan (manufactured by Tanita, Co., Ltd.) between pre- and postmenopausal women. The standard value of the body composition was obtained by DXA.

Methods

Subjects

A total of 605 Japanese women aged 30−88 yr with no serious disorders, such as stroke, cardiac disease, chronic renal failure, or peripheral arterial disease, and no hormonal replacement therapy, participated in this study. Before testing, the subjects were requested to undertake an overnight fast and to refrain from vigorous exercise and alcohol intake for 24 h. All measurements were performed at 9:00−10:00 AM. The subjects were fully informed about the procedures, risks, and purpose of this study. Written informed consent was obtained from all subjects before they participated in this study, which was approved by the Human Research Committee of the National Institute of Health and Nutrition.

Menopause was defined as the absence of menstruation for the last 2 yr *(11)* and was assessed by questionnaires. In