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Segmental Body Composition and its Association with Age and Menopausal Status

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The aim of the present study was to evaluate age and menopausal status related changes in body composition among adult Bengali women of West Bengal, India. A total of 750 adult women were measured. The results revealed significant age group wise variations in PBF, subcutaneous fat and skeletal muscles. Correlation analysis revealed that PBF and subcutaneous fat at SFWB, SFT, SFA and SFL was increased with increasing age. However, skeletal muscles at SMWB, SMT, SMA and SML demonstrated inverse correlation with age. The results also revealed that PBF, SFWB, SFT and SFA were higher among post-menopausal women compared to pre-menopausal women. On the other hand, skeletal muscles were higher among pre-menopausal women compared to post-menopausal women. In conclusion, body composition in terms of PBF, subcutaneous fat and skeletal muscle changes with age and menopausal status in women. However, the patterns of changes were different for fat mass and skeletal muscle.

*Key words***:** aging, menopause, segmental body composition, skeletal muscle, subcutaneous fat

Introduction

Body composition refers to the different components that make up a person's body weight [1] and includes both fat and fat-free mass. Body composition changes throughout the human life span by genetically determined aging processes [2, 3, 4]. Age related changes in body composition are characterized by a decrease in fat-free mass (FFM) and an increase in fat mass (FM) [5, 6, 7]. Many women also experience weight gain, increases in central adiposity and other changes in body composition around menopause [8, 9, 10]. Menopause is a condition of female hypogonadism that is characterized by ovarian failure and a rapid and dramatic decrease in female sex hormone production [11]. Epidemiological studies suggested that weight gain during the menopausal transition is associated with aging, physical inactivity and hormonal changes [12]. Studies also demonstrated that age induced changes in body composition have widespread consequences on women's health and functional capacity [11, 13, 14]. Body fat especially that located on the trunk is associated with an increased risk of cardiovascular diseases, type 2 diabetes, hypertension and breast cancer [15, 16].

It is recognized that studies on segmental body composition changes with advancement of age and menopausal status are important for better understanding of adiposity and related mortality and morbidity [4]. Precise techniques used to measure total body fat {under water weighing, dual-energy X-ray absorptiometry (DXA)} and its distribution {computed tomography (CT) scan and magnetic resonance imaging (MRI)} in humans are not appropriate for use in field-based studies because of its cost, radiation exposure, limited availability outside the research setting and also time consuming [17]. However, to obtain a reasonable estimation of body composition bioelectrical impedance analysis (BIA) method is widely used [2, 17]. The BIA is also considered a valid method of total and regional body composition analysis and also less time consuming, non-invasive and inexpensive [18].

There are few data on age and menopausal status related changes in segmental body composition, especially in Indian women. Therefore, the present study was undertaken to evaluate age and menopausal status related changes in body composition among adult Bengali women of West Bengal, India.

Materials and Methods

The present cross-sectional study was conducted on 750 apparently healthy Bengali speaking Hindu adult women from in and around Kolkata, West Bengal, India. Age range of the participants were between 18 to 73 years. The period of data collection was from March, 2015 to April, 2017**.** All participants were asked to complete a questionnaire that included specific information on bio-social information including ethnicity and age. Information about menopausal status was obtained through interviews. Anthropometric measurements namely height and weight were measured using standard procedure [19]. Height was measured using anthropometer to the nearest 0.1 cm. Weight was measured using a weighing machine to the nearest 0.1 kg. Body compositions were measured using Omron body composition monitor (Karada Scan, HBF-375). Body composition variables include percent body fat (PBF), subcutaneous fat at whole body (SFWB), trunk (SFT), arm (SFA) and leg (SFL) as well as skeletal muscle at regions like whole body (SMWB), trunk (SMT), arm (SMA) and leg (SML). Prior to the study informed consent was obtained from each participant. Pregnant, lactating women and individuals with low bone density were excluded from the study. Ethical clearance was taken from institutional ethical clearance board. Descriptive statistics includes mean and standard deviation (SD). Inferential statistics including t-test, one-way ANOVA and Pearson correlation have been applied. A p-value of 0.05 was considered as significant. All analyses were performed using the statistical program SPSS, Inc., Chicago, IL; version, 16.

Results

Characteristics of the studied participants were presented in **Table 1.** Mean age of the studied population was 41.19 ± 13.89 years. **Table 2** shows age specific changes in body composition. The participants were categorized in five age (≤30, 31-40, 41-50, 51-60, >61) groups. The results revealed significant ($p<0.05$) age group wise variations in PBF as well as in subcutaneous fat and skeletal muscle. The results of the Pearson correlation analysis revealed that body fat in terms of PBF and subcutaneous fat at whole body, trunk, arm and leg was increasing with increasing age significantly ($p<0.05$; **Table 3**).

Table 1. Characteristics of the studied participants

Variables	Mean	SD
Age (year)	41.19	13.89
Height (cm)	150.53	5.69
Weight (kg)	59.82	12.00
PBF (%)	35.19	6.27
SFWB (%)	31.93	5.10
SFT (%)	28.61	5.12
SFA (%)	49.77	5.52
SFL (%)	44.77	6.62
SMWB (%)	22.10	2.38
SMT (%)	16.69	2.58
SMA (%)	23.16	4.16
SML (%)	34.35	2.66

PBF= percent body fat, SFWB= subcutaneous fat at whole body, SFT= subcutaneous fat at trunk, SFA = subcutaneous fat at arm, SFL = subcutaneous fat at leg, SMWB = skeletal muscle at whole body, SMT = skeletal muscle at trunk, SMA = skeletal muscle at arm, SML = skeletal muscle at leg

Table 2. Age specific changes in body composition

Variables	≤ 30years		31-40years		41-50years		51-60years		> 61years		
	n = 198		n= 191		n=163		n=127		n=71		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	*P*
PBF (%)	33.31	6.62	34.99	5.61	35.82	6.32	36.57	6.03	37.12	6.03	<0.05
SFWB (%)	30.06	5.55	31.91	4.67	32.73	4.81	33.08	4.90	33.34	4.59	<0.05
SFT (%)	26.41	5.65	28.31	4.45	29.36	4.59	30.38	4.98	30.73	4.33	<0.05
SFA (%)	47.51	6.01	49.59	5.03	50.68	5.31	51.54	4.94	51.65	4.60	<0.05
SFL (%)	43.56	7.21	45.43	6.28	45.58	6.61	44.91	6.17	44.35	6.31	<0.05
SMWB (%)	23.78	2.22	22.70	2.15	21.61	1.69	20.60	1.65	19.62	1.71	<0.05
SMT (%)	18.78	2.48	17.28	2.01	16.01	1.86	14.95	1.69	13.96	1.64	<0.05
SMA (%)	25.26	4.56	23.42	3.71	22.40	3.91	21.70	3.49	20.98	3.02	<0.05
SML (%)	35.87	2.28	34.89	2.44	34.07	2.27	32.92	2.41	31.87	2.29	<0.05

Table 3. Correlation of age with body composition measures

Variables	r	*p*
PBF (%)	0.208	<0.05
SFWB (%)	0.232	<0.05
SFT (%)	0.309	<0.05
SFA (%)	0.279	<0.05
SFL (%)	0.050	<0.05
SMWB (%)	-0.592	<0.05
SMT (%)	-0.637	<0.05
SMA (%)	-0.355	<0.05
SML (%)	-0.504	<0.05

However, skeletal muscles at whole body, trunk, arm and leg demonstrated significant ($p<0.05$) negative correlation with age. Menopausal status wise comparison in body compositions were presented in **Table 4**. Result revealed significant ($p<0.05$) differences in all body composition variables except SFL ($p>0.05$) between pre-menopausal and post-menopausal women. The results also revealed that PBF, SFWB, SFT and SFA were significantly higher among post-menopausal women compared to pre-menopausal women. However, SFL was also comparatively higher among post-menopausal women as compared to pre-menopausal women. On the other hand, skeletal muscles (SMWB, SMT, SMA and SML) were significantly ($p<0.05$) higher among pre-menopausal women compared to post-menopausal women.

Table 4. Menopausal status wise comparison in body composition

Variables	Pre-menopause		Post-menopause		*p*
	n = 456		n = 294		
	Mean	SD	Mean	SD	
PBF (%)	34.43	6.17	36.38	6.27	<0.05
SFWB (%)	31.21	5.26	33.06	4.65	<0.05
SFT (%)	27.59	5.21	30.20	4.57	<0.05
SFA (%)	48.75	5.69	51.44	4.82	<0.05
SFL (%)	44.60	6.90	45.11	6.24	>0.05
SMWB (%)	23.06	2.25	20.62	1.73	<0.05
SMT (%)	17.77	2.46	15.03	1.78	<0.05
SMA (%)	24.10	4.33	21.71	3.42	<0.05
SML (%)	35.26	2.42	32.95	2.40	<0.05

Discussion

The loss of FFM and increased FM with age has been acknowledged in a number of previous studies [14, 20, 21, 22]. The present study is the first attempt among adult Bengali women to evaluate age and menopausal status related changes in segmental body composition. We found that body composition in terms of PBF as well as subcutaneous fat and skeletal muscle changes with age. However, the pattern of changes was different for fat mass and skeletal muscle. It was observed that fat mass measures like PBF and subcutaneous fat at whole body, trunk, arms and legs were increased with age. Contrary to that, fat free mass like skeletal muscles at whole body, trunk, arms and legs were decreased with the advancement of age.

The results of the present study corroborate with both cross sectional [3] and longitudinal [23] studies that demonstrated the amount of FM increases with age. In accordance with the present study, previous study by Cohn et al. [24] also observed that increasing age was associated with a greater decrease in muscle than non-muscle mass. In a recent study among Han, He et al. [7] also demonstrated a decrease in FFM and increase in PBF with age. Similar findings of greater loss in skeletal muscle mass than non-skeletal muscle mass with age were also observed by Kyle et al. [20].

The loss of FFM is interrelated with a number of factors in the elderly like decline resting metabolic rate [25], sarcopenia and related impaired mobility, increased morbidity and mortality as well as lower quality of life [20, 21] and increased risk for cardiovascular diseases [26].

Study demonstrated that these changes in body composition with aging may be due to an imbalance between energy intake and energy needs associated with increasing sedentary lifestyle [20]. Other mechanisms associated with these age-related changes include neuronal and hormonal changes as well as inflammation [27]. Moreover, among women, notable age-related changes in body composition were also observed particularly after menopause [3]. In the present study we also found a comparatively higher fat mass in terms of PBF, SFWB, SFT, SFA and SFL among post-menopausal women than pre-menopausal women. However, different patterns were observed for skeletal muscles (SMWB, SMT, SMA and SML), which were higher among pre-menopausal women as compared to post-menopausal women. In a study Gambacciani et al. [28] also demonstrated significantly higher mean PBF and regional fat percentage at trunk and arm in post-menopausal women than in the pre-menopausal women. In that study total lean tissue was also significantly less in post-menopausal women than in pre-menopausal women. Svendsen et al. [29] demonstrated that total body fat and abdominal fat increases and lean tissue mass decreases after menopause. Study also demonstrated that the decrease in FFM is more menopause related, whereas the shift toward upper body fat distribution and overall adiposity are more age related [30]. However, in contrary to the results of the present study a previous study by Toth et al. [31] demonstrated no differences in FFM or appendicular skeletal muscle mass between pre-menopausal and post-menopausal women, though PBF was higher in post-menopausal women as compared with pre-menopausal women. The relationship between menopausal status and changes in body composition may be associated with the hormonal changes in terms of decreased estrogen and progesterone concentrations and increase gonadotrophins, follicle-stimulating and luteinizing hormones [11].

Conclusion

In conclusion, body composition in terms of PBF as well as subcutaneous fat and skeletal muscle changes with age and menopausal status in women. However, the patterns of changes were different for fat mass and skeletal muscle.

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