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Menopausal Transition and Women Health: A Study among the Mid-life Women of Kolkata, India

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KEYWORDS

Peri and post menopause, body compositions, cardiovascular and musculoskeletal system, Bengali-Hindu community, West Bengal.

ABSTRACT

Women's mid life through and after menopause is associated with somatic problems like obesity, loss of skeletal muscle and bone mass, cardiovascular diseases and hyperglycemia. The present study is an endeavour to understand the impact of menopausal transition on cardio vascular risk factors and musculoskeletal system among the 160 Bengali speaking Hindu mid-life women of Kolkata, India. Statistical analysis like bivariate statistics was applied to compare the body compositions and clinical variables between peri and postmenopausal participants. Receiver Operating Characteristic (ROC) curve analyses were performed to identify the discriminatory power of the obesity indicators. And to assess the determinants of hypertension and diabetes, multivariate logistic regression analysis was applied. Result showed that significant (p<0.05) peri-post menopausal differences existed in percent *body fat (PBF), fat mass index (FMI), conicity index (CI), skeletal muscle percentage (SMP), bone mass (BM) and diastolic blood pressure (DBP).. PBF (r=0.24) showed positive but SMP (r= -0.46) and BM (r= -0.37) showed negative association (p<0.01) with increased chronological age. Area under the curve (AUC) found BMI (0.91) and CI (0.91) as the best indicator (p<0.001) of obesity among the perimenopausal participants and PBF (0.93) and FMI (0.93) among the postmenopausal participants. Thus, it can be concluded that the the menopausal transition phase brings changes in blood pressure, blood sugar level, SMP, BM and also in the overall and central adiposity markers.*

Introduction

Women's mid life health has emerged as an important concern worldwide since it undergoes a wide variety of physiological changes during the transitional period through and after menopause (Houck 2002). With an increase in chronological age, there is a decline in the number, quality and hormonal activity of ovarian follicles that eventually results in cessation of the reproductive potentiality (Dasgupta and Ray 2013). Long-term consequences of these changes in ovarian hormonal levels is a crucial determinant associated with deleterious changes in body composition that leads to many somatic problems such as obesity, loss of skeletal muscle mass and bone mass, cardiovascular diseases, hyperglycemia and so forth (Toth et al. 2000; Stachowiak et al. 2015). The prevalence of such problems are quite noticeable in a low-middle income countries like India (Wittchen et al. 2006; Petrukhin and Lunina 2011; Lemogoum et al. 2018) where the growing population of people aged 45 years and above are predominant (UNPD 2011; UNPF 2012). Thus, along with the existence of these co-morbidities, the increase in life expectancy of the menopausal women emerges as an important global concern (Traub and Santoro 2010; Dasgupta and Ray 2014).

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Globally, including the country of India, elderly women are increasing in numbers (World Health Report 1998; WHO 2000). If this trend continues, a large number of Indian women in the future may experience a longer period of menopause and be burdened with menopausal health problems. Efforts have hardly been made to study the health problems faced by women after menopause which are largely due to drastic hormonal changes during menopause and not merely the result of the normal process of aging. Therefore, the magnitude of the impact of menopausal transition on women's health, especially the CVD risk factors, is a key issue to be focused, and ensure healthy post reproductive life for women. Awareness of the burden of menopausal transition associated with the decline of oestrogen levels may instigate the management of postmenopausal health. Hence, the present study was an attempt to understand the impact of menopausal transition on cardio vascular risk factors and musculoskeletal system among the mid-life women of Kolkata, West Bengal, India.

Various longitudinal and cross-sectional studies shows that before the age of 50, majority of women tend to increase their weight slowly, whereas after menopause there appears to be an accelerated increase in fat mass and a change in preferential fat storage in the central part of the body (Toth et al 2000; Ho et al. 2010). Hyperandrogenemia, the condition of lack of estrogen, is responsible for the accumulation of fat in the subcutaneous tissue, particularly in the central region, as intra abdominal fat (android or apple shape) and gluteo-femoral region (gynoid or pear shape (Carr 2003; Davis et al. 2012; Kozakowski et al. 2017). Central fat distribution is remarkably associated with the risk of diabetes, hypertension, and CVD (Despre′s 2012).Among the menopausal women, from several decades BMI has been reported to be a measure to assess the overall fatness (Akahoshi et al. 2002; Kuh et al. 2005) but BMI do not provide information on central adiposity or body fat distribution (Wang et al. 2017). Therefore, additional anthropometric indices are required to assess abdominal adipose accumulation. Sensitivity of waist circumference (WC) is an index of disease risk in post menopausal women (Pelt et al. 2001). Additionally, in recent years, the conicity index (CI), which refers to abdominal adiposity, has been identified as the most important risk factor for cardiovascular disease than the WHR because of its several advantages over the WHR (Valdez et al. 1993). Moreover, validation studies have indicated that body fat percent (PBF) is an appropriate reference standard, or gold standard, for the measurement of adiposity (Kelly et al. 2009; Batsis et al. 2016).

Changes in body composition in menopause and especially in the postmenopausal years are accompanied by changes in musculoskeletal system resulting in decline of bone mass (osteoporosis) and muscle (sarcopenia). Increased adiposity and fat redistribution altogether leads to central obesity (Zhai et al. 2008; Lim et al. 2009; Kanis et al. 2013). Decrements on levels of oestrogen that characterize the hormonal milieu for menopausal women accelerate the rate of bone resorption and cause the loss of muscle mass leading to greater risk of osteoporosis, decreased muscle performance and functional capacity (Walsh et al. 2006; Kochi et al. 2015).The rapid loss of bone mineral density during the early-postmenopausal period may have reduced the density of fat-free mass and caused percentage body fat to be overestimated (Heymsfeld et al. 1989). This subtle metabolic musculoskeletal disease is widely prevalent in India (Avachat et al. 2013).

Following menopause, while the ovaries permanently cease to produce adequate endogenous estrogens, the cardio-protective effects of women during their fertile period is lost and control of hypertension becomes tougher, which put postmenopausal women towards high risk of debilitating and often fatal complications of cardiovascular disease (Mendelsohn and Karas 1999; Shende et al. 2014). Determining the role of sex hormones in the pathogenesis or progression of hypertension is complex but it is not solely responsible. Though renin–angiotensin system activation may lead to postmenopausal hypertension, but obesity also plays a contributory role (Jouyandeh et al. 2013; Maheshwari and

Maheshwari 2017). Nevertheless, following the lack of ovarian hormone, menopausal women also have an increased risk of insulin resistance or hyperglycemia which plays a key role in developing type 2 diabetes mellitus (Yeasmin et al. 2017). Many researchers denoted that the most crucial role in the pathogenesis of menopausal metabolic problems is played by insulin resistance and abdominal obesity (Nakagawa et al. 2006; Stachowiak et al. 2009).

Under these circumstances, the present study is an endeavour to understand the magnitude of the impact of menopausal transition on cardio vascular risk factors and musculoskeletal system among the mid-life women of Kolkata, India.

Materials and methods

Study area and study population

A cross-sectional study was conducted among Bengali Hindu women living in the urban areas of city Kolkata, the capital of West Bengal. This city is under the jurisdiction of Kolkata Municipal Corporation (KMC). The study area was selected purposively based on operational convenience.

The menopausal state i.e. peri and post menopause, was ascertained following the classification of the World Health Organization. A total 160 participants were selected, out of which 80 women was identified as peri menopause and 80 as post menopause aged between 35 to 60 years. No proper sampling technique was adopted to select the study participant. Exclusion criteria were women who had not used exogenous hormones in the past 3 months (including oral or injection contraceptives), were not pregnant or lactating and had not undergone a hysterectomy or oophorectomy. Prior to the interview, nature and purpose of the study was explained to them and a written consent was obtained. A written consent form was provided for signature by each respondent, and only those who agreed to sign to consent form after due explanation were selected voluntarily for the study.

Methods of data collection

Anthropometric measurements

All the anthropometric measurements were carried out by a well trained student, the first author (SG). Care was taken to avoid any possible systematic errors (instrumental or definition of landmarks) in the course of recording the anthropometric measurements following the standard protocol of Lohman et al. (1988). Height was measured to the nearest 0.1 centimetre by using an anthropometric rod and by asking the subject to stand erect on a levelled surface with heels together and toes apart, without her shoes, and looking straight with head oriented in the FH plane. Waist circumference (WC) was measured in centimetre at a point midway between the lower border of the ribs and the highest point of iliac crest using a non-stretchable flexible tape in horizontal position, with the subject standing erect and looking straight forward. Weight, Body Mass Index (BMI), Percent Body Fat (PBF), Bone Mass (BM) and Skeletal Muscle Percentage (SMP) was measured by using Rossmax Body Fat Monitor (WF260) following the standard technique as provided in their instruction manual. Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) of the participant was taken using mercury sphygmomanometer in a sitting position after a minimum of 10-15 minutes rest with the left forearm placed horizontally on a table. Systolic BP and diastolic BP were defined as the points of the appearance and disappearance of Korotkof sounds, respectively. Then the mean of the two readings was obtained Random Blood Sugar (RBS) level was recorded by using One Touch Ultra Glucometer.

Anthropometric indices

a) The following equations of VanItallie et al. (1990) were utilized to assess the proportion of Fat mass (FM), Fat-free mass (FFM), Fat mass index (FMI) and Fat-free mass index (FFMI):

- i. *FM (kg) = (PBF/100) × weight (kg);*
- ii. *FFM (kg) = Weight (kg) – FM (kg);*
- iii. *FMI (kg/m^2) = FM/$Height^2$ (m^2);*
- iv. *FFMI (kg/m^2) = FFM/$Height^2$ (m^2)*

b) Conicity Index (CI) was determined according to the following equation (Taylor et al. 2000):

$$CI = WC\frac{m}{\sqrt{0.109}} \times Weight\frac{kg}{Height}(m)$$

Diagnostic criteria for obesity, hypertension and hyperglycemia:

The WHO Expert Committee (2004) on Obesity in Asian and Pacific populations suggested revised cut off points for waist circumference as 80 cm for women for identifying persons with abdominal obesity.

Diagnosis of hypertension was based as per the criteria given by Seventh Report of Joint National Committee (2004): as a systolic blood pressure (SBP) ≥140 mmHg and/or a diastolic blood pressure (DBP) ≥90 mmHg.

Random blood glucose >200 mg/dl has been considered as hyperglycemia as recommended by American Diabetes Association (2014).

Statistical analysis

In descriptive statistics continuous variables were expressed by mean with standard deviation and categorical variables were expressed by frequency with percentage. Mean variation comparison of all anthropometric measures and indices and clinical measures between peri and post menopausal women were carried out by independent t-test. Pearson's correlation between chronological age of both peri and post menopausal women and BMI, PBF, CI, SMP, BM, SBP & DBP and RBS were examined using correlation coefficient, and their association were presented by individual scatter plots. Pearson's chi square test was performed between peri and post menopausal group to assess the significant differences in terms of obesity, hypertension and hyperglycemia.

Receiver Operating Characteristic (ROC) curve analyses were performed to identify the discriminatory power of the obesity indicators PBF, BMI, FMI and CI. WC was used as the golden standard tool to detect central obesity for both peri and post menopausal women based on the sex-specific cut-off values of WHO (2004). Also the cut-off points for PBF and adiposity indexes were obtained using ROC. The areas under the ROC curves (AUC) and the confidence intervals (CI: 95%) were used to compare the ability of PBF and each adiposity index to predict obesity. The higher the AUC, the higher is the discriminatory power of the obesity indicators denoted. The cut-off points for BMI, PBF, FMI and CI to predict obesity was determined according to Youden index (sensitivity +

specificity – 1) and the corresponding cut-off value for the highest Youden index was considered as the optimal cut-off value.

Multivariate logistic regression analysis (enter method) was performed to assess the determinants of hypertension and diabetes. For the two dependent variables, menopausal status (reference category: peri menopause), participants' age and all the anthropometric and clinical measures and indices were considered as the independent associates.

The analyses of the data were done using the Statistical Package for Social Sciences version18.0 (SPSS Inc., Chicago IL, USA). And *p*-values less than equal to 0.05 (two-tailed) were considered statistically significant.

Results

The mean ages of the peri and post menopausal women were 39.48±3.90 and 55.038±3.69 respectively (Table1).

The mean weight and all the body adiposity variables (overall and central) tended to be higher among the post menopausal group. On the contrary, height, SMP and bone mass shows higher mean value among the peri-menopausal group. A significant difference (p<0.05) has also been observed between these two groups in terms of FM, FMI, PBF, CI, SMP and BM (Table 2).

The mean SBP and mean random blood sugar level were higher among the post menopausal group where as among the peri menopausal group, the mean DBP and PR were found to be higher. Among all the variables, only mean DBP showed a significant difference (p<0.05) between the peri and post menopausal group (Table 3).

The association between chronological age and BMI, PBF, CI, SMP and BM of peri and post menopausal women are represented in Fig 1A to 1E. It shows that PBF (r=0.24, p<0.002) increases with the chronological age, where as SMP (r= -0.46, p< 0.001) and bone mass (r= -0.37, p< 0.001) were found to be decreasing.

A positive correlation was observed between the chronological increase in age and SBP (r= 0.14, p< 0.08) but a significant inverse association was found between age and DBP (r= -0.17, p< 0.03). Blood sugar level also showed a significant (r= 0.17, p<0.03) rise with increase in their age (Fig 2A to 2B).

ROC curves of obesity parameters PBF and anthropometric indexes BMI, FMI and CI are presented in Figures 3A and 3B respectively in respect to their sensitivity and 1-specifcity for the diagnosis of obesity of peri and postmenopausal women. The AUCs and their 95% CIs for both peri and post menopausal women reflected that among the peri menopausal women BMI (0.91, p<0.001) and CI (0.91, p<0.001) presented a slightly higher discriminatory capacity than PBF and FMI in predicting obesity risk, on the other hand, among the postmenopausal women ROC curve areas were significantly larger for PBF (0.93, p<0.001) and FMI (0.93, p<0.001) compared with other two obesity indicators (Table 4).

The cut off values, sensitivity and specificity for detecting obesity using different adiposity variables are reflected in Table 5. Among the peri menopausal women the cut off point for BMI was 23.10 kg/m^2 (sensitivity 90%, specificity 92%) and CI was1.30 (sensitivity 75%, specificity 100%) and they served to be the best predictors of obesity. The cut off point for the best predictors PBF and FMI among the post menopausal women were 39.10% (sensitivity 94%, specificity 85%) and 9.88 (sensitivity 91%, specificity 85%) respectively.

Based on the ROC assessed cut off points, obesity was classified by four obesity indicators and a chi square test was performed to identify whether any significant difference exist between peri and post menopausal group in terms of their distribution. The result showed that majority of the women in both the groups was found to be obese. Maximum percentage of the peri menopausal women were found to be obese as per the classification based on BMI (77.50%) on the other hand ,among the post menopausal group majority of the women were found to be obese as per classification based on PBF (81.25%), FMI (78.75) and CI (77.50). But no significant differences have been found for obesity between peri and post menopausal group. (Table 6)

Majority of the women in both peri and post menopausal group were found to be normal with respect to hypertension and hyperglycemia. Hypertensive women were found more among the post menopausal group (13%) than their peri menopausal counterpart (6%) but the difference was not statistically significant. No significant difference has also been found between peri and post group in case of hyperglycemia (Table 7).

Result of binary logistic regression for risk assessment of hypertension reflected none of the variable as significant predictor but the trend shows that the chance of having hypertension is 1.25 times more among the post menopausal women than their peri menopausal counterparts. The risk also increased with increase in PBF, FMI, CI as well as blood sugar level (Table 8).

This table further showed that post menopausal women have a higher chance of having hyperglycemia than peri menopausal women. No significant predictors have been found to assess the risk of hyperglycemia. But the likelihood of having hyperglycemia increased with an increase in post menopausal transition age, PBF, FMI, FFMI and CI. Moreover, it was noteworthy that the hyperglycemia risk increased with high DBP.

Discussion

Consistent with several studies worldwide (Donato et al. 2006; Sowers et al. 2007; Jaff et al. 2015), the post menopausal stage was found to be crucial for the women, since, they have shown higher weight gain status, increased central body fat distribution, lower skeletal muscle and bone mass and the tendency of hypertension and hyperglycemia. Javoor (2006) found WC and BMI to be higher among post menopausal group. Ho et al. (2010) reported a slight decrease in the lean mass but an increase in the total fat mass over the follow-up period from pre to peri to post menopause. In the present study height was found to be lower among the post menopausal women. Height loss was found to reflect low bone mass, a feature of postmenopausal osteoporosis (Takahashi et al. 2005; Kado et al. 2004; Ebeling 2010), beginning between 30 to 40 years when women generally enters in peri-menopausal transition and continues throughout life through a slow process (Bonjour et al. 1994). The present study shows that the chronological age of peri and post menopausal women has a significant positive association with PBF and an inverse association with SMP. This is in accordance with Sowers et al. (2007) who also reported that the influence of ovarian and chronological age on body composition of menopausal women and foundan absolute cumulative increase in WC, fat mass but a decrease of skeletal muscle mass. Kim (2012) also opined that the midlife increases in adiposity among the women have strong relationships with chronological aging. The potential reasons behind the development of obesity with metabolically unfavourable fat redistribution are basically caused by hyperandrogenemia and adiposity-induced suppression of sex hormone binding globulin synthesis (Selva et al. 2007; Kozakowski et al. 2017).

Receiver operating characteristics analysis revealed different discriminatory power of obesity indicators. The sensitivity and specificity of AUC's diagnostic accuracy between 0.7 ≤ AUC ≤ 0.9 meant medium accuracy and AUC ≤ 0.9meant high accuracy (Dou et al. 2016). Our study noted AUC features of all four obesity indicators like BMI, PBF, FMI and CF were greater than equal to 0.88. While peri menopausal women denoted the best indication towards obesity through BMI and CI, on contrary, post menopausal state revealed PBF and FMI as the better indicators. A study by WHO (2004) recommended that the optimal cut-off points for BMI indicating obesity in different Asian populations varies from 22 kg/m^2 to 25 kg/m^2. Similar cut-off is being determined by ROC curve analysis in the present study. Several studies reported that BMI showed high specificity and low sensitivity in the diagnosis of obesity, but also pointed out that BMI missed almost half of the obese population diagnosed by PBF (Okorodudu 2010; Carpenter et al. 2013). The reason mainly is that BMI represents body mass and represents a proportional relationship between weight and height, and it cannot reflect the body fat content (Romero-Corral et al. 2006; Lavie et al. 2010; 2011) and therefore PBF denotes a better indication towards obesity (Lavie 2012). According to WHO (1995) a PBF greater than 35% for women are the criteria for diagnosing obesity (Chang et al. 2003; Romero-Corral et al. 2008). In the present study, a cut off values for PBF in peri and post menopausal women was determined as 34.30% and 39.10% respectively and using these values, approximately 60% of peri and 65% of post menopausal women were considered as obese. A study on Bangladeshi women populations found that CI for Females as 1.21 ± 0.11 and discriminative cut off between normal and high CI as 1.18 (Flora et al. 2009) which contradicts with the current findings where, for peri and post menopausal women the cut off of CI was 1.30 and 1.32respectively. In an Iranian study among the post menopausal women mean CI was found as 1.24 ± 0.9 which verified the use of central obesity (Shidfar et al. 2012).

The prevalence of hypertension in menopausal women (Izumi et al. 2007) due to the progressive stiffening of the arterial structure, or the abrupt fall in circulating oestrogen levels or other lifestyle factors might contribute to the rise in blood pressure during and after menopausal transition (Mass and Franke 2009; Taddei 2009). The present study reported that when women entered the menopausal transition there was an increased tendency of SBP with an increased chronological age. Post menopausal women were found to be at more risk of hypertension than the peri menopausal group. Sen et al. (2017) in an Indian based study noted that cardio metabolic risk in postmenopausal women was higher than premenopausal women and the risk increases with age in both groups. Amigoni et al. (2000) also found that menopause increases the risk of hypertension twice. In a study by Staessen et al. (1989) found that the increase in SBP per decade was 5 mmHg greater in perimenopausal and postmenopausal women as compared with premenopausal women. But an inverse relation between age and DBP in the present study illuminated the fact that other than loss of ovarian function, DBP can also be regulated by various hormonal, environmental and other determinants (Juntunen et al. 2003; Yousefzadeh et al. 2014). This finding is in congruent with the findings of Beresteyn et al. (1989) as they found no consistent association between diastolic pressure and chronologic aging and a negative relation between systolic as well as diastolic pressure with the years since menopause. Studies established that factors like increased activation of the renin-angiotensin system (Fernandez-Vega et al. 2002), the rapid drop in oestrogen (Coylewright et al. 2008; Taddei 2009), obesity and in particular the redistribution of body fat surrounding abdominal region (Wildman and Sowers 2011; Davis et al. 2012) exposes the menopausal women at a risk of being hypertensive. But result of the present study was contradicting, none of the body composition parameters have been found to be significantly associated with hypertension risk. However, studies worldwide and Indian based study showed a positive association between hypertension and adiposity (Solowat et al. 2009; Tyagi and Kapoor 2010; Gupta et al. 2014).

The Center for Disease Control (CDC) indicates that the prevalence of diabetes increases with age, and the chance of occurrence doubles as women enter from reproductive years to middle years (Beckles and Thompson-Reid 2001). This is in agreement with the present study where a positive correlation between blood sugar level and chronological age of the participants is observed. Mooney et al. (2013) suggested that Asian population could have obscured a stronger association between body fat measures and metabolic outcomes. Weight gain and obesity have clearly established the risk factors for diabetes in midlife women (Colditz et al. 1995; Carey et al. 1997). The subtle changes in body fat deposition that occurs during menopausal transition negatively influences glucose metabolism (Chnadrasekhar 2016). Ren et al. (2019) found that risk of diabetes increases with postmenopausal status interacting with BMI, hypertension and waist circumference. Unlike other study (Gupta et al. 2014) though the present study did not find any significant indicators of diabetes risk factors but increased PBF, FMI and CI showed an increased diabetic tendency for both peri and post menopausal women.

Concl usion

The main risk factors of cardio-vascular disease (CVD) may be categorized as no modifiable and modifiable risk factors. The no modifiable factors includes age, gender, and CVD genetics and the modifiable factors include hypertension (HT), diabetes mellitus (DM), dyslipidaemia, obesity, tobacco usage, sedentarism and social and occupational category. The present study concluded that the hormonal changes during the menopausal transition phase brings changes in the haemostatic, blood pressure, blood sugar level, SMP, BM and also overall and central adiposity markers. This resulted in the increase of the risk of cardiovascular disease. Primary prevention and early detection can prevent the morbidities of women. Therefore, the controls of the modifiable factors are indispensable for prevention of cardiovascular disease in women. Since data on lipid profile, triglyceride, socio-economic and lifestyle variables are wanting in the present study, the effect of menopausal status on cardiovascular health could not be presented eloquently. This is the limitation of the present study. However, the present study instigates a platform for further research to provide better insight of the menopausal health problems. Subsequent consultations with the peri menopausal and postmenopausal woman can intervene significant improvements in their cardiovascular health, as well as their general health at an early age by offering Hormone Replacement Therapy (HRT). The health education of women and healthcare professionals is imperative to understand the health benefits to be gained by taking HRT and also controlling the modifiable CVD risk factors.

Declaration of interest
The authors are solely responsible for the content of the paper and report no conflicts of interest.
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Tables and figures

Table 1: Distribution of the participants in terms of their chronological age

Variables	Mean ± SD
Mean age of the peri menopausal women (years)	39.48 ± 3.90
Mean age of the post menopausal women (years)	55.038±3.69

Table 2: Distribution of the peri and post menopausal participants in terms of body composition measures

Variables	**Peri menopause (N=80)**	**Post menopause (N=80)**	**t-values**	**p-values**
Height (meter)	1.51±0.07	1.51±0.06	0.14	0.89
Weight (kg)	60.61±11.06	62.74±12.67	-1.13	0.26
Overall adiposity				
BMI	26.59±4.23	27.57±4.93	-1.35	0.18
FM	23.79±7.53	26.85±8.25	-2.45	0.02*
FMI	10.42±3.14	11.79±3.46	-2.62	0.01**
PBF	38.46±6.89	41.80±6.74	-3.10	0.002**
Central adiposity				
WC (meter)	0.91±0.14	0.95±0.15	-1.17	0.10
CI	1.34±0.09	1.38±0.09	-2.87	0.005**
Musculoskeletal variables				
SMP	30.69±2.46	27.61±4.36	5.50	0.001**
BM (kg)	6.57±0.92	5.93±1.12	3.90	0.001**

*significant at *p< 0.05, and **p< 0.01 level*

Table 3: Distribution of the peri and post menopausal participants in terms of clinical variables

Variables	**Peri menopause (N=80)**	**Post menopause (N=80)**	**t-values**	**p-values**
SBP	131.51±20.85	134.9±19.86	-1.05	0.29
DBP	83.66±12.84	79.63±8.85	2.32	0.02
PR	84.98±12.66	83±9.16	1.13	0.26
RBS	122.18±70.8	137.14±57.35	-1.47	0.14

*significant at *p< 0.05, and **p< 0.01 level*

Table 4: Area under the ROC curve of obesity indicators of peri and post menopausal women

Obesity Indicators	Peri menopause			Post menopause		
	AUC	95% CI	*p*- value	AUC	95% CI	*p*- value
BMI	0.91	0.80 - 1.02	0.001***	0.92	0.85 - 0.99	0.001***
PBF	0.88	0.73- 1.03	0.001***	0.93	0.86 - 1.00	0.001***
FMI	0.90	0.77 - 1.03	0.001***	0.93	0.87 - 1.00	0.001***
CI	0.91	0.85 - 0.99	0.001***	0.92	0.86 - 0.99	0.001***

****Significant at p<0.001*

Table 5: Optimal cut-off points and validity parameters of obesity indicators of peri and post menopausal women

Obesity indicators	Peri menopause				Post menopause			
	Cut off point	Sensitivity	Specificity	Youden index	Cut off point	Sensitivity	Specificity	Youden index
BMI	23.10	0.90	0.92	0.81	25.70	0.81	0.92	0.73
FMI	8.12	0.87	0.92	0.78	9.88	0.91	0.85	0.76
PBF	34.30	0.87	0.92	0.78	39.10	0.94	0.85	0.79
CI	1.30	0.75	1.00	0.75	1.32	0.88	0.85	0.73

Table 6: Distribution of the participants according to obesity classification based on ROC calculated cut off

Menopausal status	Obesity Classified by BMI		Obesity Classified by FMI		Obesity Classified by PBF (%)		Obesity Classified by CI	
	No	Yes	No	Yes	No	Yes	No	Yes
Perimenopause	18 (22.5)	62 77.50)	20 25.00)	60 75.00)	20 25.00)	60 (75.00)	29 36.25)	51 63.75)
Postmenopause	25 (31.25)	55 68.75)	17 21.25)	63 78.75)	15 18.75)	65 (81.25)	18 22.50)	62 77.50)
Chi-square value	1.56		0.32		0.91		3.65	
p-value	0.21		0.57		0.34		0.56	

Figures in parentheses indicates percentage

Table 7: Distribution of the participants according to Hypertension and Hyperglycemia

Menopausal status	Hypertension[a]		Hyperglycemia[b]	
	No	Yes	No	Yes
Perimenopause (N=80)	74 (92.50)	6 (7.50)	50 (62.50)	30 (37.50)
Postmenopause (N=80)	67 (83.75)	13 (16.25)	48 (60.00)	32 (40.00)
Chi-square value	2.93		0.11	
p-value	0.09		0.75	

[a] Classification is based on cut off suggested by Seventh Report of Joint National Committee (2003); [b] Classification is based on the cut off suggested by American Diabetes Association (2014).
Figures in parenthesis indicates percentage

Table 8: Logistic regression: predictors of Hypertension and Hyperglycemia

Independent indicators	Hypertension	Hyperglycemia
	Odds ratio with 95% CI	Odds ratio with 95% CI
Menopausal status		
Peri menopause	Reference category	
Post menopause	1.25 (0.24 - 6.45)	1.09 (0.08 - 15.02)
Chronological' age	0.89 (0.77 - 1.02)	1.09 (0.92 - 1.28)
WC	0.98 (0.79 - 1.21)	0.90 (0.68 - 1.2)
PBF	1.14 (0.83 - 1.57)	1.35 (0.83 - 2.18)
FMI	1.65 (0.11 - 25.5)	1.23 (0.05 - 29.54)
BMI	0.39 (0.03 - 4.75)	0.55 (0.03 - 9.28)
CI	1.07 (0 - 4.76)	9.90 (8.85 - 11.08)

FFMI	3.4 (0.29 - 40.09)	2.99 (0.15 - 57.77)
SBP	NI	0.97 (0.93 - 1.01)
DBP		1.02 (0.95 - 1.1)
RBS	1.0 (0.99 – 1.00)	NI

NI: not included in the equation

Fig. 1: Relationship between chronological age and A) BMI, B) PBF, C) CI, D) SMP, E) BM, of the study women (peri and post menopausal women in together)

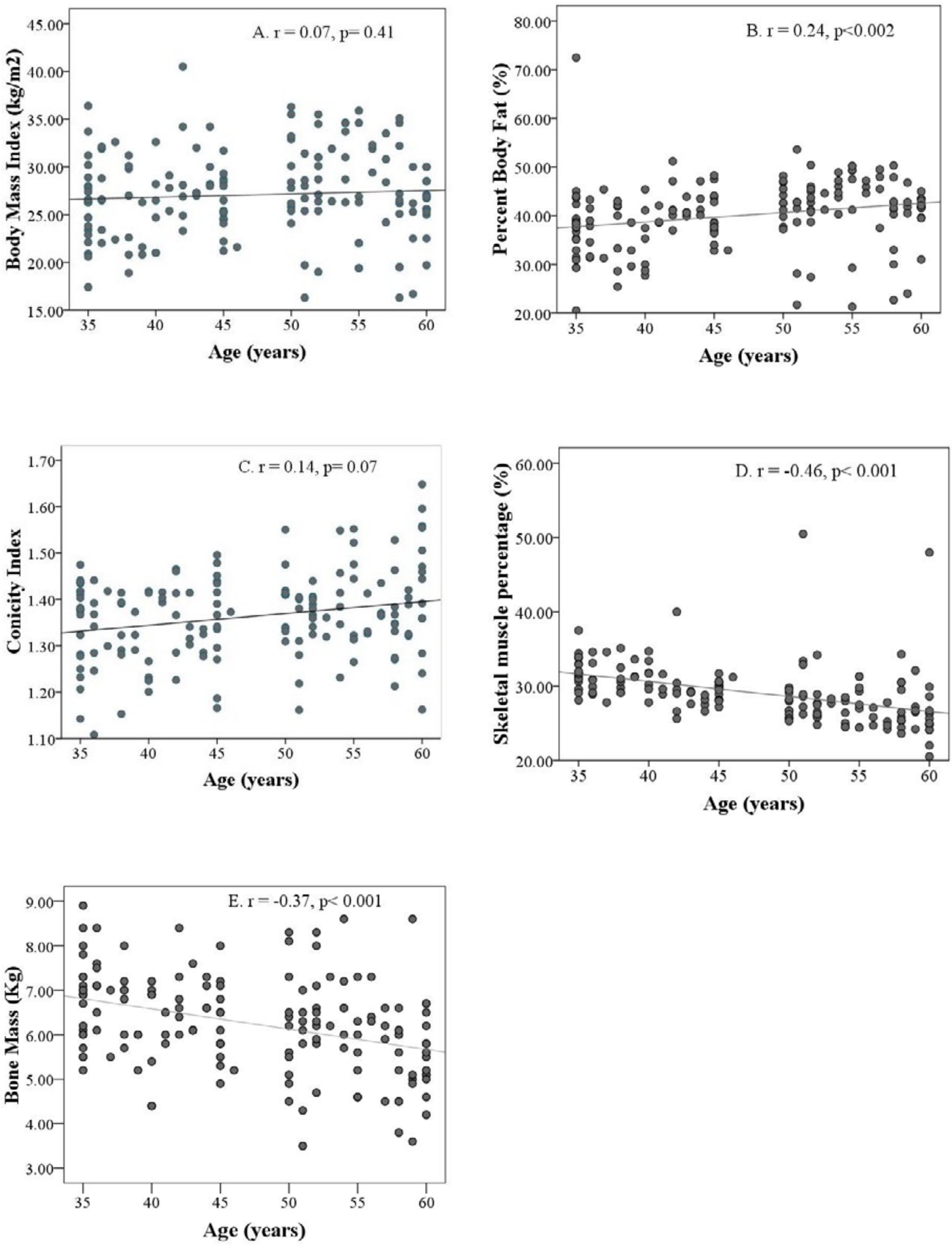

Fig. 2: Relationship between chronological age and A) SBP and DBP and B) RBS of the study women (peri and post menopausal women in together

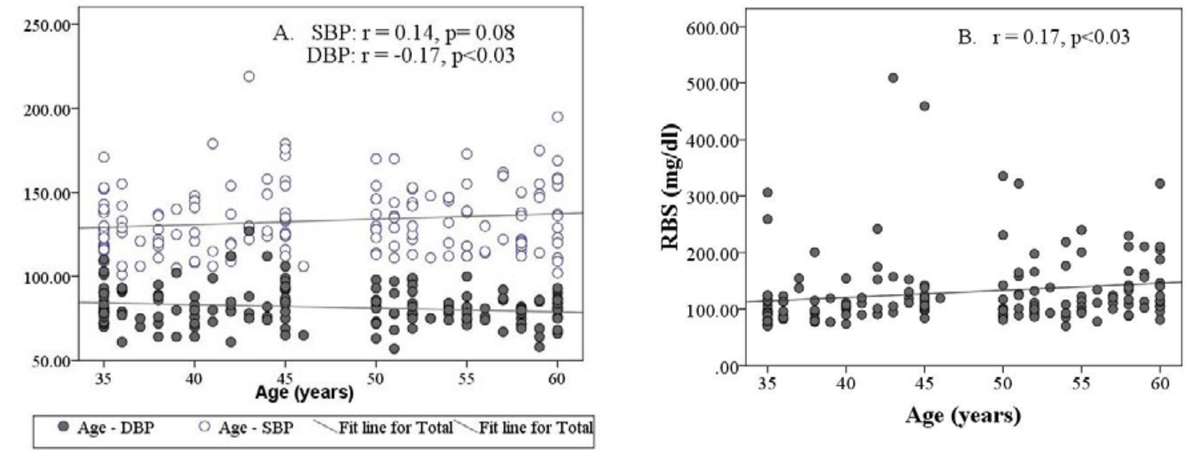

Fig. 3A (left): ROC curve comparing BMI, FMI, PBF and CI of peri menopausal women.
Fig. 3B (right): ROC curve comparing BMI, FMI, PBF and CI of post menopausal women.