Original Article

Anthropometric parameter that best predict metabolic syndrome in postmenopausal women.

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ABSTRACT:

Background: *The use of anthropometric parameter is one of the new and low-cost diagnostic methods of detection of metabolic syndrome.*

Aims and objectives: *The objective of the present study was to examine the predictive power of many anthropometric parameters as an accurate predictor for MS in postmenopausal women.*

Material and Methods: *This cross sectional study involved 199 postmenopausal women. Six anthropometric parameters : Waist circumference (WC), body mass index (BMI), waist-to-height ratio (WHtR), waist to hip ratio (WHR), lipid accumulation product (LAP) and visceral adiposity index (VAI) were measured and calculated. Metabolic syndrome (MS) was defined according to the criteria of NCEP-ATP III. The women were devided into two groups based on presence or absence of metabolic syndrome. Comparisons of clinical and metabolic characteristics were performed between the groups. To analyze the correlation of anthropometric parameters with MS Spearmann test was used. The cut-off points, area under the curve (AUC), sensitivity and specificity of parameters were determined using Receiver Operating Characteristic Curve (ROC).*

Results: *The prevalence of MS in postmenopausal women was 74.4%. Visceral adiposity index (VAI), Lipid accumulation product (LAP), waist circumference (WC), Body mass index (BMI) and waist to height ratio (WHtR) were significantly higher in women with MS. Among the anthropometric parameters assessed mainly VAI and LAP showed a significant correlation with the majority of MS criteria. Through ROC curves VAI, LAP and WC presented higher AUC being the cut- off points followed :0.85, 0.83 and 0.75 respectively. This study has shown the postmenopausal women had a high prevalence of MS and VAI and LAP regarded as most sensitive and specific predictors for MS in post menopausal women.*

Key Words:
Anthropometric, Menopause, Metabolic syndrome, Postmenopausal women

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Introduction:

Metabolic syndrome (MS) is known to be a cluster of interrelated risk factors of metabolic origin such as elevated blood pressures, glucose metabolism disturbance, dyslipidemia, and obesity which are linked to the development of atherosclerotic cardiovascular diseases and type 2 diabetes mellitus.[1,2] Of these factors obesity or body fat seems to be the predominant underlying risk factor for the development of MS.[2] The third Report of National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) (ATP III) emphasized the importance of the metabolic syndrome and provided a working definition of this syndrome for the first time in 2001.[3] The prevalence of MS is influenced by genetic background, age, diet and levels of physical activity.[4] The prevalence of MS is increased in south Asian countries due to lifestyle changes and socioeconomic transitions consequent affluence, urbanization, mechanization and rural to urban migration.[5]

Obesity was defined classically through employing many anthropometric parameters that based on fat distribution, each one has their own advantages and disadvantages in predicting serious chronic non-communicable diseases.[6] Central obesity considered as a marker of body fat can be conveniently and cost effectively estimated by measuring body mass index (BMI) and waist circumference (WC) for prediction of MS. Some other indices of abdominal obesity such as waist hip ratio (WHR) and waist to height ratio (WHtR) have been reported better predictors of CVD and metabolic risk factors than BMI and /or WC.7Recently lipid accumulation product (LAP) and Visceral adiposity index (VAI) have been proposed as simple and novel clinical markers of visceral obesity (metabolic indices), that combine anthropometric parameters and metabolic variables for prediction of MS with reliable accuracy.[8,9]

LAP while tested in the Chinese population predicts diabetes better than BMI, waist circumference (WC) and waist-to-hip ratio (WHtR), in both men and women.[10] Visceral adiposity index is a mathematical model that uses both anthropometric (BMI and WC) and functional (triglycerides and high density lipoprotein cholesterol) simple parameters.[11] It showed a strong independent association with both cardiovascular and cerebrovascular events and showed better predictive power for the incidence of diabetes than its individual components.[12]

Menopause is a normal physiological phenomenon that is characterized by the permanent cessation of menstruation due to loss of ovarian function and is marked by biological, social and psychological changes.[13,14] Post menopause is the period beginning 12 months after the definitive cessation of menses.[15] Moreover in this period emergence of many characteristics of metabolic syndrome (abdominal obesity, reduction in HDL-C, fasting hyperglycemia) progressively increase. [16, 17] So, menopausal transition and postmenopausal state are considered as a vulnerable period for developing MS, and adequate attention as early as possible must be given followed by an aggressive approach toward prevention and management. [5]

As there is a paucity of data regarding the prevalence of MS in the Bangladeshi postmenopausal women, hence, we designed current study to find out the prevalence and its anthropometric predictors for diagnosing MS.

Methodology:

In this cross-sectional study 199post menopausal women aged 47 to 75 years were studied. The study was carried out between January to June 2023 at the outpatient departments of Bangladesh medical college hospital. Postmenopausal women were women who had ceased menstruation for at least one year to several years. Women that used hormone replacement therapy, antidepressant drugs, in addition to women with polycystic ovarian disease, thyroid gland diseases, a hysterectomy and an oophorectomy were excluded from the study.

Diagnosis of MS:

The women were diagnosed MS according to the National Cholesterol Education Program Adult Treatment Panel III (ATP III) criteria which is confirmed by the presence of 3 from the following risk factors:

1) Abdominal Obesity: WC ≥ 88cm
2) Hypertriglyceridemia: Serum triglycerides (TG) level ≥ 150 mg/dl
3) Serum high density lipoprotein (HDL): < 50mg/dl
4) High blood pressure: Systolic blood pressure (SBP) ≥ 130 mm of Hg and /or diastolic blood pressure (DBP) ≥ 85 mm of Hg.
5) High fasting blood glucose (FBG): Plasma glucose level > 110 mg/dl or > 6.1mmol/L or on treatment for DM

Anthropometric measurements and calculations:

BMI was computed as weight (kg) divided by height in squared meters (m2). Waist circumference (WC) was taken using a non-stretchable standard tape measurement taken mid way between the lowest rib and iliac crest with the subject standing at the end of gentle expiration. Hip circumference (HC) was measured at the widest level over the greater trochanters. Waist-hip ratio (WHR) was calculated as waist circumference (cm) divided by hip (cm) circumferences. Waist to height ratio (WHtR) calculated by the WC (cm) divided by the height (cm).

VAI for female was calculated as:11

VAI = (WC (cm) /36.58) + (BMI*1.89) *(TG/0.81) *(1.52/HDL) for women.

The LAP was calculated as =

(WC[cm] – 58) x (triglyceride concentration [mM]) for women

Blood pressure of the participants was measured twice with a standard barometer in a sitting position, and the average blood pressure had been documented in the sheets.

Blood tests:

After taking their consent , venous blood samples were collected after 12-hours overnight fast. The samples were centrifuged for 10 minutes at 3000 rpm. Fasting levels of blood glucose, serum total cholesterol, triglycerides and high density lipoprotein cholesterol were measured by enzymatic methods analyzed in the clinical pathology lab in the Hitachi Cobas Model:C-311 biochemistry Autoanalyzer machine. Serum LDL was calculated by using Frederickson-Friedewald's formula.

Laboratory measurements:

- Blood glucose was estimated by enzymatic method.
- Total Cholesterol was estimated by enzymatic end point (CHOD-PAP) method.
- Triglyceride was estimated by enzymatic (GPO-PAP) method.
- HDL Cholesterol was estimated by enzymatic end point (CHOD-PAP) method.
- LDL Cholesterol was estimated by using Fredrickson and Friedewald's formula.

Statistical analyses:

The results obtained were statistically analyzed and compared between the two groups of the study.All baseline characteristics, clinical and biochemical data of study subjects were expressed as means ± standard deviatons. Unpaired t- tests were conducted to assess the relationship between the MS and the studied variables between the two groups. The receiver operating characteristic (ROC) analysis was employed to determine the predictive power of different anthropometric parameters for MS. For the areas under the curves (AUC) (measures of true diagnostic / discriminatory power) of the ROC analyses, threshold values for MS prediction were determined for anthropometric parameters, and their sensitivities (true positive rates) and specificities (true negative rates) were determined. An AUC value of 1 signifies that the test is perfectly accurate, while an AUC value of 0.5 indicates that the test performs equal to chance.The level of significance for all analyses was fixed at 0.05. All data analyses were done using the statistical software package, SPSS for Windows version [22].

Results

A total of 199 postmenopausal women were studied. There were 148 with metabolic syndrome and 51 women without metabolic syndrome. Table 1 shows frequency of MS in post menopausalwomen was 74.40% according to NCEP ATP III criteria.

Table 1: Frequency of metabolic syndrome in post menopausal women (n=199)

	Frequency (n)	Percentage (%)
Metabolic syndrome	148	74.4
Without metabolic syndrome	51	25.6

Table 2 shows the baseline data of postmenopausal women with and without metabolic syndrome. The weight, BMI, WC, WHtR, LAP, VAI,TC,TG, SBP, DBP and FBS were significantly higher in postmenopausal women with MS comparedto subjects without MS,while HDL significantly lower in the subjects with MS. There was no significant differences in the age, height since menopause, WHR and LDL cholesterol of post menopausal women with and without metabolic syndrome.

The mean body mass index, waist circumference (WC), waist hip ratio (WHR) and waist-to-ratio (WHtR) , Visceral adiposity index(VAI) and lipid accumulation product (LAP) were significantly high among postmenopausal women with metabolic syndrome, but the mean HDL cholesterol was low ($p<0.05$)

Table 2: Comparison of clinical parameters, anthropometric parameters, lipid profiles and fasting blood sugar between with and without metabolic syndrome in post menopausal women

	MS (n=148)	Non MS (n=51)	p-value
Age (years)	57.57 ± 7.45	57.33 ± 8.23	0.851
Height (m)	155.18 ± 4.38	155.50 ± 4.43	0.655
Weight (kg)	69.82 ± 8.36	63.47 ± 8.54	<0.001
BMI (kg/m2)	30.03 ± 3.47	27.63 ± 2.45	<0.001
WC	96.92 ± 6.72	90.64 ± 5.96	<0.001
WHR	0.91 ± 0.06	0.91 ± 0.04	0.945
WHtR	0.62 ± 0.05	0.59 ± 0.04	0.001
Visceral adiposity index (VAI)	13.21 ± 8.91	5.65 ± 3.47	<0.001
Lipid accumulation product (LAP)	249.99 ± 182.59	124.72 ± 71.76	<0.001
Systolic BP (mmHg)	129.12 ± 12.45	115.88 ± 14.03	<0.001
Diastolic BP (mmHg)	86.32 ± 6.50	79.61 ± 8.24	<0.001
FBS (mmol/l)	7.74 ± 3.05	5.93 ± 1.22	<0.001
TC (mg/dl)	189.71 ± 52.15	170.48 ± 38.47	0.017
HDL (mg/dl)	38.60 ± 10.38	49.56 ± 11.03	<0.001
LDL (mg/dl)	105.62 ± 39.13	96.56 ± 31.90	0.142
TG (mg/dl)	246.99 ± 152.47	137.69 ± 71.58	<0.001

BMI: Body mass index, WC: Waist circumference, WHR: Waist hip ratio, WHtR: Waist to height ratio, FBS: fasting blood sugar, TC: Total cholesterol, HDL: high density lipoprotein, LDL: low density lipoprotein, TG: Triglycerides.

Through the correlation analysis, fasting blood glucose, triglycerides, SBP, DBP were positively and significantly correlated to BMI, WC, WHtR, VAI and LAP. On the other hand Triglycerides, SBP and DBP showed negative correlation to WHR. Furthermore, HDL level presented a significant negative correlation to BMI, WC, WHtR, VAI and LAP. (Table 3)

Table 3: Correlation of anthropometric parameterswith components of Metabolic syndrome in the study population

		HDL	TG	SBP	DBP	FBS
BMI	r	-0.121	0.165	0.147	0.190	0.127
	p	0.088	0.020	0.038	0.007	0.074
WC	r	-0.178	0.180	0.252	0.259	0.150
	p	0.012	0.011	<0.001	<0.001	0.034
WHR	r	0.074	-0.094	-0.039	-0.037	0.058
	p	0.298	0.189	0.589	0.599	0.415
WHtR	r	-0.154	0.136	0.119	0.112	0.077
	p	0.030	0.056	0.094	0.115	0.279
VAI	r	-0.456	0.833	0.163	0.113	0.154
	p	<0.001	<0.001	0.021	0.111	0.030
LAP	r	-0.139	0.961	0.151	0.100	0.212
	p	0.051	<0.001	0.034	0.160	0.003

BMI: Body mass index, WC: Waist circumference, WHR: Waist hip ratio, WHtR: Waist to height ratio, VAI: Visceral adiposity index, LAP: Lipid accumulation product, , HDL: high density lipoprotein, TG: Triglycerides, SBP: Systolic blood pressure, DBP: Diastolic blood pressure,FBS: fasting blood sugar.

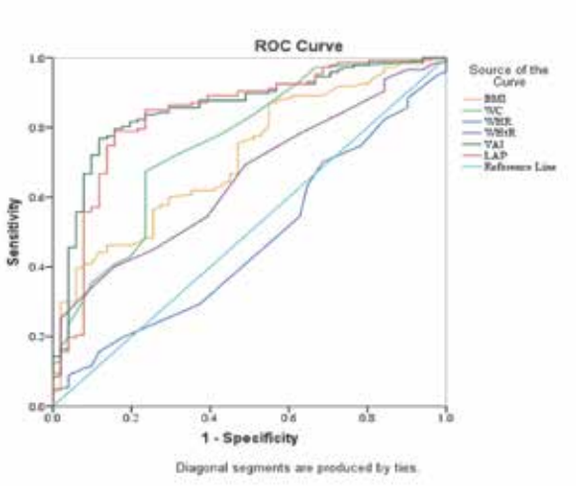

Figure 1: Receiver operating characteristic curves for anthropometric parameters in predicting MS

Results are presented in Figure 1 which show that the ROC curves for determining diagnostic accuracy and the optimal threshold for each of the anthropometric parameters in predicting MS. VAI showed the highest AUC value of 0.85, followed by LAP with the AUC of 0.83, WC with the AUC 0.75, BMI with the AUC of 0.71 and WHtR with the AUC 0.65 respectively. WC,VAI and LAP had AUC values that were ≥0.75, this indicate they offer significant accurate diagnostic tests for the MS, while WHR have not reached the significant value for predicting MS.

ROC curve analyses that illustrated in table 4 revealed that the optimal cutoff values (threshold) for VAI were 7.14 with a sensitivity of 79% and a specificity of 84%, for LAP were 147.1 with a sensitivity of 78% and a specificity of 84%,WC were 93.5 with a sensitivity 67% and a specificity 76% and for BMI were 26.5 with a sensitivity of 87% and a specificity of 45%

Table 4: Efficacy of anthropometric parameters inpredicting metabolic syndrome amongpost menopausal women

	AUC	Cut off value	Sn	Sp	PPV	NPV	YIndex
BMI	0.715	26.5	0.872	0.451	0.614	0.778	0.323
WC	0.756	93.5	0.676	0.765	0.742	0.702	0.440
WHR	0.471	0.93	0.203	0.824	0.535	0.508	0.026
WHtR	0.652	0.59	0.696	0.510	0.587	0.626	0.206
VAI	0.855	7.14	0.797	0.843	0.836	0.806	0.640
LAP	0.839	147.1	0.789	0.843	0.834	0.800	0.632

BMI: Body mass index, WC: Waist circumference, WHR: Waist hip ratio, WHtR: Waist to height ratio, VAI: Visceral adiposity index, LAP: Lipid accumulation product, AUC: Areas under the curves, Sn: sensitivity, Sp: Specificity, PPV: Positive predictive value, NPV: Negative predictive value, Y Index: Youden Index.

Discussion:

This study assessed the frequency of metabolic syndrome using the NCEP-ATP III definition and investigated its association with the biochemical and clinical parameters with the anthropometric predictors among the post menopausal women aged between 47 to 75 years. The frequency of post-menopausal women with metabolic syndrome was found 74.4%.Harraqui found prevalence of metabolic syndrome (74.18%) higher in postmenopausal women than perimenopausal women (50.62%).18 Also Correia19 from Brazil found 65.13%and Sharma et al20 in India found MS 65.7% which is similar to our study. In another study of India conducted with diabetic women found high prevalence of MS in postmenopausal women (87.7%).21 Higher prevalence also observed in studies conducted in other regions of Brazil22,23 and Spain.[24]

Unfavorable cardiovascular risk factor levels are observed during menopause, including changes in body fat distribution from gynaecoid to an android pattern, abnormal blood lipid levels, increased sympathetic tone, endothelial dysfunction, vascular inflammation and increased blood pressure. Postmenopausal women are at greater risk for CVD than men due to failure and reduction of the gonads and steroid production.[21] Estrogens play a key role in maintaining adequate levels of HDL-C.[25] The prevalence of MS in postmenopausal women was directly associated with advanced age probably because the aging process and menopausal status are linked to estrogen deprivation leading to a relative increase in serum androgen levels which promotes deposition of fat mass into the intraabdominal area.[26,27]

Measurement of obesity that used in this study included anthropometric and functional indices.In post-menopausal women with metabolic syndrome body mass index, fasting blood glucose, waist circumference, hip circumference, blood pressure, the body fat and the serum lipid levels except HDL-C were found significantly higher than in the post menopausal women without metabolic syndrome ($p < 0.001$). Our results agree with other studies.[18,28,29]

Many studies addressed the relation of menopause with blood pressure. Some other studies showed that blood pressure is not changed with menopausal status.30It has been shown that there is an elevation in systolic blood pressure among postmenopausal women without any change in diastolic blood pressure.[31] Our study showed that both systolic and diastolic blood pressure was high among postmenopausal women with metabolic syndrome. There are different studies about the menopausal effect on triglycerides. Some studies showed no effect,[32,33,34] while other studies showed elevations of triglyceride levels after menopause,[19,35,36] which is similar to our study. Our finding shows low HDL cholesterol level among post menopausal women with metabolic syndrome. Some studies show increasing of plasma HDL-C levels after menopause in Korean and Iranian population.[37,38] Like other studies it has been shown that there is an increase in fasting blood sugar among postmenopausal women with metabolic syndrome.[18,19,35,39] But in a study in Gorgan showed a significant increase in fasting blood glucose between postmenopausal with and without metabolic syndrome.[29]

Further, there were significant correlations between the anthropometric parameters and individual component of MS, which revealed that the BMI, WC, WHtR, VAI and LAP were significantly positively correlated with TG, FBS, SBP, and DBP and significantly negatively correlated with HDL. WHR positively correlated with HDL and FBS and negatively correlated with TG, SBP and DBP. On the other hand Osman found the LAP, HC, and WC were significantly positively correlated with TG, FBS, SBP, and DBP and significantly negatively correlated with HDL. VAI significantly positively correlated with TG and significantly negatively correlated with HDL. BAI significantly positively correlated with TG, FBS, SBP and DBP. WHR significantly positively correlated with TG and FBS.[35]

In order to assess the best predictor of metabolic syndrome in this study, 6 anthropometric parameters (BMI, WC, WHR, WHtR,VAI and LAP) were considered. Osman also used 6 parameters (WC, HC, BMI, BAI, VAI & LAP).[35] Whereas Adejumo used 11 parameters WC,BMI, WHtR, ABSI, BRI, VAI, AVI, CI, BAI, LAP and WTI).[39]

Anthropometric parameters that evaluated in the present study were significantly higher in the postmenopausal women with MS compared with the group without MS, and the correlation between them and the different component of the MS confirm the central role of the visceral adiposity in the development of MS.

In general all the anthropometric parameter except WHR showed significant ability to predict MS in postmenopausal women in our study.Among them VAI and LAP showed the most powerful specificity and sensitivity for the

diagnosis of MS. In our study VAI was the index that presented the largest AUC (0.85) in relation to other parameters studied. The AUC of LAP was found 0.83.In accordance with our study Ilhan and Yildizhan stated the AUC of both VAI and LAP was 0.88.36 In another study Lee et al found AUC of both VAI and LAP was 0.89 and recommended to determine appropriate cut-off values for each index in the postmenopausal group and to apply these markers in clinical practice.[40] A recent study showed that VAI and LAP were reliable surrogate markers in identifying MS in a population aged ≥40years.[41] VAI can be obtained by a previously validated formula, 11 which considers WC, BMI, TG and HDL values, easy measurements for assessing in postmenopausal women during the routine health check up.Also several studies have reported VAI as a good predictor of MS and CVD.[19,35,39] VAI has been shown by another study to be better at predicting cardiometabolic risk than WC. [42,43,44]

Many other researches documented the highest diagnostic accuracy of LAP for MS.[35,45,46,47] The use of LAP as a predictor for MS would appear superior to the use of WC, not because it captures both anthropometric and metabolic dimensions of enlarged visceral adiposity. Moreover, WC would miss the excess lipids stored as TG. LAP will reflect the lipids that deposited in the liver, blood vessels, pancreas, kidneys, and skeletal muscles, where they may adversely affect cellular function and interfere with cardiovascular regulation.[48]

It is not enough to consider anthropometric parameter with the highest AUC as the most predictive of MS, it has been suggested that simplicity of measurement and interpretation, widespread use and significant difference between AUC measurements and other factors to be considered. However WC was a more useful predictor of MS because of its simplicity of measurement and widespread.49WC also considered as best predicator for MS in other studies.18,39In our study the WC was also considered as a good predictor with AUC0.75 .

Moreover, we can emphasize that VAI, LAP and WCare good predictors of MS diagnosis. The cut-off points established in this current study may help with the prevention and early diagnosis of MS among postmenopausal women.

Conclusion:

In conclusion, the results of our study suggest that the prevalence of MS was significantly higher in postmenopausal women. Prevention must be needed through changes in lifestyle, or early detection and treatment of elevated fasting blood glucose, hypertension and hyperlipidemia are necessary to prevent many chronic diseases in Bangladeshi women after menopause. High sensitivity and specificity of VAI & LAP as a predicting tool for MS highlighted the importance of central adiposity as a key risk factor for the development of MS. These are also regarded as cheap, accurate and reliable anthropometric parameters for the diagnosis and management of MS.

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