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RESEARCH ARTICLE

Adiposity indices as predictors for metabolic syndrome in postmenopausal women

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ABSTRACT

Background: The metabolic syndrome (MS) is a clinical syndrome of metabolic abnormalities that have been associated with many cardiometabolic disorders that increase the rate of morbidity and mortality. **Aims and Objectives:** The objective of the present study was to examine the predictive power of many adiposity indices as an accurate predictor for MS in postmenopausal Sudanese women. **Materials and Methods:** This cross-sectional study involved 290 postmenopausal women. Fasting blood glucose and lipid profile, blood pressures, and relevant anthropometric indices were determined using standard protocols. **Results:** Lipid accumulation product (LAP), visceral adiposity index (VAI), body adiposity index, waist circumference (WC), hip circumference, and body mass index were significantly higher in women with MS. The receiver operating characteristic curve results revealed that the threshold values of 56.2, 90.5, and 1.4 for LAP, WC, and VAI, respectively, provide sensitive and specific predictors for MS in postmenopausal women. **Conclusion:** LAP, WC, and VAI regarded as sensitive and specific predictors for MS in postmenopausal Sudanese women.

KEY WORDS: Menopause; Metabolic Syndrome; Adiposity Indices

INTRODUCTION

Metabolic syndrome (MS) represents a cluster of risk factors specific for cardiovascular disease, type 2 diabetes mellitus, and hypertension.[1]

Enlarged visceral adiposity regarded as a key factor for the development of MS.[2] The incidence of obesity among women was increased worldwide to epidemic proportions.[3] The arrival of the menopause in middle age is associated with a tendency to gain weight.[4] Menopause associated with an increase in intra-abdominal fat.[5] Obesity was defined classically through employing many anthropometric indices that based on fat distribution, each one has their own advantages and disadvantages in predicting serious chronic non-communicable diseases.[6]

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Recently, functional adiposity indices were used for predicting chronic disease that associated with altered adiposity. Lipid accumulation product (LAP) predicts diabetes better than body mass index (BMI).[7] It was also associated with all-cause mortality in non-diabetic patients at high cardiovascular risk.[8] In addition, LAP has been tested in the Chinese population, it predicts diabetes better than waist-to-hip ratio, waist circumference (WC), and BMI, in both men and women.[9] It was also been applied to healthy Argentinean men, it provides sensitive and specific predictor for MS.[10] Visceral adiposity index (VAI) considered as a simple marker of visceral adiposity, it showed a strong independent association with both cardiovascular and cerebrovascular events[11] and showed better predictive power for the incidence of diabetes than its individual components.[12] Moreover, this index has been proved to be an easy and useful tool for the assessment of cardiometabolic risk associated with the oligomenorrheic phenotype of women with polycystic ovary syndrome.[13] Body adiposity index (BAI) has been assessed in several populations as an alternative risk factor for several cardiometabolic diseases.[14,15]

In resource poor areas as our community, the determination of simple, accurate, valid, and cost-effective diagnostic tools for chronic diseases would improve clinical outcomes and prevent the consequences of these disorders.

MATERIALS AND METHODS

In this cross-sectional study, 290 postmenopausal women aged 45–70 years were studied. Women that used hormone replacement therapy and antidepressant drugs in addition to women with polycystic ovarian disease, premature ovarian failure, adrenal insufficiency, thyroid gland diseases, a hysterectomy, and an oophorectomy were excluded from the study. A questionnaire was completed for each subject including demographic information, menopausal status, medical history, reproductive history, drug history, family history, physical examination, and clinical laboratory data.

Written Consent and Ethical Clearance

Written consent was received from all the study participants. The present study was approved and permitted by the institutional ethical clearance committee (reference number: 23-11-2017).

Diagnosis of MS

Postmenopausal women were diagnosed by MS according to the National Cholesterol Education Program Adult Treatment Panel IΠ (ATP IΠ) criteria[16] which confirmed by the presence of three from the following five risk factors.

1. Abdominal obesity: WC ≥88 cm.
2. Hypertriglyceridemia: Serum triglycerides (TG) level ≥150 mg/dl.
3. Serum high-density lipoprotein (HDL): <50 mg/dl.
4. High blood pressure: Systolic blood pressure (SBP) ≥130 mmHg and/or diastolic blood pressure (DBP) ≥85 mmHg or on treatment for hypertension.
5. High fasting blood glucose (FBG): Plasma glucose level >110 mg/dl or on treatment for diabetes.

Adiposity Indices Calculations and Measurements

BMI was computed as weight (kg) divided by height in squared meters (m^2). Waist measurement was taken using a non-stretchable standard tape measure mid-way between the lowest rib and iliac crest with the subject standing at the end of gentle expiration.

Waist–hip ratio was obtained as the quotient of waist (cm) divided by hip (cm) circumferences.

The LAP was calculated as (WC [cm] −58) × (triglyceride concentration [mM]) for women. VAI for female was calculated as (Waist/[36.58 + (1.89 × BMI)]) × (TG/0.81) × (1.52/HDL−Cholesterol).

BAI was calculated as (hip circumference [HC] [cm] divided by [height (m) 1.5–18]).

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

The subjects fasted for at least 12 h, and a blood sample was collected and analyzed under fasting conditions. FBG, TG, and HDL cholesterol were measured spectrophotometrically.

Statistical Analysis

Descriptive statistics were carried out results reported as means ± standard deviations. Independent sample *t*-tests were conducted to assess the relationship between the MS and the studied variables. The receiver operating characteristic (ROC) analysis was employed to determine the predictive power of different adiposity indices for MS. For the areas under the curves (AUCs) (measures of true diagnostic/ discriminatory power) of the ROC analyses, threshold values for MS prediction were determined for adiposity indices, 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. Threshold values whose sensitivities and specificities gave the maximum sums were recorded for each variable. 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 24 (SPSS Inc., Chicago, IL).

RESULTS

Basic characteristics for the 290 postmenopausal women are presented in Table 1. The mean age of the subjects was 53.96 ± 7.5 years. Around 51.4% of subjects were classified as having MS according to NCEPATP III criteria. The weight, BMI, WC, HC, WH ratio, LAP, VAI, BAI, TG, SBP, DBP, and FBS were significantly higher in postmenopausal women with MS compared to subjects without MS, while HDL significantly lower in the subjects with MS.

Table 1: General characteristic of the study subjects (*n*=290)

Parameters	Postmenopause with MS (*n*=149) Mean±SD	Postmenopause without MS (*n*=141) Mean±SD	*P* value
Age	54.10±7.398	53.32±7.484	0.372
Height	155.89±6.761	156.08±7.334	0.823
Weight	78.28±17.522	63.30±15.233	0.000
BMI	32.1835±6.62674	25.6916±5.86952	0.000
WC	100.48±11.356	86.77±11.270	0.000
HC	110.17±12.176	97.72±12.522	0.000
WH ratio	0.9125±0.05797	0.8834±0.09280	0.001
LAP	103.4591±58.22401	41.4294±23.03094	0.000
VAI	3.0881±2.83765	1.3746±0.94209	0.000
BAI	29.1394±5.07220	23.7799±5.27653	0.000
Triglyceride (TG)	209.49±85.121	125.54±51.188	0.000
High-density lipoprotein (HDL)	80.35±38.153	90.82±31.591	0.011
Systolic blood pressure (SBP)	147.97±22.556	125.70±20.349	0.000
Diastolic blood pressure (DBP)	84.44±17.007	74.23±13.192	0.000
Fasting blood sugar (FBS)	162.16±76.467	111.63±50.696	0.000
MS %	51.4%	0.000%	

MS: Metabolic syndrome, VAI: Visceral adiposity index, BAI: Body adiposity index, LAP: Lipid accumulation product, WC: Waist circumference, HC: Hip circumference, BMI: Body mass index

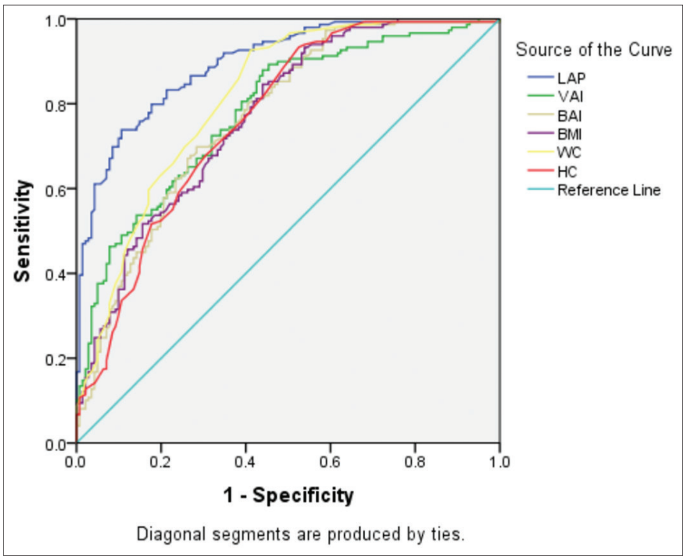

Figure 1: Receiver operating characteristic curves for adiposity indices in predicting metabolic syndrome

Results are presented in Figure 1 which show that the ROC curves for determining diagnostic accuracy and the optimal threshold for each of the obesity indices in predicting MS, LAP showed the highest AUC value of 0.90, followed by WC with the AUC of 0.81, VAI with the AUC of 0.78, and HC with the AUC of 0.77, respectively. LAP, WC, VAI, and HC had AUC values that were ≥0.75, this indicate they offer significant accurate diagnostic tests for the MS, while other adiposity indices, included BAI, BMI, and HC, were not reaching the significant value for predicting MS.

ROC curve analyses that illustrated in Table 2 revealed that the optimal cutoff values (threshold) for LAP were 56.23 with a sensitivity of 82% and a specificity of 80%, for WC were 90.50 with a sensitivity of 79% and a specificity of 65%, and for VAI were 1.397with a sensitivity of 78% and a specificity of 62%.

Results are illustrated in Table 3 which showed the correlation between the adiposity indices and individual component of MS, which revealed that LAP, HC, and WC were significantly positively correlated with TG, FBS, SBP, and DBP while 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.

DISCUSSION

The present study designed to examine the predictive power of some adiposity indices as accurate predictor for MS in postmenopausal women. Obesity measured that used in this study included anthropometric and functional indices.

In the present study, it is well clarified that postmenopausal status is associated with obesity and this determined the

Table 2: Analysis of ROC curves

Parameters	AUC; (95% C.I.)	*P* value	Threshold value	Sensitivity (%)	Specificity (%)
LAP	0.895; (0.860–0.930)	0.000	56.23	82	80
VAI	0.783; (0.731–0.835)	0.000	1.397	78	62
BAI	0.770; (0.716–0.824)	0.000	26.078	70	68
BMI	0.771; (0.718–0.824)	0.000	26.95	76	61
WC	0.813; (0.764–0.863)	0.000	90.50	79	65
HC	0.765; (0.710–0.819)	0.000	101.50	75	63

VAI: Visceral adiposity index, BAI: Body adiposity index, LAP: Lipid accumulation product, WC: Waist circumference, HC: Hip circumference, BMI: Body mass index, AUC: Areas under the curves, CI: Confidence interval, ROC: Receiver operating characteristic

Table 3: Correlation of adiposity indices with the component of the metabolic syndrome in the study population

Parameters	Statistics	TG	HDL	FBG	SBP	DBP
LAP	Pearson correlation	0.870	−0.170	0.329	0.290**	0.267**
	Significant (two tailed)	0.000	0.004	0.000	0.000	0.000
VAI	Pearson correlation	0.585	−0.598	0.084	0.061*	0.066*
	Significant (two tailed)	0.000	0.000	0.153	0.297	0.264
BAI	Pearson correlation	0.295	−0.107	0.275	0.398**	0.351**
	Significant (two tailed)	0.000	0.069	0.000	0.000	0.000
HC	Pearson correlation	0.288	−0.138	0.254	0.338**	0.314**
	Significant (two tailed)	0.000	0.018	0.000	0.000	0.000
WC	Pearson correlation	0.360	−0.147	0.314	0.367**	0.362**
	Significant (two tailed)	0.000	0.012	0.000	0.000	0.000
WHR	Pearson correlation	0.142	−0.053	0.122	0.049	0.117
	Significant (two tailed)	0.016	0.371	0.038	0.405	0.046

HDL: High-density lipoprotein, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, FBS: Fasting blood sugar, VAI: Visceral adiposity index, BAI: Body adiposity index, LAP: Lipid accumulation product, WC: Waist circumference, HC: Hip circumference, BMI: Body mass index, TG: Triglyceride, Significance: *$P \leq 0.05$.

development of MS because all obesity indices such as weight, BMI, WC, HC, WH ratio, LAP, VAI, and BAI were significantly higher in postmenopausal women with MS compared to postmenopausal women without MS [Table 1]. Further, there were significant correlations between the adiposity indices and individual component of MS, which revealed that 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 [Table 3]. LAP provides the most powerful specificity and sensitivity for the diagnosis of MS in postmenopausal women [Table 2 and Figure 1].

In this study, most of the postmenopausal women with MS belonged to obese Class I category (BMI = 32.2 ± 6.6) and those without the syndrome belonged to overweight category (BMI = 25.7 ± 5.9). Similar results were obtained by Tapadar *et al*.,[17] Paszkowski and Kłodnicka,[18] and Davis *et al*.[19] who concluded that obesity is the most common disorder associated with women in their menopausal stage and occurs in approximately 65% of all women. In the current study finding that obtained from adiposity indices indicating enlarged visceral adiposity in the postmenopausal women with the MS, this was consistent with the study that documented menopause is associated with increased incidence of central obesity.[20]

Adiposity indices 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 adiposity indices and the different component of the MS confirm the central role of the visceral adiposity in the development of MS. This is consistent with the studies that the enlarged adiposity expected to develop the MS.[21]

The finding of this study revealed that LAP provides strong specificity and sensitivity predictive accuracy for diagnosing MS in postmenopausal women, with a cutoff of 56.2. This result in agreement of many other researches that documented the highest diagnostic accuracy of LAP for MS.[22-25] 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.[26]

Strength and Limitation of the Study

This study carried out on postmenopausal women, they were divided into two groups according to the occurrence of MS. We examined the different anthropometric and functional adiposity indices as predictors for MS. The study was carried out in specific region most of the participant share same lifestyle variables.

CONCLUSION

High sensitivity and specificity of LAP as a predicting tool for MS highlight the importance of central adiposity as a key risk factor for the development of MS. It also provides cheap and accurate and reliable indices for the diagnosis and management of MS.

The sensitivity of these adiposity indices should be noted in assessing a particular cardiometabolic disease.

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