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Original Article

Metabolic syndrome among postmenopausal women in a selected rural area of northern Bangladesh

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1. Background

Metabolic syndrome (MetS) is the manifestations of clustered pathophysiological conditions which increases the risk of cardiovascular disorders (heart disease, stroke etc) including type 2 diabetes [1]. Mets is also known as syndrome of insulin resistance characterized by impaired glucose tolerance compounded with obesity, dyslipidemia and hypertension [2]. However, pathogenesis of Mets though still remain unclear, insulin resistance often considered as its underlying cause abnormality, apart from that, diet and physical inactivity which may be associated with unknown genetic factors.

Men reportedly tend to have higher prevalence of MetS than age-matched pre-menopausal women. Abdominal obesity and low HDL cholesterol also remain significant factors which contributes to MetS in women, particularly among more than 45 years, potential due to menopausal state [3], [4]. Estrogen deficiency, a typical type of body fat distribution has been reported to be observed among postmenopausal women is thought by many to be an important feature in the diagnosis of MetS [5].

Increasing trend of chronic non-communicable diseases (viz. cardiovascular diseases and type 2 diabetes) [6] has been observed among Bangladeshi urban even among rural women poor and physically inactive being more vulnerable [7]. However, Among rural Bangladeshi women, metabolic syndrome was found 20.7% following modified ATP III, 11.2% using cut off of International Diabetes Federation (IDF) but it came down to 8.6% following WHO definitions [8].

According to WHO criteria, insulin resistance has been considered as one of the most functionally essential component for the diagnosis of MetS, while in the recently proposed (2005) definition by the International Diabetes Federation (IDF), abdominal obesity remaining a compulsory component with any two of the other 4 factors; elevated triglycerides, lower HDL cholesterol, raised blood pressure and higher fasting plasma glucose [9]. Whereas the US National Cholesterol Education Program: Adult Treatment Panel III (ATP III) defined MetS as a cluster of three or more of the above CVD risk factors [10]. Thus based on all these definitions and clinical criteria of MetS, identification of metabolic risk factors in postmenopausal women remain imperative and crucial for developing primary and secondary preventive care strategies decreasing the socioeconomic burden of cardiovascular diseases grossly considering these clinical and socioeconomic issues we conducted this study designed to estimate the prevalence of Mets according to different criteria taking its associated risk determinants among postmenopausal women of Bangladesh.

2. Methods

2.1. Study participants

This cross sectional study was conducted using multistage random sampling from 12 union of Pirganj upazila situated in Thakurgoan district of northern Bangladesh among 316 postmenopausal subjects statistically calculated using the Mets in a recent study in Chaina [11]. With informed consent postmenopausal women aged 45–70 years, not taking any hormone therapy, having intact uterus being physically and mentally sound were subjected to a MetS screening program at the local community (union parishad) office. Prior to this study, postmenopausal women defined if they had reported their last menses two years before. With informed consent, 3.5 ml of IV fasting blood was collected postmenopausal women who only 10–12 h overnight fasting suitable for biochemical analysis. Sociodemographic information (age, housing, educational level, occupation, monthly income), family history of diseases, blood pressure & menopause

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duration), anthropometric measurements (height, weight, waist circumference, hip circumference & MUAC) were also recorded by using appropriate method.

Socio-economic classification was made according to 2006 Gross National Income (GNI) per capita and using the calculation of World Bank (WB). The groups were: low-income group (BDT ≤ 5360), middle to high-income group (BDT >5361) [12].

2.2. Anthropometric and clinical measurements

Height, body weight and waist circumferences were measured among the subjects on light clothing and no shoes by trained examiners. Portable standoimeter and platform beam scale were used to measure subject's height and weight. To calculate BMI, Body weight in kilograms divided by the square of height in meters (kg/m^2). Waist and hip circumferences were measured to the nearest 0.5 cm with a soft non-elastic measuring tape. Three consecutive measurements at 1 min interval on cubital region both arms in sitting position ensuring the recumbence in a calm and quite environment. Systolic and diastolic blood pressures were computed as the mean of the three measurements.

2.3. Biochemical analysis

Fasting blood sample was subjected to measure serum glucose, triglyceride (TG), total cholesterol and HDL & LDL cholesterol. Blood samples collected in plain test tube vacutainers (-ve pressured) allowed to clot for 30 min when serum was separated by standard centrifugation (10 min at 3000 rpm and the 600 μl serum was collected at least in each aliquot and the remaining aliquot was frozen at -30^0 C for further use. While serum was not allowed to thawed unless the assay started performing. Serum glucose was analyzed using, triacylglyceride was measured by enzymatic-colorimetric (GPO-PAP) methods and serum total cholesterol were analyzed using enzymatic endpoint method (cholesterol oxidase/peroxidase) (all using Radox, UK) while serum high density lipoprotein (HDL) by enzymatic-colorimetric (cholesterol CHOD-PAP) method.

2.4. Diagnosis of MetS

For the diagnosis of Mets three types of criteria were followed: 1. World Health Organization (WHO) 2. Modified Adult Treatment Panel III (ATP III) 3. International Diabetes Federation (IDF). In WHO criteria for metabolic syndrome; insulin resistance considered as a required component for diagnosis as defined one of the followings: type 2 diabetes; impaired fasting glucose (IFG); impaired glucose tolerance (IGT), or for those with normal fasting glucose values (<6.1 mmol/l), a glucose uptake below the lowest quartile for background population under hyperinsulinemic, euglycemic conditions. In addition to insulin resistance, 2 other risk factors from the followings: antihypertensive medication and/or blood pressure ≥140 mm Hg systolic or ≥90 mm Hg diastolic; plasma triglycerides ≥150 mg/dl (≥1.7 mmol/L); HDL cholesterol <39 mg/dL (1.0 mmol/L) and BMI ≥30 kg/m^2 and/or waist: hip ratio >0.85. In ATP III criteria, presented with three or more of five risk determinants: high fasting glucose (≥5.6 mmol/l or ≥100 mg/dl), abdominal obesity (>80 cm), increased serum TG (≥150 mg/dl or ≥1.7 mmol/l), decreased HDL-C (<50 mg/dl or <1.29 mmol/l), and increased blood pressure (≥130/85 mmHg). Women taking oral hypoglycemic or antihypertensive medications prescribed by a physician were considered as diabetic or hypertensive independent of the serum or blood pressure finding. According to the new (2005) IDF definition, a person to be defined having metabolic syndrome must have ethnicity specific central obesity as waist circumference >80 cm which is recommended for South Asian women and any two or more of the following four factors: raised TG levels ≥150 mg/dl (1.7 mmol/l) or specific treatment for this lipid abnormality; reduced HDL-C <50 mg/dl (1.29 mmol/l) or specific treatment for this lipid abnormality; raised blood pressure as systolic BP ≥ 130 or diastolic BP ≥ 85 mmHg or treatment of previously diagnosed hypertension; and raised fasting blood glucose ≥100 mg/dl (≥5.6 mmol/l) or previously diagnosed diabetes.

2.5. Data management

The data were collected, tallied, cleaned and analyzed using SPSS Windows version; 21. While the prevalence of Mets and its components were determined using percentages. Kappa test were performed to examine the agreement among the dentition of Mets diagnosis and for comparing the proportional variation between two group X^2 test was performed. Logistic regression model were also fitted to identify plausible risk factors related to develop Mets A p value of <0.05 was considered statistically significant (CI of 95%) and were presented in two tailed.

2.6. Ethical consideration

All participants were informed about the aims of study and they gave their written consents. Ethical issues were followed according to the guideline of Bangladesh Diabetic Somiti (BADAS) ethical Review Committee which followed Helsinki guidelines.

3. Results

The highest prevalence (41.5%) of Mets found following modified ATP III criteria while the lowest prevalence (7.6%) following WHO criteria (Fig. 1).

Subjects classified as having Mets following IDF criteria, all of them (85) also met the criteria of ATP III. However, 35.1% (46 out of 131) were identified as Mets following ATP III criteria were not found same following IDF criteria. Good agreement was observed between ATP III and IDF criteria (k = 0.683). Whereas, agreement between WHO and IDF were very low. Further finding on metabolic syndrome by IDF criteria was only 12.9% (11 out of 85) met the WHO criteria contrarily, 95.3% subjects without having any Mets according to WHO criteria yielded to be positive following IDF criteria (k = 0.09). On the other hand, 37% participants without any positive syndrome following WHO criteria

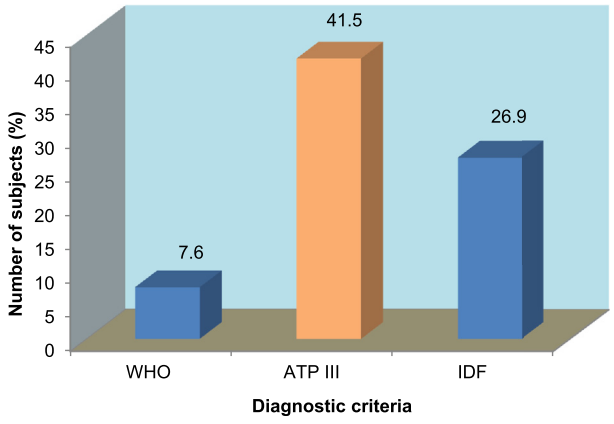

Fig. 1. Prevalence of the metabolic syndrome (MetS) using WHO, modified ATP III and IDF criteria (n = 316).

Table 1
Agreement between the WHO, modified ATP III and IDF criteria in diagnosing metabolic syndrome.

Diagnostic criteria					Kappa value
IDF criteria	MetS status	Present	Absent	Total	
	Present	85	0	85	0.683
	Absent	46	185	231	
	Total	131	185	316	
WHO criteria	**Modified ATP III**				
	MetS status	Present	Absent	Total	
	Present	22	2	24	0.178
	Absent	109	183	292	
	Total	131	185	316	
WHO criteria	**IDF criteria**				
	MetS status	Present	Absent	Total	
	Present	11	13	24	0.094
	Absent	74	218	292	
	Total	85	231	316	

met the positive criteria using ATP III. Thus WHO and ATP III showed moderate agreement ($k = 0.17$) whereas higher agreement between WHO and IDF criteria (Table 1). The most common component of MetS following WHO criteria was hypertriglyceridemia (44%), abdominal obesity (W: H; 68%) and high diastolic blood pressure (30%), whereas as per definition by ATP III and IDF these were hypertriglyceridemia (44%), low HDL-C (67%) and abdominal obesity (39%) as the most frequently encountered component among the rural postmenopausal women. However, according to WHO and IDF criteria, fasting hyperglycemia and abdominal obesity satisfied significantly higher in post-menopausal women with Mets than without MetS ($p < 0.001$) contrary to ATP III criteria being ($p < 0.001$) higher in all the six diagnostic components (Table 2).

Logistic regression analysis on metabolic syndrome against some potential confounding independent variables (age, duration of menopause, number of children, monthly income, family history of NCDs, WC and BMI) revealed that, following WHO criteria in women having menopause since past 5 years and WC $\geq$ 80 cm remained at higher risk of having Mets {OR (95% CI): 2.57 (0.87–7.59) and 1.41 (0.56–3.55) respectively}. Similarly, in women of >5 years menopause, family history of NCDs and BMI yielded as high risk category with Mets {OR (95% CI): 1.42 (0.83–2.42) and 1.32 (0.78–2.22) and 1.11 (0.30–4.04) respectively} according to ATP III criteria. Moreover, women having >3 children, family history of NCDs and BMI also fell under high risk groups develop Mets {OR (95% CI): 1.25 (0.65–2.40), 1.36 (0.76–2.42) and 1.34 (0.35–5.11), respectively} following IDF criteria (Table 3).

4. Discussion

The prevalence of Mets among these rural postmenopausal women was found lowest (7.6%) following WHO criteria, 26.9% following IDF criteria and 41.5% in modified ATP III criteria remain a little higher (39.3%) than that of an earlier study in rural Bangladesh [13]. However, our finding of 41.5% Mets prevalence in ATP III criteria remain similar to that of an African study among Ghanaian postmenopausal women while it was found 25.2%, and 43.0% in WHO and IDF criteria respectively [14]. However, in India, a study conducted among postmenopausal urban women showed higher (55%) prevalence of MetS as defined by IDF criteria [15]. These differences in prevalence of Mets can well be explained due to different investigation methods, selection criteria, study period, geographic difference etc. of the syndrome. However, there is no consensus on the criteria for the diagnosis using Mets, in adjusted to valid criteria for Mets components in a defined population may not be appropriate to other populations with varying socioeconomic condition, staying apart from genetic and environmental variability.

In the present study, the reason for higher prevalence of Mets following ATP III appeared to be its inclusion of flexible waist circumference in Asian subjects and use of new cut-off for FBG threshold. The IDF and ATP III definition shared similar five components and their cut-off values remain identical as well except æcentral obesity" which is a compulsory component in IDF criteria, whereas in ATP III definition, it requires central obesity as one of the five equally weighted components. Waist circumference is a practical anthropometric index preferred over Waist Hip ratio (WHR) and BMI to estimate the amount of abdominal visceral fat [16]. This may explain the lower prevalence of MetS according to WHO compared with modified ATPIII and IDF criteria in this study.

However, poor agreement between IDF and WHO criteria may explain the importance of fasting blood glucose and WC as the required component for detecting MetS while good concordance between ATP III and IDF criteria signifies the magnitude of all the components including WC with the same cut-off. By this way ATP III criteria might be suggested to be the best criteria for the diagnosis of MetS among postmenopausal women since it obtain all on equally weighted diagnostic components including WC and FBG.

The most prevalent component of metabolic syndrome (MetS) in WHO criteria was hypertriglyceridemia, abdominal obesity (WHR) and high diastolic blood pressure with has been also reported in a study of Arab Americans [17] revealing higher prevalence of hypertriglyceridemia (48%), abdominal obesity (WHR; 81%) and high blood pressure (21%) among 45^{+} years aged women which remain rather close to our findings. However, in this study fasting blood glucose (FBG) showed significantly higher ($P = 0.001$)

Table 2
Prevalence of the components of MetS using WHO, modified ATPIII and IDF criteria (n = 316).

MetS Components	WHO			ATP III			IDF		
	Mets Present	Mets Absent	p- value	Mets Present	Mets Absent	p- value	Mets Present	Mets Absent	p-value
↑SBP (mmHg)	6 (1.9)	73 (23.1)	0.60	71 (22.5)	50 (15.8)	0.001	43 (13.6)	78 (24.7)	0.006
↑DBP (mmHg)	8 (2.5)	87 (27.5)	0.71	60 (19.0)	41 (13.0)	0.001	35 (11.1)	66 (20.9)	0.033
↑FBG (mmol/dl)	24 (7.6)	13 (4.1)	0.001	65 (20.7)	27 (8.6)	0.001	34 (10.8)	58 (18.5)	0.011
↑TG (mg/dl)	16 (5.1)	121 (38.5)	0.017	93 (29.6)	44 (14.0)	0.001	52 (16.6)	85 (27.1)	0.001
↓HDL (mg/dl)	13 (4.2)	73 (23.3)	0.002	120 (38.3)	89 (28.4)	0.001	76 (24.3)	133 (42.5)	0.001
↑WC (cm)	–	–	–	85 (26.9)	39 (12.3)	0.001	85 (26.9)	39 (12.3)	0.001
↑BMI (kg/m^2)	1 (1.0)	3 (2.0)	0.186	–	–	–	–	–	–
↑Waist: hip	20 (6.3)	195 (61.7)	0.094	–	–	–	–	–	–

Results are expressed as Number (%), according to WHO criteria ↑FBG ≥6.1 mmol/dl, ↑SBP≥140 mmHg, ↑DBP≥90 mmHg, ↑TG ≥ 150 ↓HDL (male≤35 mg/dl: female≤39 mg/dl), ↑BMI>30 kg/m^2 and/or ↑Waist:hip ratio (male>0.9 cm, female>0.85 cm); according to IDF criteria ↑FBG≥5.6 mmol/dl, ↑SBP≥130 mmHg, ↑DBP≥85 mmHg, ↑TG ≥ 150 mg/dl, ↓HDL (male≤40 mg/dl: female≤50 mg/dl), ↑Waist circumference (male≥90 cm, female≥80 cm); according to modified ATP III criteria↑FBG ≥6.1 mmol/dl, ↑SBP≥130 mmHg, ↑DBP≥85 mmHg, ↑FBG≥6.1 mmol/dl, ↑TG ≥ 150 mg/dl, ↓HDL (male≤40 mg/dl: female≤50 mg/dl), ↑Waist circumference (male≥80 cm, female≥90 cm); $p < 0.05$. ↑: High/increased & ↓: Low.

Table 3
Determinants of metabolic syndrome (MetS) of the study subjects according to different criteria (n = 316).

Independent variables	OR (95% CI)		
	WHO criteria	**ATP III criteria**	**IDF criteria**
Age	0.99 (0.93–1.06)	1.02 (0.98–1.05)	1.00 (0.95–1.04)
Duration of menopause (years)			
1–5 yrs	Ref.	Ref.	Ref.
>5 yrs	2.57 (0.87–7.59)	1.42 (0.83–2.42)	0.81 (0.44–1.47)
Number of children			
1-3 child	Ref.	Ref.	Ref.
>3 child	0.70 (0.26–1.86)	0.93 (0.53–1.65)	1.25 (0.65–2.40)
Low income			
Yes	Ref.	Ref.	Ref.
No	0.78 (0.29–2.08)	0.842 (0.50–1.41)	0.78 (0.43–1.41)
Family History of NCDs			
No	Ref.	Ref.	Ref.
Yes	0.64 (0.23–1.74)	1.32 (0.78–2.22)	1.36 (0.76–2.42)
***Waist circumference (cm)**			
<80 cm	Ref.		
≥80 cm	1.41 (0.56–3.55)	–	–
***BMI**			
Underweight (<18.5)	–	Ref.	Ref.
Acceptable risk (18.5–23)	–	0.76 (0.44–1.32)	0.72 (0.39–1.34)
Increased risk (23–27.5)	–	0.93 (0.42–2.07)	0.80 (0.32–1.97)
High risk (≥27.5)	–	1.11 (0.30–4.04)	1.34 (0.35–5.11)

Metabolic Syndrome was taken as a dependent variable whereas other variables were taken as independent variables. OR, odds ratios; CI, confidence interval; NCDs, Noncommunicable diseases; WC, Waist circumference.
*In case of ATP III & IDF criteria waist circumference and in WHO criteria, BMI has been excluded as a confounding factor being one of the components of Mets.

among women with MetS than without which is obvious for FBG as a compulsory Mets diagnostic component following WHO criteria. On the contrary, as per definition of modified ATP III and IDF, low HDL-C, hypertriglyceridemia and abdominal obesity are the most frequent components among the rural postmenopausal women.

A recent study on rural Bangladeshi postmenopausal women reporting Low HDL (77%) as the most common component of MetS is also remaining comparable to the findings of the present study though the MetS prevalence rate was higher (67%). High blood pressure and elevated FBG (49%) was the second highest prevailing metabolic risk factor [13]. Different literature demonstrated that the atherogenic lipoprotein profile characterized by high triglyceride and low HDL cholesterol is a more powerful predictor of insulin resistance than obesity, elevated blood pressure, or FPG and, in the presence of obesity, greatly increases the risk of coronary heart disease [18]. Other studies in Korea and Iran with low HDL-cholesterol level reported as the most prevalent MetS component [19]. Contrary to a Chinese study where the most frequent component was abdominal obesity (49.4%) including the least frequent component of lower HDL-C (21.3%) [20] Higher waist circumference (85.2%) was the most prevalent component of MetS and lower HDL (82.8%) and high blood pressure (73.4%) was the second most frequent components in a Brazilian study [19].

Prevalence of all metabolic components among subjects with MetS showed significantly higher than subjects with no MetS in postmenopausal women. This reflects the superiority of assessment for modified ATP III criteria over the WHO and IDF criteria for screening metabolic abnormalities more precisely.

A study conducted in Korean pre and postmenopausal women revealed family history of CVD and diabetes being significantly associated with increased risk of metabolic syndrome (OR 1.73 and 1.55, respectively) [21] which remain consistent in our present study revealing (postmenopausal women with) a family history of NCDs (CVD or diabetes) remaining at higher risk of having MetS according to ATP III and IDF criteria (OR; 1.32 and 1.36 respectively). More importantly, time since menopause onset (>5 years) also yielded to be an independent risk factor associated with MetS (OR: 2.57 and 1.42) as per WHO and ATP III both.

Multivariable analysis in a Chinese study revealed BMI >30 kg/m^2 and family history of CVD as the significant independent risk factors for MetS {OR (95% CI): 2.83 (2.06–3.89) and 2.24 (1.41–3.56) [20] which was consistent of our present study. We identified Increased BMI (>27 kg/m^2) as a risk determinants (OR 1.11 and 1.34) of MetS as per ATP III and IDF definitions. While as per WHO definition, abdominal obesity (WC > 80 cm) was significantly associated (OR 1.41) with MetS. In a study at San Juan revealed that women with metabolic syndrome were more likely to have had at least three children [22] which is attested by the findings of our present study where >3 children was significantly associated (OR 1.25) with MetS according to IDF definition.

5. Conclusions

Higher prevalence of MetS were observed among postmenopausal women of rural Bangladesh and it was observed higher following ATP III compared to IDF and the WHO criteria. Our finding suggests modified ATP III would be the appropriate diagnostic criteria for postmenopausal women of Bangladesh. Lower HDL cholesterol, hypertriglyceridemia, abdominal obesity and high blood pressures were fund to be the most frequent features of MetS among them following all the three criteria. More than 5 years since menopause, family history of NCDs, increased BMI, abdominal obesity and number of children were yielded as main determinants to develop metabolic syndrome in them. Our finding suggests to create specialized group for menopause women who should be treated as a special group in a societies like Bangladesh were women rarely wish to expose themselves in such pathophysiological issue enduring several disease condition.

Abbreviations

MetS, Metabolic Syndrome; ATP III, Adult Treatment Panel III; IDF, International Diabetes Federation; BUHS, Bangladesh University of Health Sciences; BMI, Body Mass Index; TG, Triglyceride; LDL, Low Density Lipoprotein; HDL, High Density Lipoprotein; IUHW, International University of Health & Welfare.

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Author contributions

Ferdous Ara: Conceptualize, design and develop study tools, data analysis, drafting and review of the manuscript; Dr. Kazi Selim Anwar: Drafting and review of the manuscript; Taslima Khatun: Review of the manuscript. All authors accept the final responsibility for the paper. All authors read and approved the final manuscript.

Conflicts of interest

None.

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