ORIGINAL ARTICLE

Waist Circumference as a Screening Tool for Metabolic Syndrome in Resource-Limited Countries

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ABSTRACT

Background: The prevalence of metabolic syndrome (MetS) has been increasing, especially in developing countries. It is important to have an easy to perform and inexpensive screening system in such resource-bound countries. ***Objective:*** To compare the value of waist circumference over body mass index (BMI) for a better assessment of MetS. ***Methods:*** In this cross-sectional study, we collected data from 492 participants residing in both urban and rural areas of Bangladesh, as a secondary dataset from another previous cross-sectional study. Receiver operating characteristic (ROC) analyses were performed to construct three curves that illustrate the sensitivity and specificity of waist circumference vs. BMI in predicting the presence of MetS. ***Results:*** The overall prevalence of MetS was 38.6% and was higher among males. In addition, waist circumference showed a consistent strong statistical association with the ATP III components. More importantly, diagnostic accuracy analysis of waist circumference showed a sensitivity and a specificity of 72.6% and 68.3% in females and 88% and 85%, in males, respectively. In contrast, BMI resulted in a sensitivity and a specificity of 65.8% and 62.9% in females and 76.1% and 64%, in males, respectively. ***Conclusion:*** Waist circumference could be used as good predictor of MetS. Clinicians should use this information in their practice to ease the financial burden associated with diagnosing MetS.

Keywords: Metabolic syndrome, waist circumference, body mass index, health status indicators

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INTRODUCTION

Metabolic syndrome (MetS) collectively describes a collection of chronically-presenting metabolic disorders namely; hypertension, obesity, dysinsulinemia, and dyslipidemia.[1] In recent years, the prevalence of non-communicable chronic diseases such as MetS has been increasing rapidly, especially in developing countries (e.g. India, Bangladesh).[2, 3] This is thought to be due to the insidious westernization of local diet which has led to exponential growth in obesity rates among those nations. [4, 5] In such resource-limited countries, it could be burdensome on the healthcare system to perform the battery of tests required to establish the presence of MetS. Despite that, early identification and management of MetS could save the resources that would have been lost in managing advanced complications of poorly identified MetS.[6-8]

Furthermore, the healthcare system in many developing countries is sometimes subpar and

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easily stagnant leading many of its desperate utilizers to pay out of pocket for their healthcare[9, 10]. For instance, a report from Bangladesh showed that, in one month, the average out-of-pocket payment on healthcare expenditure for chronic illness was approximately $23.78 USD, almost 15% of the average monthly income.[10]

The most widely used definition of metabolic syndrome was devised by the National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATP III) in 2001. To be labeled as having MetS, an individual must exhibit three or more criteria out of the following five: (1) waist circumference over 102 or 88 cm in men and women, respectively, (2) blood pressure exceeding 130/85 mmHg, (3) fasting triglyceride (TG) level over 150 mg/dl, (4) fasting high-density lipoprotein (HDL) cholesterol level less than 40 or 50 mg/dl in men and women, respectively, and (5) fasting blood sugar (FBS) of or greater than 110 mg/dl.[1]

On the other hand, the World Health Organization (WHO) defines MetS as diabetes, impaired glucose tolerance or insulin resistance plus any two of the following: (1) a body mass index (BMI) of ≥30 kg/m2, (2) blood pressure exceeding 140/90 mmHg or on medications, (3) urinary albumin excretion rate ≥20 µg/min, (4) Triglycerides ≥1.7 mmol/L, and (5) HDL-C less than 0.91 mmol/L and 1.01 in males and females, respectively.[11] Therefore, this research aims to investigate the value of using an inexpensive, easy-to-perform screening measurement that could accurately predict the occurrence of MetS. We also aim to assess which parameter is more effective and accurate in predicting MetS, ATP III's waist circumference or WHO's BMI.

METHODS

Design and setting: This cross-sectional study was conducted based on a re-analysis of secondary dataset from another cross-sectional study that assessed the gender difference of MetS among a group of Bangladeshi individuals.[12, 13] Research ethical standards were followed and ethical approval was obtained from the responsible authority to conduct the study. Thereafter, informed consent was attained from 492 participants residing in both urban and rural areas of Bangladesh. The sample collection strategies aimed to recruit a balanced mixture of males and females. To avoid repetition, we only reported the analysis plan unique to the current study.

Data analysis: Baseline characteristics were assessed for the three categories of respondents. The five components of MetS were transformed to binary variables following the ATP III). Then, a new binary variable that shows the MetS status (i.e. present or absent) was created. Chi-squared test was then performed to measure the degree of association between the newly formed ATP III waist measurement binary variable against the four remaining MetS components (i.e. HTN, HDL, TG, and FBS). The same was repeated using the BMI dichotomous variable.

Receiver operating characteristic (ROC) analyses were performed to construct three curves that illustrate the sensitivity and specificity of waist circumference as compared to BMI in predicting the presence of MetS in both genders and area of residence.

Means and standard deviations (±SD) were used to report continuous variables while frequencies and percentages were used to report categorical variables. chi-square test was used to examine the relations between categorical variables. A p-value of ≤0.05 was considered significant and above the cut-off value was taken insignificant. The statistical analysis for our study was carried out using SPSS software version 25.0 for Windows.

RESULTS

Females constituted 55.9% of the total sample. The mean age of females was 38(±10) years. Males, on the other hand, had a mean age of 44 (±11) years. Table 1 summarizes the main baseline characteristics. A little more than one-third (38.6%) of the sample met the ATP III criteria for MetS. Out of those, males constituted the largest proportion at approximately two-thirds (61.6%) while postmenopausal women constituted roughly one-tenth (11%) of the participants with MetS. Table 2 shows the level of association between BMI abnormality and MetS components (except waist circumference). None of the tested MetS components were significantly associated with BMI ($p \leq 0.05$). In contrast, all MetS components (except for HDL) were significantly associated when they were compared with waist circumference. For example, p values for HTN, TG, and FBS were 0.003, <0.001 and <0.001, respectively. Table 3 shows a summary

Table 1: Main baseline characteristics of the sample population

Parameters		Frequency	Percentage
Age	Up to 30 years	116	23.6%
	31-40 years	146	29.7%
	41-50 years	147	29.9%
	51-60 years	62	12.6%
	>60 years	21	4.3%
Gender	Female	275	55.9%
	Male	217	44.1%
Marital Status	Single	30	6.1%
	Married	448	91.1%
	Divorced	2	0.4%
	Widower/widowed	12	2.4%
Food Habits	Carbohydrate main	442	89.8%
	Vegetable Main	21	4.3%
	Fish Main	6	1.2%
	Meat Main	5	1.0%
	Balanced	17	3.5%
	Others	1	0.2%
Smoking	No	437	88.8%
	Yes	55	11.2%
Alcohol Drinking	No	488	99.2%
	Yes	4	0.8%
Income USD	Poor (<60$)	236	48.0%
	Middle Income (60-249.99$)	189	38.4%
	Rich (>=250$)	67	13.6%
Education	Illiterate	63	12.8%
	Some Education	274	55.7%
	Good Education	155	31.5%
Occupation	Sedentary Work	245	49.8%
	Heavy Work	247	50.2%

USD: United States Dollar.

of these findings. We looked at the differences in the area under the curve (AUC) between waist circumference and BMI for each gender to illustrate the diagnostic accuracy. In females, both the waist circumference and BMI produced significant (p <0.001) AUC. However, waist circumference had a 7.3% better performance than BMI, 73.6% vs. 66.3%, respectively (Figure 1). We determined a cutoff value of ≥87.5 cm for waist circumference with 72.6% sensitivity and 68.3% specificity. Table 4 shows a confusion matrix of the waist circumference and ATP Criteria definition of Metabolic Syndrome for males and females. In regard to BMI, a cutoff value of 24.4 kg/m2 resulted in maximum sensitivity and specificity, 65.8% and 62.9% respectively, which is noticeably lower than that of waist circumference.

Similarly, in males, waist circumference and BMI produced significant (p<0.001) curves, albeit with much better performance for waist circumference by an AUC of 88% compared to 75.2% for BMI (Figure 2). A waist circumference greater than or equals to 87.5 cm produced the highest sensitivity and specificity, 88% and 85% respectively, and was chosen as a cut-off value. In relation to BMI, a cut-off value of 22.2 kg/m2 resulted in maximum sensitivity and specificity, 76.1% and 64% respectively, considerably lower than that of waist circumference.

Finally, similar to gender, a waist circumference greater than or equals to 87.5 cm produced the highest sensitivity and specificity, 61.3% and 58.2% respectively, for the area of residence. Despite being significant (p = 0.002), area of residence did not provide a strong predictor of MetS as the AUC was marginally higher than the chance line (58.5%).

DISCUSSION

This study has three main findings: (1) the overall prevalence of metabolic syndrome was 38.6% and was higher among males, (2) waist circumference showed a consistent strong statistical association with the ATP III components, and (3) the diagnostic accuracy analysis of waist circumference showed a sensitivity and a specificity of 72.6% and 68.3% in females and 88% and 85%, in males, respectively.

The prevalence of noncommunicable chronic diseases in Bangladesh has been constantly increasing. For example, a recent report showed that approximately one person in every ten suffer from a multimorbidity (e.g. diabetes, cancer, cardiovascular diseases, stroke and chronic obstructive pulmonary disease).[14] We found that the prevalence of metabolic syndrome was 38.6%. A meta-analysis of metabolic syndrome prevalence in Bangladesh reported a similar figure of 30%.[15] Shen et al. have suggested a stronger association between waist circumference and metabolic syndrome indicators compared to percentage fat.[16] Our results have shown similar findings where waist circumference was significantly associated with all MetS components except for HDL. In addition, among men, waist circumference was better at determining percentage body fat than was BMI.[17] Moreover, waist circumference performed best at identifying each of the 5

Table 2: Associations between ATP III Waist Circumference Criterion and other components.

		ATP III Waist Circumference Criterion				P Value
		Normal		Obese		
		Frequency	Percentage	Frequency	Percentage	
Blood Pressure	Normotensive	306	86.2%	103	75.2%	0.003*
	Hypertensive	49	13.8%	34	24.8%	
High-Density Lipoprotein	Normal	19	5.4%	2	1.5%	0.054
	Low	334	94.6%	135	98.5%	
Triglyceride	Normal	201	56.9%	39	28.5%	< 0.001*
	Elevated	152	43.1%	98	71.5%	
Fasting Blood Sugar	Normal	277	78.0%	81	59.1%	< 0.001*
	Elevated	78	22.0%	56	40.9%	

*Significant values.

ATP III: Adult Treatment Panel III.

Table 3: Associations between WHO's Body Mass Index Criterion and other components.

		WHO's Body Mass Index				P Value
		Normal		Abnormal		
		Frequency	Percentage	Frequency	Percentage	
Blood Pressure	Normotensive	383	83.1%	26	83.9%	0.909
	Hypertensive	78	16.9%	5	16.1%	
High-Density Lipoprotein	Normal	20	4.4%	1	3.2%	0.763
	Low	439	95.6%	30	96.8%	
Triglyceride	Normal	227	49.5%	13	41.9%	0.418
	Elevated	232	50.5%	18	58.1%	
Fasting Blood Sugar	Normal	339	73.5%	19	61.3%	0.138
	Elevated	122	26.5%	12	38.7%	

WHO: World Health Organization.

metabolic syndrome components in either or both genders among HIV patients, as compared with weight, height, BMI, hip circumference, thigh circumference, body adiposity index, waist to hip ratio, and waist to thigh ratio.[18]

Early diagnosis of MetS is imperative to minimize the risk of devastating complications such as cardiovascular disease and type 2 diabetes mellitus and decreasing associated financial burdens.[6] We found that waist circumference could provide a useful and cost-effective tool for metabolic syndrome diagnosis especially in resource-limited countries. It showed a sensitivity and a specificity of 72.6% and 68.3% in females and 88% and 85%, in males, respectively. Other studies have reported findings supporting the diagnostic role of waist circumference.[18-20]

CONCLUSION

The burden of chronic diseases in developing countries has become an increasing problem. Frugal and cost-effective tools for the diagnosis of such diseases could help ease the short- and long-term financial burden associated with them. We have shown that waist circumference could

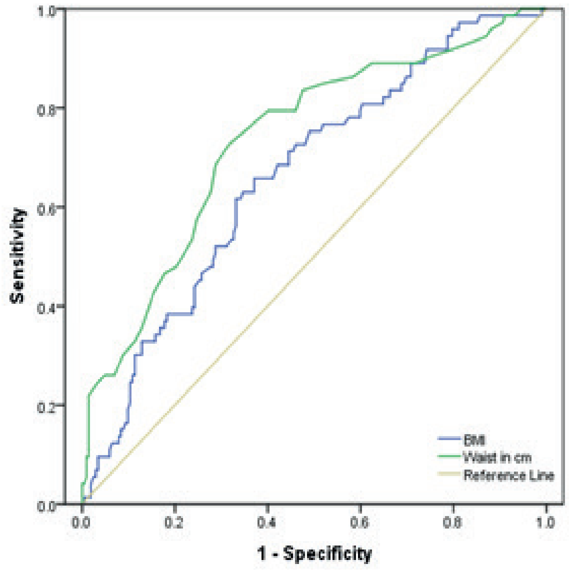

Figure 1. Receiver operating characteristic curve (ROC) for females comparing the performance of Body Mass Index against Waist circumference in detecting metabolic syndrome. (BMI: Body Mass Index, cm: Centimeter).

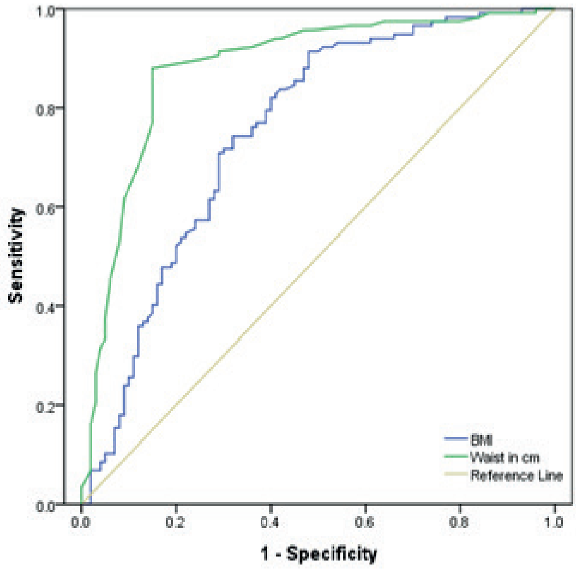

Figure 2. Receiver operating characteristic curve (ROC) for males comparing the performance of Body Mass Index against Waist circumference in detecting metabolic syndrome. (BMI: Body Mass Index, cm: Centimeter).

be highly valuable in predicting MetS. Clinicians ought to use this information in their practice to help use a more cost-efficient alternative in the diagnosis of metabolic syndrome.

Conflict of Interest: We declare no conflict of interest.

Funding Statement: There was no funding source for the study we carried out.

Ethical Approval: Based on secondary dataset, ethical approval was not sought. However, the primary study approved by the Bangladesh Medical Research Council (BMRC), Dhaka, Bangladesh, and Ethical Review Committee of Tokai University Graduate School of Medicine, Japan.

Author's Contribution: AMK and SMB conceptualized and designed the study, AMK and SMB collected data, entered and analyzed the data, AMK, MAK, ACB, and SMB prepared the original manuscript. All the authors read the manuscript, reviewed and finalized the draft.

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