ORIGINAL ARTICLE

# EVALUATION OF SOME PREDICTORS OF METABOLIC SYNDROME IN AN IMPORTANT GROUP OF HEALTH CARE PROVIDERS OF BANGLADESH

SK Baul[1], D Parvin[2], SMR Hossain[3], M Hadiuzzaman[4], FH Mollah[5], MM Hoque[5]

*[1]Dept of Biochemistry, Satkhira Medical College, Satkhira; [2]Dept. of Clinical Biochemistry, NICVD, Dhaka [3]Dept of Microbiology, Sheikh Hasina Medical College, Tangail; [4]Dept of Biochemistry, Sheikh Shayera Khatun Medical College, Gopalgonj; [5]Dept of Biochemistry and Molecular Biology, Bangabandhu Sheik Mujib Medical College, Dhaka*

## ABSTRACT

Metabolic syndrome (MS), a global epidemic, is a cluster of risk factors for CHD, T2DM, stroke and other various medical problems, which affects specially those who lead sedentary and stressful life. Among the health service providers of Bangladesh, doctors are very important group who leads sedentary and mentally stressful life with low physical exercise. The aim was to evaluate WHR (waist-hip ratio), WHtR (waist-height ratio) and TG, HDL-C for their predictive value of MS. In this cross-sectional study, by convenient and purposive sampling technique, 25-55 years aged 500 Bangladeshi doctors (male 334, female 166) were enrolled. The study was carried out in the Department of Biochemistry, BSMMU, Shahbag, Dhaka, Bangladesh. MS was diagnosed by modified NCEP ATP III criteria. Prevalence of MS was measured at 95% CI. Statistical significance was set at $p<0.05$. Prevalence of MS was found 38.8% in total study subjects; that in male and female was 24.6% and 14.2% respectively. Performance tests of predictors were done. WHR was the most sensitive (99.19% male & 98.59% female), TG was the most specific (94.79% male & 62.11% female) & accurate (78.1% male & 68.1% female) predictor. ROC curves of predictors were produced and all were found good (AUC > 0.6) for their predictive value of MS; WHtR was revealed better than WHR as an index for MS (AUC 0.667 vs. 0.652 in male; 0.706 vs. 0.681 in female). It can be concluded, the prevalence of MS is very high among the doctors of Bangladesh; WHtR can be used as a good and relevant index for MS.

**Key Words:** Metabolic syndromes, NCEP ATP III, WHR, WHtR, TG, HDL-C, ROC curve.

## Introduction

Metabolic syndrome (MS), also termed as Syndrome X or Insulin Resistance Syndrome, is a cluster of widely prevalent multi-factorial medical disorders that increases the risk of developing cardiovascular disease and diabetes. The prevalence of MS varies considerably worldwide. In line with the rising prevalence of obesity, the metabolic syndrome is also increasing in developing countries. The situation appears to be similar in South Asian countries including Bangladesh. MS is considered to be a pre-diabetic state leading to DM2; beyond cardio-

vascular disease (CVD) and DM2, individuals with MS are also susceptible to other life threatening medical problems like polycystic ovarian syndrome, fatty liver, cholesterol gallstones, asthma, sleep disturbances and some forms of cancer[1-7].

Central adiposity is a key feature of the metabolic syndrome, reflecting the fact that the prevalence of MS is driven by the strong relationship between waist circumference and increasing adiposity. However, patients of normal body weight may also be insulin-resistant and have the syndrome. Physical inactivity is an important factor of CVD events related mortality.

Many components of MS are associated with the sedentary lifestyle including increased adipose tissue (predominantly central), reduced HDL-C and a trend toward increased triacylglycerol, blood pressure and fasting serum glucose in genetically susceptible person.

Practicing physicians involved in clinical care are important segment of public health care delivery system.

Illnesses among doctors include all the expected categories for the general population at large such as cardiovascular diseases, respiratory disorders, musculo-skeletal disorders, cancer and psychiatric illness[8-21]. In India, doctors are found to have high prevalence of metabolic disorders that reflect negative attitude to care of their health. Diagnosis of metabolic syndrome was made using the modified NCEP ATP III criteria to suit Indian population[11]. As MS can be prevented easily, it is imperative to identify individuals with metabolic syndrome early so that life style interventions and treatment can be started to prevent the development of diabetes and/or cardiovascular diseases.

There are different sets of criteria for diagnosis of MS. The first formal definition of the MS was put forward in 1998 by the World Health Organization (WHO). This report was finalized in 1999 for individual having insulin resistance with any two of hypertension, dyslipidemia, central obesity and high urinary albumin excretion rate or high urinary albumin:creatinine ratio[5]. The European Group for the Study of Insulin Resistance (EGIR) and International Diabetes Federation (IDF) published a separate set of criteria thereafter[22,23]. In 2001, the National Cholesterol Education Program Adult Treatment Panel III (NCEP: ATP III, 2001)[4] published a new set of criteria based on common clinical measurements: Waist circumference (WC), blood lipids, blood pressure, and fasting glucose[12]. There are many criteria present for diagnosing MS. But the aim of this study was to evaluate WC, TG and LDH-C as their predictive efficiency to diagnose MS. Though not included in any persisting sets of diagnostic criteria, a new anthropometric parameter WHtR (waist to height ratio) was taken in our study to evaluate also as a predictor of MS. Because, WHtR was tested and found effective in many other studies[21].

**Materials and Method**

This Cross sectional study was done at the Department of Biochemistry & Molecular Biology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh during the period of July 2009 to June 2010 by purposive and convenient sampling technique maintaining Inclusion and Exclusion Criteria strictly. A data collection sheet was prepared for this purpose which included all the variables of interest.

Metabolic Syndrome (MS) was defined according to modified NCEP-ATP III, 2001as-presence of $\geqslant 3$ of Central obesity: Waist circumference $> 90 \geqslant$ cm (male), $> 80 \geqslant$ cm (female), Dyslipidemia: S. TAG 150 mg/dl, S. HDL-C $< 40$ mg/dl (male), $< 50$ mg/dl (female), Blood pressure: (BP): 130/85 mmHg, Fasting plasma glucose: $\geqslant 6.1$mmol/L.

Ethical clearance for the study was taken from the department of Biochemistry and central ethical committee, BSMMU. All the study subjects were thoroughly appraised about the nature, purpose, implications, procedure, benefits and risk of the study. Every study subject was assured about privacy and confidentiality; and about adequate free treatment of any risk developed during this study. Interest of the subjects was not compromised to safeguard their rights and health. Subjects were assured about their freedom to withdraw themselves from the study any time. Finally informed written consent of all study subjects were taken.

Doctors of both sexes having minimum MBBS degree were enrolled from urban and rural area in the study. Anthropometric measurements including height, weight, waist circumference and hip circumference were taken in all study subjects and WHR, WHtR & BMI were calculated. Systolic and diastolic blood pressure was recorded in sitting position. Then with full aseptic precaution, fasting blood samples were collected from them to estimate the serum glucose, triacylglycerol (TAG), high density lipoprotein cholesterol (HDL-C) with standard methods and procedures, and were compiled for analysis. Finally, prevalence of metabolic syndrome (MS) was measured among the doctors using modified NCEP-ATP III criteria. The prevalence of MS was compared in male and female doctors. WHR, WHtR, TAG and HDL-C were measured as predictors of MS.

Data was analyzed by using SPSS version 14.0 for windows. Prevalence of metabolic syndrome in total study subjects as well as in male and female were determined at 95% confidence interval (CI) based on the modified NCEP-ATP III criteria. Statistical significance was set at $p < 0.05$. Performance test of all predictors (WHR, WHtR, TAG and HDL-C) were done for detection of MS and ROC curve was also created to evaluate the weightage of predictors in detection of MS, specially to compare WHR with WHtR.

## Results and Observation

Of total 500 study subjects, male doctors were 334 (66.8%) and female doctors were 166 (33.2%). Age range of the study subjects was 25 to 55 years with mean age (mean±SD) 38.7±8.4 yrs in total study subjects, 39.7±8.9 yrs in male doctors and 36.7±7.1 yrs in female doctors. Mean height (cm) was 164.2±3.0, mean body weight (kg) was 67.8±5.2, mean waist circumference (cm) was 92.7±5.3, and mean hip circumference (cm) 92.7±5.3 was found in total study subjects. Mean WHR of total study subjects as well as of male and female were 1.0±0.1. Mean WHtR of total study subjects as well as of male and female were 0.6±0.0. Mean BMI ($kg/m^2$) of total study subjects was 25.4±2.2. Mean TAG (mg/dl) was 190.4±95.6 for total study subjects; 195.7±91.9 and 179.8±102.3 were for male and female respectively, HDL-C (mg/dl) was 41.9±9.3 for total study subjects; 40.4±7.9 and 44.7±11.0 were for male and female respectively. Out of 334 males, 178 had waist circumference > 90 cm and 137 females out of 166 had waist circumference > 80 cm. TAG > 150 mg/dl found in 102 male and 90 female doctors. HDL-C < 40 mg/dl was found in 152 male and HDL < 50 mg/dl was found in 129 female doctors respectively. 194 had metabolic syndrome, of which 123 were male and 71 were female (Table- I & II).

**Table-I:** Baseline characteristics of study population

| Parameter | Total study subjects n=500 | Male n=334 |
|---|---|---|
| Age (years) distribution of study subjects | | |
| Mean age (m±SD) | 38.7±8.4 | 39.7±8.9 |
| **Anthropometric indices (mean±SD) of study subjects** | | |
| Height (cm) | 164.2±3.0 | 164.5±2.8 |
| Weight (kg) | 67.8±5.2 | 67.9±5.1 |
| WC (cm) | 91.0±5.3 | 91.1±4.3 |
| HC (cm) | 92.7±5.3 | 92.6±5.3 |
| WHR | 1.0±0.1 | 1.0±0.1 |
| WHtR | 0.6±0.0 | 0.6±0.0 |
| BMI | 25.4±2.2 | 25.3±2.2 |
| **Biochemical and other indices (mean±SD) of study subjects** | | |
| SBP (mmHg) | 129.0±9.4 | 130.1±8.9 |
| DBP (mmHg) | 75.6±5.4 | 76.2±5.1 |
| FSG (mmol/L) | 5.8±1.0 | 5.9±1.1 |
| TAG (mg/dl) | 190.4±95.6 | 195.7±91.9 |
| HDL-C (mg/dl) | 41.9±9.3 | 40.4±7.9 |

WC: Waist circumference, HC: Hip circumference, WHR: Waist to hip ratio, WHtR: Waist to height ratio, BMI: Body mass index. SBP: Systolic blood pressure, DBP: Diastolic blood pressure, FSG: Fasting serum glucose, TAG: Triacylglycerol, HDL-C: High density lipoprotein cholesterol.

**Table-II:** Distribution of the components of MS among the study subjects

| Parameters | Total (N= 500) | Male (n= 334) |
|---|---|---|
| WC (M->90 cm, F->80 cm) | 315 | 178 |
| **BP** | | |
| SBP (>130 mmHg) | 222 | 156 |
| DBP (>85 mmHg) | 41 | 34 |
| FSG (>6.1 mmol/L) | 141 | 108 |
| TAG (>150 mg/dl) | 192 | 102 |
| HDL-C (M<40 mg/dl,F<50 mg/dl) | 281 | 152 |

WC: Waist circumference, BP: Blood pressure, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, FSG: Fasting serum glucose, TAG: Triacylglycerol, HDL-C: High density lipoprotein cholesterol.

The prevalence of MS (95% CI) among the total population was found to be 38.8% and that in male and female doctors were 24.6% and 14.2% respectively.

Performance test of WHR, WHtR, HDL-C and TAG were done for prediction of MS and is summarized in Table-III.

**Table-III:** Summary of the performance tests of WHR, WHtR, TAG and HDL for prediction of MS

| Performance tool | Predictors | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | WHR | | WHtR | | | TAG | | | HDL-C | |
| | M | F | M | F | T | M | F | T | M | F |
| SEN | 99.2 | 98.6 | 96.0 | 88.7 | 93.3 | 74.0 | 76.1 | 74.7 | 67.5 | 93.0 |
| SPE | 07.1 | 03.2 | 08.1 | 11.6 | 09.2 | 94.8 | 62.1 | 84.6 | 67.3 | 33.7 |
| PPV | 38.4 | 43.2 | 37.3 | 42.9 | 39.4 | 89.2 | 60.0 | 75.5 | 54.6 | 51.2 |
| NPV | 93.8 | 75.0 | 77.3 | 57.9 | 68.3 | 86.2 | 77.6 | 84.1 | 78.0 | 86.5 |
| Accuracy | 41.0 | 44.0 | 40.4 | 44.6 | 01.0 | 87.1 | 68.1 | 04.9 | 67.4 | 59.0 |
| LR+ | 01.1 | 01.0 | 01.0 | 01.0 | 00.7 | 14.2 | 02.0 | 00.3 | 02.1 | 01.4 |
| LR- | 00.1 | 00.5 | 00.5 | 01.0 | 01.8 | 00.3 | 00.4 | 80.8 | 00.5 | 00.2 |

WHR= Waist-Hip Ratio, WHtR= Waist-Height Ratio, TAG= Triacylglycerol,
HDL-C= High Density Lipoprotein cholesterol, MS= Metabolic Syndrome, M=Male, F=Female, T=Total study subject
SEN: Sensitivity, SPE: Specificity, PPV: Positive Predictive Value, NPV: Negative Predictive Value, LR+: Positive Liklihood Ratio, LR-: Negative Liklihood Ratio

Figure-1&2 show ROC curve of the performance of WHtR and TAG as predictors of MS in total population (both sex). ROC curve of the performance of WHR, WHtR, TAG and HDL-C as predictors of MS in male and female were shown in Figure-3-6 & 7-10 respectively.

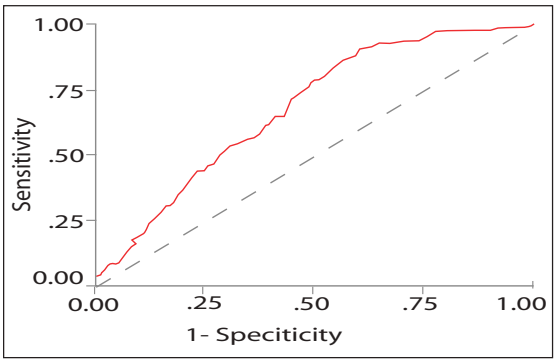


**Figure-1:** ROC curve for WHtR as predictor for detection of MS in total population (both sex).

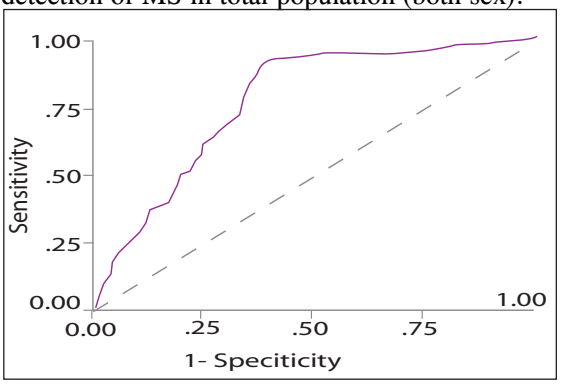


**Figure-2:** ROC curve for TAG as predictor for detection of MS in total population (both sex).

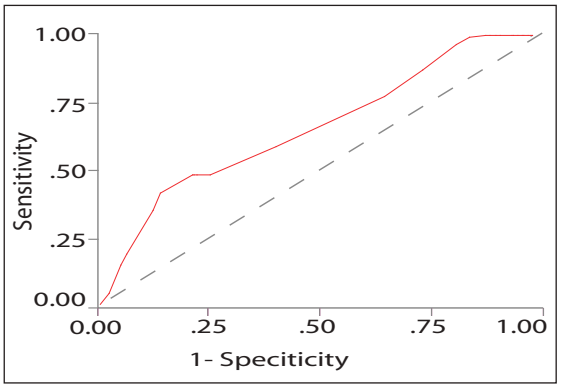


**Figure-3:** ROC curve for WHR as predictor for detection of MS in male.

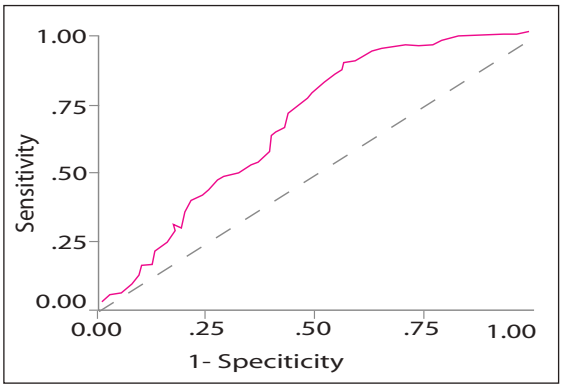


**Figure-4:** ROC curve for WHtR as predictor for detection of MS in male.

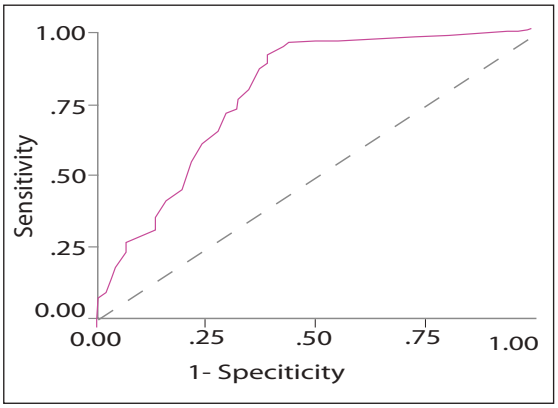


**Figure-5:** ROC curve for TAG as predictor for detection of MS in male.

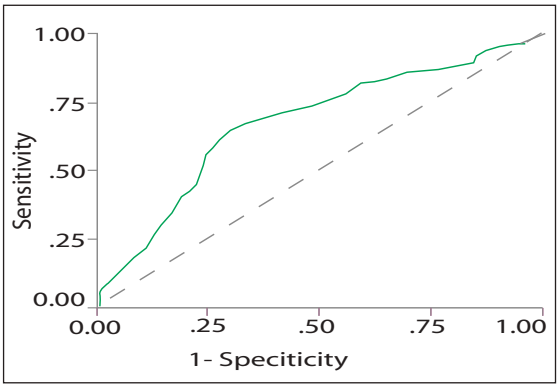


**Figure-6:** ROC curve for HDL-C as predictor for detection of MS in male.

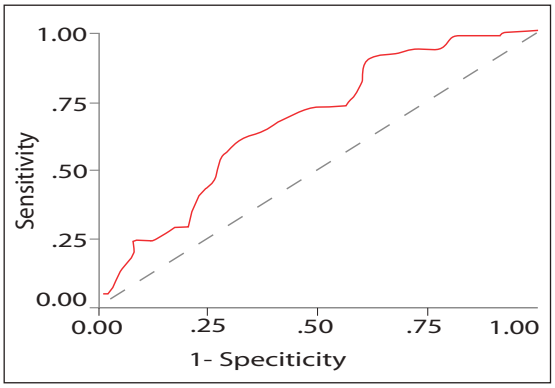


**Figure-7:** ROC curve for WHR as predictor for detection of MS in female.

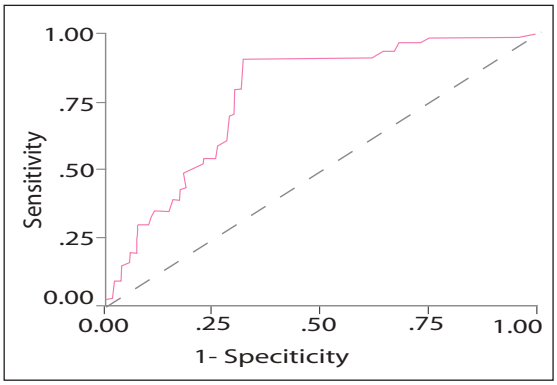


**Figure-9:** ROC curve for TAG as predictor for detection of MS in female.

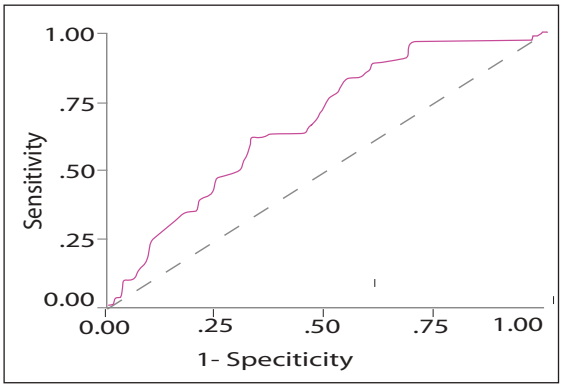


**Figure-8:** ROC curve for WHtR as predictor for detection of MS in female.

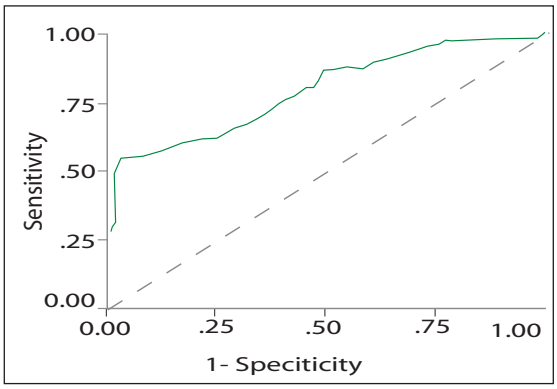


**Figure-10:** ROC curve for HDL-C as predictor for detection of MS in female.

Table-IV shows area under the ROC curve (AUC) representing the weightage of WHR, WHtR, TAG and HDL-C as predictors in male, female and in total population for detection of MS. In male the area under the curve for WHR, WHtR, TAG and HDL-C were 0.652, 0.667, 0.773 and 0.670; whereas in female these were 0.681, 0.706, 0.775 and 0.789 respectively. AUC for WHtR was 0.682 and that for TAG was 0.768 in total population.

**Table-IV:** Area under the Curves of WHR, WHtR, TAG and HDL-C in male, female and total population (both sex)

| | Male | | Female | | Total population (both sex) | |
|---|---|---|---|---|---|---|
| **Predictors** | **AUC** | **P-value** | **AUC** | **P-value** | **AUC** | **P-value** |
| WHR | 0.652 (0.6 - 0.7) | .000 | 0.681 (0.6 - 0.8) | .000 | | |
| WHtR | 0.667 (0.6 - 0.7) | .000 | 0.706 (0.6 - 0.8) | .000 | 0.682 (0.6 - 0.7) | .000 |
| TAG | 0.773 (0.7 - 0.8) | 000 | 0.775 (0.7 - 0.8) | .000 | 0.768 (0.7 - 0.8) | .000 |
| HDL-C | 0.670 (0.6 - 0.7) | .000 | 0.789 (0.7 - 0.9) | .000 | | |

Parenthesis shows 95% CI

**Discussion**

The doctors are members of affluent society. They usually live sedentary life. But they have experience of different types of physical and mental stress due to their duties. As our participants are doctors they are comparable with persons of same profession and other sedentary workers. Our finding (prevalence of MS 38.8%) was supported by Ramachadran et al (2008). They conducted a study among 2499 Indian physician of mean age 39.0±9.0 yrs and found the prevalence of metabolic syndrome 29.0%. They concluded that in India, doctors had high prevalence of metabolic syndrome[11].

The findings of our study were consistent with the previous observations of high prevalence of metabolic syndrome.

The prevalence rates are also high in general population of Venezuela (31.2%) and urban Brazil (25.4%)[24-26], in US population & Mexican Americans[6], in the Sindh province of Pakistan[7]. These also supported our findings.

In this cross sectional study, our aim was to determine the predictive value of WHR, WHtR, TAG and HDL-C for diagnosis of metabolic syndrome among them.

In our study, we have calculated SEN, SPE, PPV, NPV, LR+, LR- & Accuracy of WHR, WHtR, TAG & HDL-C as predictors of MS. WHR showed SEN 99.2%, SPE 07.1% for male & SEN 98.6%, SPE 03.2% for female; WHtR showed SEN 96.0% & SPE 08.1% for male, SEN 88.7% & SPE 11.6% for female, SEN 93.3% & SPE 09.2% for total study subjects; TAG showed SEN 74.0% & SPE 94.8% for male, SEN 76.1% & SPE 62.1% for female, SEN 74.7% & SPE 84.6% for total study subjects; and HDL-C showed SEN 67.5%, SPE 67.3% for male & SEN 93.0%, SPE 33.7% for female. Dhanaraj et al (2008) found TAG in the overall population SEN 73.3%, SPE 77.8%. In that study HDL-C for men showed SEN 55.8%, SPE 90.2% and HDL-C for women showed SEN 87.0%, SPE 87.5%; WC for men showed SEN 67.3%, SPE 72.3% and WC for women showed SEN 73.5%, SPE 70.6%27. Another study was carried out in the department of Biochemistry, Dhaka Medical College, Dhaka in 2010 by Khanam et al. Their statistical analysis of TAG showed SEN 74.3%, SPE 54.7%; HDL-C for male showed SEN 66.7%, SPE 23.3% and for female showed SEN 66.7%, SPE 40.0%. In their study WHR for male showed SEN 100.0%, SPE 10.0% and for female WHR showed SEN 100.0%28. But, in their study Mombelli et al found SEN 92.0%, SPE 28.1% in male and SEN 87.4%, SPE 37.6% in female for WHtR. In our study, the most sensitive predictor for male and female was found WHR (99.19% & 98.59%) followed by WHtR (95.93%), TAG (73.98%) & HDL-C (67.48%) in case of male and HDL-C (92.96%), WHtR (88.73%) & TAG (76.06%) in case of female. On the other hand, most specific predictor for both male and female was TAG (94.79% & 62.11%) which was followed by HDL-C (67.30% & 33.68%), WHtR (08.06% & 11.58%) and WHR (07.11% & 03.16%). ROC curves of WHR, WHtR, TAG and HDL-C were produced to see the area under the curve (AUC) and to evaluate their predictive value of metabolic syndrome. AUC of WHR were 0.652 (male) & 0.0681 (female), WHtR 0.667 (male), 0.706 (female)& 0.682 (both sex); TAG 0.773 (male), 0.775(female), 0.768 (both sex) and HDL-C 0.670 (male), 0.789 (female). In one study, according to modified NCEP ATP III criteria, Dhanaraj et al observed AUC of WHR (men 0.671, women 0.691), TAG (overall 0.777, men 0.796, women 0.770) and HDL-C (men 0.688, women 0.885). They did not evaluate WHtR as a predictor. In 2009, Mombelli et al carried a study among Italian

population and he selected WHtR as a predictor of MS and found AUC 0.713 in male and 0.701 in female. In our study all those indices were found good (AUC > 0.5) for their predictive value of metabolic syndrome; and it was also revealed that WHtR was better than WHR as an index for metabolic syndrome in all (both sex, male and female) which is in agreement with other previous studies[21,29]. Mombelli et al. found WHtR ⩾ 0.5 in all, though Weili et al. found lower threshold for WHtR, but it was in children and adolescents (0.485 in boys, 0.475 in girls)[21,27,29].

WHR and WHtR are not the diagnostic criteria for diagnosis of MS according to modified NCEP ATP III. WHR is a criterion of modified WHO. But we have taken WHR and WHtR as the predictors of MS, because there is variation of value of WC in different diagnostic groups as well as in different sex and ethnic groups. BMI is clearly dependent on the height of the individual, but does not provide much information on the presence of abdominal fat. Greater BMI indicates general obesity and larger WC indicates central obesity, whereas WHR indicates excessive fat on the upper part of the body or abdomen. So WHR & WHtR can play an important role in diagnosis/ detection of MS in non-obese MS individuals in comparison with the non-obese without MS individuals[27]. WC is also a determinant, but different WC thresholds for the identification of the metabolic syndrome have been reported. Furthermore, determination of an enlarged WC may prove technically problematic and frequently with poor reliability. When evaluating different WC cutoffs in large populations of European ancestry (by using NCEP ATP III vs. IDF criteria), the prevalence of metabolic syndrome was essentially identical, and cardiovascular disease risk factors status did not vary substantially when subjects were divided on the basis of WC or BMI. The advantage of the WHtR is the opportunity of using a common threshold for different populations. A threshold value of WHtR 0.5 may, in fact provide an optimal common anthropometric index[29]. In our study it was proved that according to performance tests, WHtR was significantly same with WHR; and according to AUC of ROC curve of them WHtR was better than WRH.

It can be apparently concluded that, the prevalence of metabolic syndrome is alarmingly high among the doctors of Bangladesh. All the indices (WHR, WHtR, TAG, HDL-C) were found good for their predictive value of metabolic syndrome; and WHtR was found better than WHR as an index for metabolic syndrome.

It can be recomended that doctors as well as people of other sectors of the society who live sedentary and stressful life should be more aware of their health. WHR and WHtR can be used as easy and effective index for diagnosing MS. This study should be done in a large scale for more accuracy and further evaluation.

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