Body Fat Distribution and Metabolic Syndrome in Bangladeshi Urban Adults

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Abstract

Background: Metabolic syndrome patients are having increased risk of developing into cardiovascular diseases & diabetes in their later life.

Objective: To determine the risk factors of metabolic syndrome and to identify the most potential risk factor that helps in early diagnosis of metabolic syndrome and prevention of Coronary Heart Disease (CHD), diabetes by early intervention.

Methods: A case control study was carried out during March-December 2011. The purposive sampling method with face to face interview using questionnaire, measurement tools were applied among 48 diagnosed metabolic syndrome patients in national Heart Foundation Hospital, Dhaka & 47 healthy controls in Shaheed Shaikh Abu Naser Hospital, Khulna in the study. Metabolic syndrome patients were confirmed according to NCEP ATP III criteria. Body fat distribution was measured and waist to height ratio (WHR). Body mass index (BMI), waist to hip ratio (WHR) was used as the markers of body fat distribution. Unadjusted odds ratio was generated for all the variables with 95% confidence interval and only significant factors were considered as candidate for multivariate analysis. A binary logistic regression model was generated to assess risk factor of metabolic syndrome in comparison to non metabolic syndrome control adjusting for possible confounders. The statistical analysis was performed with SPSS 16 version.

Results: Among the participants significant increased risk of metabolic syndrome was evident in increased WHR (OR 420.3, 6.3 - 27664.0), increased WHR (OR 155.5, 3.8 - 6336.9), increased BMI (OR 52.1, 2.5 - 1110.0), increased age > 50 years (OR 44.0, 1.5 - 1225.8), doing low level of physical activity (PAL) (OR 35.4, 1.5 - 786.7) and inadequate fruits and vegetables in diet (OR 576.8, 7.0 - 47185.0). Among the anthropometric risk factors WHR appeared as an independent and highest risk for metabolic syndrome with an odds ratio of 420.3 which was statistically significant. Area under the receiver operating characteristics (ROC) curve was 0.977 and was statistically significant.

Conclusion: Not only BMI also WHR and WHR were strongly and positively associated with metabolic syndrome among Bangladeshi urban adults and they are the markers of metabolic syndrome diagnosis. The study recommended that WHR, BMI, WHR as predictors should be routinely examined in metabolic syndrome diagnosis to prevent cardiovascular diseases and diabetes in the later life.

Key Words: BMI, WHR, WHR, PAL, SFT.

Introduction

Metabolic syndrome is a group of conditions that put a person at risk for heart diseases and diabetes. These conditions are: high blood pressure, high blood sugar levels, high levels of triglycerides (TG), low levels of high density lipoprotein (HDL), too much fat around the waist. When at least any three of the above five criteria are present then it is called metabolic syndrome and the risk of cardiovascular diseases and diabetes is increased by 1.5 to 2 folds. The metabolic syndrome has been proposed as an indicator of cardiovascular disease risk, type 2 diabetes.¹ Beyond CVD and type 2 diabetes, individuals with metabolic syndrome are susceptible to other conditions, notably polycystic ovary syndrome, fatty liver, gallstones, asthma, sleep disturbances, and some forms of cancer. In Bangladesh around 12.5% of all deaths are caused due to various types of cardiovascular diseases. The prevalence of ischemic heart diseases among the rural population is around 3.4%, prevalence of hypertension to be 17.9% which is increased in times.² In urban people prevalence of hypertension is more particularly in the slum population, have even higher prevalence (37.5% in men and 24.5% in women).³,⁴ 1.1millions people died from diabetes in the year 2005.² Another report by ICDDR, B suggests that in urban area the prevalence of diabetes is just double (10%) in rural area (5%).⁵ According to the ICDDR, B the risk of these diseases are increasing with urbanization. In general, the International Diabetes Federation estimates that one-quarter of the world's adult population has Metabolic Syndrome. Metabolic syndrome was found to be frequent (2.9%) in Bangladeshi rural women.⁶ Increasing prevalence of obesity is also evident in our country and that is 8.9%.² Metabolic syndrome needed to be studied more among the urban adults of Bangladesh because of their mechanical life style and more proneness to become obese.
Methodology

A case control study was carried out during March-December 2011. A total of 46 cases and 47 controls to detect two folds or higher odds ratio, with the prevalence of obesity 0.098 among the general population at 80% power and at a case control ratio of one to two instead of a total of 34 cases and 68 controls due to the resource constraints. Cases were the consecutive hypertensive patients having at least any two metabolic syndrome criteria as defined by National cholesterol education programme Adult treatment panel (NCEP ATP III) (like increased TG level, increased blood sugar level or frank diabetes, decreased HDL level, increased waist circumference) reported in hypertensive department of NHFH, Dhaka. Controls were the patients reported in the out patient department of Sheikh Sirajul Islam Medical College Hospital, Khulna for any minor ailment, diagnosed as healthy controls free of metabolic syndrome or any other diseases later on by laboratory tests. Controls were selected purposively matched for age, sex and residence from Sheikh Sirajul Islam Medical College Hospital, Khulna.

Data was collected with the semi-structured interview questionnaire, through face to face interview after taking informed consent from the participants. Interview was taken in patients coming regularly in the hospital departments for hypertension and controls (healthy people) previously diagnosed correctly after biochemical testing of their blood for sugar and triglyceride. Information regarding risk factors and behaviors were inquired taking effort to minimize the recall bias. The protocol received ethical clearance from National heart foundation and Sheikh Sirajul Islam Medical College Hospital. Blood pressure was measured through sphygmomanometer at sitting position thrice after taking 30 min. rest and average B.P was taken. Body mass index was measured by measuring height and weight by standard bathroom scale. Body mass index was calculated as kg/m2. Waist circumference was measured by measuring tape dividing folds of clothing at the site one inch above the umbilicus. Hip circumference was measured at the maximum protrusion of hip. Waist to hip ratio (WHR) was calculated. Triceps skin fold thickness was measured by slide caliper.

After data collection variables were entered in SPSS 16. Data was checked for out of range errors, consistency etc and screened and cleaned for any missing value and discrepancies. Then variables were sorted as categorical and numeric. Then proportion of each of the risk factors was compared in between metabolic and non-metabolic syndrome groups; association was sought for socio demographic variables, Behavioral factors, Family diseases factors, Anthropometric factors. Unadjusted odds ratio was estimated for all the variables with 95% confidence interval and only significant factors were considered as candidate for multivariate analysis. A binary logistic regression model was generated to assess risk factor of metabolic syndrome in comparison to non-metabolic syndrome control adjusting for possible confounders.

Data was presented in the form of tables and ROC curve.

Results

A total 95 subjects were interviewed for the case-control study. Average age of the case was 46.44 years and control was 42.87 years and 54.7% were men. All the participants were from urban residence. Then proportion of each of the risk factors was compared in between metabolic syndrome and non metabolic syndrome groups; association was sought for socio demographic variables, Behavioral factors, Family diseases factors, Anthropometric factors. Unadjusted odds ratio was generated for all the variables with 95% confidence interval. Among the variables monthly family income, Ever use of tobacco, Body mass index, Waist to height ratio found statistically significant during univariate analysis and were considered as candidate for multivariate analysis & metabolic syndrome risk model was developed.

Table - I : Metabolic Syndrome Risk

<table>
<thead>
<tr>
<th>Variable</th>
<th>Case (%), N</th>
<th>Control (%), N</th>
<th>OR (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHR Increased</td>
<td>46 (55.8)</td>
<td>25 (53.2)</td>
<td>4.03 (3.82, 7.66)</td>
<td>0.005*</td>
</tr>
<tr>
<td>WHR Increased</td>
<td>44 (91.7)</td>
<td>33 (70.2)</td>
<td>155.5 (53.8, 333.9)</td>
<td>0.008*</td>
</tr>
<tr>
<td>BMI (Increased)</td>
<td>33 (68.8)</td>
<td>22 (49.2)</td>
<td>53.1 (25.4, 111.3)</td>
<td>0.01*</td>
</tr>
<tr>
<td>Increased Age (&gt;50yrs)</td>
<td>25 (57.1)</td>
<td>13 (27.7)</td>
<td>4.4 (1.5, 12.2)</td>
<td>0.02*</td>
</tr>
<tr>
<td>Low PAL</td>
<td>35 (71.9)</td>
<td>25 (53.2)</td>
<td>3.59 (1.5, 8.88)</td>
<td>0.02*</td>
</tr>
<tr>
<td>Inadequate fruits &amp; vegetables intake</td>
<td>42 (87.5)</td>
<td>25 (53.2)</td>
<td>576.6 (7.0, 478.15)</td>
<td>0.005*</td>
</tr>
<tr>
<td>Positive F/H of CHD</td>
<td>23 (47.9)</td>
<td>10 (21.3)</td>
<td>0.7 (0.0, 0.6)</td>
<td>0.83</td>
</tr>
<tr>
<td>Positive F/H of HTN</td>
<td>24 (50.0)</td>
<td>13 (27.7)</td>
<td>6.0 (0.3, 11.8)</td>
<td>0.18</td>
</tr>
<tr>
<td>Family income (&gt;20,000 tk)</td>
<td>13 (27.0)</td>
<td>19 (40.4)</td>
<td>0.2 (0.0, 2.8)</td>
<td>0.25</td>
</tr>
<tr>
<td>Education level (S.S.C. &amp; I litreate)</td>
<td>33 (68.8)</td>
<td>25 (53.2)</td>
<td>2.0 (0.1, 24.2)</td>
<td>0.58</td>
</tr>
<tr>
<td>Tobacco ever smoker</td>
<td>25 (54.1)</td>
<td>37 (78.7)</td>
<td>0.0 (0.0, 1.0)</td>
<td>0.05</td>
</tr>
<tr>
<td>Sex (female)</td>
<td>25 (54.1)</td>
<td>22 (46.8)</td>
<td>1.0 (0.0, 1.5)</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Nagelkerke R Square 0.843

Metabolic syndrome risk model

Metabolic syndrome risk factors had been assessed through binary logistic regression model. The model explained 84% of the variability in the metabolic syndrome status.

Increased BMI, increased WHR, increased WHtR, inadequate fruit and vegetable intake, low physical activity level (PAL), increased age (>50 years) appeared as significant predictors of metabolic syndrome in comparison with referent healthy adults.
control. Significant increased risk of metabolic syndrome was evident in inadequate fruit and vegetable intake (OR 576.8, 7.0 - 47185.0), low level of physical activity (OR 35.4, 1.5 - 788.7), increased age >50 years (OR 44.0, 1.5 - 1225.8). Anthropometric factors like WHR was statistically significant risk with the highest OR (420.37, 6.3-27664.0). Other anthropometric factors like WHR (OR 155.5, 3.81-6338.9) and BMI (OR 53.1, 2.5 -1119.0) were also statistically significant increased risk for metabolic syndrome. However increased skin fold thickness (SFT) was not appeared as a statistically significant risk for metabolic syndrome. On the other hand F/H of HTN, F/H of CHD, tobacco use, table salt intake, education level, income and sex factors were not significant risks or predictors of metabolic syndrome in the current study. (Table-I)

Table-II : Correlation of WHR, BMI, SFT, WHR with each other

<table>
<thead>
<tr>
<th>Step</th>
<th>Constant</th>
<th>WHR_(1)</th>
<th>BMI_gr(1)</th>
<th>SFT</th>
<th>WHR(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1 Constant</td>
<td>1.000</td>
<td>1.000</td>
<td>1.000</td>
<td>.230</td>
<td>.744</td>
</tr>
<tr>
<td>WHR_(1)</td>
<td>.627</td>
<td>.682</td>
<td>.682</td>
<td>.325</td>
<td></td>
</tr>
<tr>
<td>BMI_gr(1)</td>
<td>1.000</td>
<td>.408</td>
<td>.474</td>
<td>.296</td>
<td></td>
</tr>
<tr>
<td>SFT</td>
<td>.230</td>
<td>.1000</td>
<td>.073</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WHR(1)</td>
<td>.325</td>
<td>.073</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Correlation matrix : It showed that WHR and BMI correlated with each other (0.5). So either WHR or BMI could be used for the same purpose. WHR (0.3 with WHR and 0.2 with BMI) was an independent predictor and can be used independently for metabolic syndrome diagnosis. SFT (0.4) was also an independent predictor but it was not statistically significant. (Table II)

Discussion

In the current study increased BMI and increased WHR, increased WHR, low level of physical activity, having inadequate fruits and vegetable in diet and increased age (>50 years) appeared as significant risk factors of metabolic syndrome in general. The ROC curve (Fig. I) can generate risks up to 97.7% and that was statistically significant.

Metabolic syndrome Risk

The correlation matrix (Table-II) in the current study showed that WHR was an independent and better marker. BMI and WHR both acted as the same predictors of metabolic syndrome. SFT was also an independent predictor of metabolic syndrome but it was statistically non-significant.

This finding of current study was somehow similar to the study by Ashwell and Hsieh who suggested global use of WHR as a rapid screening tool for cardio metabolic risk factors with this simple public health message: "Keep your waist circumference to less than half your height." Following six reasons given by Ashwell and Hsieh to defend the superiority of WHR over other anthropometric indices were: WHR is more sensitive than BMI as an early warning of health risks, WHR is cheaper and easier to measure and calculate than BMI, a cut-off point of WHR 0.5 indicates increased risk for man and woman, WHR 0.50 is also for different ethnic groups, WHR boundary values can be converted into a consumer-friendly chart, WHR may allow the same boundary values for children and adults. In the current study increased WHR (0.50) in both sexes appeared as a risk factor with an OR of 420.37 which was the highest of all anthropometric factors in the model.

BMI can diagnose metabolic syndrome up to certain limit even in slightly overweight condition than Caucasians as shown by MC. Keigue. et al. However in our study we found WHR (a proxy to central fat measurement) had diagnosed metabolic syndrome most accurately with the OR of 420.3.

MC. Keigue, et al. stated that waist/hip circumference ratios were higher in South Asians than in Europeans of similar body mass index due to their pattern of body fat distribution. South Asians had more waist circumference than hip circumference. They confirmed the existence of an insulin resistance syndrome, prevalent in South Asian populations with increased WHR. Current study also unveiled this fact that increased WHR irrespective of sex appeared as a risk factor of metabolic syndrome with an OR of 155.5.

Conversely, St. Pierre, et al found normal-weight men with four or more features of the insulin resistance syndrome had a three-fold increase in the risk of ischemic heart disease. The researchers concluded that BMI alone poorly reflects the risk of ischemic heart disease associated with the features of insulin resistance syndrome. Current study exactly unveiled the same fact that central adiposity was more irrespective of the heights of the cases and the hip circumference was also more in cases as well. Thus the study unveiled WHR as well...
as WHR were more reliable risks of metabolic syndrome along with BMI.

The current study showed having history of inadequate fruits and vegetables intake was a risk factor of metabolic syndrome with an OR of 5.768 and increased age also appeared as a risk for metabolic syndrome.

People in urban area are likely to live a very mechanical life. With the urbanization people are used to less physical activity. Leisure time physical activity is quite absent from their daily life because of lack of time. Lifestyle factors alone or modulated by inherited factors appear to play an important role because obesity and dyslipidemia become worse with urbanization and migration as stated by Anoop Misra et al. This urbanization reflected in our study too. As this current study was among urban population, low physical activity level appeared as significant risk against metabolic syndrome with an OR of 3.54. This was similar to findings by studies on Bangladeshi immigrants to the U.K. by McKeigue et al. showing the high prevalence of metabolic syndrome occurred due to the fact that a large proportion (65%) of women had low HDL cholesterol because of unfavorable environmental triggers such as stress, physical inactivity, and smoking. Current study was also similar to the study findings by Zaman et al. showing relatively low (3%) prevalence of metabolic syndrome due to sufficient physical activity protecting the rural women of Bangladesh.

Tobacco use, Table salt intake, Family income (>20000), education level S.S.C or illiteracy, positive family history of CHD, positive family history of HTN, sex (female) were not found as statistically significant risks of metabolic syndrome in the current study.

On the contrary to the findings in the article by La Moreno et al. SFT of triceps was not found as a risk of metabolic syndrome.11 This might be due to the fact that all four body sites (Biceps, Triceps, Sub scapular, Abdominal) SFT should be measured and then body fat content should be calculated for risk assessment. But due to the social context SFT could not be measured in all four body sites. Table salt non use did not appear as statistically protective factor of metabolic syndrome. There might be other explanation of such finding or could there be any missing link in the current study.

Limitations and scope of the study

1. This study was conducted among hospital controls in selected hospitals which may give rise to Barkit’s Paradox.
2. Due to small sample size we had to take some prevalent cases which may give rise to Neyman’s Fallacy.
3. No population specific cut off for Skin fold thickness measurement was available among Bangladeshi population.

Conclusion & Recommendation: This study concluded as—Not only BMI also WHR and WHR were strongly and positively associated with metabolic syndrome among Bangladeshi urban adults and they are the markers of metabolic syndrome diagnosis. Not only BMI also WHR, and WHR should be used as routine surveillance in metabolic syndrome diagnosis. Measures should be taken to maintain normal WHR (0.5), WHR (0.85 in female and 0.90 in male), BMI (18-25 in both sexes) by lifestyle modification, increased physical activity level (PAL) and there by prevent metabolic syndrome and cardiovascular diseases risk.

References