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Original Article

Association of general and central obesity with diabetes and prediabetes in rural Bangladeshi population

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ABSTRACT

Background and aims: Recent data shown that both general and central obesity indices are significantly associated with diabetes (T2DM) and prediabetes (impaired glucose tolerance [IGT] and impaired fasting glucose [IFG]). Data regarding association of obesity with T2DM and prediabetes in rural Bangladeshi population is scarce. This study aims to observe the association of general and central obesity with diabetes (T2DM) and prediabetes in rural Bangladeshi population.
Materials and methods: A total of 2293 rural Bangladeshi adults aged ≥20 years were randomly selected in a population-based, cross-sectional survey which was conducted in 2009. The association of general (defined by body mass index [BMI]) and central obesity (defined by waist circumference [WC] and waist hip ratio [WHR]) with T2DM and prediabetes was assessed by using receiver operating characteristic curve analysis and logistic regression.
Results: Subjects with T2DM, IGT and IFG had a higher rate of general and central obesity than normal subjects. WHR was more closely associated with T2DM than WC and BMI. However, all three obesity indices were significantly associated with IGT and IFG.
Conclusions: In rural Bangladeshi population, both general and central obesity showed good association with T2DM and prediabetes.

1. Introduction

People in the developing countries are increasingly vulnerable to the worldwide epidemic of obesity. It is a major modifiable risk factor for type 2 diabetes (T2DM) and also for prediabetes, an intermediate hyperglycemic status and future risk for T2DM [1,2]. Epidemiological studies have shown body mass index (BMI) as an index of general obesity, whereas waist circumference (WC) and waist hip ratio (WHR) as indices of central obesity [3–6]. Evidences have shown both general and central obesity indices are significantly associated with T2DM [7–9] but the association varies in different ethnic groups [10–17].

Data on association of obesity with T2DM, impaired glucose tolerance (IGT) and impaired fasting glucose (IFG) are very limited for Bangladeshi rural population. Therefore, we aimed to explore the association of general and central obesity indices with T2DM, IGT and IFG in rural Bangladeshi population.

2. Materials and methods

In 2009, a cross-sectional study was carried out in a rural community called Chandra, 40 km north of capital Dhaka city in Bangladesh. Approximately 20,000 inhabitants aged ≥20 years were listed from the 10 selected villages out of 25 villages. The study included both gender, age ≥20 years, willing to participate and being able to communicate, and excluded pregnant women, subjects with myocardial infarction, liver disease, renal disease, tuberculosis, malignant disease and any severe disease at the time of screening. For this study, 3000 individuals were randomly selected and among them 2376 (79.2%) participated. The study population and methods have been described in more detail in a previous report [18]. Data were collected in nearby project site after overnight fasting for at least 12 h. Information on socio-demographic, clinical and nutritional data

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were collected by interviewing the participants using a predesigned pretested questionnaire. The study was conducted according to the guidelines of the Helsinki Declaration. This study was approved by Regional Ethics Committe (REK) of Norway and the Ethical Committee of Diabetic Association of Bangladesh for Medical Research. Informed verbal consent was taken from the subjects prior to inclusion in the study.

2.1. Measurements

Upon arrival in the field sites, different sets of investigations and physical examinations were done for each of the subjects taking part in the study. At first, an initial blood sample was taken to estimate the fasting plasma glucose (FPG). Then all the subjects other than those with known diabetes were given 75 g glucose drink. Blood samples were collected in a tube containing sodium fluoride and potassium oxalate (1:3) and were centrifuged immediately. Separated plasma samples were sent in ice gel packed cooling boxes to the laboratory of Bangladesh Institute of Research and Rehabilitation for Diabetes, Endocrine and Metabolic Disorders (BIRDEM), and stored at −70 °C until laboratory assays. Plasma glucose was measured using glucose oxidase method (Dimalesion RxL Max, Siemens AG, Erlangen, Germany). Anthropometric measurements including height, weight, hip and waist circumference (WC) were taken with the subjects wearing light clothes and without shoes. Weight and height were recorded to the nearest 0.1 kg and 0.1 cm. Body mass index was (BMI) calculated as the weight (kg) divided by square of the height (m^2). WC was measured by placing a tape horizontally midway between the lower border of the ribs and upper border of iliac crest on the mid-axillary line. Hip circumference was measured to the nearest centimeter at the greatest protrusion of the buttocks. Waist hip ratio (WHR) was then calculated from waist (cm) and hip circumference (cm).

2.2. Definitions

According to the International Association for the Study of Obesity and the International Obesity Task Force guidelines, overweight was defined as a BMI of 23.0–24.9 kg/m^2, while obesity was defined as BMI ≥25 kg/m^2, central obesity was defined as a WC of ≥90 cm for male and ≥80 cm for female and WHR of ≥0.90 for male and ≥0.80 for female [6,19]. T2DM was defined as FPG ≥7.0 mmol/l and/or 2hPG ≥11.1 mmol/l [20], self-reported T2DM, or use of diabetes medication. IGT was defined as FPG <7.0 mmol/l and 2 h plasma glucose (2hPG) ≥7.8 mmol/l, but <11.1 mmol/l. IFG was defined when FPG was ≥6.1 mmol/l, but <7.0 mmol/l and 2hPG <7.8 mmol/l. Subjects with IFG and/or IGT were classified as pre-diabetes. Smoking habit was classified as either current, non- or ex-smoker. Socio-economic condition was classified as low (<5000 Bangladeshi Taka [BDT, 1USD = 84 BDT]), medium (5000–1000 BDT) and high (>10,000 BDT) based on monthly expenditure. Education level was graded as illiterate: unable to write and read; undergraduate: having primary and higher secondary education and graduate. Physical activity was graded on the ordinal scale of 1–3, corresponding to light, moderate and heavy, according to the activity level based on their occupation. For the purpose of data analysis, these results were transformed into a binary variable – inactive (grade 1) and active (grade 2 and 3).

2.3. Statistical analysis

The present analysis is based on 2293 participants (842 male and 1451 female) for whom all the variables were available. Means and percentages with 95% confidence intervals (CI) were given for normally distributed continuous variables and categorical variables as needed. Differences between the groups of means and proportions were tested by analysis of variance (ANOVA) and χ^2 test. Receiver operating characteristic (ROC) curve analysis was used to assess the association of WHR, WC and BMI with T2DM, IGT and IFG. The area under the ROC curve (AUC) for anthropometric indices was used to identify the presence of T2DM, IGT and IFG. Additionally, we calculated adjusted odds ratios (ORS) of respective anthropometric indices for T2DM, IGT, and IFG. Adjusted ORs were obtained by applying logistic regression analysis with adjustments for age, sex, social class, cigarette smoking and physical activity. Statistical inference is based on 95% confidence intervals (CIs) and the significance level was set at 0.05.

3. Results

Table 1 shows the characteristics of the study participants by glycemic status. The mean age of the participants was 41.8 years. Subjects with T2DM were more solvent and those in the IGT and T2DM groups were less educated than others. Rate of cigarette smoking was higher in both IFG and T2DM groups, and participants

Table 1
Characteristics of the study participants by glycemic status.

Variable	Total (n = 2293)	Normal (n = 1915)	IFG (n = 79)	IGT (n = 118)	DM (n = 181)	P value*
Female, %	63.3 (61.4, 65.3)	64.6 (62.5, 66.8)	49.4 (38.3, 60.5)	61.9 (53.1, 70.7)	55.8 (48.5, 63.1)	0.006
Age (yrs)	41.8 (41.2, 42.4)	41.2 (40.6, 41.8)	45.3 (42.3, 48.3)	43.5 (41.1, 48.2)	45.8 (43.8, 47.7)	<0.001
SES (high), %	16.3 (14.8, 17.8)	15.2 (13.6, 16.9)	20.3 (11.3, 29.2)	20.3 (13.0, 27.6)	22.7 (16.5, 28.8)	0.026
Higher education, %	9.2 (7.9, 10.3)	9.8 (8.4, 11.1)	10.1 (3.4, 16.8)	5.1 (1.1, 9.1)	4.4 (1.4, 7.4)	0.040
Smoking, %	15.9 (14.4, 17.4)	15.9 (14.3, 17.6)	18.9 (10.3, 27.7)	9.3 (4.1, 14.6)	18.8 (13.1, 24.5)	0.138
Physical inactivity, %	15.1 (13.7, 16.6)	13.8 (12.3, 15.4)	20.3 (11.3, 29.2)	19.5 (12.3, 26.7)	23.8 (17.5, 29.9)	0.001
BMI	22.6 (22.5, 22.8)	22.3 (22.2, 22.5)	23.5 (22.6, 24.5)	24.6 (23.8, 25.4)	24.2 (23.7, 24.7)	<0.001
General obesity (BMI ≥25 kg/m^2), %	26.2 (24.4, 28.0)	23.3 (21.4, 25.2)	35.4 (24.8, 46.1)	46.6 (37.6, 55.7)	40.0 (32.6, 46.9)	<0.001
WC	80.5 (80.1, 80.9)	79.4 (78.9, 79.9)	83.1 (80.7, 85.6)	86.0 (85.5, 88.3)	86.9 (80.1, 80.9)	<0.001
Central obesity by WC (M ≥ 90 and F ≥ 80), %	39.8 (37.8, 41.8)	36.4 (34.3, 38.6)	46.8 (35.8, 57.9)	59.3 (50.4, 68.2)	59.7 (52.5, 66.8)	<0.001
WHR	0.88 (0.87, 0.89)	0. 87 (0.86, 0.88)	0.89 (0.88, 0.91)	0.91 (0.89, 0.92)	0.93 (0.92, 0.94)	<0.001
Central obesity by WHR (M ≥ 0.90 and F ≥ 0.80), %	71.6 (69.8, 73.5)	69.0 (67.0, 71.1)	77.2 (67.9, 86.5)	82.2 (75.3, 89.1)	89.5 (85.0, 93.9)	<0.001
FPG (mmol/l)	5.2 (5.1, 5.3)	4.7 (4.6, 4.8)	6.3 (6.2, 6.4)	5.3 (5.2, 5.5)	9.7 (9.2, 10.3)	<0.001
2hPG (mmol/l)	6.3 (6.1, 6.4)	5.4 (5.3, 5.6)	6.1 (6.9, 6.3)	8.8 (8.6, 8.9)	14.3 (13.4, 15.1)	<0.001

IFG, impaired fasting glucose; IGT, impaired glucose tolerance; DM, diabetes mellitus; SES, socio-economic status; BMI, body mass index; WC, waist circumference; WHR, waist hip ratio; M, male; F, female; FPG, fasting plasma glucose; 2hPG, 2 h plasma glucose

* P value: comparison among four groups. Values are mean (95% CI) or percentage (95% CI) as indicated.