Original article

Central Obesity Plays an Important Role for the Development of Type 2 Diabetes in Bangladeshi Women

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Abstract:

Background: Diabetes mellitus coexists at a greater frequency with hypertension, obesity, central obesity, and dyslipidemia. Obesity has been identified as the most important modifiable risk factor in the aetiology of type-2 diabetes mellitus. Central obesity has been shown to be the most pathogenically important in the causation of metabolic disorders including type-2 diabetes. ***Aims:*** To determine the association of central obesity with type 2 diabetes in Bangladeshi women. ***Subjects and Methods:*** A total of 60 type 2 diabetic female subjects along with 60 healthy female subjects were recruited in this study. Anthropometric indices were measured using standard techniques. Serum glucose was measured using glucose-oxidase method, insulin was measured using ELISA and thyroid hormones were measured using chemiluminescence based automated Immulite Auto analyzer (DPC, USA). Insulin secretory capacity and insulin sensitivity were estimated using fasting glucose and fasting insulin by HOMA-CIGMA software. ***Results:*** Waist circumference of the control (89±8) subjects was significantly (p=0.046) lower than the diabetic (94±11) subjects. Waist-hip ratio of the control subjects was significantly lower compared to diabetic subjects. Fasting plasma insulin level in control sub-jects (7.6±2.2) was significantly (p=0.009) lower compared to diabetic subjects (11.8±9.8). Plasma lipid profile and thyroid hormone status in control and diabetic subjects were not found significantly different. Insulin secretory capacity (HOMA %B) and insulin sensitivity (HOMA%S) in control subjects (93 ±21, 95±39 respectively) were found to be significantly higher com-pared to diabetic subjects (45±32, 67±42 respectively). In age-adjusted binary logistic regression analysis, waist circumference was found to be significantly associated with diabetes. In multiple linear regression analysis TSH was found to be significantly associated with waist circumference. ***Conclusion:*** Waist circumference may be an independent indicator for the development type 2 diabetes in Bangladeshi women which may have influenced by thyroid stimulating hormone (TSH).

Key Words: waist circumference; thyroid hormone; type 2 diabetes mellitus

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Introduction

The number of adults with diabetes in the world increases rapidly than it was expected earlier, In 2004 the number was expected to be 300 million by the year 2025 but in 2011 the number of diabetic people in the World reached 366 million and it again expected to be 552 million by the year 2030[1]. The major part of this numerical increase will occur in developing countries, including Africa[1,2,3]. Diabetes coexists at greater frequency with dyslipidemia, hypertension, central obesity, and micro-albuminuria, which markedly increase the risk and accelerates the course of atherosclerotic diseases[4]. World Health Organization (WHO) indicates that in 2005 approximately 1.6 billion adults (aged 15 years and over) were overweight worldwide, while at least 400 mil-

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lion adults were obese. Furthermore, the WHO predicts that by 2015 approximately 2.3 billion adults will be overweight and more than 700 million will be obese[5]. Recent evidence[6] from the non-communicable disease risk factor survey Bangladesh 2010 has shown that 17.6% of the Bangladeshi population are overweight and obesity and noticed that urban population (25.1%) are more prone than rural population (10.2%). Reports on rural Bangladeshi population[7,8] over a 10 year period have shown that the prevalence of diabetes increased from 2.3% in 1999 to 7.9% in 2009. In that study under nutrition, overweight and obesity in 2009 were 14%, 17% and 26% respectively, and the presence of metabolic syndrome (cluster of metabolic risk factors, i.e., insulin resistance, diabetes, obesity indicators, hypertension, hyperlipidemia) according to WHO, IDF (International Diabetes Federation) and ATP III (Adult Treatment Panel III) criteria were 9.9%, 23.7% and 29.6% respectively with the prevalence of overweight and obesity, diabetes and other non-communicable diseases also on the rise.

Excess weight is the most important modifiable risk factor for the development of type 2 diabetes because 85–90% of people with type 2 diabetes are either overweight or obese[9]. The term ‘diabesity’ has been coined to express that type 2 diabetes is obesity-dependent and that obesity is the main aetiological cause of type 2 diabetes[10]. Epidemiological studies have shown that body mass index (BMI) is a powerful predictor of type 2 diabetes[11]. Field et al. reported that both men and women with BMI >35kg/m^2 were approximately 20 times more likely to develop type 2 diabetes compared with normal BMI counterparts[12]. However, obesity is remarkably heterogeneous and some obese patients are insulin-sensitive, and even some massively obese patients show a normal plasma lipoprotein–lipid profile despite their significant excess of body fat[13].

Waist circumference as a measure of abdominal obesity was proposed as a better predictor of risk of type 2 diabetes development[14]. However, total body fat is not the only source of adverse health complications of obesity; in fact, fat distribution and the relative portion of lipids in various insulin sensitive tissues (skeletal muscle and liver), which affects their normal metabolic pathways, actually determine metabolic risk[15]. Accumulation of intra-abdominal or visceral fat is associated with insulin resistance and is a major feature of metabolic syndrome, which confers a 1.5–2-fold increased risk of developing diabetes and cardiovascular disease (CVD)[16].

A study on US population have shown that measures of overall and central adiposity were associated with higher circulating levels of TSH and FT_3 in euthyroid adults[17]. Thus, hormonal and metabolic alterations common to central adiposity (e.g., insulin resistance) may influence, or be influenced by, thyroid status.

Insulin resistance is thought to be provoked by visceral obesity due to increased flux of free fatty acids (FFAs) to the liver and increased secretion of inflammatory mediators. It was shown that abdominally obese patients have about 50% increased FFA lipolysis and 50% lower FFA turnover compared with lean individuals[18]. At the same time, abdominally obese patients have a greater FFA lipolysis rate compared with non-abdominally obese patients[18].

While weight change is largely attributable to an imbalance in energy intake and expenditure[19], it is also a well recognized and common manifestation of overt thyroid dysfunction due to regulation of resting energy expenditure (REE) by thyroid hormones[20, 21]. Another study has shown that measures of overall and central adiposity were associated with higher circulating levels of TSH and FT_3 in euthyroid adults[17]. To look into this question further, we have investigated type 2 diabetes of Bangladeshi women whether central obesity along with thyroid hormones are associates with the risk of type 2 diabetes.

Subjects and Methods

A total of 60 type 2 diabetic female subjects were selected on the basis of availability from the Out Patient Department (OPD) of BIRDEM and Mitford Hospital, age- and BMI-matched 60 healthy female subjects without family history of diabetes from the friend circles of diabetic subjects were also recruited in this study. Subjects were considered as T2DM using WHO guidelines (fasting serum glucose >6.9 mmol/l and/or 2h serum glucose >11.1mmol/l)[22]. The aim of the study was explained and consent was taken from all the volunteers; clinical examination was done by a registered physician using a predesigned questionnaire. Anthropometric measurements were taken using standard methods. Subjects were requested to come in a prescheduled morning after overnight fasting for the fasting blood sample; subjects were then given 75 gm anhydrous glucose dissolved in 250 ml water. Blood was taken by venepuncture at fasting condition and two hours after glucose loading. Serum was separated through centrifuging for 15 min at 300rpm and stored at -40°C. Serum glucose was measured by glucose-oxidase method and lipid profile by enzymatic colorimetric method using commercial kits (Randox Laboratories Ltd., UK), HbA1c was measured using modified HPLC method (Variant, Bio-Rad, USA). Serum insulin levels were determined by enzyme linked immunosorbent assay (ELISA) method (Linco Research Inc., USA). Serum TSH, T_3, FT_3, T_4 and FT_4 concentrations were measured by solid phase, enzyme labeled, chemiluminescent immunometric assay (IMMULITE, DPC). Insulin secretory capacity (HOMA %B) and insulin sensitivity (HOMA %S) were calculated from fasting glucose and fasting insulin using HOMA-CIGMA software[23]. This study protocol was approved by the Ethics Committee of BIRDEM.

Statistical analysis

Statistical analysis was performed using SPSS (Statistical Package for Social Science) software for Windows version 17 (SPSS Inc., Chicago, Illinois, USA). All the data were expressed as mean ±SD (standard deviation), the statistical significance of differences between the values was assessed by unpaired 't' test, binary logistic and multiple linear regression were done among the parameters. A two-tailed p value of <0.05 was considered as statistically significant.

Results

Clinical characteristics of the study subjects

Age and BMI of the control (36±5, 25.9±3.1) and diabetic (39±6, 26.4±3.7) subjects were not significantly different. Waist circumference of the control (89±8) subjects was significantly (p=0.046) lower than the diabetic (94±11) subjects. Although hip circumference was not significantly different between the two groups but waist-hip ratio of the control subjects was significantly lower compared to diabetic subjects. Percent body fat content was also not significantly different between the two groups. Although both the systolic and diastolic blood pressure of the two groups were within the normal range but diastolic blood pressure of the control subjects was significantly lower in control subjects compared to diabetic subjects (table 1).

Biochemical characteristics of the study subjects

Fasting plasma glucose in control and diabetic subjects were 5.3±0.4 and 11.9±5.4. Glycosylated hemoglobin (HbA_{1c}) in control and diabetic subjects were 5.8±0.5 and 9.1±2.1. Fasting plasma insulin level in control subjects (7.6±2.2) was significantly (p=0.009) lower compared to diabetic subjects (11.8±9.8). Plasma lipid profile and thyroid hormone status in control and diabetic subjects were not found significantly different (table 2).

Lipid profile (TG, cholesterol, HDL, LDL) status and thyroid hormone (TT3, FT3, TT4, FT4, TSH) status of the diabetic and control subjects were not significantly different in this study. Insulin secretory capacity (HOMA %B) and insulin sensitivity (HOMA %S) in control subjects (93±21, 95±39 respectively) were found to be significantly higher compared to diabetic subjects (45±32, 67±42 respectively) (table 2).

Regression analysis

In age-adjusted binary logistic regression analysis, when healthy control subjects were considered as reference group, waist circumference was found to be significantly associated with diabetes (table 3). When serum TSH and waist circumference have been fittrd in a regression curve, TSH have shown positively associated with waist circumference (r=0.398, p=0.005; Figure 1). In multiple linear regression analysis TSH was found to be significantly associated with waist circumference.

Discussion

Obesity is the most important modifiable risk factor in the aetiology of type-2 diabetes mellitus[19,22]. Body mass index (BMI) is the commonest index used to define obesity in clinical practice. However, BMI does not define the presence or absence of central obesity which has been shown to be the most pathogenically important in the aetiology of metabolic disorders. Waist-hip ratio (WHR) has been shown to be a sensitive index of both the total amount of intra-abdominal fat as well as the ratio of intra-abdominal to subcutaneous fat ratio[24]. The study done on Nigerian type 2 diabetic patients have shown that BMI is rare, central obesity is quite common[25]. This is crucial in the management of type-2 diabetic patients as central obesity is the form of obesity that is associated with cardiovascular morbidity and mortality[26]. This was first highlighted by Vague[27] in 1947 who subsequently re-echoed the same observations nine years later[28]. There is evidence to suggest that visceral adipose tissue is more active metabolically than peripheral adipose tissue and is therefore more deleterious than the latter. For example visceral fat is known to be characterized by increased production of interleukin-6 and tumor necrosis factor-? factors known to be associated with complications of the metabolic syndrome[29]. Obesity occurred more commonly among female patients compared to their male counterparts as shown in the findings of Akintewe and Adetuyibi in Western Nigeria[30] and may be due to cultural practices that tend to limit physical exertion by females with resultant sedentary habits, obesity and its attendant complications. Although the tendency to do outside works have been increasing among the Bangladeshi women but still a large proportion of them are habituated with sedentary lifestyle. Therefore, the present study aims to determine the central obesity in Bangladeshi women whether it played an important role in the development of type 2 diabetes.

In the present study BMI of the control (25.9±3.1) and diabetic (26.4±3.7) subjects was not significantly different. Waist circumference of the control (89±8) subjects was significantly (p=0.046) lower than the diabetic (94±11) subjects. Although hip circumference was not significantly different between the two groups but waist-hip ratio of the control subjects was significantly lower compared to diabetic subjects. Percent body fat content was also not significantly different between the two groups. Recently in Southern Ethiopia, Giday et al., have shown that hypertension, central obesity and overweight were found to be significantly associated with risk of having diabetes[31]. Central obesity was found significantly higher in female than male irrespective of having diabetes mellitus, but obesity had no significant difference among both sexes. Abdominal obesity had a graded relationship with diabetes mellitus in both male and females[32]. Abdominal obesity as a clinical feature of excessive accumulation of visceral fat is usually associated with a cluster of cardiovascular risk factors, defined by the WHO as 'metabolic syndrome'. This syndrome is characterized by abdominal obesity, insulin resistance, dyslipidaemia (high

Table 1: Clinical characteristics of the study subjects

Parameters	Control	T2DM	P value
Age (yrs)	36±5	39±6	0.54
BMI (kg/m^2)	25.9±3.1	26.4±3.7	0.64
W_Cir	89±8	94±11	0.046
H_Cir	96±6	96±9	0.56
WHR	0.93±0.08	0.98±0.08	0.024
% Body Fat	31.2±5.1	33.1±6.6	0.286
SBP (mm_hg)	118±11	125±17	0.086
DBP (mm_hg)	73±8	81±10	0.010

BMI, Body Mass Index; W_Cir, waist circumference; H_Cir, hip circumference;

WHR, waist-hip ratio; SBP, systolic blood pressure; DBP, diastolic blood pressure

Table 2: Biochemical characteristics of the study subjects

Parameters	Controls	T2DM	P value
FPG (mmol/l)	5.3±0.4	11.9±5.4	0.0001
HbA_{1c} (%)	5.8±0.5	9.1±2.1	0.0001
Insulin (µIU/ml)	7.6±2.2	11.8±9.8	0.009
TG (mg/dl)	163±63	198±106	0.26
Cholesterol (mg/dl)	193±35	207±48	0.33
HDL (mg/dl)	41±15	37±10	0.439
LDL (mg/dl)	119±32	130±50	0.444
S Creat (mg/dl)	0.96±0.14	0.99±0.21	0.610
TT_3 (ng/ml)	84±15	83±21	0.870
FT_3 (ng/ml)	2.49±0.69	2.39±0.71	0.647
TT_4 (ng/ml)	8.0±1.3	8.6±1.7	0.208
FT_4 (ng/ml)	1.31±0.27	1.33±0.27	0.859
TSH (ng/ml)	1.71±1.45	1.73±1.37	0.965
HOMA %B	93±21	45±32	0.0001
HOMA %S	95±39	67±42	0.036

FPG, Fasting plasma glucose; TG, Triglyceride ; S Creat, serum creatinine ; TT3, Total T3 ;

FT3, Free T3, TT4, Total T4 ; FT4, free T4 ; TSH, Thyroid stimulating hormone ;

HOMA %B, insulin secretory capacity ; HOMA %S, insulin sensitivity.

Table 3: Binary logistic regression analysis of BMI and waist circumference adjusted with hip circumference and age (taking healthy controls as reference)

	B	S.E.	Sig.	Exp(B)
BMI	0.045	0.160	0.777	1.046
W_CIRC	-0.090	0.045	0.045	0.914
HIP_CIRC	0.059	0.062	0.336	1.061
AGE	-0.096	0.071	0.177	0.908
Constant	3.596	4.606	0.435	36.451

Reference group healthy control subjects

Table 4:Relationship of waist circumference and Thyroid hormones in type 2 diabetic subjects using multiple linear regression analysis

	Unstandardized Coefficients		Standardized Coefficients	t	*p-value*
	B	**Std. Error**	**Beta**		
(Constant)	98.61	12.186		8.092	0.000
TSH	2.542	1.193	0.318	2.131	**0.039**
TT_3	-0.005	0.081	-0.011	-0.067	0.947
TT_4	-0.551	1059	-0.084	-0.520	0.606
HBA_{1C}	-0.139	0.764	-0.027	-0.182	0.857
HOMAS	-0.033	0.038	-0.130	-0.883	0.382

Dependent Variable: Waist circumference

triglyceride level and low high-density lipoprotein [HDL] cholesterol level), hypertension, high fasting glucose, procoagulant (elevated plasminogen activator inhibitor [PAI-1] levels) and pro-inflammatory state, i.e. elevated tumor necrosis factor (TNF), C-reactive protein (CRP) and interleukin (IL)-6[33].

A study on Egyptian population has shown that central obesity was significantly and independently associated with diabetes and hypertension among adults. Obese subjects with predominantly abdominal fat mass (android type) showed a risk profile that was less favorable than gluteofemoral fat distribution (gynoid type). Waist circumference (WC) was most highly correlated with both diabetes and hypertension, while WHR was not a significant predictor of any of the 2 conditions[34]. WC measurement is a potentially useful tool for clinicians in counseling patients regarding diabetes and hypertension risk and risk reduction.

Insulin secretory capacity (HOMA %B) and insulin sensitivity (HOMA %S) in control subjects (93±21, 95±39 respectively) were found to be significantly higher compared to diabetic subjects (45±32, 67±42 respectively) which is a normal phenomena in type 2 diabetic subjects.

Thyroid hormones influence carbohydrate metabolism, even in the euthyroid state. They regulate hepatic gluconeogenesis, lipogenesis, and lipolysis. Also, thyroid hormones modulate mRNA and protein expression of the glucose transporter-4 (GLUT-4), AMP-activated protein kinase, and acetyl CoA carboxylase in skeletal muscle[35] but in the present study no differences were found between type 2 diabetic and healthy women in a Bangladeshi population.

In age-adjusted binary logistic regression analysis, when healthy control subjects were considered as reference group, waist circumference was found to be significantly associated with diabetes. Bivariate correlation analysis of TSH and waist circumference of the type 2 diabetic subjects which has expressed as regression curve in figure has shown that TSH is significantly and positively associated with waist circumference which is also remained in multiple linear regression analysis. Therefore, the viewpoint of above data concluded that waist circumference may be an independent indicator for the development of type 2 diabetes in Bangladeshi women which may have influenced by thyroid stimulating hormone (TSH).

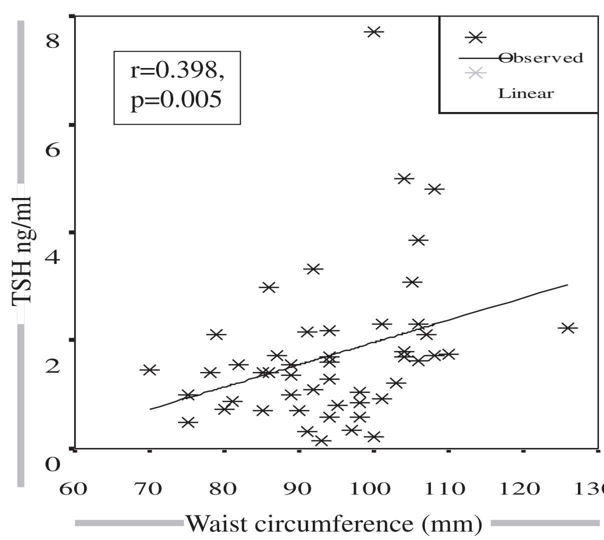

Figure 1: Association of serum TSH with waist circumference

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