Original Article

Central adiposity is significantly higher in female compared to male in Pakistani type 2 diabetes mellitus patients

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ABSTRACT

Background: Type 2 diabetes mellitus (DM) rates are increasing rapidly in South Asians. Cardiovascular complications are more frequent and occur earlier in our patients than patients in many other ethnic groups. Reasons for this are not fully understood. **Aims:** The aim of this study is to evaluate the body total and central fat percentage in type 2 Diabetes Mellitus patients and to check correlation with BMI, waist circumference and metabolic profile. **Settings and Design:** A cross-sectional study conducted at endocrine clinic, Aga Khan University Hospital Karachi, Pakistan, from May to December 2012. **Materials and Methods:** Patients of either gender with type 2 diabetes mellitus were randomly selected. A separate proforma for each patient was recorded for demographics, risk factors, bioelectrical impedance measurement for body fat and investigations. **Statistical Analysis:** Correlation between body fat and other covariate were compared by Pearson correlation coefficient test. A $P < 0.05$ was considered significant. SPSS19.0 was used to analyze the data. **Results:** One hundred and seventy five patients (95 male and 80 female) with mean age of 54.1 ± 12 years were evaluated. Mean duration of diabetes was 8.1 years, mean HbA1c was 8.1% and 53.7% were on oral agents and rest were on insulin with or without oral agents. Hypertension was present in 65.7%, 13.7% had known coronary artery disease and 2.3% had cerebrovascular disease. Mean BMI in males was 29.1 ± 4.74 kg/m^2 and females 31.7 ± 5.3 kg/m^2. Mean waist circumference in males was 107.3 ± 16.6 cm and 103 ± 12 cm in females. Total body fat percentage (%BF) in males was 30.9 ± 7.1% and females 40 ± 8.2% with 89% of the total cohort having total body fat percentage above the normal, less than 25% central fat percentage was 13.3 ± 5.2% in males and 14.6 ± 5.5% in females with 79.4% of cohort having increased central fat (normal <9%). Total and central body fat correlated with BMI ($r = 0.68$, $P < 0.001$) and waist circumference ($r = 0.66$, $P < 0.001$) but not with HbA1c, triglyceride level or with fasting or random blood glucose levels. Women had significantly higher total body fat percentage compared to men ($P < 0.001$) although central fat percentage was similar in both sexes. **Conclusions:** High body fat percentage, waist circumference are seen especially in woman and central body fat percentage in both sexes among patients with type 2 diabetes mellitus in Pakistan. Body fat percentage should be measured and followed as this may be an important contributing factor to the high macrovascular complication rate in this part of world.

Key words: Bio-impedance analysis, body fat, type 2 diabetes mellitus

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Introduction

Diabetes is one of the most common non-communicable chronic diseases worldwide. The International Diabetes Federation (IDF) estimates the current worldwide population of people with diabetes to be 371 million people of which 70 million live in South Asia.[1] The

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prevalence rate in South Asia is estimated to increase by 2% annually with about 69% increase in number of people with diabetes over the next 20 years.[1] Similarly in Pakistan, the prevalence rates of diabetes among adults is estimated to be 8% and these rates are also on the rise.[1] Among the causes of this rising prevalence are lifestyle changes over the past several decades and the concurrent increasing obesity rates.[2] There is a close association between body mass index (BMI) and diabetes prevalence.[3,4] Abdominal or central obesity due to increased visceral fat is associated with insulin resistance.[5] Insulin resistance and subsequent hyperinsulinemia play a role in the pathogenesis of type 2 diabetes. The combination of diabetes and obesity (Diabesity) are associated with significant increase in morbidity and mortality due to cardiovascular diseases.[6,7]

Studies on relationship between BMI and body fat percentage suggest that Asian population have a high percentage of body fat at a low BMI [8-10] and the risk of developing diabetes or cardiovascular disease is higher at lower BMI among them.[11,12] Therefore BMI may not be an accurate measure of body adiposity in the Asian population. There are a few studies estimating percentage of total fat and central fat among Asian diabetic populations, mostly residing in western countries,[13] but none from Pakistan.

The aim of this study is to evaluate the body total and central fat percentage in indigenous Pakistan patients with type 2 diabetes mellitus and to evaluate correlations of these percentages with BMI, waist circumference and metabolic profile using a bio-impedance analysis meter, which measures body fat and composition, a simple relatively inexpensive tool, which can be utilized in clinics throughout the country.

Materials and Methods

This was a cross-sectional study conducted in the Endocrine clinic, Aga Khan University Hospital Karachi, Pakistan from May 2012 to December 2012. One hundred and seventy five patients with type 2 DM were randomly selected and enrolled in the study. Patients with type 1 DM, gestational DM or secondary diabetes were excluded. After obtaining consent each patient's data including age, duration of diabetes, BMI, comorbid conditions, cardiovascular risk factors including lipid profile and glycemic control was recorded. Risk factors and co-morbidities studied were hypertension, dyslipidemia, smoking history, coronary artery disease, cerebrovascular disease, neuropathy, nephropathy and retinopathy. Medication history was obtained from charts and confirmed with the patients. Charts were reviewed and patients were questioned for prior cardiovascular or cerebrovascular events. Documentation of retinal exam, feet symptoms and foot exam and urine microalbumin were used to determine presence of microvascular complications.

Weight was measured without shoes and body height measured without shoes using a wall-mounted stadiometer. From weight and height the body mass index (kg/m^2) was calculated. Waist circumference was measured at the mid-point between the iliac crest and the lower rib margin. Most recent (within past 3 months) fasting lipid levels, HbA1c level, urine microalbuminuria and laboratory result of fasting and random blood glucose on treatment was documented. Bio-impedance analysis was performed on Omron body fat analyzer model no. HBF-306. Two parameters were measured: total body fat percentage (% BF) indicating percentage of fat in human body (normal is less than 25%) and central or visceral fat percentage (% VF) indicating percentage of fat deposited in abdomen (normal less than 9%).

Bio-impedance analysis provides good estimates of BF% and has been validated in previous studies.[8,14] Group of medical students were sufficiently trained and demonstrated by the distributors for taking the measurements and meter use.

Statistical analysis

Results were analyzed using the SPSS statistical software package (version 19.0 for Windows). Continuous variables are presented as mean ± SD and quartiles of study variables were obtained, as appropriate, categorical variables were presented as numbers and percentages. Continuous variables between genders were compared by using unpaired *t* test. Correlation between body fat and other covariate were compared by Pearson correlation co-efficient test. Continuous variables between groups were compared by using independent sample *t* test, and categorical variables were compared by using the Chi-square test. A $P < 0.05$ was considered significant.

Results

Ninety five male and 80 female patients with T2DM who consented were recruited and evaluated. The mean age (±SD) was 54.1 ± 12 years. Mean duration of diabetes was 8.1 years, mean HbA1c was 8.1% and 53.7% were on oral agents and rest was on insulin with or without oral agents. Hypertension was present in 65.7%, 13.7% had known coronary artery disease and 2.3% had a cerebrovascular accident previously. The mean BMI (±SD) was significantly lower in males 29.1 ± 4.74 kg/m^2 as compared to females 31.7 ± 5.3 kg/m^2 ($P = 0.001$). Women had significantly higher HDL level as compared to man ($P < 0.001$). Mean (±SD) waist circumference in males was 107.3 ± 16.6 cm and 103 ± 12 cm in females [Table 1]. Total body fat percentage (±SD) in males was 30.9 ± 7.1% and females 40 ± 8.2% with 89% of the cohort having

increased total body fat percentage (normal < 25%). Central fat percentage (±SD) was 13.3 ± 5.2% in males and 14.6 ± 5.5% in females with 79.4% of cohort having increased central fat (normal < 9%) [Tables 2 and 3].

Total and central body fat correlated with BMI ($r = 0.68$, $P < 0.001$) and waist circumference ($r = 0.66$, $P < 0.001$) but not with HbA1c, triglyceride level, fasting and random blood glucose levels. Women had significantly higher total body fat percentage compared to men ($P < 0.001$) although elevated central fat percentage was similar in both sexes.

Further analysis of data showed that percentage of central fat correlated with total cholesterol ($P = 0.042$) but not with LDL cholesterol, HDL cholesterol or triglycerides. There was no correlation of total or central fat percentage with HbA1c. Percentage of central obesity correlated statistically with presence of nephropathy but not neuropathy or retinopathy. While there was a trend for the correlation of central obesity with hypertension and coronary artery disease, this did not reach statistical significance in our cohort of patients.

Table 1: Characteristics of study population (mean±SD)

		Male *n* (%) 95 (54.3%)	Female *n* (%) 80 (45.7%)	*P* value
Age (years)	54.1±12.0	54.2±13.0	54±10.6	0.87
Duration of diabetes	8.1 years	11 years	9.5 years	0.30
Treatment regimen				
Diet control/ exercise	3 (1.7%)	2 (2.1)	1 (1.3)	0.86
Oral hypoglycemic	95 (54.3%)	49 (51.6)	46 (57.5)	
Insulin	23 (13.7%)	14 (14.7)	10 (12.5)	
Combine therapy	53 (30.3%)	30 (31.6)	23 (28.8)	
Height (cm)	162.2±11.0	168.8±9.8	154.4±6.4	<0.001
Weight (kg)	80.2±17.1	83.0±16.1	76.8±17.8	0.01
Total Cholesterol (mg/dl)	157.3±36.3	151.6±38.6	164.3±32.1	0.03
LDL (mg/dl)	86.9±32.2	84.1±30	90.1±34.5	0.23
HDL (mg/dl)	43.6±12.6	40.4±11	47.6±13.3	<0.001
Triglyceride (mg/dl)	150.9±84.1	150.6±79	151.2±90.4	0.96
Retinopathy	20 (11.4%)	13 (13.7)	12 (15)	0.83
Nephropathy	20 (11.4%)	15 (15.8)	5 (6.3)	0.058
CAD	24 (13.7%)	18 (18.9)	6 (7.5)	0.04
Hypertension	115 (65.7%)	60 (63.2)	55 (68.8)	0.52
Stroke	4 (2.3%)	3 (3.2)	1 (1.3)	0.62
Neuropathy	66 (37.7%)	29 (30.5)	37 (46.3)	0.04
Dyslipidemia	105 (60%)	57 (60)	48 (60)	0.99
Smoking				
Current	19 (10.9%)	16 (16.8)	3 (3.8)	<0.001
No	140 (80%)	63 (66.3)	77 (96.3)	
Ex	16 (9.1%)	16 (16.8)	0	

SD: Standard deviation, LDL: Low density lipoprotein, HDL: High density lipoprotein, CAD: Coronary artery disease

Table 2: Body composition and glycemic control in study subjects (mean±SD)

Variable	Male	Female	*P* value
BMI (Kg/m^2)	29.1±4.74	31.7±5.3	0.001
Waist circumference, (cm)	107.3±16.6	103.09±12.0	0.056
Total body fat % (BF)	30.9±7.1	40±8.2	<0.001
Central or Visceral fat % (VF)	13.3±5.2	14.6±5.5	0.11
HbA1c level	8.1±1.6	8.2±2.0	0.83

SD: Standard deviation, BMI: Body mass index

Table 3: Patients with high total and central body fat percentage

	N (%)		*P* value
	Male	Female	
Total body fat % (BF)			
<25 (normal)	16 (16.8)	2 (2.5)	0.002
>25 (elevated)	79 (83.2)	78 (97.5)	
Central fat % (VF)			
<9 (normal)	23 (24.2)	13 (16.3)	0.19
>9 (elevated)	72 (75.8)	67 (83.8)	

Discussion

In our study we observed elevated total body fat and central fat percentage in more than three quarter of indigenous type 2 diabetic patients residing in Karachi. Women have significantly higher total body fat percentage with almost all diabetic women having elevated total body fat and 84% women having elevated central fat percentage. The percentage of body fat and central fat correlated with BMI and waist circumference in these patients.

In a multiethnic Singaporean study, Indians had the highest percentage of body fat compared with Chinese and other groups at similar BMI.[12] Study from Lucknow, India, revealed large number of study participants have body fat more than 25% in lower BMI range between 20 and 24.9 kg/m^2.[15] Similarly Kagawa *et al.* found that Japanese men had greater body fat deposition than Australian Caucasians at the same BMI value.[16] Studies done by another group have shown higher total and visceral body fat percentage in males type 2 diabetic patients compared to women.[13] Asian Indian diabetic men have 30% and 21% more total body fat than African American diabetic men and Swedish diabetic men, respectively.[17,18] More visceral fat was noted in the elderly population compared to younger patients with diabetes in one study.[13] Elevated amount of visceral fat is highly predictive of development and progression of type 2 diabetes, and with the development of cardiovascular disease.[19,20] Increased visceral fat is associated with hyperinsulinemia and insulin resistance especially in the South Asian population.[21,22]

Higher waist: hip ratios are seen at similar BMI in South Asians compared to Europeans and is associated with four times increased risk of diabetes.[23] This altered body composition plays a key role in etiopathogenesis of metabolic derangements that lead to diabetes in the Asian population. Hence the need of different and lower cut-off

values for overweight and obesity categories in the South Asian population compared to the Caucasian population.[24]

Correlation between body fat percentage and HbA1c, FBS, RBS, triglycerides were not observed in our study. One possible explanation is that the most recent values were taken and almost all patients were receiving treatment for hyperglycemia and dyslipidemia in our clinic. Other limitations of our study include the fact that this is a relatively smaller study which may not have had the power to detect the associations that a much larger study could do. This was also done in a tertiary care clinic and may not exactly reflect values seen in the community.

A larger community-based study looking at the prediabetic and diabetic population and comparing this with age and sex-matched non-diabetic population would be useful. A larger study may confirm the trend we noted of association of central obesity with cardiovascular disease in our population. Certainly there are limitations of bio-impedance analysis as well. BIA values can be affected by hydration status of body, skin and air temperature, recent physical activity, consumption of food and beverages. Importantly BIA is not recommended at extremes of BMI ranges like in lean subjects[25] so reliability of BIA measurements need control of these factors.[15]

This data emphasizes the need for controlling weight (and body fat percentage) in our population as a whole and especially in the prediabetic and diabetic population. The prevalence of obesity is driving the worldwide diabetic epidemic and especially in the setting of large urban South Asian cities. The rampant adoption of westernized diet and lifestyle is having a major toll on diabetes prevalence and obesity.

This study highlights the high prevalence of central obesity especially in women with diabetes in Karachi. We need to draw increased attention to this amongst our patients and monitor body fat percentage and further motivate patients to address these abnormalities. A further invention study could be conducted to see if changes can be brought in these fat percentage values through lifestyle modification and medication. These changes in body fat percentage can be measured by using BIA. BIA is a relatively cheap (single time cost of instrument), noninvasive tool taking less time and not requiring expertise for measurement which can be utilized in the primary care setting.

In conclusion, high total and central body fat percentage was seen in patients with type 2 diabetes in Karachi, Pakistan. This was more prevalent in women and almost all had high total body fat. Reduction in weight, waist circumference and central body fat percentage should be emphasized and monitored in patients with type 2 diabetes mellitus and those at risk.

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