Body Mass composition among Underweight Type 2 Diabetes Mellitus Patients—A Cross-sectional Comparative Study

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Abstract

Background: Over the past decades, various epidemiological data have shown that the pattern and profile of diabetes mellitus in India are different. The present study was carried out with an aim to study body mass composition in underweight type 2 diabetics and to compare with the normal population. **Materials and Methods:** The cross-sectional comparative study was conducted between January 2015 and December 2016 and included 60 participants who were selected using the convenient sampling technique. Newly diagnosed patients with type 2 diabetes mellitus and BMI less than 18.5 kg/m^2 were considered for the study. Chi square test and Independent student *t* test were used for finding the statistically significant difference in proportions and between means, respectively; Pearson correlation coefficient was estimated for finding the linear association between two continuous variables. **Results:** No statistically significant difference was observed between the two groups in terms of age, waist-hip ratio, and BMI. Higher amount of fat mass and percentage were observed among the patients with diabetes as compared to that of the control group (P value < 0.05). However, there was no statistically significant difference between the underweight and the control group patients (P value > 0.05). A significant positive correlation was observed between HbA1c values and body fat mass values (P value < 0.05). **Conclusion:** Underweight type 2 diabetic patients were found to have high body fat mass as compared to healthy controls and the HbA1C values of the study participants were found to be positively correlated with fat mass.

Keywords: Body mass composition, BMI, underweight type 2 diabetics

Introduction

Diabetes mellitus is a clinical syndrome characterized by hyperglycemia caused by absolute or relative deficiency of insulin. Adult onset diabetes with body mass index (BMI) <25 was initially placed under the category of "malnutrition-related diabetes mellitus" in a subcategory termed "protein-deficient pancreatic diabetes.[1] Later, this syndrome was noted to be similar to that originally described as "Jamaica-type Diabetes", a term used to represent around 5% of Caribbean diabetics.[2] Although various studies have reported different operational definitions for underweight type 2 diabetics in different parts of the world, diabetes mellitus and BMI less than 18.5 Kg/m^2 was the most commonly accepted operational definition for underweight diabetics in the tropics.[3] The regional prevalence of underweight type 2 diabetic varied from 3.5% to 10% across India.[4-8] Over the past decades, various epidemiological studies have shown that the pattern and profile of diabetes mellitus in India are different, as well as in certain developing countries of Asia and Africa as compared to the West.[9] While almost 80% of type 2 diabetes mellitus patients in India are nonobese, 60%–80% of those in the west are obese.[10-12] Also, Asian Indians were found to have more fat, both total and abdominal fat, with less underweight mass, skeletal muscles, and bone minerals than all the other ethnic groups.[13] Underweight patients are more likely to be older at diagnosis, possibly have an immune component and may have a tendency toward certain pathophysiological characteristics, notably less insulin resistance and poorer insulin secretory capacity.[14] Moreover, the risk of diabetes among nonobese individuals is influenced by genetics.[15]

Body mass composition is the measure of underweight body mass and fat mass. Historically, these two were considered as the main body compartments and several methods and

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techniques were developed to quantify them. BMI (calculated as weight in kg/height in m^2), though being the most commonly used index, was not able to differentiate them.[16] South Asian men have a phenotype of high fat mass and low underweight mass as compared with the aboriginal Chinese and European population.[17] For the same BMI, compared with the Europeans, the body fat percentage of Pacific Island men was 4% points lower and that of the Asian Indian men was 7–8% points higher.[13] Over 65% of the body fat is subcutaneous, 20% is abdominal, and the rest is intramuscular. Abdominal fat which includes intra-abdominal fat (80%) and subcutaneous fat, plays a major role in metabolic disorders.[18] Body fat percentage was also found to be a significant predictor of plasma leptin concentration among patients with diabetes mellitus.[19]

Although there are many methods available to measure body mass composition, most of them are time consuming and invasive. Dual-energy X-ray absorptiometry (DXA) has emerged as one of the most commonly used clinical standards as it has a higher degree of accuracy and precision in measuring the body mass composition.[20,21]A study of body fat distribution among Asian Indians with diabetes mellitus using computed tomography, dual-energy X-ray absorptiometry, and anthropometry by Anjana *et al*.[22] found that patients with type 2 diabetic mellitus had significantly higher visceral ($P = 0.005$) and central abdominal ($P = 0.011$) fat compared with that of the nondiabetic subjects. The percentage of body fat among diabetics (34.71 ± 8.57) was significantly lower (P value < 0.05) as compared to healthy controls (39.24 ± 4.74); similarly, Arora *et al*. reported that individuals with type 2 diabetes mellitus had higher percentage of underweight body mass as compared to that of healthy controls (65.13 ± 8.82 vs 60.75 ± 4.73; P value = <0.05)[23] To the best of our knowledge, there were no studies conducted to analyze the body mass composition among underweight type 2 diabetics in India. The present study was carried out as an attempt to study the body mass composition among patients with underweight type 2 diabetes and to compare them with the normal population.

Materials and Methods

The cross-sectional comparative study was carried out by the department of general medicine in a tertiary care hospital in New Delhi. The study participants were selected using the convenient sampling technique from the patients who sought medical care from January 2015 to December 2016. Newly diagnosed type 2 diabetes mellitus and a BMI of <18.5 kg/m^2 were considered as the inclusion criteria. A total of 60 patients were selected and were equally categorized as underweight type 2 diabetics and normal controls, which improved the study results. The minimum required sample size was calculated using the formula Z^2pq/d^2, with an alpha error of 5% and considering the power of the study as 80%. The expected proportion of underweight patients with type 2 diabetes mellitus was taken as 6.67% as per the study by Modal *et al*.[7] Absolute precision of 10% was used for sample size calculation ($Z^2pq/d^2 = 4 * 6.67 * 93.33/10 * 10$), where $P = 6.67$, q is 100-p, and d is 10, which derives the value of 25). Patients diagnosed with type 1 DM, LADA, and pancreatic DM (FCPD) using anti-GAD 65 autoantibodies test, abdominal X-ray, and USG pancreas were excluded from the study. In addition, individuals with BMI > 18.5 kg/m^2, acute illnesses, chronic systemic diseases other than type 2 diabetes mellitus (especially renal failure, liver failure, malignant disease, on steroids, anti-epileptic drugs or other chronic medication, and other endocrinopathies), pregnant/lactating and postmenopausal women were not included in the study. Only those individuals who were healthy, nondiabetic (based on fasting and postprandial glucose level), BMI <18.5 kg/m^2, and not related with the diabetic group patients of our study were considered as eligible controls so as to avoid any confounding effects of genetic origin. All the patients were included in the study after detailed medical examination and gathering of their medical histories to check their eligibility to participate in the study. Patients who meet the eligibility criteria were explained about the procedures involved and the implications of the study in their own language. The study was approved by the institutional ethical committee approval. Informed written consent was obtained from all the patients before including them in the study. After which, study specific examinations were done followed by biochemical investigations and radiographic analysis. A predesigned semistructured questionnaire was used for collecting the sociodemographic information and the detailed evaluation of subjects about family history, past history of fractures, drug history, especially steroid use, hepatic, renal, thyroid, and parathyroid diseases, inflammatory conditions like rheumatoid arthritis, malabsorption, and menopausal status. The following anthropometric parameters were assessed for all the study participants: - (i) height (measured with a standard stadiometer; rounded off to the nearest centimeter); (ii) weight (measured using a dial type weighing scale; rounded off to the nearest 100gm); (iii) waist circumference and hip circumference (measured using an inch tape; rounded off to the nearest centimeter). Body mass composition was measured using dual-energy radiograph absorptiometry (DEXA—Hologic QDR-4500 DOS Series bone densitometer).

Statistical analysis

Means and proportions were calculated for continuous variables and categorical variables respectively; Chi square test was used to find the statistically significant difference in proportions and the independent student t test was used for finding the statically significant difference between means. Pearson correlation coefficient was estimated for finding linear association between two continuous variables; a P value < 0.05 was considered to be statistically significant. Data entry was done using MS Excel 2013 and IBM SPSS (version 23.0) was used for statistical analysis.

Results

On comparison, no statistically significant differences were observed between the diabetic group and the control group in terms of age, waist-hip ratio, and BMI (P value > 0.05). Also, it was noted that blood sugar values (fasting and postprandial) and HbA1c values were significantly higher among the diabetic patients as compared to that of controls [P value < 0.05; Table 1]. Although, higher amount of fat mass and fat percentage was observed among the diabetic group as compared to that of the controls (P value < 0.05), no statistically significant difference was observed with reference to the underweight mass [P value > 0.05; Table 2]. Significant positive correlation was observed between HbA1c values and body fat mass values [P value < 0.05; Figure 1].

Discussion

The present study was an attempt to study the body mass composition in underweight type 2 diabetic patients and to compare them with the normal population. The study involved 30 underweight type 2 diabetes cases and 30 underweight controls without diabetes mellitus. Though the patients were underweight, their body mass composition revealed that they had a higher amount of body fat mass and fat percentage as compared to that of healthy, underweight control patients. In addition, HbA1c values were found to positively correlate with fat mass.

Due to paucity of research work comparing underweight type 2 diabetes patients and controls in terms of body mass composition, the present study results could be compared with that of similar studies. However, various other studies on body mass composition among patients with diabetes mellitus reported findings similar to that of the present study. A study by Anjana *et al*. reported that visceral and central abdominal fat was high among diabetic subjects as compared to nondiabetic subjects (P value = 0.005 and 0.011)[22]. Arora *et al*. report that the percentage of body fat was significantly high among diabetics as compared to healthy controls (P value < 0.05)[23]. Strotmeyer *et al*.[24] in their study stated that fat mass was significantly high among individuals with diabetes mellitus (P value < 0.05). Similarly, Dayem *et al*.[25] found that underweight body mass and fat ratio were lower, while, total fat mass, abdominal fat percentage, soft tissue fat mass percentage, and fat/underweight ratio were higher in non-insulin-dependent diabetes mellitus patients compared to controls. The findings of these studies were comparable with the current study results. Lee *et al*.[26] in their longitudinal study observed that total fat mass was high among the individuals with diabetes mellitus. Bouche *et al*.[27] in their experimental study reported that low glycemic diet resulted in lower postprandial glucose levels and were associated with a decrease in the total fat mass by ~700 g. The present study also observed a similar correlation between HbA1C values and fat mass. (Pearson correlation coefficient = 0.452, P value < 0.001). Body shape and composition concerns among the patients may result in faulty dietary habits among them which might worsen the diet management of diabetes mellitus.[28] Also, underweight was noted to be more prevalent than obesity among the young Indian population.[29]

One of the strengths of this study was the use of DEXA to assess the body mass composition, which has got better validity and reliability, especially in normal weight and underweight individuals. Comparison with identical controls improves the validity of the study findings. The study is one of the novel research work carried out in India, based on the literature search of the authors. The study participants were from a diverse population of the country. The possible limitation of the study could be that the fat distributions at various parts of the body and their associations were not assessed in the present study considering the feasibility.

Conclusion

Body fat mass was found to be high among underweight, type 2 diabetic patients as compared to healthy controls in our study population and the HbA1C values of the study participants were found to positively correlate with that of fat mass.

Limitation

Nonavailability of regional fat data.

Table 1: Distribution of study participants based on demographic and baseline characteristics

Characteristics	Cases (n=30) n (%)/μ± SE	Controls (n=30) n (%)/μ± SE	Total n (%)/Difference in μ (95% CI)	P
Age (in years)				
18-30	1 (50.0)	1 (50.0)	2 (100.0)	
31-45	18 (51.4)	17 (48.6)	35 (100.0)	
46-60	8 (44.4)	10 (55.6)	18 (100.0)	
>60	3 (60.0)	2 (40.0)	5 (100.0)	
BMI (in kg/m^2)	17.9±0.1	17.7±0.1	0.2 (0.0-.04)	0.11
Waist Hip Ratio	0.87±0.003	0.85±0.005	0.02(.0-0.3)	0.028
Fasting Blood Sugar (in mg/dL)	170.2±12.2	87.6±1.3	82.6 (58-107)	<0.001
Postprandial Blood Sugar (in mg/dL)	231.9±15.3	119.3±2.1	112.6 (82-144)	<0.001
HbA1C	7.9±0.17	5.1±0.06	2.7 (2.3-3.0)	<0.001

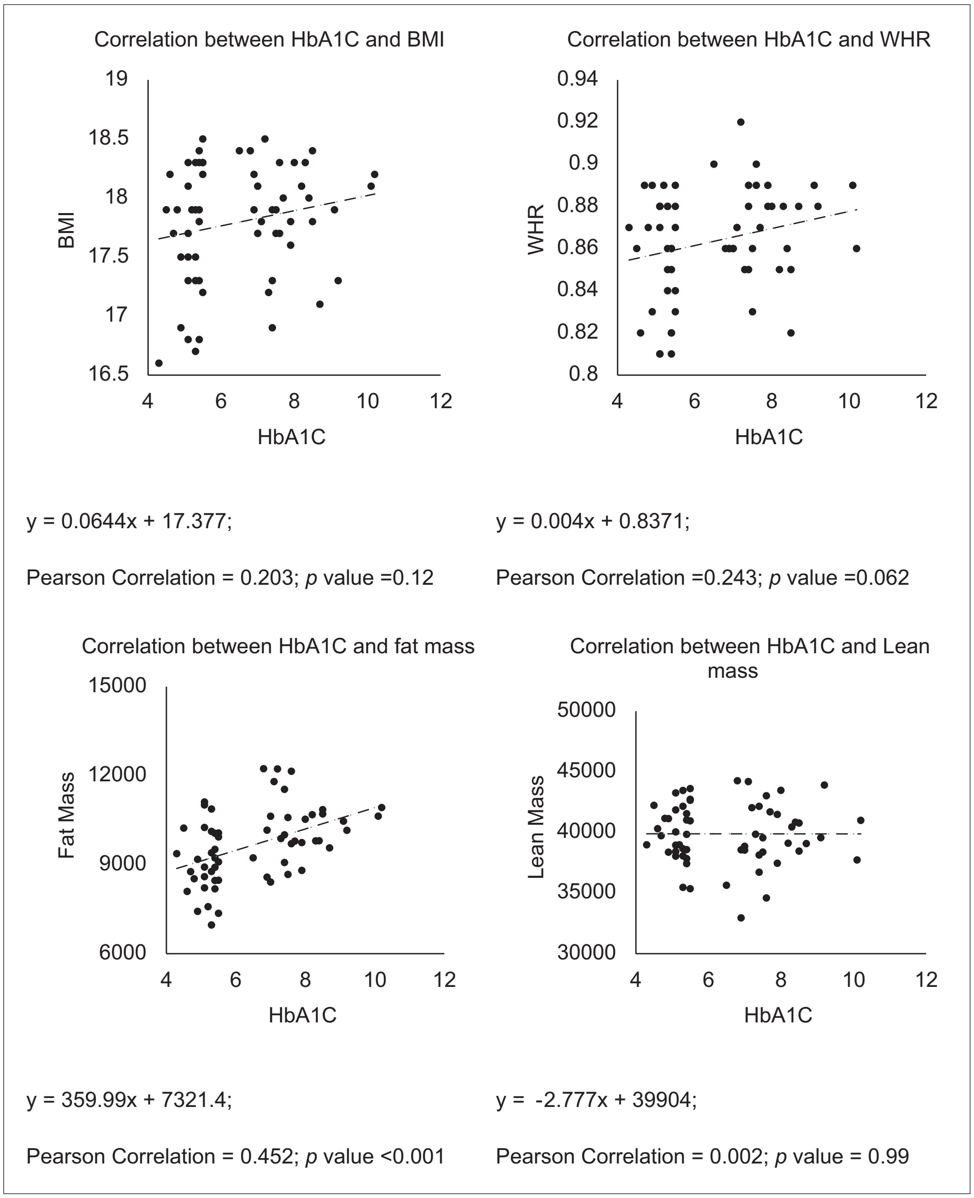

Figure 1: Correlation between body mass composition parameters and HbA1c values

Table 2: Body mass composition parameters among cases and controls

Characteristics	Cases (n=30) μ± SE	Controls (n=30) μ± SE	Difference in μ (95% CI)	*P*
Fat Mass	10243±192	9087±199	1156 (601-1710)	<0.001
Lean Mass	39747±506	40025±406	278(-1577-1021)	0.67
Fat Percentage	19.68±0.23	17.74±0.32	1.9 (1.1-2.7)	<0.001

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Conflicts of interest

There are no conflicts of interest.

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