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Cross-Sectional Study

The Association of Fat Mass and Muscle Mass with Metabolic Conditions: An Indian Cross-Sectional Study

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ABSTRACT

Background: India is the world's growing capital for metabolic disorders like diabetes mellitus (DM), obesity, dyslipidaemia, hypertension, etc., which are pathologically associated with each other and considered as cardiovascular diseases risk factors. In obese patients, the body fat proportion remains high, but it is also dependent on diet, exercise, ethnicity and other factors. Due to these reasons, the body fat proportions paradoxically may be higher in low body mass index (BMI) patients as well.

Aims: In this cross-sectional study, we aimed to evaluate the association of overall fat mass, visceral fat mass and muscle mass with various metabolic conditions in the Indian population.

Materials and Methods: In this cross-sectional study of 423 patients, we measured the body fat percentage including the visceral fat and muscle mass of each patient using Omron™ Body Composition Monitor. The association of body fat percentage with various metabolic conditions was analysed too.

Results: It was observed that Indians have a higher baseline value of HbA1c, BMI than other population. It was also seen that visceral fat mass was higher in DM, hypertensive and obese patients. In fact, in obese patients, as BMI level was increasing the parallel visceral fat proportion was also increasing, while the muscle mass was declining.

Conclusion: This study showed that Indian diabetic, hypertensive and obese patients have considerable overall higher body fat and visceral fat than the White population. We need such type of more studies with a large number and on the various types of Indian populations to compare their association with the rest of the world population.

Keywords: Diabetes mellitus, obesity, hypertension, body fat mass, visceral fat mass, muscle mass

Introduction

Diseases like diabetes mellitus (T2DM), hypertension, and obesity are one of the top five continuing risk factors for cardiovascular deaths in the world and where in obesity is one of the major contributors of disease which is linked pathologically to other cardiovascular risks such as hypertension and diabetes.[1] Currently, metabolic conditions like T2DM, hypertension and obesity are commonly prevalent in India with prevalence rate is ~6%, ~30% and up to ~31%; which is considered as higher level and expected to still increase in future as well[2-4].

Many studies have indicated that the prevalence of diabetes and insulin resistance is rising in India, as Indians are more susceptible to T2DM and insulin resistance compared with western populations.[5,6] As we know that obesity is a major contributing factor to diabetes, Asian Indians are known to have a lower BMI but for any given BMI, Asian Indians have a greater waist-to-hip ratio and abdominal fat[7] than the Europeans. There are very few studies on fat distribution in Indians and virtually none showing its association with co-morbid conditions like T2DM, Obesity and hypertension. Different populations are associated with various patterns of association between impaired fasting glucose (IFG) and body composition parameters and risk factors of cardiovascular disease (CVD). Prediabetic patients have higher body mass index (BMI), waist circumference (WC), and body fat (BF) in comparison to the normal population. In prediabetic population, total cholesterol (TC), triglyceride (TG), and FBS are predictors of the risk of CVDs.[8]

Hypertension is the commonest chronic disease prompting visits to any level of health care centres in the world. Studies suggest that undesirable body composition has a major bearing on health, fitness, and also lifestyle diseases such as hypertension, ischemic heart disease (IHD), and diabetes. Various studies have suggested that out of various body composition parameters, it is the visceral fat area (VFA) that could be best associated with the risk of a chronic condition like hypertension.[9]

BMI has been used traditionally as an anthropometric mean of measuring generalized obesity, but it does not reflect the adiposity or percentage (%) of body fat (BF). The central adiposity measured by the waist-height ratio, waist circumference, and % of BF is known to be a better predictor of diabetes and cardiovascular events than BMI. Moreover, at the same level of BMI, South Asians are believed to have a high % of BF (both central and generalized) and lesser lean, muscle and skeletal mass than the Caucasians and thus being at a higher risk of cardiovascular events and deaths. Currently, limited information exists in the Indian population.[10]

Methods

At Shivam Medicare Clinic, Ahmedabad, Gujarat, India, we did a cross-sectional study on 423 patients. The patients were enrolled randomly. The patient should have any of these comorbid conditions of diabetes, hypertension or obesity. Along with their blood glucose and lipid parameter, we also measured the overall fat mass including visceral and muscle fat mass of each patient. Body fat was measured using Omron™ Body Composition Monitor. We did a statistical analysis of each clinical parameter like HbA1c, obesity, and high blood pressure and observed their correlation with overall fat, visceral fat and muscle mass.

Results

In this Outpatient Department (OPD)-based cross-sectional study, a total of 423 patients were enrolled. Their demographic detail is shown in **Table 1**.

Table 1. Patients demographic data. Abbreviations: T2DM- Type 2 diabetes mellitus; Hb1Ac- Haemoglobin A1c; BMI- Body mass index, SBP- Systolic blood pressure; DBP- Diastolic blood pressure.

Parameter	Value
Total no. of patients	423
Mean age (years)	56±12.86
Total no. of T2DM patients	355
Percentage of T2DM patients	84 %
Mean HbA1c (%)	7.94±1.8
Total no. of obese patients	63
Percentage of obese patients	15 %
Mean BMI (kg/m^2)	28.43±5.32
Mean overall fat mass (%)	33.26±7.18
Mean visceral mass (%)	14.25±6.6
Mean muscle mass (%)	25.8±4.2
Total no. of hypertensive patients	144
Percentage of hypertensive patients	34 %
Mean SBP (mmHg)	132.47±14.1
Mean DBP (mmHg)	81.14±5.0

As per the analysis, with HbA1c (6.5%), high SBP (≥130 mmHg) and high DBP (≥80 mmHg); there was no significant association of visceral fat mass, and the muscle mass was higher than the visceral fat mass. But in obese patients (BMI ≥30 kg/m^2), overall fat mass (body fat - BF) was higher (~36.4%) compared to other clinical parameters. Even in obese patients,

visceral fat mass (~22.7%) and muscle mass (~25.12%) both were higher compared to other conditions (**Table 2**). In T2DM (HbA1c ≥6.5%) and hypertensive patients, the overall fat mass is high, including higher muscle mass in comparison to visceral fat (**Table 2**).

Table 2. Clinical association of metabolic parameter with fat mass and muscle mass

Clinical parameter	Overall fat mass (%)	Visceral fat mass (%)	Muscle mass (%)
HbA1c (≥6.5%)	33.0±7.3	14.16±6.9	26.12±4.3
Obesity (BMI ≥30 kg/m^2)	36.4±6.5	22.7±5.2	25.12±4.29
SBP ≥130 mmHg	33.77±7.36	14.99±6.88	25.57±4.48
DBP ≥80 mmHg	33.26±7.14	14.20±6.52	25.76±4.28

In **Table 3**, fat mass comparison of diabetic and non-diabetic patients is illustrated; which clearly shows that diabetic patients have a more proportion of overall fat mass (33% vs. 31%); where visceral fat (14.1% vs. 11.9%) is in more amount, respectively.

Table 3. Comparison of fat mass and muscle mass in diabetic vs. non-diabetic patients

HbA1c level (%)	Overall fat mass (%)	Visceral fat mass (%)	Muscle mass (%)
Non-diabetic (<6.5%)	31.2±6.21	11.9±5.32	25.42±3.21
Diabetes mellitus (≥ 6.5)	33.0±7.3	14.16±6.9	26.12±4.3

Hypertensive patients are having more amount of total body fat mass compared to normotensive patients (33.3% vs. 27.3%), respectively. There was not much difference in the visceral fat mass between these 2 groups (**Table 4**).

Table 4. Comparison of fat mass and muscle mass in hypertensive vs. non-hypertensive patients

Patients	Overall fat mass (%)	Visceral fat mass (%)	Muscle mass (%)
Normotensive patients	27.3±5.51	13.75±6.21	26.52±4.02
Hypertensive patients	33.34±7.2	14.56±6.62	25.62±4.34

Figure 1 is showing that in obese patients as BMI is increasing from grade 1 to 3, the proportion of visceral fat is increasing from 18.65% to 29%. And accordingly, the muscle mass is declining from 24.4% to 22.2%, respectively.

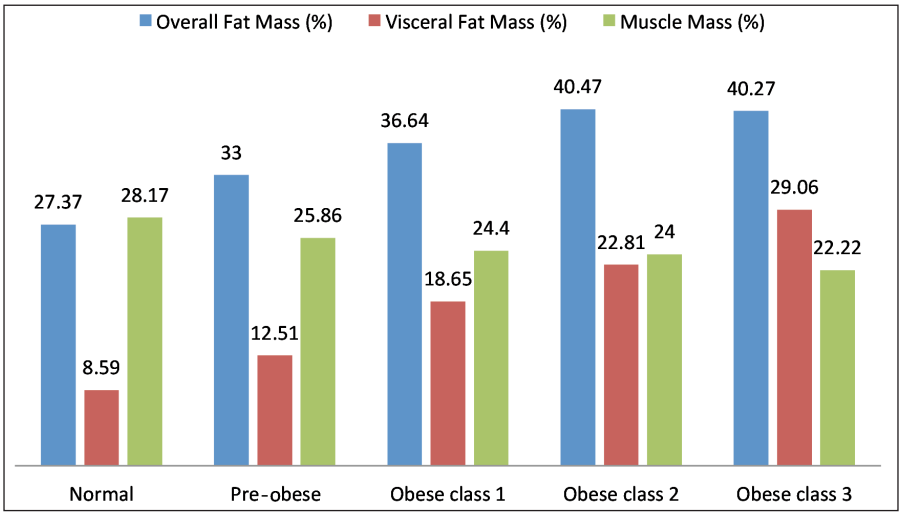

Figure 1. Proportion of fat mass and muscle mass in obese patients (classified based on BMI level)

[Classification of obesity based on body mass index (BMI): normal (18.5 kg/m^2 – 24.9 kg/m^2), pre-obese (25 kg/m^2 -29.9 kg/m^2), obese class 1 (30 kg/m^2 -34.9 kg/m^2), obese class 2 (35 kg/m^2 -39.9 kg/m^2), obese class 3 (> 40 kg/m^2)]

Discussion

Metabolic conditions like T2DM, hypertension and obesity have become extremely prevalent worldwide today. These conditions are associated as risk factors for various cardiovascular diseases (CVD). In these 3 metabolic conditions, the overall fat mass plays a crucial role to assess future CVD risk. A sex-specific threshold of body fat was adopted as 25% for men and 35% for women given by the American Association of Clinical Endocrinologists/American College of Endocrinology (AACE/ACE) guideline (obesity in men ≥25% and women ≥35%).[11] Relationship of body fat and metabolic conditions like obesity is ethnic-specific. Wang D *et al*. observed that Chinese males had more body fat and a greater degree of central fat deposition pattern than white males. Even laboratory parameters like blood pressure, fasting glucose and blood lipids suggest that Chinese men may be more prone to obesity-related risk factors than white men.[12]

Indians tend to have a higher proportion of body fat, especially abdominal fat than white Caucasians, which is very important because of its metabolic implications. As abdominal fat is associated with insulin resistance because of the inflammatory profile of intra-abdominal adipocyte secretions is important and due to that, it has been known that Indians, even from infancy, are more insulin resistant than white Caucasians and a proportionately greater distribution of fat within the abdomen is one possible reason.[13] In our study of 423 patients, it was observed that average body fat is ~33%, while visceral fat and muscle mass is 14% and 26% respectively; which shows that Indians have higher proportion total body fat and visceral fat compared to the Western population.

Indian diabetics have more body fat compared to the western population. Even visceral and central fat proportion remains more compared to non-diabetic patients. In our study, it was observed that patients with high HbA1c (≥6.5%) have 33% total body fat; which is considered as significantly high compared to the normal population. Even visceral fat proportion was also high (14%); which supports that in Indians visceral and central abdominal fat shows a strong association with type 2 diabetes similar to the study conducted by Anjana M *et al*.[6]

Hypertension is such type of metabolic condition which is commonly associated with dyslipidaemia, obesity and T2DM; and one of the most responsible risk factors for CVD like myocardial infarction and stroke. In a study conducted by Bhaskar S V *et al.,* had observed that body fat can be a potent marker for risk assessment in hypertensive patients. In an analysis of 200 hypertensive patients, the mean body fat mass was found to be 21.7 kg, while the mean percent of body fat was 28.9%, which was much higher than the normal. Various parameters depicting body fat were compared. All of them, namely body fat mass, percent body fat, obesity degree, and VFA were found to be significantly higher in hypertensives as compared to the other group.[9] In our study hypertensive patients had significantly higher total body fat (33%); irrespective of high systolic or diastolic blood pressure. Visceral fat mass is also invariably high by 14% in hypertensive patients.

Population with a similar BMI will have different body fat level, which is dependent on variable factors like exercise, diet, genetic factors, etc. The Y-Y paradox theory is a reminder of the limitations of BMI as a measure of adiposity across populations.[14] The percentage of body fat is found to be a better predictor of cardiovascular morbidity and mortality than BMI, but data is very limited on the Indian population. In our analysis, the mean BMI was found to be very high (28.3 kg/m^2) compared to the Asian population cut off level (23 kg/m^2).[15] That is the probable reason for having higher total fat mass in this study population. Misra P *et al*. had done one study on Indian obese patients to observe the relationship between body mass index and percentage of body fat in the rural patients of India.[10] In this study of 388 patients, it was seen that mean fat mass and BF% was 19.2 kg and 33.6%. BMI and BF% were highly correlated among obese, whereas least correlated in the underweight population. In our cross-sectional study, obese patients were associated with the highest body fat percentage (36.4%) and visceral fat (22.7%); which is higher than average western population fat proportion as well.

Limitations of the Study

Major limitations of this study are its design of the cross-sectional study and small sample size. We need clinical study with an objective to assess long term association of total body fat with metabolic and cardiovascular disease and their outcome and currently, we are doing such analysis on the similar patient population. Long term follow-up these patients will provide long term effect of body fat on metabolic and cardiovascular disease in the Indian population.

Conclusion

Our study concludes that Indian diabetic, hypertensive and obese patients have considerable overall higher body fat and visceral fat than the White population. High-fat level in the body is a strong indicator for the futuristic development of CVD

events and insulin resistance as well. Hence, considering these factors, today India is the global capital of T2DM and other cardiovascular diseases as well, and in the future, it is going to increase.

Declaration of conflicting interests

The authors declare no any conflict of interest.

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Ethical approval

Considering this study as a cross-sectional and observational study, ethics committee approval was not required.

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