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Observational Study

Association of Fat Mass and Muscle Mass with Metabolic Conditions: Single Centre Indian Cross-Sectional Study

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ABSTRACT

Background: Diseases like diabetes mellitus (T2DM), hypertension, and obesity are one of the top five continuing risk factors for cardiovascular deaths in the world and are commonly more prevalent in India ,which is considered as higher level and expected to still increase in future as well. There are very few studies on fat distribution in Indians and virtually none showing its association with comorbid conditions like T2DM, obesity and hypertension. Body Mass Index (BMI) has been used traditionally as an anthropometric mean of measuring generalized obesity, but it does not reflect the adiposity or body fat (BF) percentage. Central adiposity as measured by waist height ratio, waist circumference, and BF% are known to be better predictor of diabetes and cardiovascular events than BMI. Moreover, at same level of BMI, south Asians are believed to have high BF% (both central and generalized) and lesser lean, muscle and skeletal mass than Caucasians and thus being at a higher risk of cardiovascular events and deaths. Currently, very limited information exists showing relationship between metabolic condition and body fat, visceral fat and muscle mass in Indian population. In this cross sectional study, we aimed to evaluate association of overall fat mass, visceral fat mass and muscle mass with metabolic conditions like T2DM, obesity, hypertension & waist hip ratio (WHR), in Indian population. **Materials and Methods:** In Ahmedabad at our OPD center, we did cross sectional study in 618 patients and did statistical analysis of each clinical parameter like T2DM, obesity, high blood pressure and WHR and observed their correlation with overall fat, visceral fat and muscle mass. **Results:** In this study, it was observed that in Indians the average total body fat % is ~35%, while visceral fat and muscle mass are 15% and 25% respectively; which is higher compared to the western population. It is also observed that in obese patients and patients with high WHR, visceral fat is more in proportion compared to other metabolic conditions. **Conclusion:** This study showed that Indian patients have higher proportion of metabolic syndrome inclusive of T2DM, hypertension and obesity with overall higher body fat and visceral fat than white population. We need more of such type of studies with large number and on various types of Indian populations to compare their association with rest of the world population.

Keywords: Diabetes Mellitus, Obesity, Hypertension, Body fat mass, Visceral fat mass, Muscle mass

Introduction

One of the root causes of metabolic disturbances such as insulin resistance and dyslipidemia is obesity, leading to disorders such as diabetes, hypertension and atherosclerotic disease. Apart from higher body mass index (BMI), presence of increased body fat, its distribution within the body, particularly central body obesity, and dysfunction of the body fat within these deposits is more important, which is known as 'sick fat' or adiposopathy that are associated with the development of diseases.[1]

Currently, metabolic conditions like T2DM, hypertension and obesity are commonly prevalent in India with prevalence rate of ~7.4%, ~36.5% and upto ~40%; which is considered as higher level and expected to still increase in future as well.[2-4] Many studies have indicated that 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] We know that obesity is a leading contributor for diabetes and dyslipidemia. Due to that Asian Indians have more probability of visceral or central obesity than Caucasians.[7] Currently, there is a lack of studies showing fat distribution in Indian population and its association with comorbid 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 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 centers 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. Central adiposity as measured by WHR, WC, and % of BF are known to be better predictor of diabetes and cardiovascular events than BMI. Using WHR rather than BMI as a measure of obesity and hence risk for CVD makes a considerable difference, particularly important in regions such as Asia, which have not had significant problems with obesity as measured by BMI but would have considerably greater cardiovascular risk if WHR was used.[10]

Aims: In this cross-sectional study, we aimed to evaluate association of overall fat mass, visceral fat mass and muscle mass with metabolic conditions like high HbA1c, obesity (according to BMI and WHR) and hypertension, in Indian population.

Methods: In Ahmedabad at our Diabetic Clinic center, we did cross sectional study in 618 patients. Patients were enrolled randomly. Patient should have any of these comorbid conditions of diabetes, hypertension or obesity. Along with their blood glucose and lipid parameter, we also measured overall fat mass including visceral and muscle mass of each patient. Body fat was measured through instrument of Omron™ Body Composition Monitor. We did 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 OPD-based cross sectional study, total 618 patients were enrolled. Their demographic details are mentioned in Table 1.

Table 1. Demographic data of patients

Parameter	Value
Total no. of patients	618
Mean age (years)	54.78 ± 12.71
Mean Waist Hip Ratio (cm)	0.92 ± 0.07
Mean HbA1c (%)	7.81 ± 1.79
Proportion of T2DM patients (%)	64.4
Mean BMI (kg/m^2)	29.34 ± 6.32
Mean overall fat mass (%)	34.90 ± 7.27
Mean visceral mass (%)	14.65 ± 6.58
Mean muscle mass (%)	24.96 ± 3.82
Proportion of obese patients (%)	35.9
Mean SBP (mmHg)	132.41 ± 14.3
Mean DP (mmHg)	81.04 ± 7.18
Proportion of hypertensive patients (%)	37.2%

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

Clinical Parameter	Overall Fat Mass (%)	Visceral Fat Mass (%)	Muscle Mass (%)	HbA1c (%)
HbA1c (> 6.5%)	35.34 ± 7.2	15.57 ± 6.0	25.08 ± 3.8	NA
Obesity (BMI > 30 kg/m^2)	38.63 ± 6.82	21.16 ± 5.23	22.83 ± 3.32	8.02 ± 1.93
High WHR in Male (> 1.0)	38.27 ± 6.45	19.4 ± 6.71	21.29 ± 4.92	7.98 ± 2.13
High WHR in Female (> 0.86)	37.77 ± 5.45	18.89 ± 5.81	21.59 ± 5.29	7.88 ± 2.01
Hypertension	35.52 ± 7.13	15.54 ± 6.71	24.64 ± 3.71	7.75 ± 2.01

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

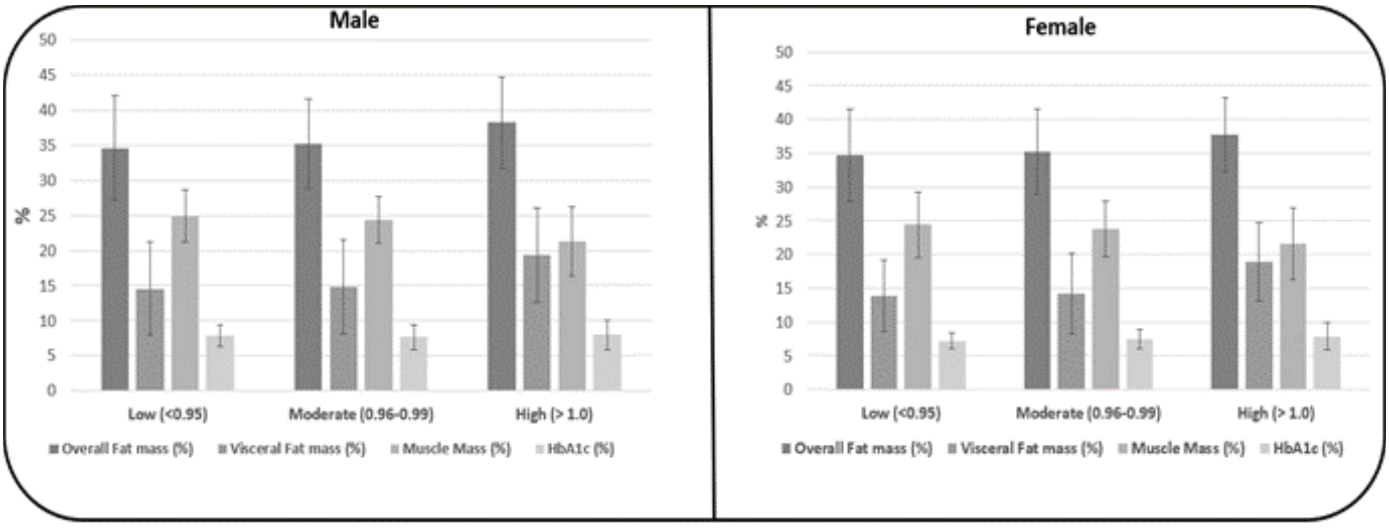
HbA1c Level (%)	Overall Fat Mass (%)	Visceral Fat Mass (%)	Muscle Mass (%)
Non Diabetic (<6.5%)	33.87 ± 6.01	14.00 ± 5.57	26.00 ± 3.41
Diabetes Mellitus (>6.5)	35.34 ± 7.2	15.57 ± 6.0	25.08 ± 3.8

As per analysis, with HbA1c (6.5%), high SBP (>130 mmHg) & high DBP (>80 mmHg); there was no significant association of visceral fat mass, in fact muscle mass was higher than visceral fat mass. But in obese patients (BMI > 30 kg/m^2), overall fat mass (BF) was higher (~38.6%) compared to other clinical parameters. Even in obese patients, visceral fat mass (~21.2%) and muscle mass (~22.8%) both were higher compared to other conditions (Table 2). In T2DM (HbA1c > 6.5%) and hypertensive patients overall fat mass is high, including higher muscle mass compared to visceral fat. Waist hip ratio should be ideal marker to assess overall body fat and visceral fat. In male and female both with high WHR had ~38.2% and ~37.8% overall fat mass which was higher compared to other metabolic parameters. (Table 2).

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

Presence of overall fat mass was almost similar in both male and female with high WHR. Higher WHR was also associated with high HbA1c in males (~8.0%) and females (~7.9%) (Table 4).

Table 4. Association of waist hip ration (WHR) with fat mass, muscle mass and HbA1c in male and female



Discussion

Metabolic conditions like T2DM, hypertension and obesity have become extremely prevalent worldwide today. These conditions are associated as risk factors for various CVDs. In these three metabolic conditions, overall fat mass plays a crucial role to assess in-future CVD risk. A sex-specific threshold of body fat was adopted as 25% for men and 35% for women given by the AACE/ACE guideline (obesity in men ≥25% and women ≥35%).[11] Relationship of BF and metabolic conditions like obesity is ethnicity specific. Pradeepa R et al. observed that due to industrialization and changes in lifestyle, in urban population of India, obesity prevalence is increasing. Being south Asians, visceral deposition is much higher compared to other ethnic people. Associated conditions like type 2 diabetes, hypertension, obesity are also prevailing on higher side in India.[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 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 BF is ~33%, while visceral fat and muscle mass are 14% and 26% respectively; which shows that Indians have higher proportion of total body fat and visceral fat compared to western population.

Indian diabetics have more body fat compared to 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 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; which was resembling with Chhaya G et al. study from one of the Indian diabetes centre.[14]

Hypertension is such type of metabolic condition which is commonly associated with dyslipidemia, obesity and T2DM; and one of the most responsible risk factor for CVD like MI and Stroke. Bhaskar S V et al. 2017, had observed that body fat can be a potent marker for risk assessment in hypertensive patients. In analysis of 200 hypertensive patients, the mean body fat mass was found to be 21.7 kg, while mean percent BF was 28.9%, which was much higher than the normal. Various parameters depicting BF were compared. All of them, namely, body fat mass, percent body fat, obesity degree, and visceral fat area (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 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.[15] Percentage of BF is found to be better predictor of cardiovascular morbidity and mortality than body mass index (BMI), but data is very limited on Indian population. In our analysis, mean BMI was found to be very high (28.3 kg/m^2) compared to Asian population cut off level (23 kg/m^2).[16] That is probable reason of having higher total fat mass in this study population. Mishra P et al. 2019[17] had carried out one study on Indian obese patients to observe relationship between body mass index and percentage of body fat in Indian rural patients. 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 underweight population. In our cross sectional study, obese patients were associated with highest body fat % (36.4%) and visceral fat (22.7%); which is higher than average western population fat proportion as well.

Visceral fat (VF) is the underlying culprit for cardiovascular diseases, type 2 diabetes, breast cancer, etc. WHR measurement can be used as a proxy for VF. Gadekar T et al. observed very strong correlation between VFA and WHR ($r = 0.936$, $p < 0.05$) among males and females ($r = 0.920$, $p < 0.05$) and correlation between WC and BMI with VFA was significantly higher in males and modest in females.[18]

Limitations of study

This study is limited with cross sectional design and small sample size. We need to have long-term follow up study showing outcome of CVD events in patients having higher body fat with metabolic complications, especially in Indian setting. Accuracy data of the OMRON™ Body Composition Monitor when estimating BF% is scarce, so comparisons against validated techniques should be conducted. This instrument needs more comparative validity data especially in female patients, as in such group of patients, it shows overestimated proportion of fat.

Conclusion

Our study concludes that Indian diabetic, hypertensive and obese patients have considerable overall higher body fat and visceral fat than white population. To assess visceral fat, waist hip ratio is much reliable marker than BMI; and high WHR is indicator of elevated risk of CVD and insulin resistance as well. Hence considering all these factors, today India is global capital of T2DM and other cardiovascular diseases as well; and in future it is going to increase.

Conflict of Interest

No any conflict of interest

Ethics Committee approval

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

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