Journal for Re Attach Therapy and Developmental Diversities
eISSN: 2589-7799
2022 November; 5 (2): 526-532

# Body Composition Alterations About Chronic Diseases: A Focus On Obesity And Diabetes

**Dr. Umesh Zadgaonkar***

*Fitness Consultants, Nagpur (Maharashtra), 440015, Email: umesh.zadgaonkar@gmail.com

**Abstract**

Numerous chronic diseases affect the metabolism system and the most common diseases include obesity and diabetes. Changes in body composition like obesity and reduced muscle mass are directly linked to these disorders. It helps to better understand the interconnections between body composition and biochemical parameters as well as to identify the metabolic derangements associated with obesity and diabetes. This study aimed to evaluate body mass index (BMI) and other anthropometric indices concerning Cancer and the underlying biochemical biomarkers in three groups, healthy controls, obese patients without diabetes, and obese patients with diabetes. The interactions between anthropometry, namely BMI, % body fat (BF), visceral fat, muscle mass, and bone mineral content (BMC), with biochemical markers, Fasting Blood Glucose (FBG), HbA1c, lipid profile, and triglycerides. In total 300 participants were included in the study, and 100 participants in each group. The obesity with diabetes group showed the highest FBG (142.3 ± 15.7 mg/dL) and HbA1c (7.8 ± 1.1%) compared to controls (FBG, 88. Fasting blood glucose as well, 127 ± 41 mg/dL, and HbA1c, 5.3 ± 0.4. Compared to controls, BMI was considerably higher among the obese groups: 33.2 ± 3.8 kg/m² for obesity only and 34.5 ± 4.2 kg/m² for obesity with diabetes. Obesity groups had the lowest muscle mass and BMC. Significant moderate significant correlations between %BF and FBG were found and MM was inversely correlated to HbA1c. These findings stress the need for individual targeted interventions to reduce metabolic risks.

**Keywords:** Anthropometry, Obesity, Diabetes, Abdominal fat, Lean body mass, Fasting blood glucose, Lipid profile, and Biochemical values.

## 1. Introduction

Obesity and diabetes are chronic diseases that have become global threats that significantly affect health and healthcare systems. According to WHO, over 650 million people are obese, and about 537 million adults are diagnosed with diabetes (Rohm et al., 2022). Obesity and diabetes are two conditions that are known to be associated with changes in body composition such as the distribution of fat, fat-free mass, and BMC (Scherer & Hill, 2016). These changes are not only the signs of the diseases but are also connected with several pathologic states, including dyslipidemia, insulin resistance, and cardiovascular diseases. The impact of body composition on biochemical markers, in this population can help elucidate the etiology of these diseases and inform the creation of individualized treatment plans (Klein et al., 2022). Being overweight is defined as having a BMI greater than 25 with or without obesity, which includes having abnormal proportions of fat with or without increased visceral fat, the latter being associated with adverse metabolic outcomes. This is a dysmetabolic risk factor since the condition causes insulin resistance, which is a key feature of type 2 diabetes (Pillon et al., 2021). Type 2 diabetes is defined by long-standing hyperglycemia because of relative insulin deficiency. Obesity and diabetes are said to have impacts on body composition in that, obesity leads to a decrease in muscle mass and a reduction of BMC which in turn compounds health risks (Shu et al., 2019). Body composition and its contribution to the development and advancement of obesity and diabetes has been researched with a focus on how the distribution of body fat and muscle mass affects the metabolopathies of the diseases (Aleksandrova et al., 2013). In comparing patients with different levels of obesity and diabetes, the relationship between different indices of body composition and biochemical indicators FBG, HbA1c, total cholesterol, LDL, HDL, and triglycerides remains understudied (Singla et al., 2010). Several works presented the role of body mass in metabolic disorders especially in type 2 diabetes mellitus. It has also been found that higher BMI, higher percentage of body fat, and greater amount of visceral fat are good predictors of the development of insulin resistance and type 2 diabetes. It was established that people with large visceral fat have a high possibility of developing insulin resistance and Type 2 diabetes (Lin et al., 2021). Omentum and mesenteric fat or the fat deposited around the internal organs is more dangerous because it secretes cytokines and hormones that interfere with normal metabolic activity and promote insulin resistance. The decrease in muscle mass was found to be linked to worse glucose tolerance and decreased insulin sensitivity (Heshka et al., 2008). Besides fat mass, BMC was also reported to be decreased in obesity and diabetes groups, which raised questions regarding the future bone health of these populations. The obese people with type 2 diabetes had higher risks of fracture when their BMC was low (Ortega et al., 2020). Muscle mass is an independent protective factor for glucose metabolism, and individuals with higher muscle mass have improved insulin sensitivity and metabolic profile. Sarcopenia has both been reported to be positively related to insulin resistance,

and sarcopenia was independently associated with insulin resistance and higher HbA1c levels in older adults emphasizing the significance of muscle mass in the management of metabolic diseases (Lin & Li, 2021&Anton et al., 2013). Previous investigations either utilized a single parameter or compared a few variables at most, across small groups of participants. Obesity and diabetes are two of the leading chronic conditions worldwide and when they occur together, increase the chance of contracting other critical conditions including cardiovascular disease, stroke, and renal failure (Gadde et al., 2018). These conditions result in changes in body composition characterized by elevated percentage of body fat especially visceral fat and reduced percent fat-free mass and BMC. The specific links between these changes in body composition and biochemical abnormalities like elevated fasting blood glucose, HbA1c, dyslipidemia, and other indices of metabolic dysfunction are not well understood (Sikaris, 2004). There is a lack of a detailed investigation of multiple body composition parameter and their relationships with biochemical markers in various groups (Scully et al., 2021). This study will address this gap by comparing these parameters across three distinct groups, with healthy controls, subjects with obesity but no diabetes, and subjects with obesity and diabetes.

**Objectives of the study**

The primary objective of this study is to investigate the relationship between body composition parameters and biochemical profiles across three distinct groups, the three groups were healthy controls, only obesity, and obesity with diabetes. This work will seek to evaluate the relationships between BMI, %BF, central obesity, lean mass, and BMC with FBG, HbA1c, total cholesterol (TC), LDL-C, HDL-C, and triglycerides. This study aims to explore how changes in body composition affect the biochemical parameters and the development of obesity and diabetes.

## 2. Materials and Methods

### 2.1 Study Design

The study utilized a cross-sectional design to assess body composition differences among three groups of participants normal subjects, obese subjects, and obese combined with diabetic subjects. There were 100 people in each group out of 300 in total. Anthropometric measurements of BMI, %BF, Visceral Fat Area (VFA), skeletal muscle mass, and BMC were assessed and compared. The study sought to compare interesting differences across the groups and assess the relationship between anthropometric measurements and biochemistry.

### 2.3 Inclusion and exclusion criteria

All together 300 participants were included in the study, 100 each from the three categories of patients attending the outpatient clinic of a tertiary care teaching hospital.

#### 2.3.1 Inclusion Criteria

The participants aged between 18 and 65 years with valid informed consent and no known neurological disease or history of alcohol dependence. The study involved students of the university and all of them volunteered to take part in the research.

#### 2.3.2 Exclusion Criteria

Patients in their pregnancies, chronic renal disease patients, and patients diagnosed with any type of cancer were not included in the study. These criteria were adopted to minimize the vulnerability of participants and more so to avoid interference of features that would skew the findings. Any participant who fell under these exclusion characteristics was not invited into the study to keep clear the distinct features of the targeted research design and the causes and effects under observation.

### 2.4 Body Composition Analysis

Body composition was assessed using bioelectrical impedance analysis (BIA) instruments from Pvt. Ltd., Mumbai, India. The results presented offered specific quantitative values of different aspects of fatness. By height weight measurements of the participant's BMI were calculated to ascertain their weight status. The proportion of fat in the body was found through the assessment of the Total Body Fat Percentage (% BF). The Visceral Fat Level measurement was conducted to determine the quantity of fat that is deposited around the organs. Muscle Mass was also taken to measure the poundage of muscles in the body. BMC was taken to measure the mineral deposition in bones. These parameters were assessed for each participant to ensure that the complete picture of their assessment of physical health was obtained.

### 2.5 Biochemical Analysis

Before the test session, conventional fasting blood samples were obtained from all the participants, and their biochemical results were assessed in terms of the following parameters. (FBG) Fasting Blood Glucose was taken to check the participants' glucose handling capacity and to include or exclude them as diabetic patients. Glycated Hemoglobin (HbA1c)

was also measured to give an impression of mean blood glucose control in the previous 2-3 months. In terms of Lipid Profile, the evaluations were TC, LDL- Cholesterol, HDL-Cholesterol, and Triglycerides. These lipid indexes were useful to determine the lipid status of the participants and their potential risk of cardiovascular diseases. All biochemical assays were conducted using conventional methods and the values obtained were used in assessing the metabolic status of the participants and also in checking for biochemical derangement or changes in the participant's markers.

**2.6 Statistical Analysis**

The study results were analyzed using a statistical tool commonly known as Statistical Package for Social Sciences (SPSS) software for Windows version 26.0. The descriptive data was analyzed and the results were described by mean ± standard deviation (SD) per parameter. One-way analysis of variance (ANOVA) was used to assess variance between groups, and to compare between the groups, Tukey's post hoc test was applied. It was possible to identify the statistically significant differences among the groups. Laboratory findings were analyzed using Pearson correlation to analyze correlations between body composition parameters and biochemical indices. It also enabled the levels of association and directions between variables such as body fat percentage, muscle mass, and biochemical indicators like fasting blood glucose and lipids. The overall assessment of the results in our study was facilitated by the statistical analysis that revealed the relationship between body composition and biochemical health in subjects.

## 3. Results

**3.1 Baseline Characteristics of Study Groups**

In Table 1, the demography of the subjects, age, and BMI differences between healthy controls, obesity only, and obesity with diabetes were compared. The sample consisted of 100 participants in each group, healthy controls (Group 1), obesity only (Group 2), and obesity with diabetes (Group 3). The mean age for healthy control subjects was 40.5 years, for obesity only group, 42.3 years, and for the obesity + diabetes group 43.8 years. The p-value obtained for age comparison was 0.08. As for BMI, it also differed significantly between groups BMI in healthy controls=23.4, in obese only patients =33.2, and in the Obese with diabetes group=34.5, p-value <0. 001. The percent of body fat and visceral obesity levels was also significantly elevated with obesity only and obesity + diabetes than healthy controls. In both obesity groups, the muscle mass and the bone mineral content were reduced in comparison with the control group.

**Table 1: Baseline Characteristics of Study Groups**

| Parameter | Healthy Controls (n=100) | Obesity Only (n=100) | Obesity + Diabetes (n=100) | p-value |
|---|---|---|---|---|
| Age (years) | 40.5 ± 10.2 | 42.3 ± 11.1 | 43.8 ± 9.7 | 0.08 (not statistically significant) |
| BMI (kg/m²) | 23.4 ± 2.1 | 33.2 ± 3.8 | 34.5 ± 4.2 | <0.001 |
| % Body Fat | 20.1 ± 3.5 | 35.6 ± 4.1 | 36.8 ± 3.8 | <0.001 |
| Visceral Fat Level | 6.2 ± 2.1 | 12.5 ± 3.5 | 14.3 ± 3.7 | <0.001 |
| Muscle Mass (kg) | 28.7 ± 4.3 | 25.5 ± 3.8 | 24.8 ± 4.1 | <0.001 |
| Bone Mineral Content (kg) | 2.6 ± 0.4 | 2.4 ± 0.3 | 2.3 ± 0.3 | <0.001 |

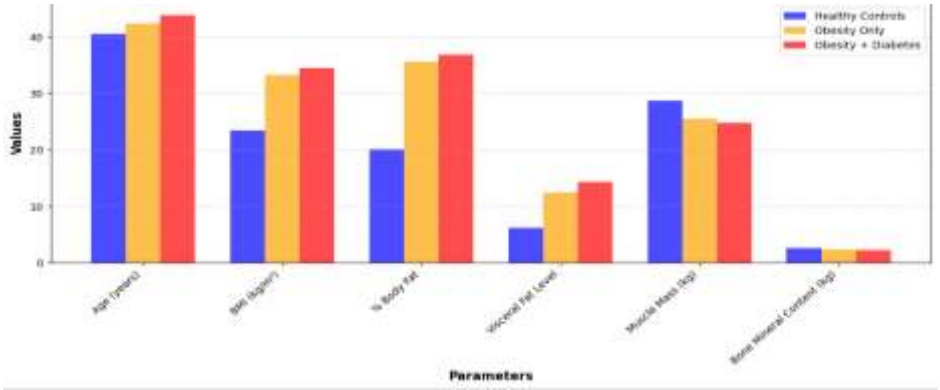


**Figure 1: Baseline Characteristics of Study Groups**

Figure 1 illustrated baseline characteristics across three study groups, Higher healthy control (HC) combinations were observed in Healthy Controls, Obesity Only, and obesity + diabetes groups. All the recorded results of the participant's assessment showed the highest scores in the Obesity + Diabetes client's group, including age and body mass index. After the group comparison, results showed that the BFP% and VFA were lowest in HC but significantly escalated across the other groups. HC had the greatest muscle mass while obese without Diabetes Mellitus (DM) and obese with DM had less muscle mass. The BMC did not significantly differ between the lean and obesity groups. There was some evidence that these values are, on average, slightly lower in Obesity-related groups than in lean HC.

### 3.2 Biochemical Parameters Across Groups

In Table 2 the biochemical parameters variability between groups used 100 HC, 100 only obesity patients, and 100 obese patients with diabetes. Hyperglycemia was manifested by a fasting blood glucose level significantly raised both in obesity-only and obesity + diabetes groups, 92.7 ± 10.3 mg/dL and 142.3 ± 15.7mg/dL, respectively. Obesity-associated diabetes had significantly ($P<0.05$) higher HbA1c levels than the other groups, 7.8 ± 1.1. The obesity only also obesity combined with diabetes groups had a higher value in TC, LDL, and triglycerides when compared to the control group. Both obesity-only as well as obesity-plus diabetes subjects had significantly reduced levels of HDL cholesterol as compared to normal subjects.

**Table 2: Biochemical Parameters Across Groups**

| Parameter | Healthy Controls (n=100) | Obesity Only (n=100) | Obesity + Diabetes (n=100) | p-value |
|---|---|---|---|---|
| Fasting Blood Glucose (mg/dL) | 88.2 ± 9.1 | 92.7 ± 10.3 | 142.3 ± 15.7 | <0.001 |
| HbA1c (%) | 5.3 ± 0.4 | 5.5 ± 0.5 | 7.8 ± 1.1 | <0.001 |
| Total Cholesterol (mg/dL) | 175.8 ± 20.1 | 192.3 ± 25.4 | 210.6 ± 28.7 | <0.001 |
| LDL (mg/dL) | 100.4 ± 15.3 | 112.5 ± 18.7 | 130.2 ± 21.8 | <0.001 |
| HDL (mg/dL) | 55.2 ± 9.8 | 48.3 ± 7.6 | 45.6 ± 8.1 | <0.001 |
| Triglycerides (mg/dL) | 112.4 ± 23.6 | 138.2 ± 30.4 | 162.3 ± 35.7 | <0.001 |

### 3.3 Correlations Between Body Composition and Biochemical Parameters

Table 3 shows actual and multiple relationships between body composition parameters and several biochemical properties. The analysis of the results of the current study demonstrated a moderate to high positive correlation between BMI, % body fat, and visceral fat, combined with their relation to higher levels of FBG and HbA1c. There is a significant, but positive association between BMI, % body fat, and visceral fat with TC and LDL cholesterol. A negative regression was established between BMI, % body fat, visceral fat, and HDL cholesterol. A negative relationship was also observed between muscle mass and BMC with FBG, HbA1c, total cholesterol, and LDL cholesterol.

**Table 3: Correlations Between Body Composition and Biochemical Parameters**

| Parameter | BMI | % Body Fat | Visceral Fat | Muscle Mass | BMC |
|---|---|---|---|---|---|
| FBG | 0.52** | 0.48** | 0.56** | -0.34** | -0.21* |
| HbA1c | 0.48** | 0.44** | 0.50** | -0.30** | -0.20* |
| Total Cholesterol | 0.40** | 0.38** | 0.42** | -0.25** | -0.15 |
| LDL | 0.35** | 0.34** | 0.37** | -0.22* | -0.12 |
| HDL | -0.25* | -0.24* | -0.28** | 0.18 | 0.15 |
| Triglycerides | 0.42** | 0.40** | 0.44** | -0.27** | -0.18 |

**Note:** *p < 0.05, **p < 0.01

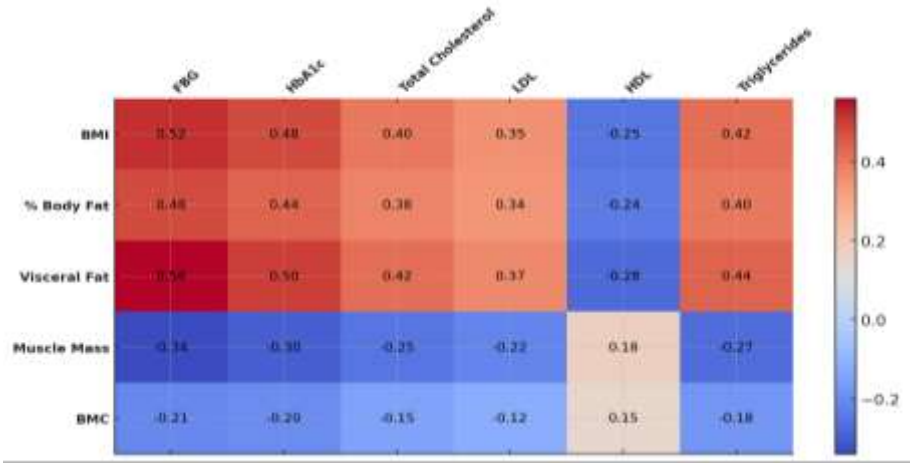


**Figure 2: Correlations Between Body Composition and Biochemical Parameters**

In Figure 2 the heatmap illustrates the correlations between body composition metrics and biochemical parameters. Strong positive correlations were observed between VF and FBG (r = 0.56) and between BMI and FBG (r = 0.52). Body fat metrics, including % body fat and visceral fat, were positively associated with triglycerides and HbA1c. Muscle mass showed weak negative correlations with most biochemical parameters, notably with LDL (r = -0.22). BMC exhibited the weakest correlations overall, including a slight negative correlation with HDL.

## DISCUSSION

The primary objective of this study was to examine the relationship between body composition parameters and biochemical profiles across three distinct groups, The three groups include HC, individuals with obesity only, and those with obesity and diabetes. The study aimed to assess the relationship between anthropometric measurements including BMI, % body fat, visceral fat, muscle mass, and BMC with biochemical parameters including FBG, HbA1c, lipid profile, and triglycerides. The study's purpose was to explain the connections between obesity and diabetes and improve understanding of the effects of both conditions on metabolic and physiological well-being. The result of the study was to establish that obesity and obesity with diabetes hurt body composition and biochemical factors as compared to the normal group of people. BMI, % body fat, and visceral fat were significantly increased in obesity-only and obesity with diabetes, and the highest level was observed in obesity with diabetes. These results show that obesity has a progressive effect on body composition, which is compounded when the patient also has diabetes. Serum FBG, HbA1c, and lipid profiles showed a shift in obesity only and obesity with diabetes. The mean value for both FBG and HbA1c was significantly higher in the obesity with diabetes group suggesting poor glycemic control. Lipid profile abnormalities were evident in both obesity-related groups, with increased levels of LDL, and triglycerides and decreased levels of HDL pointing to a dyslipidemic state (Schwartz et al., 2017). Obesity groups had significantly lower mean muscle mass and BMC compared with the healthy control group, which underlines the deleterious impact of obesity on the musculoskeletal system. The findings of this study also indicated that body composition was significantly and positively related to biochemical

parameters such as BMI, % body fat, and visceral fat with some of the undesirable metabolic biomarkers including FBG, HbA1,c, and triglycerides. Muscle mass and BMC were inversely related to these markers and this implies that lean body mass and higher BMC may prevent metabolic abnormalities (Jura & Kozak, 2016). The results corroborate previous evidence suggesting that obesity and diabetes impact metabolic homeostasis. Several investigations have established that both increased BMI and increased visceral fat are major predictors of insulin resistance, hyperglycemia, and dyslipidemia. Comparable relationships of visceral fat to high FBG and HbA1c concentrations (Eckel et al., 2011). Loss of muscle mass in obesity-related conditions has been described in other growing research, which further rotates concerning the well-being of metabolism. Muscle also plays a large role in glucose uptake and when it is lost, hyperglycemia is worsened. The present study contributes to this pool of information by showing that loss of muscle mass and BMC is linked with elevated FBG and HbA1c values, which point to poor metabolic performance (Zhang et al., 2022). There was a significant difference when evaluating the lipid profiles of the participants. Several works described higher dispersion of LDL cholesterol within populations, which might be attributed to the contributions of diet, genes, or physical activity (Strasser, 2013). The study supports the concept of focusing on body composition parameters to reduce metabolic risks in obesity and diabetes. The interventions directed towards visceral fat and muscle mass have huge impacts on glycemia and lipidemia. These findings provide a rationale for developing more effective weight loss interventions that incorporate not only BMI but also the composition of the body and the effects of obesity-related comorbidities (Pulgaron & Delamater, 2014). The high level of dependency between body composition parameters and biochemical markers indicates that body composition should be incorporated as a standard diagnostic check. Future studies should continue to examine the cross-sectional associations between body compositions and metabolic profiles (Al-Sofiani et al., 2019). This would help in the assessment of causality, and the trend analysis of the changes that may occur in the future. Further research could also be directed toward comparing the effect of some interventional measures including exercise, dietary changes, and pharmacologic treatments on both adiposity and metabolic indices (St-Onge & Gallagher, 2010). There is a need to understand the direct and indirect effects of genetic factors and epigenetic effects on the observed relationships. Knowledge of the gene might give clues to dealing with obesity and diabetes more effectively depending on each person's genetic traits. Understanding the relationship of body composition with other diseases like cardiovascular diseases, osteoporosis, etc., would give better insight into the disease susceptibility to obesity and diabetes (Szadkowska et al., 2015). There were some limitations of the study which need recognition Some of them include the following. The cross-sectional study design reduces the prospects of inferring causality between body composition parameters and biochemical markers. The influence of physical activity level, diet, and other factors such as socioeconomic status, which can affect body composition as well as biochemical parameters, was not considered. The sample was restricted to three different groups, and the results cannot necessarily be applied to other populations especially those with different ethnic, genetic, or environmental endowments. There was a focus on a few body composition variables including BMI and visceral fat, which do not accurately represent body fat distribution.

## CONCLUSION

The study revealed significant differences in body composition and biochemical parameters between the three study groups, Control, Healthy Controls, Obese, and Obese with Type II diabetes. The outcomes revealed that the obese participants particularly those diagnosed with diabetes had a significantly greater body fat % and visceral fat and lower skeletal muscle mass when compared to the control group. Obesity-related groups had significantly higher BMI and less bone mineral density suggesting that obesity is a health risk. The study showed that fasting blood glucose and HbA1c were raised in both obesity only and obesity with diabetes groups, but those with the highest levels were the obesity with diabetes groups. Lipid profile analysis showed that obesity-related groups had significantly higher total cholesterol, LDL, and triglycerides, though they had lower levels of HDL cholesterol. These biochemical derangements were significantly higher in the obesity with diabetes group suggesting that obesity and diabetes have an independent negative impact on metabolism. Composition parameters with biochemical indices revealed a direct relation between BMI, % body fat, and visceral fat with fasting blood glucose, HbA1c, and lipid dysfunction and an inverse relation between muscle mass and bone mineral content and biochemical markers. Such observations raise the probability that obesity, particularly in people with diabetes, is a major contributor to poor metabolic health.

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