

Study of Relationship between Body Mass Index and Body Fat Percentage in Female Subjects

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ABSTRACT

50 Female subjects of Bhilai Township between the age group of 40-60 years were selected for the study. Their height and weight were measured to calculate the Body Mass Index (02 subjects couldn't Co-operate, so study was conducted on 48 Subjects). Obesity is defined as Body Mass Index of 30 kg/m² or above. According to World Health Organization 50% of Adult population worldwide is expected to be Obese by the year 2030. Body Mass Index is a simple method for evaluating Obesity but Individuals with similar Body Mass Index may have different Body Fat Percentage. Visceral Fat is found around the abdominal organs inside our body, which we cannot see. A person with thin structure may have excess fat. This excess fat is associated with several metabolic disorders. Calculation of Lean Muscle Mass and Fat Mass has been proved to be more informative which is measured by Bioelectrical Impedance Analysis. This study is an attempt to find out the relationship between Body Mass Index with quantity and distribution of Fat.

Key Words : BMI, Obese, Visceral Fat

INTRODUCTION

Obesity is defined as Body Mass Index (BMI) of 30 kg/m² or above. According to World Health Organization (WHO) 50% of Adult population worldwide is expected to be Obese by 2030 (<http://www.who.int/mediacentre/factsheets/fs311/es/2018>).

Our Body Weight consists of Lean Mass and Fat Mass. Fat free mass (Lean mass) consists of Muscle, Water, Bones and Organs etc. Muscle tissues require more calories for maintenance so individual with more muscle mass (athletes) burn more calories and store less as Fat. If the proportion of Fat to Muscle is high, increase in the level of free fatty acid in blood occurs which leads to Hyperinsulinaemia and Type 2 Diabetes.

Body Mass Index and Body Fat percentage are used to assess health and fitness. Although Body Mass Index formula includes weight measures, it is difficult to find the weight from fat or lean muscle tissue. In this way, Body Mass Index is sometimes misleading because when the body has plenty of lean muscle tissues the body frame

looks heavy but it does not contain fat. Hence when the Body Mass Index of this body type is calculated, it gives false predictions about health and fitness levels. So, an individual with a high Body Mass Index may have a low Body Fat Percentage.

In healthy lean individuals, most of the Adipose Tissue is present in subcutaneous depots, where they serve thermoregulatory function and the stored Triglycerides are readily mobilized when required. (Schoetl *et al.*, 2018). Too little Body Fat may cause deficiencies related to fat-soluble vitamins and can adversely affect our immune system complications related to the Heart, Gastrointestinal and Nervous system are observed. Adipose tissue is very important part of body. It is required for Energy regulation, Lipid metabolism, Glucose metabolism, Insulin Sensitivity and appetite (Dhawan and Sharma, 2020)

Visceral Fat is found in the Abdominal Cavity. It surrounds the stomach, Liver and intestines. It is more dangerous to health than subcutaneous fat- found below our skin. Visceral fat protects our organs, it is an active

fat and plays an important role in the functioning of our body.

A potbelly indicate not only Visceral but Subcutaneous Fat also. Apple shaped belly is more likely to have excess amount of Visceral Fat than the Subcutaneous Fat. Genetics and Environment are some of the factors that determine Visceral Fat. Genetics is related to the body shape and how the body stores Visceral Fat. Stress activates the Cortisol hormone to increase Visceral Fat for “fight or flight” response of our body.

According to WHO abnormal or excessive accumulation of Fat may impair health. Body Mass Index is not a guide to degree of obesity. People with normal Body Mass Index can have more than 30% of Body Fat (www.wpro.who.int/mediacentre/factsheets/obesity/en/2018).

It is easy to calculate Visceral Fat which is about 10% of total Body Fat. A percentage of Visceral Fat higher than 10% of total Body Fat denotes improper health. Visceral Fat metabolizes quickly hence it is relatively easy to lose it as compared to Subcutaneous Fat

Review of Literature:

Bosomworth (2019) conducted a study on normal weight subjects with Central Obesity and subjects with high Body Mass Index. Their study denoted that subjects with normal Body Mass Index with Central Obesity are at similar or higher risk of mortality as compared to centrally Obese and Overweight according to their Body Mass Index.

Lopez *et al.* (2020) conducted a study on 97 Overweight and Obese subjects. Their study revealed that lifestyle interventions can reduce Visceral Fat Index. According to their study people over 45 years of age taking inadequate diet with higher amount of meat, fat and refined cereals were at higher risk of Visceral Fat accumulation and Cardiovascular Disorders.

Gupta *et al.* (2021) Conducted a study to find out the effect of increased in Body Mass Index on Diabetes. They found that Overweight and Obese individuals are almost two times more prone to suffer from Diabetes as compared to normal weight .Their study denoted that with a unit increase in Body Mass Index the possibility of being Diabetic increases by about 1.5% among Obese and Overweight individuals. They emphasized to further investigate the effect of Abdominal Obesity on Diabetes.

Lin *et al.* (2021) conducted a study on association of Body Composition with Type 2 Diabetes. They performed Bioelectrical Impedance Analysis (In Body 770). They found that Body Fat percentage was higher in Type 2 Diabetic subjects. Sarcopenic Obesity and low Muscle Mass was observed in people with normal Body Mass Index.

Xuan (2021) Conducted study on 7942 participants with normal Body Mass Index over 45yrs of age. They assessed abdominal Obesity by Waist Circumference and Waist to Hip Ratio. They found that Abdominal Obesity was highly prevalent in middle age and older adult with normal Body Mass Index.

METHODOLOGY

1. **Selection of sample:** 50 subjects were selected for the study, 02 subjects could not cooperate and they left the study.

Inclusion Criteria=only females were selected for the study. Purpose of the study was explained to the subjects, requesting their cooperation and voluntary participation.

Exclusion Criteria= Subjects suffering from infectious diseases and pregnant ladies were excluded from the study. Individual with cardiac pacemaker and kidney patients were excluded from the study.

2. **Anthropometric Measurements:**
 - **Height :** Height was measured in centimeters with the help of Stadiometer or anthropometer (Warrier *et al.*, 2023).
 - **Weight :** Body Weight was measured in Kilograms (Kg) using beam balance, spring or digital scales.
 - **Body Mass Index:** According to Pasco *et al.* (2014) The Body Mass Index (BMI) is commonly used as a surrogate marker of adiposity.
 - According to Nuttall (2015) It is being frequently used for defining the health status of an individual and also categorizes them into groups.

$$BMI = \frac{\text{Weight (Kg)}}{\text{Height (m}^2\text{)}}$$

Range of BMI	Categories
<18.50	Underweight
18.50-24.99	Healthy Weight
25-29.99	Overweight
30-39	Obese
≥40	Morbidly Obese

WHO 2004

3. Bioelectrical Impedance Analysis :

(BIA) is a non-invasive, portable, easy to operate tool used in analysis of whole Body Composition, Body Fat and Muscle Mass. A low voltage current flows through the body which measures the resistance of body (Muscle mass). Along with Body Mass Index, Bioelectrical Impedance Analysis measures Body Fat percentage, Visceral Fat and Subcutaneous Fat.

RESULTS AND DISCUSSION

People who are athletes have higher percentage of Lean Mass with lower percentage of Fat Mass. They are included in overweight category though their health is good. Keeping this theory in mind it was decided to calculate Body Fat Percentage and Visceral Fat of selected subjects to get another view of their health and fitness.

Table 1 revealed that out of total screened females (N=48), 27.2% were underweight, 54.1% had normal weight, 10.4% were overweight, 6.2% were Class 1 Obese and 2.1% came under Class 2 Obesity (Fig. 1).

Table 1 : Distribution of Females Based on BMI		
BMI Categories	N	%
Underweight (<18.5 kg/m ²)	13	27.2
Normal weight (18.5-24.9 kg/m ²)	26	54.1
Overweight (25.0-29.9 kg/m ²)	05	10.4
Obesity Class 1 (30-34.9 kg/m ²)	03	6.2
Obesity Class 2 (35-39.9 kg/m ²)	01	2.1
Obesity Class 3 (> 40 kg/m ²)	-	-
Total	48	100.0

This shows that the majority of the screened subjects had normal weight (54.1 %). This calculated $\chi^2 = 43.66$ also confirms this finding at $p < .01$

Table 2 revealed that out of the total screened females (N=48), 60.4 % had ideal Body Fat % and 39.6% were Obese. This shows that the majority of the screened

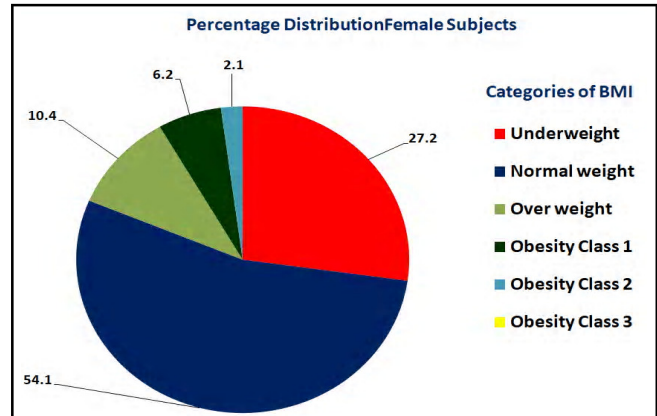


Fig. 1 : Percentage Distribution of Females Based on BMI

subjects belonged to the ideal Fat Percentage category (Fig. 2).

Table 2 : Distribution of Females Based on Body Fat %		
Body Fat %	N	%
Normal (21-32%)	29	60.4
Obese (> 32%)	19	39.6
Total	48	100.0

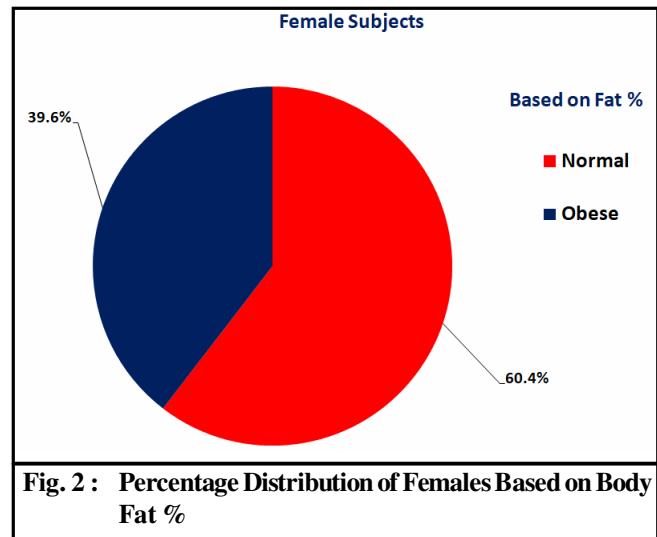


Fig. 2 : Percentage Distribution of Females Based on Body Fat %

The results of Table 2 deviated from Table 1 in a way that according to Body Mass Index 54.1% females came in the normal weight category and 27.2% of females were Underweight, while 18.7% were Overweight and Obese but according to the classification based on Fat Percentage 39.6% females were Obese. This shows that Body Mass Index is sometimes misleading in identifying health and fitness levels. The results are extensively given in the following tables comparing the statistics of Body Mass Index and Fat Percentage.

Sr. No.	Weight	Fat%	BMI	Status according to BMI	Status according to Fat %
1.	47	26.7	18.4	Underweight	Normal
2.	44.6	26.9	18	Underweight	Normal
3.	36.2	28	16.1	Underweight	Normal
4.	40.3	25.8	15.7	Underweight	Normal
5.	39.9	25.6	15.2	Underweight	Normal
6.	35.7	28.3	14.5	Underweight	Normal
7.	37	25.5	14	Underweight	Normal
8.	40.7	27.6	17.6	Underweight	Normal
9.	37.8	31.1	17.5	Underweight	Normal
10.	34.6	31.1	16	Underweight	Normal
11.	42.1	28.2	18.1	Underweight	Normal
12.	45.5	36	18.3	Underweight	Obese
13.	37.6	36.5	16.7	Underweight	Obese

A perusal of Table 3 reveals that according to Body Mass Index status, 13 females were Underweight but the classification according to Fat Percentage shows that 11 females had normal Body Fat Percentage while 02 had excess Body Fat Percentage.

A perusal of Table 4 revealed that according to Body Mass Index status 26 females were of normal weight

but the classification according to Fat Percentage shows that 17 females had normal Body Fat Percentage while 09 had excess Body Fat Percentage.

A perusal of Table 5 revealed that according to Body Mass Index status, all the 05 females were Overweight, but the classification according to Fat Percentage shows that 01 female had normal Body Fat Percentage while

Sr. No.	Weight	Fat%	BMI	Status according to BMI	Status according to Fat %
1.	43.6	31.9	22.2	Normal	Normal
2.	48	28.3	20.8	Normal	Normal
3.	44.6	28.1	20.5	Normal	Normal
4.	52.5	29.9	21.2	Normal	Normal
5.	49.2	31.7	21.2	Normal	Normal
6.	42.6	30	19.8	Normal	Normal
7.	50.2	27.3	19.6	Normal	Normal
8.	53.4	30.5	21.5	Normal	Normal
9.	49.1	28.9	22.7	Normal	Normal
10.	50.7	26.8	20.4	Normal	Normal
11.	45.5	31	19.7	Normal	Normal
12.	51.3	30.7	22.3	Normal	Normal
13.	48.6	24.2	21	Normal	Normal
14.	52.8	26.9	20	Normal	Normal
15.	49.8	30.2	19.5	Normal	Normal
16.	49.3	31.5	21.9	Normal	Normal
17.	44	29.2	20.6	Normal	Normal
18.	54.7	36.6	21.4	Normal	Obese
19.	47.8	34.8	22.1	Normal	Obese
20.	56.2	32.3	22	Normal	Obese
21.	55.2	33.9	21.6	Normal	Obese
22.	53.9	36.8	24.9	Normal	Obese
23.	52.2	34.9	24.2	Normal	Obese
24.	67	32.4	24	Normal	Obese
25.	54.7	36.8	24.8	Normal	Obese
26.	41.6	33.7	18.9	Normal	Obese

Table 5 : Distribution of Females Based on Body Fat % and BMI (25.0-29.9 kg/m²)

Sr. No.	Weight	Fat%	BMI	Status according to BMI	Status according to Fat %
1.	70.3	30.1	25.1	Overweight	Normal
2.	76.3	38	29.1	Overweight	Obese
3.	61.9	37	27.5	Overweight	Obese
4.	67.2	35.5	29.1	Overweight	Obese
5.	67.3	32.9	25.5	Overweight	Obese

Table 6 : Distribution of Females Based on Body Fat % and BMI (30-39.9 kg/m²)

Sr. No.	Weight	Fat%	BMI	Status according to BMI	Status according to Fat %
1.	72.7	38.2	30.3	Obese	Obese
2.	97.7	40.7	34.8	Obese	Obese
3.	95.2	40	36.1	Obese	Obese
4.	73	39	32	Obese	Obese

04 had excess Body Fat Percentage.

A perusal of Table 6 revealed that according to Body Mass Index status 04 females were Obese and these subjects were classified as Obese even in classification according to Fat Percentage.

This results revealed that although a female subject had normal weight based on Body Mass Index classification, she may be Obese according to the Ideal Fat in the body.

Conclusion:

BMI is a simple method for evaluating Obesity but people with same BMI may have different health risks due to different distribution of Visceral and Ectopic Fat. Body Mass Index does not measure Body Fat directly so it is used to measure weight and problems related to weight. It is not a measure of Body Composition. Some people have normal BMI but high Body Fat Percentage known as Normal Weight Obesity. Estimation of Body Fat percentage helps to distinguish fat from Muscles. The study denoted that measurement of Body Fat Percentage is a more accurate predictor of health than BMI. Obesity is excess adiposity not excess weight.

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