# Body Fat Estimation by Anthropometric and Impedance Techniques in Bengalee Females Engaged in Sedentary Work

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## ABSTRACT

Anthropometry, a simple reliable and widely used method for quantifying body size and estimating fat distribution, is a science that defines physical measures of a person's size, form and functional capacities. Measurement of body fat percentage using prediction equation is one of the popular methods. Newer techniques are also available for body fat measurements and bioelectrical impedance analysis is one of them. But information about the association between these two methods in Indian specifically Bengalee population is scanty. A study was undertaken in this backdrop to estimate body fat using prediction equations and to find out its association with body fat measure obtained using impedance technique. 54 adult Bengalee female individuals, residing in and around Kolkata volunteered for the study. Body fat assessment was carried out on them using both the anthropometric and impedance techniques. It was found that body fat measure obtained from prediction equation had significant ($P < 0.05$) positive correlation with that using impedance method in case of adult Bengalee females. Further regression modeling has been resorted using the computed coefficient of correlation and subsequently the validity of the model has been tested.

**Key words:** BIA, correlation, predictive modeling, validation

## INTRODUCTION

Obesity, a complex disorder of excess body fat, is the most prevalent nutritional disorder in prosperous communities[1] in general and hence a challenge from public health perspective. The scenario is neither different in the developing economies[2,3] and nor in working population[1]. Prolonged engagement in sedentary behavior, i.e. the time spent in activities of 1.5 or lower metabolic equivalents (METs)[4], may have a role in development of obesity[5] as it involves adoption of activities requiring little to no physical effort. Overweight individuals with a high fat mass have a higher risk of a range of adverse health outcomes, including type 2 diabetes, hypertension, stroke, impaired physical functioning and higher rates of mortality[6]. Emerging long term health complications of obesity have highlighted the importance of assessment of body composition, particularly body fat, making it a central topic of current epidemiological

research. Assessment of total and regional body composition can be undertaken by Anthropometry, which is the measurement of the size and proportions of the human body[7]. Different anthropometric measures are used to determine body fatness with a high level of accuracy and identify individuals at risk for diseases. Similarly, impedance analysis is also an easy, portable, noninvasive body composition measurement technique. Present work has been undertaken, in this context, to find out the association between the body fat values obtained by these two methods and the study has focused on Bengalee women, engaged in sedentary type of work.

## MATERIALS AND METHODS

**Selection of subjects:** For the present study after obtaining the required consents, data have been collected from 54 randomly selected Bengalee women belonging to the age group of 27-57 years working in different educational institute, of Kolkata Metropolitan area, West Bengal, India. The inclusion criterion inter alia included minimum working experience 5 years. Female individuals with any regular recreational sports activity and self reported disease history were kept out of the purview of the study. Ethical approval was obtained for the study protocol. On the scheduled date, arranged on mutual convenience, initially information regarding age in years, educational status and family economic condition was collected to assess the socio-economic condition[8] from each individual separately.

**Assessment of physical and physiological parameters:** Body height (to the nearest accuracy of 0.1 cm) using an anthropometric rod and body weight (to the nearest accuracy of 0.1 kg), using a pre calibrated weighing scale, was recorded with subjects in light clothing and without shoes. Body Mass Index (BMI) was then calculated and obesity status was assessed. The suggested critical limits of BMI recommended by WHO[2] were utilized for the assessment of obesity. Body fat percentage was measured from impedance method [9,10] as well as estimated using the values of BMI ($kg.m^{-2}$), age(year) and sex of the subjects[11]. From percentage values, the absolute values of body fat were estimated.

**Statistical analysis:** Standard descriptive statistics (mean ± Standard deviation) were found out for directly measured and derived variables. Pearson's Correlation coefficient was found out to measure the strength of association between the fat mass values obtained by two methods of body fat estimation. Prediction equations were developed and validated. Suitability of the prediction equation was studied using test-retest correlation. Obtained data were analyzed with significance set at $P<0.05$.

## RESULTS

Descriptive characteristics of participating volunteers of the present study are presented in Table 1. The participating individuals of the study were adult married Bengalee female individuals hailing from Hooghly district, West Bengal (WB), India. They were Hindu in religion, were from general category and belonged to the upper middle socio-economic category.

**Table 1:** Basic profile of the study participants

| Variables | |
|---|---|
| Sample size | 54 |
| Religion | Hindu (Bengalee) |
| Residence | Urban region |
| Economic status | Upper middle socioeconomic category |
| Marital status | Married |
| Addiction (smoking or alcoholism) | Nil |
| Occupation | Sedentary in nature |
| Work experience | Minimum 5 years |
| Working hours/week | 33 |

Physical characteristic, anthropometric measurements values and body fat percentage measured by two methods (impedance and anthropometry) of the individuals are presented in Table 2. Mean values of absolute of body fat measured by impedance method and anthropometry are found to be 20.3 kg and 20.6 kg respectively.

**Table 2:** Physical and physiological characteristics of the study participants

| Variables | | |
|---|---|---|
| Age (year) | | 37.0 ± 6.98 |
| Body Height (cm) | | 153.3 ± 5.47 |
| Body weight (kg) | | 59.9 ± 10.94 |
| BMI (kg/m²) | | 25.4 ± 4.03 |
| Fat mass (kg) ^ | Impedance technique | 20.3 ± 6.18 |
| | Anthropometry | 20.6 ± 6.92 |

^ns

It has been hound that a significant correlation exists ($P < 0.05$) between the mean absolute values of body fat as obtained by two techniques of body fat estimation. The relationship between the fat mass values obtained by anthropometry and impedance has been presented in Fig 1.

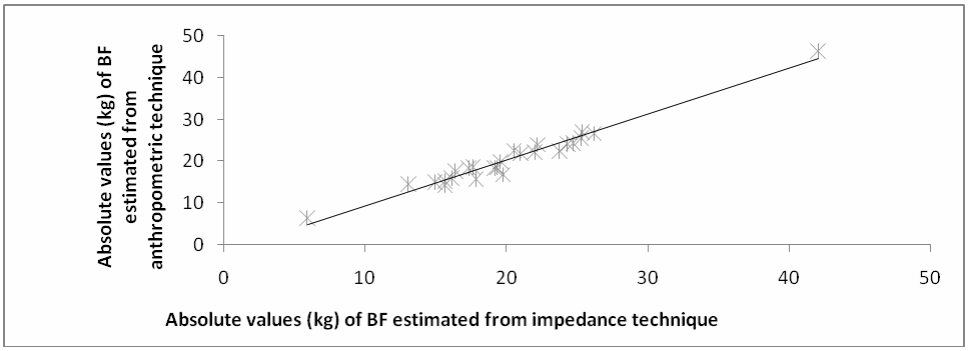


**Fig 1: Scatter plot showing the relationship between fat mass values obtained from two methods of body fat estimation**

From Figure 1 it has been found that the relation between the body fat mass values obtained by two different methods is linear. Based on the relationship between fat mass values obtained from two different methods of estimation, regression analysis has been resorted and prediction equations were developed as follows:

$$Y_1 = 2.275 + 0.875\ X_1 \quad \ldots \quad \text{equation 1}$$

[$X_1$ denotes the absolute value of body fat obtained experimentally by anthropometric technique, $Y_1$ denotes absolute value of body fat obtained experimentally by BIA technique, $Y_1$ refers to predicted absolute value of body fat obtained using equation 1]

$$Y_2 = 1.669 + 1.097\ X_2 \quad \ldots \quad \text{equation 2}$$

[$X_2$ denotes absolute value of body fat obtained experimentally by impedance technique, $Y_2$ denotes absolute value of body fat obtained experimentally by anthropometric technique, $Y_2$ denotes predicted absolute value of body fat obtained using equation 2]

The developed equations have been retested on a new sample of 33 individuals of comparable age and socio-economic status constituting validation group. Physical, anthropometric characteristics and body fat values obtained from two different experimental procedures of validation group individuals are presented in Table 3. Again significant correlation ($P < 0.05$) have been found between the values obtained by experimental procedure and predicted using the equations developed in course of the present study.

**Table 3:** Physical and physiological characteristics of the validation group participants

| Variables | | |
|---|---|---|
| Sample size | | 33 |
| Age (year) | | 35.4 ± 6.26 |
| Body Height (cm) | | 154.5 ± 6.29 |
| Body weight (kg) | | 57.3 ± 10.32 |
| BMI (kg/m²) | | 23.9 ± 3.34 |
| Fat mass (kg) ^ | Impedance technique | 18.0 ± 5.05 |
| | Anthropometry | 16.3 ± 5.47 |

^ns

## DISCUSSION

All female individuals participating in the present study are engaged in teaching, a sedentary avocation requiring little to almost no physical activity. The estimated mean BMI (25.4 $kg.m^{-2}$) of the study group individuals has crossed the cutoff point of being referred to as overweight[2]. The results revealed that 53.7% and 3.7% of the participating individuals fall into the overweight and obese categories respectively (Fig 2).

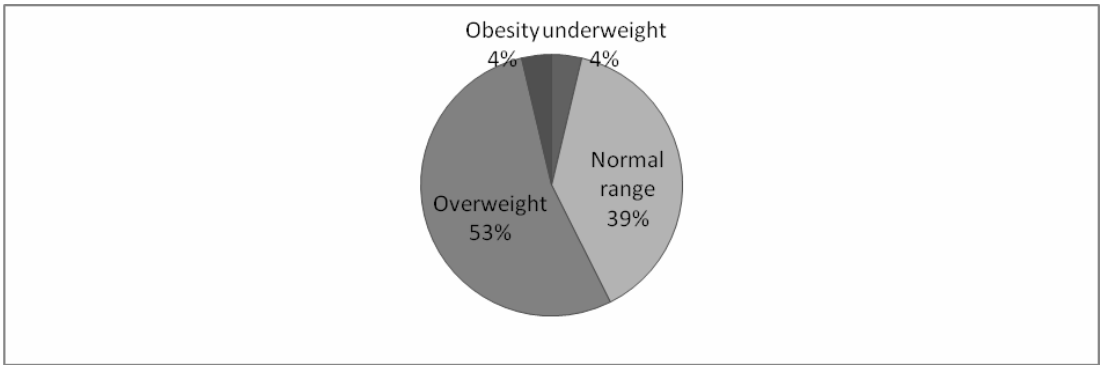


**Fig 2: Obesity profile of study participants indicating the relative proportions**

As an increased BMI is linked with several metabolic disorders, more than half of the participating individuals possess the chance of suffering from those diseases. The prevalence of overweight is higher in the present study compared to the findings from a study conducted in Raipur district of Chhattisgarh[12]; in case of obesity the trend is just opposite. Average BF%, obtained from both methods, of participating female individuals is 33%; 66% individuals cross the median standard for being considered as obese in terms of BF%[13]. Mean value of body fat percentage of the participating subjects in the present study is lower than that obtained (37.6%) in a study conducted on women residing in Howrah district of West Bengal [14]. However, the extent of overweight and obesity and body fat values reported in these studies is not strictly comparable because of the variation in the socio- economic status of the subjects and the methodology adopted.

BMI is significantly positively ($P<0.05$) correlated ($r=0.83$, $P < 0.05$) with BF% in this study population. No significant ($P>0.05$) difference has been found between the absolute body fat values as obtained from two methods. Significant positive correlation existed between the absolute body fat as obtained by two methods of estimation ($r = 0.98$, $P < 0.05$). Body fat values estimated from 2 methods have a linear relationship and based on this regression analysis was performed to develop prediction equation. The new equations were validated on a new group of individuals of comparable age, occupation and socioeconomic status. The prediction equations have a significant ($P <0.05$) test-retest correlation.

In most of the earlier studies the comparisons between different methods of body fat estimation have been made using Air Displacement plethysmography (ADP), Dual Energy X-ray Absorptiometry (DEXA) and also impedance[15,16]. Very little information is available regarding the association between anthropometry especially Deurenberg model and impedance technique. A study by Krachler et al[17] in Central Finland found the association of anthropometry using Deurenberg equation with impedance along with other anthropometric equations; the trend of findings is in agreement with that of the present study. Although there are several indirect

methods to estimate body fat values, but there is no universal 'gold standard' for both macro scale epidemiological studies and micro scale studies; however Spanish Society for Obesity Research has recommend Siri model, an anthropometric technique as reference method for body fat estimation[18]. But it has been also been reported that the difference between the mean values of estimated body fat is higher when Siri model and impedance technique are considered, compared to that when Siri and Deurenberg models are considered [19].

Both the anthropometric techniques and impedance techniques have their own merits and demerits. The values obtained following impedance technique may be subjected to variation due to alteration in hydration status[20], if the experimental protocol is not strictly followed during the measurement process. The high degree of correlation between the values obtained following two different experimental technique that is anthropometry and impedance not only indicate that the experimental protocol has been followed accurately but also affirm that the relatively newer impedance analysis is also a reliable and dependable technique for obtaining body fat values. The retesting of the developed equation with new set of subjects of comparable background also reaffirms the validity of the technique. On the other hand, assumptions of prediction models are also not flawless; it often underestimates BF% at high values of body fat. However, different methods of body composition assessment have their own advantages and limitations and therefore the study based on comparison between different methods can be useful for the interpretation of results.

Form the present study, it may be concluded that no significant difference exists between the body fat values estimated from the anthropometric and impedance techniques in the present study population and the body fat values estimated from the two methods have a significant positive correlation. These two methods could also be used interchangeably as valid methods. Further studies on different ethnic groups will increase the applicability of the prediction models developed.

## ACKNOWLEDGEMENTS

We are thankful to all volunteers participating in the study and concerned institutional authorities for their kind consent and cooperation.

## CONFLICTS OF INTEREST

Nil

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