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ASSESSMENT OF BODY FAT IN FEMALES FROM ANTHROPOMETRIC MEASUREMENTS AND BIOELECTRICAL IMPEDANCE ANALYSIS

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ABSTRACT

Assessment of human body composition is an important factor in determining nutritional status of an individual and of population. The majority of nutritional problems are due to excess or insufficient energy nutrition. Energy nutritional status is often affected by other nutritional states. Wasting accompanying inadequate nutrient intakes and in turn influence the initiation or maintenance of metabolic and endocrine abnormalities leading to a plethora of degenerative diseases. The present study was planned with the objective to assess the percent body fat of adult females using anthropometric measurements and bioelectrical impedance analysis method. Forty one female volunteers were included in the study. Age of the subjects ranged between 17 to 23 years. Body weight, standing height, MUAC and skinfold thickness at four sites viz. triceps, biceps, sub scapular and suprailiac were measured. Then bioelectrical impedance was measured on the same day. Body composition of females was determined using Durnin and Womersely (1974) equation according to age for women. Results of the study revealed that percent body fat value obtained from four skinfold thickness method is comparable to value obtained using bioelectrical impedance (r=0.885). Average percent body fat was found to be 25.75 ±3.49 and percent fat free mass was 32.55±2.99. The study concludes that there is linear and significant correlation between body weight and body fat, which indicates that increase in body weight in adult females, is largely due to increase in body fat.

Keywords: Body fat, bioelectrical impedance analysis, Anthropometry, Females.

INTRODUCTION

Assessment of human body composition is an important factor in determining nutritional status of an individual and of population. To better understand the impact of erosion of lean mass and the normal or abnormal utilization of protein and fat for fuel, a general understanding of normal body composition is required. Information on body composition is required in many situations, both in clinical settings as well as in the epidemiological studies. The body composition can be divided into fat and lean mass components. Fat mass makes up 20 to 30 percent of total body mass. Fat is biologically inactive. Its only role is a reservoir for calories. The fat content of the human body has physiological and medical importance. It may influence morbidity and mortality, alter the effectiveness of drugs and anesthetics and affect the ability to withstand exposure to cold and starvation. Thus, the measure of body fat may provide useful information.

The majority of nutritional problems are due to problems of energy nutrition, may it be excess or insufficiency. Energy is stored in the body as fat, and the degree of malnutrition-induced morbidity, is dependent on the loss of lean mass relative to body weight. With starvation alone, lean mass is initially preserved. In the presence of infection or injury (wound), the stress response is activated, which leads to a rapid loss of protein stores. Lukaski (1987).

Body composition (particularly body fat percentage) can be measured in several ways. The most common method is by using a set of measurement calipers to measure the thickness of subcutaneous fat in multiple places on the body. These measurements are then used to estimate total body fat. Anthropometric measurements are simple, valid, safe and inexpensive measurements of body fat, therefore suitable in field studies and in epidemiological studies. Another method is bioelectrical impedance analysis (BIA), which uses the resistance of electrical flow through the body to estimate body fat.

The present study was planned with the objective to assess the percent body fat of adult females using anthropometric measurements and bioelectrical impedance analysis.

MATERIALS AND METHODS

The subjects selected for the study were forty one female volunteers aged between 17 to 23 years. Body weight was measured in normal clothes without shoes to the nearest 0.1 kg on a beam balance. Body weight indicates the body mass and is a composite of all body constituents like water, minerals, fat, protein and bone. Standing height was measured to nearest 0.1 cm using anthropometric rod. Subjects were asked to stand without shoes and their arms hanging freely on their sides. Body Mass Index (BMI) was calculated using the formula kg/m^2 (body weight in kg and height in meters). BMI provides a reasonable indication of the nutritional status of adults. The BMI has good correlation with fatness and may also be used as an indicator of health risk. Lange caliper was used to measure skinfold thickness to the nearest 0.5 mm. Skinfold thickness was measured at four sites viz. triceps, biceps, subscapular and suprailiac. Measurements were done on left side of Body composition was determined using the anthropometric measurements using the equation of Durnin and Womersley (1974) according to age for women.

17-19 years $D = 1.1549 - 0.0678 \times (\log\sum)$ ---------- **(1)**
20-29 years $D = 1.1599 - 0.0717 \times (\log\sum)$ ---------- **(2)**
Where, *D* is body density/cc and $\log\sum$ is logarithim of sum of four skinfold thickness.

FAT AND FAT FREE MASS WAS CALCULATED USING THE FORMULA

$$Fat\ mass\ (kg) = Body\ weight(kg) \times \left(\frac{4.95}{D} - 4.50\right) \text{ ---- (3)}$$

$$Fat\ free\ mass\ (kg) Body\ weight(kg) - Fat\ mass(kg) \text{ ------- (4)}$$

After anthropometric measurements bioelectrical impedance was measured on the same day. Bioelectrical impedance analyzer (RJL systems, model 101A, Detroit USA) was used to measure resistance component of body impedance. Two electrodes method was used. Body resistance was measured after subjects were refrained from exercising for six hours before testing. Subjects were asked to take off their shoes and assume supine position on examination task with and legs abducted from the body. After cleaning all skin contact areas with alcohol foils containing electrolyte gel were placed on the dorsal surface of the hand and feet at distal metacarpals and metatarsal respectively. ECG electrodes were attached to these foils. An excitation current of 800µA at 50 kHz was introduced in to the subject. The voltage drop was detected by electrodes. The recorded system was calibrated against a standard 500ohm resistor before each measurement. The measurements noted were fat mass, fat free mass and body density. Statistical analysis was done using mean, standard deviation, correlation and regression. Subjects standing in relaxed condition. Anthropometric measurements were made by a single observer.

RESULTS AND DISCUSSION

Total forty one females participated in the study. Present study revealed that the mean age of the subjects was 18.7±1.16 years and age of the subject ranged between 17 to 23 years. Body weight is one of the most convenient and useful indicators of nutritional status. Weight measurement revealed that weight of the subjects ranged between 34.5 kg to 60 kg with the mean body weight 44.02±5.38 kg (Table 1). Height of the subjects ranged from 143.0 to 164.5 cm with the mean height of 155.1±5.69 cm. BMI of the subjects revealed that 50% of the subjects were underweight. BMI of the subjects ranged between 15.42 to 23.14 kg /m^2 with mean BMI of 18.33±2.03. No subject was found to be overweight or obese. According to classification, persons with BMI<18.5 are classified as underweight and with BMI 20-25 are considered normal body weight individuals. It was found that there was insignificant variation in weight and height parameters among the subjects. Shaikh et al (2003) reported that girls being more stunted and underweight lean body mass percentage decreased in girls with increasing age suggesting hidden deprivation of female children.

Table-1 - Age, Height, Weight and BMI of the subjects

Age (years)	18.70 ±1.16
Weight (Kg)	44.02 ±5.38
Height (cm)	155.10 ±5.69
Body Mass Index (kg/m^2)	18.33±2.03

Table- 2- Skinfold thickness measured at four sites

Site	Mean ± SD	Range (mm)
Bicep (mm)	6.56 ±2.67	3-11
Tricep (mm)	16.34 ± 4.42	9-27
Suprailiac (mm)	13.02 ±3.38	8-20
Subscapular (mm)	13.26 ±3.72	9-24

Table- 3- Average skinfold thickness of subjects taken at four sites

Age group (years)	Mean ± SD	Range (mm)
17	46.60 ±9.93	38-65
18	49.33±10.74	30-67
19	48.18±12.20	33-71
20-23	52.62±13.87	39-80

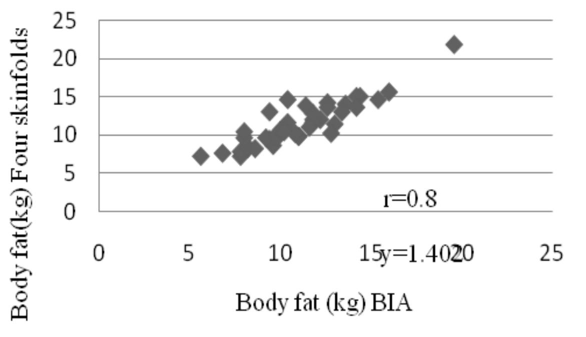
Table 2 shows the mean value of each skinfold thickness measured at four sites and it was found that mean values for suprailiac and subscapular measurements were nearly same. Mean skinfold thickness of subjects was

49.18±14.18mm. Bicep thickness ranged from 3 to 11 mm and the average thickness was found to be 6.56 ±2.67. Tricep skinfold thickness ranged from 9 to 27 mm with the average value of 16.34 ±4.42 mm. The average of the sum of four skinfold thickness did not differ significantly because of large variation in the range. However, the upper limit of the range of sum of four skinfold thickness showed a tendency to increase with age (Table -3).

Table-4- Body composition of subjects using two methods

Anthropometric indices	Methods	
	Four skinfold thickness	BIA
Per cent body fat	25.75 ±3.49	25.36±3.85
Per cent fat free mass	32.55 ±2.99	32.63±3.07

Fig-1 Individual values and regression equation for body fat from four skinfolds andBIA



Qamra et al (1990) reported that skinfold thickness of Punjabi girls increased rapidly after 13 years of age. Percent body fat values obtained from four skinfold thickness method is very close to value obtained using bioelectrical impedance (r=0.885).This shows a close relationship between the two methods used (Fig-1). Leppik *et. a*l (2004) reported that skinfold thickness highly predicted fat mass measured by bioelectrical impedance analysis for total body, trunk, arms and legs. Correlation coefficient among various indices and measurements of body composition was worked out. Significant inverse relationship was found between resistance and fat free mass. Significant correlation was found when Ht^2/R was used as a predictor of fat free mass. A linear and significant correlation was observed between body weight and body fat. This indicates that increase in body weight is largely due to increase in body fat. A significant correlation was also found between height and fat free mass (r=0.648).

CONCLUSION

This study concludes that for estimating percent body fat in females, anthropometric measurements provide comparable values against the bioelectrical impedance analysis method.

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