Relationship between Body Mass Index and Skin Fold Thickness in Young Females

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Authors’ contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Anthropometric indicators are used to evaluate the prognosis of chronic and acute diseases, and to guide medical intervention. In anthropometry, body mass index (BMI) is widely accepted in determining obesity and skin fold thickness measurements provide good estimates of body fat.

Aim: To see the relationship between BMI and skin fold thickness in young females.

Study Design: Observational study

Methodology: This was a cross-sectional study. Measurements of height, weight, BMI and skin fold thickness were obtained for young adult females. Triceps, suprailiac and abdomen skin fold thickness were measured by using a skin fold calliper. For skin fold thickness, all measurements were taken three times and an average value was recorded.

Results: Total 251 participants took part in the study. The mean skin fold thickness in the triceps was 22±6.02 mm, abdominal was 24.41±5.84 mm, and suprailiac was 21.23±5.74 mm. There was a significant correlation seen between BMI and triceps SFT (ρ=0.816,P=0.000), BMI and Abdominal SFT (ρ=0.854,P=0.000) and BMI and suprailiac SFT (ρ=0.850,P=0.000). There was a significant association between BMI and physical activities (P=0.000).

Conclusion: There was a significant correlation seen between BMI and SFT at triceps, abdominal and suprailiac region. There was a significant association between BMI and physical activities.
1. INTRODUCTION

Overweight and obesity result from an energy imbalance. Bodyweight tends to remain the same when the intake of calories equals the number of calories the body uses or burns. If the intake of calories is more than the calories burnt, the energy balance tips towards weight gain, overweight and obesity [1]. Obesity, especially central body fatness is associated with many diseases like dyslipidemia, hypertension, insulin resistance and type 2 diabetes and increases the risk of cardiovascular diseases [1,2]. Body mass index (BMI) which is the most widely used measure of overweight and obesity is defined as a person’s weight in kilograms divided by the square of their height in metres [3]. Those individuals whose BMI is 35 or greater have a 20 times more risk of developing diabetes, two times more risk of developing heart disease or stroke and 2.5 times more risk of developing hypertension[1]. A consensus statement on cut-off values for BMI suggested 18.0-22.9 kg/m² to indicate Normal BMI, 23.0-24.9 kg/m² to indicate overweight and >25 kg/m² to indicate obesity for Asian Indians [4].

Men and women differ in their body composition. Women have a higher percentage of total fat mass and men have more lean and muscle mass. Men have higher visceral adipose tissue (VAT), intrahepatic (IHL), and intramyocellular lipids (IMCL) while women have greater lower extremity fat [2].

Anthropometry is mainly used to characterize growth patterns and body composition [5] and includes height, weight and size including skinfold thickness, circumference, length and breadth [6]. Anthropometric evaluation is inexpensive, non-invasive and gives detailed information of body structure especially, muscular and fat components [5]. In adults, it evaluates health and dietary status, disease risk, and changes in body composition that occur over the lifespan [5]. It is an important indicator of an individual's health and nutritional status [7]. Anthropometric measures are highly reliable for determining the nutritional status when compared with more advanced methods like hydro densitometry and electronic bioimpedance, which due to their cost and complexity are used restrictively [5].

In epidemiological studies, assessment methods that are relatively low cost and easy to measure are used. BMI is used extensively as an indirect measure of body fatness as it is easy to calculate, noninvasive, indirect and simple and can be used on a large number of subjects [8]. Some methods like underwater weighing, dual-energy X-ray absorptiometry (DXA), air displacement plethysmography estimate body composition accurately. But they are time-consuming and expensive. Anthropometry and bioelectrical impedance are most commonly used for quick measurements, large populations and when less economic resources are available. Skinfold thickness (SFT) measurements provide good estimates of body fat, but the observer needs to be skilled to obtain reliable measurements. It is often used as a bedside method of body composition measurement, is quick, cheap and simple, with limited training and standardized assessment required, to obtain reliable data. SFT is accepted as a body fatness predictor because subcutaneous fat (40-60% of total body fat) can be directly measured with a calliper [9].

There is a dearth of studies on the skinfold thickness values for the Indian population in young adults. So the present study was undertaken to know the BMI and SFT measurement in young females (suprailliac, abdominal, triceps) and to find a relationship between BMI and SFT.

2. MATERIALS AND METHODOLOGY

This was a cross-sectional study. After receiving ethical approval, self-declared healthy young females between 18 to 26 years, from different constituent colleges of Sumandeep Vidyapeeth, were included in the study. Anyone with neurological deficit, a recent history of upper or lower limb fractures, musculoskeletal deformities, visual or vestibular impairments, were excluded.

Anthropometric measurements of height, weight, BMI and SFTs were taken for all the included participants. For SFT an average of three values was recorded.

2.1 Height and Weight

The height of the subject was measured with shoes removed. Subjects had to stand straight up and as tall as possible, look straight ahead, without lifting the heels. Height was measured from the floor to the highest point on the head. The height of the subject was recorded in...
centimetres and then converted to a metre for calculation.

The weight of the subject was taken without shoes on an analogue weighing scale with excess clothing removed. The weight of the subject was recorded in kilograms.

2.1.1 BMI
BMI was calculated as:

\[ BMI \, (kg/m^2) = \frac{\text{Weight (kg)}}{\text{Height}^2 \, (m^2)} \]

2.2 Skinfold Measurement
All skinfold measurements were taken using a skinfold calliper and on the right side of the body. Participants were asked to stand in a straight position and the measurement was taken as mentioned in the literature [10]. A retest was performed by allowing the skin to regain its properties in around 1 to 2 seconds.

- Measurement of triceps skinfold (TSF) was taken on the posterior aspect of the bare extended arm over the triceps muscle, midway between the lateral projection of the acromion process of the scapula and the inferior margin of the olecranon process of the ulna.
- The abdominal skinfold was taken as a vertical fold; 2 cm to the right side of the umbilicus.
- Measurement of suprailiac skinfold was taken as a diagonal fold; in line with the natural angle of the iliac crest taken in the anterior axillary line immediately superior to the iliac crest [10].

The physical activities of the females were classified as less active/active based on the activities they performed.

2.3 Statistical Analysis
Descriptive statistics were calculated as mean and standard deviation for variables like age, weight, BMI. Kolmogorov-Smirnov test was used to see the normality of data. Spearman’s rank correlation coefficient was used to see the correlation between BMI and skin fold thickness. Statistical significance was set at p<0.05.

3. RESULTS
Total 251 females were included in the study.

The average age was 20.28 years. Table 1 gives the mean and SD of various variables and Table 2 gives the average skin fold thickness of the population. The average SFT for all the three sites are shown in Table 3 and Table 4 shows the correlation between BMI and SFT.

Table 1. Mean and SD of various variables

| Variable       | Mean  | SD  |
|----------------|-------|-----|
| Height (m)     | 1.57  | 0.06|
| Weight (kg)    | 51.44 | 10.18|
| BMI (kg/m^2)   | 20.68 | 3.97|

Table 2. Frequency distribution of BMI

| BMI category | Number of females | %  |
|--------------|------------------|----|
| Underweight  | 68               | 27.09|
| Normal       | 121              | 48.21|
| Overweight   | 30               | 11.95|
| Obese        | 32               | 12.75|
| Total        | 251              | 100 |

Table 3. Average skinfold thickness

| Site          | Mean  | SD   | Range |
|---------------|-------|------|-------|
| Triceps (mm)  | 22    | 6.02 | 13.67-43|
| Abdominal (mm)| 24.41 | 5.84 | 14.67-45.67|
| Suprailiac (mm)| 21.23 | 5.74 | 11.33-47.33|

4. DISCUSSION
The present study included young female adults between the age group of 18 to 26 years. As shown in Table 2, 48% of our population was in the ‘normal’ BMI category.

In this study, we found that the average skinfold thickness of the abdominal region was 24.41 mm which was the highest, triceps was 22 mm and lowest was the suprailiac region with 21.2 mm. Aslan et al, in a study on sedentary and exercising young adults also found the average skin fold thickness to be highest in the abdominal region in young females [11]. The average SFT in the abdominal region in females of 18 years was 18.16±6.72 mm, in 19 years was 24.28±5.33 mm in 20 years was 22.70±6.31 mm and in 21 years was 22.35±6.47 mm. The average SFT in the Triceps region was 13.17±3.50 mm in 18-year females, 12.92±3.61 mm in 19-year-olds, 12.58±3.51 mm in 20 year age group and 12.15±3.84 mm in 21 year age group [11]. This was very low compared to the average in our population. Ojo et al in a study from Nigeria, reported abdominal SFT of females from 16 to 25 years of age to be 19.77±6.96 mm and triceps SFT to be 17.82±11.16 mm [12]. Moffatt et al reported the mean value for triceps SFT in females aged 18-24 to be 19.4±6.64 mm in the United States [13].
Table 4. Correlation between BMI and SFT using Spearman’s rank correlation coefficient

| Variables                        | Spearman’s rank correlation coefficient (ρ) | P value |
|----------------------------------|--------------------------------------------|---------|
| BMI and Triceps skin fold thickness           | 0.816                                   | 0.000*  |
| BMI and Abdominal skin fold thickness          | 0.854                                   | 0.000*  |
| BMI and Suprailiac skin fold thickness         | 0.850                                   | 0.000*  |

*Correlation is significant at the 0.01 level

![Fig. 1. Physical activity levels in different categories of BMI](image)

Skinfold thickness measurements give a fairly accurate measurement of subcutaneous fat which forms a major part of fat deposits in the human body. The sum of skinfold measurement can be used to estimate total body fat [14]. It has shown a significant correlation (r=0.869, P<0.001) with Dual energy X-ray absorptiometry (DXA), which is the gold standard, in estimating the percentage of body fat [15]. Skin fold thickness rather than BMI measured during adolescence is a better predictor of high body fatness during adulthood [16].

Nadia et al. reported that a combination of a high BMI as well as trunk skin fold thickness predisposes to centralized obesity in adulthood which may lead to increased risk of cardiovascular disease [7].

There was a significant positive correlation between BMI and SFT at all the three sites; triceps, abdominal and suprailiac, showing that as BMI increased, SFT also increased. BMI does not distinguish between fat mass and lean body mass whereas skin fold thickness is a better alternative for determining body fatness [16]. Aslan et al. also found a significant correlation (P<0.05) between BMI and sum of skin fold thickness in females who exercised and males who were sedentary and exercised [11].

The current study showed a significant association between BMI and physical activities (χ²=55.73, P=0.000) where the females categorized under the ‘overweight’ and ‘obese’ category were less active compared to the ‘underweight’ category as shown in Fig. 1. The ‘normal’ category had an almost equal number of females in ‘active’ and ‘less active’ groups. In the present study, physical activity was not studied in a structured way, using a structured questionnaire but the activity levels were only enquired from the participants.

5. CONCLUSION

There was a significant correlation seen between BMI and SFT at triceps, abdominal and suprailiac region. There was a significant association between BMI and physical activities.

6. LIMITATIONS

Limitations of the present study were that only female subjects were included and only two measures of body composition were taken.
We recommend future studies to find out skin fold thickness in different age groups, with a larger sample size. A more structured way of assessing physical activity by means of a questionnaire like Global Physical activity questionnaire (GPAQ) can be taken.

CONSENT
The participants’ written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL
This study approved by Sumandeep Vidyapeeth Institutional Ethics committee (SVIEC), approval number SVIEC/ON/PHYS/SPR/1359.

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COMPETING INTERESTS
Authors have declared that no competing interests exist.

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