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COMPARING BMI RATING WITH TRICEPS AND SUPRAILIAC SKINFOLD MEASUREMENTS AS INDICATOR OF OBESITY IN FEMALE STUDENTS OF LUMHS

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ABSTRACT

Objective: To compare the BMI rating and skinfold measurements of triceps and suprailiac for screening of obesity. **Methods and Materials:** A total of 316 female students with the age group of 17 to 25 were included from Liaquat University of Medical and Health sciences (LUMHS), Jamshoro. The triceps and suprailiac skinfold thickness of the subjects was measured with skin-fold calipers. The measurement of skin fold thickness was entered into SLOAN body density equations i.e. Body Density = 1.0764 - (0.0008 x iliac crestskinfold in mm) - (0.00088 x triceps skinfold in mm), based on a sample aged 17-25. Then body density is converted into percent body fat using the following formula (Siri, 1961). %fat = [495/body density] 450 For Statistical analysis correlation was performed on SPSS. **Design of study:** An observational cross sectional study was conducted. **Database:** APTA, Pub Med, Google scholar, Cochrane Libraray **Outcome:** According to the results of BMI rating 81 (25.6 %) participants were underweight, 190 (60.1 %) were normal, 39 (12.3 %) were overweight, and 6 (1.9%) were obese. According to the results of body fat percentage 39 (12.3 %) were lean, 267 (84.5%) were acceptable, 10(3.2%) were moderately overweight. **Result:** There is a strong positive correlation between the weight and BMI [r =0.907, n = 316, p =0.000]. There is a weak positive correlation between the weight and body fat percentage [r =0.646, n = 316, p =0.000]. **Conclusion:** BMI alone is not a valid indicator of overweight and obesity. Therefore, BMI must be considered with other factors and should not be used as a sole measurement of obesity.

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INTRODUCTION

Obesity has been considered an important health disorder around the world. Obesity in childhood and in adolescence is considered an independent risk factor in the development of cardiovascular diseases in adulthood.[1] The early development of non-communicable chronic diseases such as cardiovascular disease, hypertension, and high levels of low density lipoproteins is significantly associated with increased body fat levels.[2,3]

On the other hand, extremely low fat levels may be associated to bulimia nervosa, anorexia and calorie protein undernourishment.[4, 1] Therefore, quantifying body fat with the smallest error as possible becomes vital, fact that has led researchers to develop and to validate different techniques to assess obesity such as: hydrostatic weighting, anthropometry, bioelectric impedance, double-energy x-ray absorptiometry, pletismography and others. Among these techniques the anthropometrical technique is considered as a simple, rapid, inexpensive and reliable method that can be applied to a great number of individuals. This technique makes use of linear measurements, mass, diameters,

perimeters and skinfolds. These measurements, alone or combined, are used in order to obtain indexes such as the body mass index (BMI) or the body fat percentage (F%) for the respective age.

Consequently, two (2) persons with the same amount of body fat can have quite different BMI values. These problems are underscored by the discordant estimates of prevalence when obesity is estimated from BMI and other anthropometric measures such as skinfold thicknesses.[5, 6] The BMI has been recommended by WHO as an indicative of body fat for being quickly obtained with no cost at all. However, studies have discussed its use with the objective of diagnosing body fat at different age ranges.[7, 8] On the other hand; the F% obtained from skinfolds measurements has had a wide acceptance among clinical setting.[9]

The Body Mass Index, or BMI, was created by Adolphe Quetelet in the 19th century. It was, in his vision, a simple way to gauge a person's body weight.[10]

The components of the equation weighed an individual's height and overall body mass to generate an index number indicating whether a person was under, over or at the appropriate weight level based on those components. Also, Samuel Smith found that BMI values have become simple to use because the values can be easily tracked over time.[12] According to WHO the BMI measurements are divided into four categories ranging from Underweight to Obese based on scores obtained by dividing weight by the square of the individual's height (kg/m^2).[13] Within each category there are sub-classifications that address specific ranges of the index scores. A skinfold thickness is the double layer of skin and subcutaneous fat (panniculus adipose) lifted as a fold and measured with standardized calipers and methodology at specific sites on the body.[14,15] The skin fold is measured at triceps, biceps, suprailiac, subscapular, supraspinale, abdominal, calf, thigh ,chest and axilla.[16]

Despite more reliability and simplicity is associated with BMI, skinfold thicknesses are widely used to assess body fatness.[17] Although several investigators have found the levels of percent body fat estimated from skinfold thickness equations are more strongly correlated with more accurate estimates of body fatness than is BMI.[18,19] According to Peymane Adab, BMI cannot distinguish between body fatness, muscle mass, and skeletal mass and its use can result in large errors in the estimation of body fatness because it has low sensitivity (0.50).[18] Freedman (2015) finds that BMI is almost useless as an estimator of percentage of body fat in normal-weight children. The difference between lean muscle mass and bone from body fat are large determinants in classifying obesity.[20] Skinfolds measurements are one of the most practical methods to use to determine body fat.[22] A study done by Pilly Chillo et al. found results indicated "skinfolds measurements most accurately estimated the percentage of body fat".[22]

There are many reasons why women have more body fat than men. One is biological. Body fat content is 25% for women at normal size compared to 15% for men. Estrogen alone will cause increased deposition of fat in females.[23]The reason for this difference is that women at some point in their lives may nourish a fetus and then a baby from their own reserves, so women have to stock energy in the form of fat in anticipation of future pregnancies (and must stock even more energy during the last two trimesters of pregnancy).[24] BMI is popular, simple and touted as accurate in determining health and obesity rates.[25] Skin folds measurements, while requiring some simple equipment and a skilled person to perform the measurements, may more directly measure body fat.

MATERIALS AND METHODS

An observational cross sectional study was conducted in Liaquat Univeristy of Medical and

Health Sciences (LUMHS) Jamshoro, Pakistan. A written consent was taken from the students as being an observational cross sectional study ethical committee approval was taken. The time duration of the study was six (06) months ranging from July 2017- December 2017, with sample population of 316 in total. The inclusion and exclusion criuteria was defined clearly on the basis of reserach question.

All the available sample population in the study included female students (17 to 25 years of age with all the others and male gender was exculded. Informed consent will be obtained from the participants. Each participant was assigned a number on the Participant Profile For and the participants underwent an assessment of BMI and measurement of body fat composition by triceps and suprailiac skinfold measurement. Measurements for each site was recorded on the data collection sheet which is taken from Ezzeldin R. Aly (2014) with slight modifications according to the reserach question i.e. sites to be measured for skinfold thickness are changed according to the topic.[10]

SUBJECT PROFILE FORM[10]

First Name _____
Last Name _____
Subject testing number: _____

BMI
Weight (kg)Height (inches)Age
SKIN FOLD SITES
TricepsSuprailiac

The BMI was obtained by recording the weight with a bathroom scale and for the height with a height measuring scale fixed on a wall. For height measurement subjects stood without shoes on a horizontal surface with their bodies stretched to the fullest extension and their heads in the Frankfort plane (a position in which lower margins of the orbits, the orbitals and the upper margins of the era canals all lie in the same horizontal plane).[26] The measurement was substituted in a BMI equation i.e.

$BMI = weight (kg)/\{height (m)\}^2$

The triceps and suprailiac skinfold were measured according to standardization of AAHPERD (American Alliance for Health Physical Education Recreation and Dance) with the aid of skinfold measuring caliper.[27]

Triceps skinfold landmark is the back of upper arm halfway between shoulder and elbow. The arm should be relaxed with palm of the hand facing forward (supinated).[28] a vertical pinch parallel to the long axis of arm is made on the landmark.

Suprailiac skinfold landmark is above the crest of ilium in the mid axillary line, the fold is directed anteriorly and downward in line with the natural fold of the skin, the arm was held across the body to keep it away from the measurement area.[28]

The measurement was entered into SLOAN body density equations i.e.

Body Density = 1.0764 - (0.0008 x iliac crestskinfold in mm) - (0.00088 x triceps skinfold in mm), based on a sample aged 17-25.
Then body density is converted into percent body fat using the following formula (Siri, 1961).[25]

% fat = [495/body density]-450

STATICAL ANALYSIS

The study was focused to compare the difference between BMI rating and skinfold measurement of triceps and suprailiac for screening of obesity. The BMI is a measurement of relative body mass not body fat composition, because lean body weighs far more than fat. Many adults are incorrectly classified as obese based on BMI.

The purpose of this study is to prove that skinfold measurement provides a more accurate body assessment than BMI in adults. So the data was

presented and analyzed on the SPSS version 16 and the Statistical analysis was presented in tabular and graphical form.

RESULTS

According to the results of the BMI 81 (25.6 %) participants were underweight, 190 (60.1 %) were normal, 39 (12.3 %) were overweight, and 6 (1.9%) were obese as shown in table 5.1, fig 5.1 and 5.2.

Table 5.1: Obese according to BMI

Classification	Frequency	Percent	Valid Percent	Cumulative Percent
Underweight	81	25.6	25.6	25.6
Normal	190	60.1	60.1	85.8
Overweight	39	12.3	12.3	98.1
Obese	6	1.9	1.9	100.0

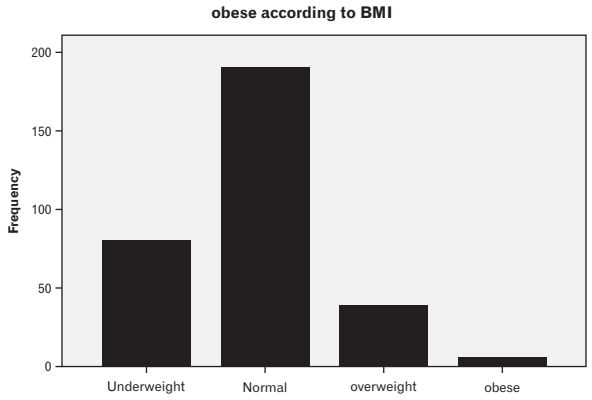

Figure 5.1: Obese according to BMI

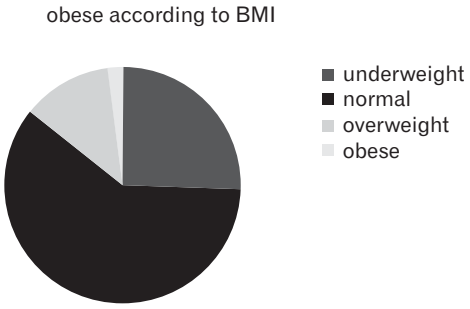

Figure 5.2: Obese according to BMI

According to the results of body fat percentage 39 (12.3 %) were lean, 267 (84.5%) were acceptable, 10(3.2%) were moderately overweight, and 0 were overweight as shown in table 5.2, fig 5.3 and 5.4.

Table 5.2: Obese according to Body fat percentage

Classification	Frequency	Percent	Valid Percent	Cumulative Percent
Lean	39	12.3	12.3	12.3
Acceptable	267	84.5	84.5	96.8
Moderately overweight	10	3.2	3.2	100.0
Total	316	100.0	100.0	

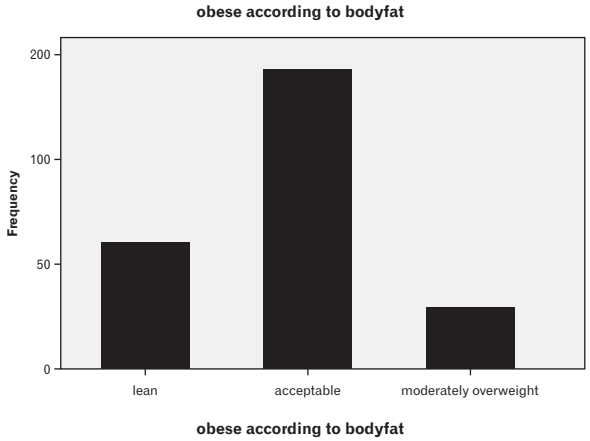

Figure 5.3: Obese according to body fat percentage

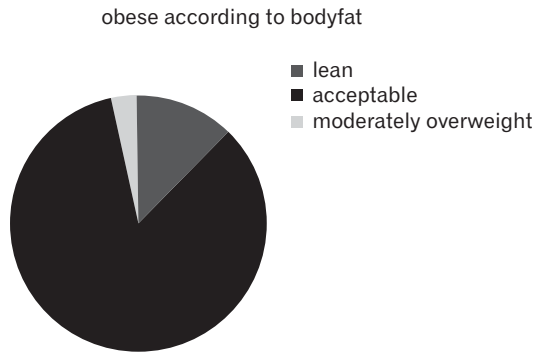

Figure 5.4: 0bese according to body fat percentage

For statistical analysis, A Pearson product-moment correlation coefficient was computed to assess the relationship between the weight and body mass index (BMI).There is a strong positive correlation between the weight and BMI[r =0.907, n = 316, p =0.000]. As shown in table 5.3. A scatter plot summarizes the results (Fig 5.5).

Table 5.3: Correlation between weight and BMI

		body mass index	Weight
body mass index	Pearson Correlation	1	.907**
	Sig. (1-tailed)		.000
	N	316	316
Weight	Pearson Correlation	.907**	1
	Sig. (1-tailed)	.000	
	N	316	316

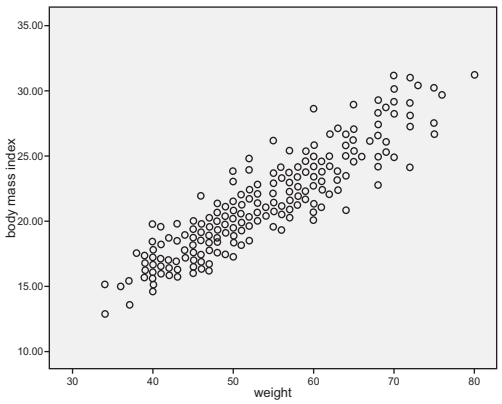

Figure 5.5: Correlation between weight and BMI

A Pearson product-moment correlation coefficient was computed to assess the relationship between the weight and body fat percentage. There is a weak positive correlation between the weight and body fat percentage[r =0.646, n = 316, p =0.000] as shown in table 5.4. A scatter plot summarizes the results (Fig 5.6).

Table 5.4: Correlation between weight and body fat percentage

	weight	body fat %
Weight / Pearson Correlation	1	.646**
Sig. (1-tailed)		.000
N	316	316
body fat % Pearson Correlation	.646**	1
Sig. (1-tailed)	.000	
N	316	316

**. Correlation is significant at the 0.01 level (1-tailed).

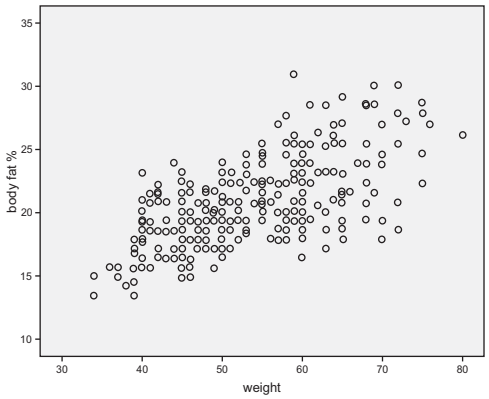

Figure 5.6: Correlation between weight and body fat percentage

"Overall, there was a strong, positive correlation between weight and BMI and weak positive correlation between weight and skinfold thickness. That means Increases in weight is directly correlated with increases in body mass index and increase in weight increases in body fat percent only 60% of times not always that means BMI classifies 90 % of population is obese but according to skin fold thickness only 60% of population is obese."

DISCUSSION

The aims of the study was to show the correlation of weight and BMI and correlation of weight with body fat percentage and comparing the diagnostic values of triceps and suprailliac skin fold thickness for diagnosing obesity in relation with BMI. However, a limitation of BMI is that it cannot differentiate an obese individual from a muscular one. It also cannot locate the site of fat.

In our study according to BMI total prevalence of overweight was 12.3 % and obesity was 1.9% and according to body fat percentage total prevalence of moderately overweight was 3.2%, and overweight was 0 %. So, a strong positive correlation was found between the weight and BMI [r =0.907, n = 316, p =0.000]." but correlation of weight and body fat percentage was a weak positive correlation [r =0.646, n = 316, p =0.000]. In the study Khadgawat*et al* studied that BMI misclassified 13-14% of girls into an incorrect adiposity category in comparison to body fat percentage.[32] This narrative supports our study because this study when compared the BMI and body fat percentage about 12.3% were classified as overweight by BMI and only 3.2 % were moderately overweight by body fat percentage. And when compared BMI and body fat percentage, 1.9% were classified as obese by BMI which were not obese by body fat percentage. Means BMI misclassifies 9.1 % as overweight according to the study findings and literature availble. Out of all the study participants using the BMI equation, 39 out of 316 were classified as overweight, compared to the skin fold test, where only 10 were classified

with a risk of obesity.[32] The margin of difference is very substantial when looking at these two tests. The results show the BMI equation should not be used as a single indicator of obesity and is not reliable enough when measuring body composition by itself [25].

Knowing that the BMI equation may not be a reliable indicator when used alone could have implications on the classification of the overall population being obese or overweight. The results do not claim the entire population is wrongfully of being overweight or obese, but the numbers would be more accurate if other measurements or tests were applied as discussed in this study. The author Etchison *et al, did* a cross-sectional study for BMI and percentage body fat as indicators of obesity in adolescent athletic population and according to BMI 13.31% were obese and by using skinfold thickness 5.59% were obese.[33] So, the conclusion of the study was that BMI is a measurement of relative body weight, not body composition. The study results show a P=0.000 indicates that it is significant. According to the SPSS the data collected reflects the P value as significant which supports the fact that BMI is not only the indicator of obesity in the population. The narrative of levels of BMI being not only the accurate basis of obesity measurements with other factors being considered highly, influence the results. Further more, this point of view is supported by Bogalusa Heart a study done by Freedman, 2009 concluded that despite the more accurate prediction of body fatness by skinfold thicknesses, the results indicate that levels of BMI are as strongly related to levels of lipids, fasting insulin, and blood pressure Because skinfold thickness measurements require careful training of observers and found that skinfold thicknesses do not provide a more accurate assessment of metabolic risk than does BMI.

If there were to be a continuance of this study, we suggest adding two of three different ways to measure body fat and compare all of the different tests next to BMI and see which would ultimately be the most accurate. Another recommendation for further research would be to test both male and female students. Having a wide variety of subject would give a good perspective on the overall classification of obesity.

CONCLUSIONS

To consice, the study was done to compare bmi rating with triceps and suprailiac skinfold measurement as indicator of obesity in females with support of literature available reported a marked differnce that BMI equation should not be uesd as the sole indicator. On a proportionate basis, the skin fold result in this study appears to provide a more accurate analysis. The results do not claim the entire population is wrongfully of being overweight or obese, but the numbers would be more accurate if other measurements or tests were applied.

Therefore, BMI followed by skinfold thickness measurement may help to correctly identify body weight along with excess body fat so that comprehensive actions can be taken to prevent obesity and its consequences. There is still room for the reserah on this topic with inclusion of the male gender in order to reflect the topic on the popualtion with good qualilty Randomized Controlled Trial or even a Systematic Review to update the literature and helps to understand obesity. This would help to relfect the data on the large scale population and the pshycolgical trauma suffered by being called as Obese could be reduced.

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