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Original Article

The Relationship between Skinfold Thickness and Body Mass Index in Estimating Body Fat Percentage on Bowen University Students

Gideon Ojo*, Olamide Adetola

Department of Anatomy, Faculty of Basic Medical and Health Sciences, Iwo, Osun State, Nigeria.

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Body Mass Index (BMI) is a weight-to-height ratio used as a quick and easy guide to obesity classification. BMI of 30 or greater is indicative of excess body fat and has been labelled as increasing the risk of degenerative diseases such as cardiovascular disease and diabetes. Body fat percentage is also assessed through skinfold thickness measurement.. The aim of this study was to estimate the prevalence of underweight and obese individuals, and determine the body fat percentage on male and female students of Bowen University, Nigeria. 150 male and 150 female students aged between 16-25 years were randomly selected. Their weight, height, triceps skinfold, abdominal skinfold, and subscapular skinfold were measured. Male students had a lower BMI (21.52±3.16 kg/m^2 versus 24.47±22.99 kg/m^2), and body fat percentage (11.225±3.163 versus 29.97±11.733) than the female subjects. The male and female subjects had a mean weight of 66.56±10.29 kg and 61.16±11.83 kg; height 176.05±7.73 cm and 163.93±6.54 cm, respectively. There were significant differences in all the physical characteristics ($P< 0.05$) except for BMI and age. Our data showed that differences exist between body composition variables of male and female studied subjects. The body fat percentage was higher in females in comparison to males who also had lower mass. Further studies in diverse populations in developing countries should help to clarify ethnic differences in body composition, and produce functional reference standards.

Keywords: Skinfold measurements, body mass index (BMI), body fat percentage, body density

Nutrition has important impact on health, and surveying its issues is one of the main concernsof public health (1). The prevalence of overweight continues to increase in many developing countries, although the prevalence of under- nutrition remains relatively high (2). Access to techniques allowing body composition analysis, such as dual energy x-ray absorptiometry (DEXA) or bioelectrical impedance (BIA), available in wealthier countries, is limited in many others, and assessment of those at risk of excess body fat generally relies on simpler and cheaper techniques, such as body mass index (BMI) or skinfold measurements (3).

Obesity had reached epidemic proportion worldwide especially in the developed nations both in children and adults (4). Over-nutrition is increasing in parts of sub-Saharan African society, particularly in urbanized regions with westernized lifestyles, leading to the accumulation of adverse

*Correspondence: Department of Anatomy, Faculty of Basic Medical and Health Sciences, Iwo, Osun State, Nigeria.
E-mail: ojogbfavour@yahoo.com

health effects such as diabetes, dyslipidaemia, coronary heart disease, atherosclerosis, hypertension, high blood cholesterol concentration, stroke, certain cancers and arthritis (5). Other co-morbidities such as orthopaedic complications, skin fungal infections, hepatic steatosis, and psychological and behavioural problems are also associated with childhood obesity (5).

Anthropometric measures are widely available for human body composition assessment. Anthropometry concerns the measurement of different parts of human body such as bone, muscle, and adipose (fat) tissue. Various anthropometric measurements such as BMI, waist circumference, waist hip ratio, waist height ratio, and various skin fold thicknesses have been studied in relation to the health and nutritional status of individuals (6).

Analysing skinfolds and circumferences measurements was used to determine the relationship between obesity and risk of disease.

Subcutaneous adipose tissue measurements are important as upper values increase the risks for hypertension, diabetes, cardiovascular disease, gallstones, arthritis, and cancer. Dietary questionnaire combined with biochemical indices, and anthropometric measurements can provide critical information on individuals health performance (7). Skinfold measurement, also known as pinch test, is measured by a caliper at several precise points on the body, and allows to determine subcutaneous fat layer thickness and body fat percentage (8).

Body fat percentage of a human is the total mass of fat divided by total body mass. Body fat includes both essential body fat and storage body fat. Essential body fat which is important for life maintenance and reproductive functions, is relatively greater in women due to hormonal activities and childbearing demands. Storage body fat represents fat accumulation in adipose tissue, and helps to protect the internal organs (9).

BMI is the international standard that measures body size in adults. It is a statistical measure of an individual's weight scaled according to his/her height. It is widely used to classify adults as underweight, overweight and obese (1).

Body composition refers to the constituents of body-lean mass, fat mass and water.

The aim of this study was to estimate the prevalence of underweight and obese individuals, and the average body fat percentage among Bowen University students in Nigeria.

Materials and methods

Subjects

Subjects for the study consisted of 300 students from Bowen University Iwo, Osun State of Nigeria which consisted of 150 males and 150 females, aged between 16-25 years. This study was carried out in April on Bowen University campus. The students were consenting and anthropometric values like weight, height, skinfold thickness, and BMI were measured or calculated with the use of standard techniques.

Data collection

Data were collected by structured questionnaire. The questionnaire included information on sociodemographic factors and direct measurements of body weight, height, triceps, abdominal, and subscapular skin fold thicknesses.

Body weight measurement

Weight measurement was carried out after the subject had removed shoes, heavy clothes and objects. A weighing scale was used to take the measurement of the body weight in kilograms, after checking for zero balance before each use.

Height measurement

The measurement of height required a vertical metric rule, a horizontal headboard and a non-compressible flat and even surface which the subject stood (as stadiometer). The equipment used was portable. The calibrations on the metric rule were at 0.1cm intervals and the metric rule had the capacity to measure up to 210 cm. To measure the height, the subjects stood upright at the wall without shoes, cap or hair ornaments, and the height was marked at the

wall. The calibrations were carefully inscribed on the wall using a meter rule and a chalk.

Skinfold measurement

Skinfold was measured according to the anthropometry procedure manual from national health and nutrition examination survey (NHANES) with the aid of a skinfold caliper. The subscapular skinfold was measured at the inferior angle of the right scapula. The triceps skinfold was measured at the upper arm mid-point mark on the posterior surface of the right upper arm. The abdominal skinfold was measured at a mark made 5 cm adjacent to the umbilicus (belly-button).

Calculating the body mass index (BMI)

BMI was calculated by dividing the person's weight in kilograms by the square of their height in metres. BMI categories were determined according to world health organisation (WHO) criteria with overweight defined as BMI= above 25, obese above 30, normal between 18.5 to 25 and underweight below 18.5.

Calculating the body fat percentage

The body density was calculated using Jackson and Pollock and Ward generalized equations that have been validated for various age groups and both athletic and non-athletic populations (10). These equations are:

Men: D=1.1125025-0.0013125(x) + 0.0000055(x2) – 0.000244(y)

Women: D=1.089733-0.0009245(x) + 0.0000025(x2) – 0.0000979(y)

Where x= sum of triceps, abdominal, and subscapular skinfolds (in mm) and y= age in years.

The percent fat was calculated from body density using the Siri method (11).

Percent fat = (495/body density)-450

Body fat percentage categories were determined according to Gallagher et al. at NewYork Obesity research centre (12).

Statistical analyzes

The data generated was analysed using descriptive statistics such as means, standard deviations, percentages and frequencies. All data analyzes were performed using SPSS statistical package (version 20). Descriptive statistics of mean and standard deviation was computed for the purpose of data interpretation. Independent sample t- test was used for evaluating the difference between male and female parameters. A p-value lower than 0.05 was considered to be significant.

Results

Descriptive statistics

The study population consisted of 300 subjects with equal sex distribution. Table 1 shows the anthropometric data of the studied population.

Body mass index classification

Table 2 shows the classification of BMI in male and female subjects. Female subjects had higher number of overweight and obese individuals while male subjects had a higher number of underweight individuals.

Figures 1 and 2 show the percentage of underweight, normal, over weight, and obese male and female subjects. More than 10% of males and 9% of females were underweight. 12% and 15% of males and females respectively, were overweight. 2% of males and 6.7% of females were obese. Over 70% of male subjects and 69% of female subjects had normal weight.

Body fat percentage classification

Table 3 shows the classification of the body fat percentage in male and female subjects. Generally, males showed lower body fat percentage than females.

Figures 3 and 4 show the distribution of male and female subjects with low, normal, and high body fat percentage. Regarding male subjects, 54% were under-fat, 32.7% normal, 7.3% over-fat and 6% obese, while females' distribution was 21.3% under-fat, 50% normal, 10.6% over-fat, and 18% obese.

There were significant differences between the mean height, weight, triceps skinfold, abdominal skinfold, and subscapular skinfold ($P < 0.005$) but no significant difference in mean age and BMI ($P > 0.005$).

Table 1. Anthropometric data of the studied population

	SEX	N	Mean	Std. Deviation	Std. Error Mean
Weight (Kg)	Male	150	66.56	10.286	.840
	Female	150	61.16	11.827	.966
BMI (Kg/m^2)	Male	150	21.522	3.1629	.2583
	Female	150	24.475	22.9939	1.8774
Body fat (%)	Male	150	11.2225	9.78957	.79932
	Female	150	29.9780	11.73332	.95802
Triceps skinfold (mm)	Male	150	7.046	2.8599	.2335
	Female	150	17.815	11.1566	.9109
Subscapular skinfold (mm)	Male	150	11.101	4.4289	.3616
	Female	150	18.625	9.6776	.7902
Aabdominal skinfold (mm)	Male	150	10.854	5.0819	.4149
	Female	150	19.765	6.9597	.5683
Height (cm)	Male	150	176.05	7.730	.631
	Female	150	163.93	6.541	.534
Age (years)	Male	150	20.23	1.793	.146
	Female	150	20.08	1.491	.122

Table 2. BMI classification for studied subjects

	Number of subjects		
BMI (Kg/m^2)	**Male**	**Female**	**Grade**
Below 18.5	18	14	Underweight
18.5-24.9	117	103	Normal
25-30	13	23	Overweight
Above 30	3	10	Obese

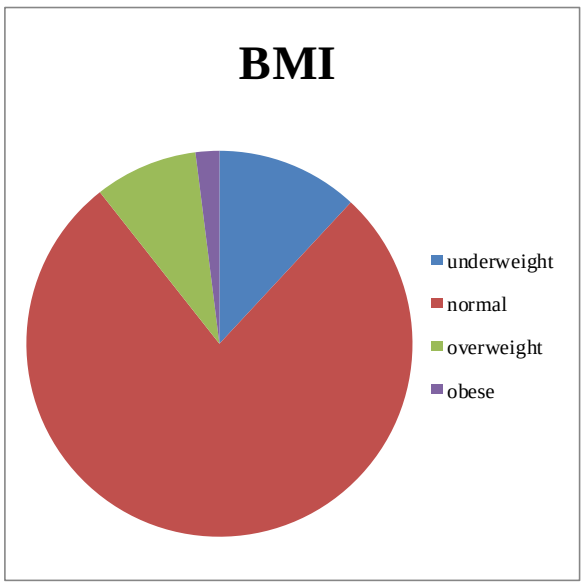

Figure 1. BMI distribution for male subjects.

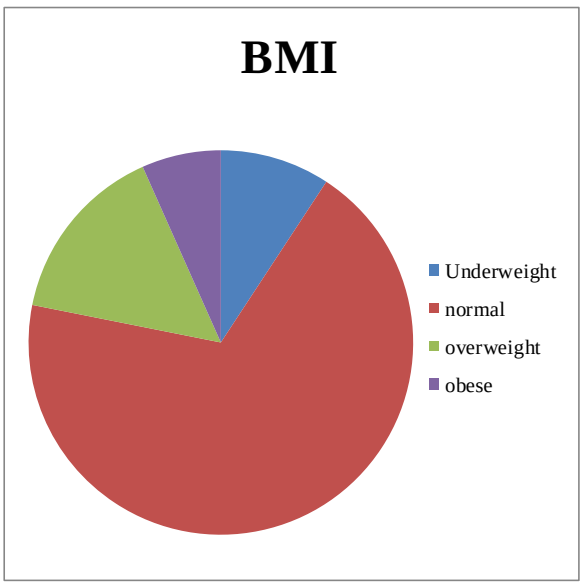

Figure 2. BMI distribution for female subjects.

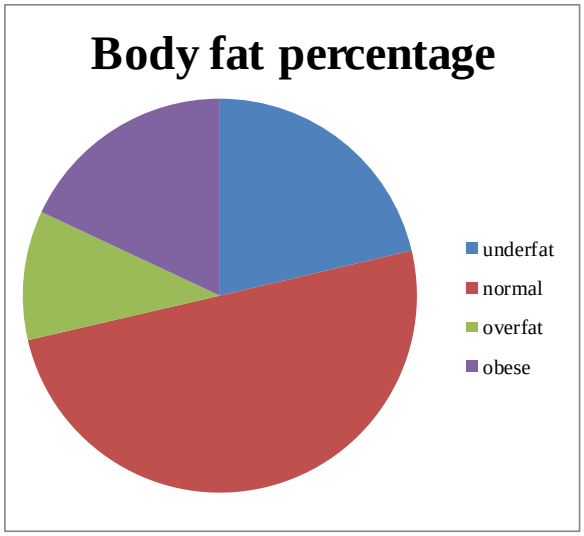

Figure 3. Body fat percentage in male subjects.

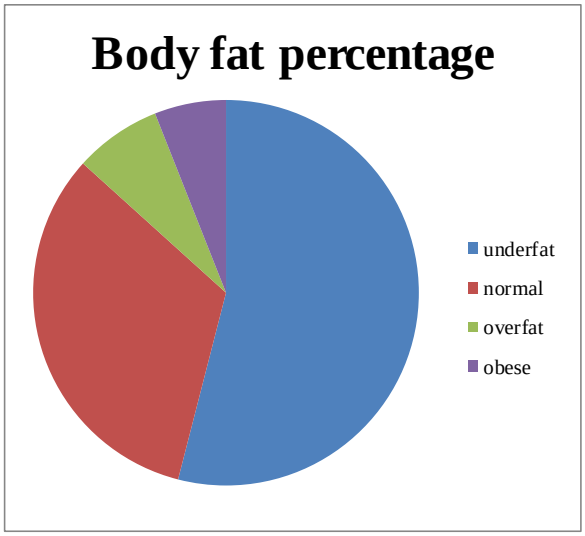

Figure 4. Body fat percentage in female subjects.

Table 3. Body fat percentage classification for studied subjects

	Number of subjects		
Body fat percentage	**Male**	**Female**	**Grade**
Below 20%	81	32	Under fat
21-33%	49	75	Healthy
34-39%	11	16	Over fat
Above 39	9	27	Obese

Discussion

Obesity is a major public health problem in the developed world, and there is evidence that it is rapidly becoming a problem in the developing world. Obesity is a risk factor for diabetes, coronary artery disease, hypertension, gallstones, gout, and osteoarthritis, as well as cancer of the breast, colon, and prostate. Thus, it is important to develop programs that improve the prevention and treatment of obesity. Therefore, the purpose of this study was to classify the male and female subjects of Bowen University based on BMI and body fat percentage.

The results obtained from the statistical comparison of the variables showed a significant difference in BMI, body fat percentage and skinfold thicknesses between the groups. This is in line with literature reporting lower essential fat in men with about 3% of the total weight, versus 12% in women. The higher fat percentage in women is due to sex-specific fat, such as breast, uterus and other sex related fat deposits (13).

The mean BMI was 21.52 kg/m^2 for men and 24.48 kg/m^2 for women. The value obtained for male subjects corresponds to mild thinness on the BMI reference data (14). Using the classification of BMI ranges (15), the result reflects that over 70% of male subjects and 69% of female subjects had normal weight. More than 10% of males and 9% of females were underweight, while 12% and 15% of males and females respectively, were overweight. 2% of males and 6.7% of females were obese. The mean BMI in this study is in accordance with studies carried out in other parts of Nigeria (14, 16-18). Deshmukh et al reported the prevalence of overweight (BMI= 25 kg/m^2) to be 2.2% and this is in line also with results of the present study (19). The skinfold

measurements from all sites were consistently higher in women in comparison with men ($P < 0.05$). Skinfold thickness, triceps skinfold, subscapular skinfold, and abdominal skinfold were relatively low. Low skinfold thickness was previously reported among Nigerians (20). Onimawo et al pointed out the usefulness of assessing the degree of malnutrition. Judging from the values obtained, only about 50% of the subjects met the recommendations. Using triceps skinfold thickness values, the male subjects were undernourished (21). Nnayelugo et al reported triceps skinfold of 6.05 mm and this compares well with results of the present study where the average male triceps skinfold thickness was 7.046 mm (22).

Percent body fat was significantly higher in women in comparison with men. The higher body fat in women could be attributed to the fact that females tend to lay down more subcutaneous fat layer than males during the growth spurt at puberty (23).

The results of this study show that the majority of males subjects were under-fat, and only 6% were obese, while the majority of females showed normal fat percentage, and 18% were obese. Moderate body fat percentage values should range between 19-24% for males and 26-29% for females (24).

In conclusion, concurrent use of several simple anthropometric assessments including skinfold thickness measurements may provide a more complete picture of body fat percentage. The present research showed that differences exist between body composition variables of male and female students. The percentage of body fat was higher in females in comparison with males who also showed lower mass.

Further studies in diverse populations in developing countries over a long time frame should help to clarify ethnic differences in body composition, and produce functional reference standards.

Conflict of interest

The authors declared no conflict of interest.

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