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A Comparative Study of Different Methods of Body Fat Assessment

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Abstract: The aim of the study was to compare the results of body fat percentage obtained from 20 young non-obese adults with the use of various selected methods: instrumental – Under Water Weigh-in (UWW) and anthropometric – Four Skinfold Measurements, Girth Measurements and BMI related formula, and to assess their correlation with UWW as a reference. 20 subjects were selected from different colleges of Gwalior city. Purposive sampling was used for selection of subjects. The age of subjects ranged from 20 to 25 years. The data collected with various methods on body fat measurement was analyzed by using one way analysis of variance (ANOVA) and multiple range test (LSD) for significance of the differences among means. Product moment correlation coefficient was used to know the correlation among selected methods of body fat measurement. The descriptive statistics was used for demographic information. The level of significance was set at 0.05 for the study. The analysis of data revealed that there was a significant difference among the means of body fat percentage measured with selected body fat measurement methods But when the Post Hoc test was applied it was found that the means of fat percentage measured with UWW method, Skinfold method and Girth measurement method was not having any significant difference at 0.05 level of significance (p>0.05). And likewise, there was insignificant difference were found in between BMI method and Girth measurement method. When the correlation coefficient was calculated, it was found that UWW Method for body fat measurement was positively correlated with the other selected methods.

Key Words: *Body Fat, Skinfold, Demographic and Anthropometry.*

Introduction:

An organism's composition reflects net lifetime accumulation of nutrients and other substrates acquired from the environment and retained by the body [Heymsfield, 2005] The first body composition concepts can be traced to the Greeks around 400 B.C. Assessment of body fat levels has increasingly assumed greater importance in recent years [Albrinks, and

Meigs, 1964]. In addition, since with physical training, body fat can decline while muscle mass can increase, net changes in body weight cannot reliably predict body fat levels [Heyward, 2001]. The assessment of the body composition is an important measure of the nutritional status in man, because body fat (BF) is directly related to obesity and diet- related diseases, whereas low levels of fat-free mass (FFM) may be more critical to the health of infants and children, elderly, malnourished persons, maturating women, and those with muscle-wasting diseases [Heyward, 2000]. We are now too aware that excessive body fat increases one's risk of developing a number of serious diseases, including coronary heart diseases, hypertension, stroke, chronic obstructive pulmonary disease, diabetes, arthritis, and some form of cancer, Since, then a wide variety of methods have been developed. These methods will be described with emphasis on the most practical techniques. Most body composition analysis is based on seeing the body as consisting of two separate compartments, fat and fat-free. Thus, body composition is often defined as the ratio fat to fat-free mass [Nicman, 1990]. The only way to actually measure the fat content of a human body is to dissect a cadaver, remove the fatty tissue, extract the fat with a solvent and weigh the extracted fat [Snyder, 1984]. Therefore, alternative procedures have been employed, all with their own limitations depending on assumptions and theoretical model, cost, ease of operation, technical skills and subject's cooperation. The method regarded as a reference one is underwater weighing (UWW). After correction for residual lung volume, it gives results of body density (BD), which are used to estimate percentage or total BF from the equation of Siri. The cheapest and most common methods to assess BF are anthropometric techniques, especially skin folds thickness measure, which provide an estimate of the subcutaneous fat depot, recalculated for the total BF or BD. For the assessment of BF in epidemiological studies, a weight-height index is the most simple and inexpensive method, and the errors in measurement due to intra- or inter-observed variation are small. The body mass index (BMI) seems to be the most appropriate, because its correlation is high with BF% and low with body height [Bujko, 2006]. Girth measurements offer an easily administered, valid and attractive alternative to skin folds. Along with predicting percentage body fat, girth measurements can also be used to analyze patterns of body fat distribution [William, 2001]. The sites commonly used for girth measurements are: upper arm (biceps), forearm, abdomen, hips (buttocks), thigh, and calf. The aim of the study was to compare the results of body fat content (in% and kg) obtained from 20 young non-obese adults (males) with the use of presented, different methods: instrumental – UWW and anthropometric – 4 skin folds measurements and BMI related formula, girth measurement related formula to assess their correlation with UWW as a reference.

Methods:

20 subjects were purposely selected from different colleges of Gwalior city. The age of subjects ranged from 20 to 25 years. The selection of the test with their justification is as follows: Hydrostatic Weighing: To assess the body density hydrostatic weighing was used because it is considered standard method for measuring fat percentage and the standard error of estimate for it is believed to be in the range of ±0.8% and ±1.2% of the estimate (5,6). This is relatively small, so estimate of body composition by hydrostatic weighing are quite precise [Behnke and Welham] Body fat prediction from body mass index: It is the most simple and inexpensive method, and the errors in measurement due to intra- or inter-observed variation are small. Body fat can be estimated from your body mass index (BMI). There are a number of alternative formulae that relate body fat to BMI. Although these calculations are based on equations published in peer reviewed journals they are only an estimate and there will be variations around the results, as slightly over for obesity. Body fat percentage can be calculated with the help of body mass index by simply seeing to the tables provided by the Deurenberg P. (199 1) Body fat prediction from body mass index: It is the most simple and inexpensive method and the errors in measurement due to intra- or inter-observed variation are small. Body fat can be estimated from your body mass index (BMI). There are a number of alternative formulae that relate body fat to BMI. Although these calculations are based on equations published in peer reviewed journals they are only an estimate and there will be variations around the results, as slightly over for obesity. Body fat percentage can be calculated with the help of body mass index by simply seeing to the tables provided by the Deurenberg P. (1991). Body fat prediction from girths: The girth based prediction equations are most useful in ranking or ordering individuals within a group according to relative fatness. As with fat fold measures, girth can also be used to predict body density and/or percentage body fat. If one uses the equations and constants for young men, the error in predicting an individual's body fat is generally ±2.5 to 4.0%. These relatively small prediction errors make the equations particularly useful to those without excess to laboratory facilities: a tape measure is inexpensive and the measurements are easy to take.

Result:

Finding pertaining to the descriptive Statistics of fat percentage measured with selected fat measurement techniques have been presented in table 1.

Table 1

Descriptive Ststistics of the Fat Percentage Measured With Selected Fat Measurement Methods

	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
UWW Method	20	16.8810	2.21288	.49482	10.94	21.22
Skinfold Method	20	15.6035	3.19311	.71400	9.50	22.20
Girth Measurements	20	17.0495	3.08959	.69085	9.13	21.64
BMI method	20	18.7316	3.07275	.68709	12.54	24.60
Total	80	17.0664	3.07393	.34368	9.13	24.60

Table 1. indicates that mean of fat percentage with UWW, Skinfold method, Girth measurement method and BMI method is 16.9, 15.6, 17, and 18.7 respectively. However, SD of fat percentage with UWW, Skinfold method, Girth measurement method and BMI method is 2.2, 3.2, 3.1 and 3.1 respectively. This reflects that variation in Skinfold method, Girth measurement method and BMI method is more as compared to UWW method for fat measurement.

Figure. 1

Graphical Representation of Mean Scores of Fat Percentage Assessed From Various Selected Methods

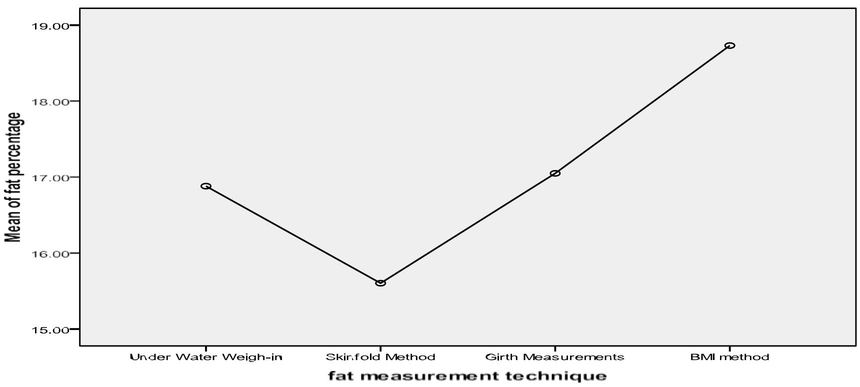

Figure 1 implies that mean of fat percentage measured by BMI method is highest and by skinfold method is lowest.

Findings pertaining to Fat percentage measured with various selected fat measurement methods have been subjected to one way analysis of variance which is presented in table 3.

Table 3

One Way Analysis of Variance of Fat Percentage Measured With The Selected Fat Measurement Techniques.

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	98.952	3	32.984	3.871	.012
Within Groups	647.524	76	8.520		
Total	746.476	79			

Table 3 indicates that Calculated F-Value is significant at 0.05 level of significance ($p<0.05$). Thus, it may be assumed that there is a significant difference in the means of fat percentage measured with the selected fat measurement techniques.

Since, there is a significant difference in the fat percentage measured with the selected fat measurement techniques the post hoc test should be done for testing the significance of mean between groups. The least significant test (LSD) should be applied as the number of samples was equal.

Table 4

Post Hoc Test (Lsd) Of Fat Percentage Measured With The Selected Fat Measurement Techniques.

(I) Fat Measurement Technique	(J) Fat Measurement Technique	Mean Difference (I–J)	Sig.
Under Water Weighing	Skinfold Method	1.27750	.170
	Girth Measurements	-0.16850	.856
	BMI Method	-1.85059*	.049*
Skinfold Method	Under Water Weighing	-1.27750	.170
	Girth Measurements	-1.44600	.121
	BMI Method	-3.12809*	.001*
Girth Measurements	Under Water Weighing	0.16850	.856
	Skinfold Method	1.44600	.121
	BMI Method	-1.68209	.072
BMI Method	Under Water Weighing	1.85059*	.049*
	Skinfold Method	3.12809*	.001*
	Girth Measurements	1.68209	.072

*significant at 0.05 level of significance ($p<0.05$)

Table 4 indicates that there may be no significant difference lies between the following fat measurement methods when the mean of fat percentages was compared:

1. UWW method with Skinfold method and Girth measurement method.
2. Skinfold method with UWW method and Girth measurement method.
3. Girth measurement method with UWW method and Skinfold method.
4. BMI method with Girth measurement method.

Since, the aim of the study was to compare the results of body fat percentage obtained from 20 young non-obese adults with the use of presented, different methods: instrumental – UWW and anthropometric – 4 skinfolds measurements, girth measurements and BMI related formula, and to assess their correlation with UWW as a reference. A measure known as product moment correlation coefficient was computed In order to know the strength of relationship between various selected fat measurement methods. It gives us a fair estimate of the extent of relationship between the two variables.

Table 5

Correlation Coefficient (R) Table Showing Comparison of Each Method with Uww Method as the Reference

	UWW Method	**Skinfold Method**	**Girth Measurements Method**	**Body Mass Index Method**
UWW Method	1	.794**	.722**	.589**
Sig. (2-tailed)	—	.000	.000	.006
N	20	20	20	20

**** Correlation is significant at the 0.05 level (2-tailed).**

Interpretation

Table 5 indicates that all the three methods of fat percentage measurement, namely Skinfold Method, Girth Measurement Method, and Body Mass Index Method, are positively correlated with the UWW Method at the 0.01 level (2-tailed).

Discussion:

The results of mean body fat content in the studied group of young, non-obese adults measured by different methods are shown in Table 3. ANOVA shows significant differences ($p>0.05$) between percentage of body fat obtained by different methods. The mean BF content measured by UWW was 16.9 ± 2.2 in percentage. The value obtained with the use of skinfold method was slightly lower whereas data from girth measurement method and BMI method was slightly higher than the UWW ones. The closest mean values to the reference gave skinfold and Girth measurement method, whereas the biggest difference, but still very close was BMI method. Data from correlation of different methods of body fat measurement with reference (UWW) are presented in Table 5. All the correlation coefficient signifies that the selected body fat measurement methods are positively correlated with the reference (UWW). The highest correlated method with the reference (UWW) was Skinfold Method, after that it was Girth measurement method whereas the least correlated but still positively correlated was BMI method for fat percentage prediction. From the data analysis, it may be concluded that the best method which can be used in the absence of UWW is skinfold method (r=.794), after that it is Girth measurement method (r=.722) and at last it can be BMI method (r=.589) for body fat measurement.

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