DETERMINATION OF İNTRAOBSERVER AND İNTEROBSERVER VARİABİLİTY WITH THE ASSESSMENT OF UNDERWATER WEIGHING AND SKINFOLD MEASUREMENT METHODS

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ABSTRACT

The purpose of this study was to investigate the precision of skinfold (SK) anthropometry to evaluate percentage body fat (BF %) against underwater weighing (UW) and find out if sex differences in skinfold assessments would be apparent in intraobserver and interobserver consistency as well as validity when compared with underwater weighing (UW) measurements. Ten male and ten female subjects were assessed to find out intraobserver and interobserver variability by 5 separate observers who each took 5 separate skinfold measurements. Pearson test were used to test correlations between skinfold measurements and underwater weighing techniques for male and female subjects were plotted independently to assess validity. Although men tended to have greater amounts of intraobserver and interobserver inconsistency when compared with women, these differences were not significant. In consideration to validity, there was no significant difference between skinfold measurements and underwater weighing between man and women. The differences observed in variability could be explained by the fact that there is a difference in skinfold compressibility between men and women.

Key words: Skinfold measurement; Observer variation; Underwater weighing;

SU ALTI YAĞ YÜZDESİ ÖLÇÜMÜ VE DERİ KIVRIM YÖNTEMLERİ İLE BELİRLENEN VÜCUT YAĞ ORANLARINDA FARKLI GÖZLEMCİ RAPORLARININ TUTARLILIĞI

ÖZET

Bu çalışmanın amacı, sualtı vücut yağ yüzdesine karşılık (BF%) deri kıvrımı (SK) antropometri hassasiyetini araştırmak ve deri kıvrım ölçümlerinde cinsiyet farklılıklarının ve gözlemciler arası ölçüm tutarlılığının incelenmesidir. Araştırmada On erkek ve on kadın deneğin 5 ayrı bölgesinden, 5 ayrı gözlemci tarafından alınan değerler karşılaştırıldı. Erkek ve kadınların deri kıvrım ölçümleri ve sualtı tartım teknikleri arasındaki korelasyonu test etmek için Pearson testi kullanıldı. sonuç olarak Erkeklerde kadınlara göre grup içi ve gözlemciler arasında ki tutarsızlık daha fazla miktarda olma eğiliminde olsa da, bu fark anlamlı değildi. Deri kıvrım ölçümleri ve sualtı ölçümleri karşılaştırıldığında erkek ve kadınlar arasında anlamlı bir fark yoktu. Değişkenlik gözlenen farklılıklar kadın ve erkek arasındaki deri kıvrımı sıkıştırılabilirliğinden kaynaklanan bir fark olduğu gerçeği ile açıklanabilir.

Anahtar kelimeler: Skinfold; Gözlemci varyasyonu; Sualtı tartım;

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INTRODUCTION

Physical fitness is major variable for all sports. Having a precise, simple, and cost-effective instrument to assess physical fitness is essential[6, 8]. One such easy assessment of physical fitness is measurement of body mass index (BMI). Perfectly estimating percentage body fat can be completed indirectly by various techniques, including skinfold assessments, bioelectrical impedance analysis (BIA), underwater weighing, air displacement plethysmography, isotope dilution, potassium-40 counting, dual-energy x-ray absorptiometry, ultrasonography, and magnetic resonance spectroscopy[4,12]. But, the majority of these techniques require hard work and they are not feasible to practice in most occasions. Skinfold measurement is most common due to the method's low cost and practicality[2]. The procedure involves measuring skinfold fat at particular anatomical sites and using these values in a certain calculation to forecast the subject's proportion of body fat.

Skinfold measurement is practical and useful in field studies[4, 6] because it is applicable, portable, relatively inexpensive, and they do not require extensive training for use. Furthermore, it is non-invasive and necessitates a nominal amount of time to administer[4]. The technique also has enormous capability for use by universities, sports and fitness institutions and hospitals[2].

Hydro densitometry (underwater weighing) is accepted as 'gold' standard for measuring body composition. However, it requires much more subject's collaboration than other methods. Compared to skinfold method, it is not extensively available, hard to administer, and more costly[9]. Many researchers and clinicians have questioned the use of skinfold fat measurement as body composition assessment test[9]. Even though good reliability and validity have been established for skinfold measurement, calipers may not necessarily assess complete fat width. Since tissue compressibility varies across gender, there may be these small possible differences when evaluating total body fatness. Although good reliability and validity be established for skinfold measurement analysis using mixed-sex populations, it has not been sufficiently determined if sex differences will affect reliability and validity equally when men are compared against women[7]. The purpose of the study was to investigate the accuracy of skinfold (SK) anthropometry to assess percentage body fat (BF %) against underwater weighing (UW). In addition, since the measurement of skinfolds is sensitive to inter observer and even intra observer error, the article also aimed to assess to verify if sex differences in skinfold measurements will be evident in intraobserver and interobserver reliability, as well as validity when compared with underwater weighing (UW) (accepted as 'gold' standard for measuring body fat composition)[9].

It can be hypothesized that differences would occur because the compressibility of fat differs between men and women, with the trend for women to be slightly less compressible than men. However, there would not be any significant difference between the skinfold (SK) anthropometry and underwater weighing (UW) measurements.

METHODS

Subjects

This study was conducted with 10 male and 10 female physically active sophomore exercise physiology students. All subjects gave their informed consent and volunteered to take part in the study. Subject characteristics are further described in Table 1.

Skinfold Assessment

The subjects measurements were taken by 5 separate observers (to determine interobserver variability) who each took 5 separate skinfold measurements (to determine intraobserver variability) using the Lange skinfold calipers. The skinfold measurement obtained from each separate observation was based on the sum of 4 skinfold sites (bicep, triceps, subscapular, and suprailiac). The subject's percentage body fat was obtained using the sum of skinfolds from the tables designed for the Lange skinfold calipers.

Underwater Weighing (UW)

Body density was calculated by underwater weighing and corrected for residual lung volume. Underwater weight was calculated in a water tank with a salter spring scale (model 235, London, UK). The subjects exhaled maximally, then submerge and stay put as static as possible for about 5 seconds while underwater weight was recorded to the nearby 0.1 kg.14. The mean of three heaviest underwater weight values among 10 measurements was taken. All measurements were completed with the subjects in a fasting condition. Residual lung volume (RV) was calculated outside the water tank soon after underwater weight measurement[16].

Body density (Db) was calculated using the following formula[1]:

Db = Wa/{[(Wa- Ww)/Dw] - RV - 100 ml}

Where Db = body density ; Wa = weight in air ; Ww = weight in water during maximal exhalation ; RV = residual lung volume and converted to percentage body fat (BF %) using the formula developed by Weststrate &Deurenberg[15]:

BF % = {(562 -4.2 (age-2)/Db) - (525 - 4.7 (age - 2)}

Data Analysis

Descriptive statistics included calculation of mean values and standard deviations for male and female subjects for percentage body fat estimated from skinfold and underwater weighing (UW). Correlation coefficients were also calculated for both male and female comparisons between skinfold and underwater weighing (UW) techniques. Statistical analysis was performed using paired t-tests to compare mean values.

RESULTS

The intraobserver and the interobserver variability results are presented in Table 1

Table 1. Comparison of intraobserver and interobserver variability across gender

Gender	Mean Age (Y)	Mean Weight (kg)	Interobserver variability (mm)	Intraobserver variability (mm)
Group	24.94 ± 5.05	73.84 ± 22.16		
Males	26.13 ± 6.24	89.50± 21.05	10.02± 5.5	5.2± 2.6
Females	23.67 ± 2.66	58.17 ±6.96	9.8± 4.9	4.7± 2.5

No statistical difference was found across gender for intraobserver and interobserver variability.

Table 2. Comparison between skinfold measurements and underwater weighting to verify validity for men and women

Gender	Estimated percentage body fat for Skinfold	Estimated percentage body fat for UW	Pearson Correlation Coefficient
Group	18.96± 6.95	18.94± 8.64	0.79
Males	17.79± 7.77	21.21 ± 10.27	0.90
Females	20.12 ± 5.66	16.68 ± 6.37	0.83

No statistical difference was found across the methods.

The correlation coefficient was higher for men compared with women (0.83 vs. 0.90, respectively). The mean values for body fat percentage were found as 18.94± 8.64, 18.96± 6.95 by UW and skinfold respectively. Strong correlations were observed between the body fat percentage values obtained by UW and Skinfold (r= 0.79, p<O.O5).

DISCUSSION

Skinfold measurement showed good validity with respect to UW both for men and women. The correlation coefficients observed between skinfold measures and UW was parallel with the past literature. In this study, the female subjects had a correlation coefficient of 0.83, whereas the men had a coefficient of 0.90. In a study, a correlation of 0.78 for women[10] and 0.96[13] for men was found. Also, consistent with our study, a study comparing skinfold measurements and magnetic resonance imaging, they found no significant difference in the correlation respectively[5].

Male subjects had greater the intraobserver and interobserver variability compared to the female subjects while there were no statistical significance observed. This difference is because of significant variability in among men's skinfold compressibility compared with women[7]. Previous literature noted that the compressibility of fat differs between men and women, and women are to some extent less compressible than men. Likewise, greater intraobserver and interobserver variability in men compared with women was observed in this study. There may be various causes for these differences such as the distribution of fibrous tissue, and genetic or hormonal differences between men and women[14].

This study is not without its limitations. First and foremost, this study used sample small size of 20 subjects. This sample size is very low for especially validation studies; however, because of complexity, harder applicability of underwater weighing measurement, it was hard to allocate many subjects in this experiment. Another limitation of this study is based on the possibility that the tiresome measurements taken on the subjects may result may affect the results of the measurement negatively and could boost the probability of the observers making mistakes.

Although the higher variability the measurements existed in our study, the correlation coefficients were parallel to previous studies. Skinfold measurement can offer useful measurement for following the results of diet and exercise programs. However, since tissue compressibility differs across gender, sports facilitators who are using skinfold caliper for body composition measurement should be careful for these small potential differences when assessing total body fatness.

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