Determination of Body Composition: Comparative Investigation of Skinfold Thickness Measures with Ultrasound Imaging

Karina Volceka1,2, Liga Ozolina-Moll2, Zbignevs Marcinkevics1,2
1University of Latvia, Institute of Atomic Physics and Spectroscopy
Raina Blvd. 19, Riga, LV-1586, Latvia
2University of Latvia, Faculty of Biology, Department of Human and Animal Physiology
Kronvalda Blvd. 4, Riga, LV-1586, Latvia

Introduction

Both in clinics and in field-survey there are a number of techniques for body composition assessment, but in both cases the applied methods have some advantages and disadvantages. The methods applied in clinics usually are unportable and expensive, whereas those methods devised for mass population often are less precise. Therefore the development of a method that would be easy to perform, precise and low-cost is required.

Body fat determination by skinfold caliper and ultrasound techniques are mobile and quite simple techniques, however ultrasonographic investigation of subcutaneous tissue allows visualization of fat tissue, whereas skinfold caliper technique relies only upon the competence of the measurer. Therefore the obtained results might be more accurate and less dependent on both skills of measurer as well as specific body composition of the measured person.

OBJECTIVE

The aim of the study was to compare the thickness of subcutaneous fat measurements, determined by both the skinfold thickness measurement technique and ultrasonography.

Methods

The study was performed on 32 healthy volunteers (8 males, 24 females) aged from 18 to 25 years. Height and weight were estimated in order to calculate the body mass index, which is considered to be representative of the whole body fat mass.

Each person had the thickness of subcutaneous adipose tissue measured, first by skinfold caliper and then by ultrasound. Measurements were obtained on the dominant side of the body at four sites on the extremities: triceps, biceps, thigh and calf, and four sites on the trunk: subcapsula, suprailiac, abdomen and chest.

All caliper measurements were made by one observer using a Harpenden skinfold caliper and each measurement site was marked for further examination with ultrasound.

Ultrasonic measurements were taken at the same sites, using The SonoSite TITAN® (SonoSite, Inc., USA) equipped with 10-MHz linear transducer and 5-MHz curvilinear transducer for cases when subcutaneous fat layer was larger than that can be measured by linear probe.

The percentage compression associated with caliper technique was determined for each body site, using the following formula, adapted from Fanelli and Kuczynski [1] who developed it for similar study:

\[ \text{Compression} = (1 - \frac{C}{U}) \times 100 \]

where \( U \) is mean fat doublefold thickness [mm] measured by ultrasound, and \( C \) is mean thickness [mm] of skinfold measured by caliper.

Results

The correlation coefficients show that the skinfold caliper and ultrasound measurements of subcutaneous fat were highly correlated and therefore significantly related to each other at all body sites, which is consistent with results from previous studies [1,2,3].

![Fig.4. Correlation between skinfold caliper and ultrasound measurements.](image)

However, after calculating the percentage compression, the results showed that on some body sites the skinfold measured by caliper exceeds that from the ultrasound, which is indicated by negative compression percentage.

That is pronounced on following sites: subcapsula (results in 100% of all measurements by caliper were higher than by ultrasound in men and 66.7% in women), thigh (100% and 62.5% respectively), calf (87.5% and 70.8%) also on triceps (men 100%) and suprailiac (men 100%), but in women it was less pronounced (29.2% and 20.8%, respectively).

![Fig.4. Correlation between skinfold caliper and ultrasound measurements.](image)

It is characteristic for these sites that it is difficult to palpate the interface between fat and muscle layer, hence we may conclude that the measurement might be taken from not only the doublefold of subcutaneous fat layer, but also includes the muscle tissue, as the skinfold measured by caliper exceeds that from the ultrasound.

Therefore this result indicates that the thickness of subcutaneous adipose tissue measured with skinfold caliper might substantially influence the precision of the results obtained with this method.

We estimated the coefficient of variation (CV) for relative difference in resulting thickness between both methods. The results show, that the difference tends to be greater on sites where it is difficult to distinguish the fat tissue from the muscle (in men on biceps was 1.3, on triceps – 1.4; in women on cuff – 1.9, calf – 1.2) or hard to obtain the skinfold because of thick layer of fat (in men CV on subcapular – 1.2 and suprailiac – 1.1; in women suprailiac – 1.1 and abdominal – 1.0).

Conclusion

Ultrasonic subcutaneous fat measurement could be a better alternative to the skinfold thickness technique for determining body fat percentage, especially in cases when the BF% is to be estimated in persons with irregularities in their body composition (i.e. obese, athletic etc.) as it permits direct measurement of subcutaneous adipose tissue thickness.

References


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