

# Sonographic Prediction of Body Fat Volume (Subcutaneous and Visceral Fat) in Cardiovascular Patients

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## Abstract

**Background:** Inappropriate body composition represents impaired energy and nutrient intake and can be a risk factor for many diseases, especially for cardiovascular disease. Different methods have been suggested for the estimation of body fat volume and its distribution. However, they may be either expensive or hazardous for some groups of patients. Sonography is a very accessible technique, which may be used for the evaluation of visceral and subcutaneous fat volume. The purpose of this study was to evaluate the sonographic prediction of body fat and its distribution in subcutaneous and visceral compartments.

**Methods:** During a three-month period, we conducted sonographic evaluations for visceral and subcutaneous fat in 106 patients who were admitted to our hospital. The subcutaneous fat was measured at the para-umbilical region and visceral fat was measured in the right para-renal space. The results were compared with the data obtained from the body mass index (BMI) and bioelectric impedance analysis.

**Results:** The mean age of the patients was 58.8 years, and the mean BMI was  $26.48 \pm 0.33$ . The mean values of fat percent and fat mass obtained by the electric-method were  $31.07 \pm 0.81\%$  and  $22.12 \pm 0.68$  kg, respectively. The respective mean values of subcutaneous and visceral fat obtained by sonography were  $20.50 \pm 0.56$  mm and  $24.14 \pm 0.58$  mm. The correlation between BMI and subcutaneous fat was 0.85 ( $p$  value  $< 0.0001$ ) and the correlation between BMI and visceral fat was 0.46 ( $p$  value  $< 0.0001$ ).

**Conclusion:** Sonography is a reliable and available method for the estimation of body fat and its distribution in cardiovascular patients, in subcutaneous and visceral compartments.

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**Keywords:** Body mass index • Body fat distribution • Subcutaneous fat • Intra-abdominal fat • Ultrasonography

## Introduction

Body fat distribution assessment, especially visceral fat accumulation, is an important method to evaluate the association between obesity, cardiovascular diseases, and metabolic disorders.<sup>1</sup> There have been various methods for body composition analysis. Computed tomography is known

to be the best method for evaluating visceral fat, but it is not used routinely for the diagnostic procedures of patients. Magnetic resonance imaging is another alternative method; however, factors such as high cost, morbid obesity, and claustrophobia in patients, or history of metal prostheses and pacemaker limit its utilization.<sup>2</sup>

Bioelectric impedance analysis (BIA) is not so appropriate

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for a wide range of patients with cardiovascular diseases, including patients suffering from congestive heart failure (CHF), patients having extra body fluid, patients receiving serum therapy, and patients in post-operation condition.<sup>3,4</sup>

Formerly, the waist-hip ratio was used to as a simple indicator of visceral fat volume, but it has been demonstrated that this ratio is unable to distinguish between subcutaneous and visceral fat volumes and is, therefore, a poor predictor of change in visceral fat volume.<sup>5</sup>

Thus, there is a great need for a simple and appropriate method to estimate the amount of visceral fat in a clinical setting. The development of sonography has offered reliable distance measurement, especially for the assessment and distribution of fat tissues.<sup>6</sup> In a study, Leite reported that intra-abdominal thickness measured by sonography could predict cardiovascular diseases.<sup>7</sup>

The purpose of this study was to evaluate the distribution of subcutaneous and visceral fat volumes measured by sonography as a determinant risk factor for cardiovascular patients and compare its results with those via body mass index (BMI) and BIA methods.

## Methods

This cross sectional study enrolled 106 patients (63 men and 43 women) with coronary artery disease (CAD) who were admitted to our hospital during a 3-month period. The patients, who had abdominal sonography for the evaluation of gastrointestinal or genitourinary problems, were given a complete description of the study. The study was approved by the Ethics Committee of the hospital, and informed written consent was obtained from all of them.

Patients older than 80 years were excluded from the study since their normal anatomy was impaired by old age. Additionally, extra dehydrated (more than 10% loss in total body water, documented by clinical and laboratory findings)

patients and those with severe edema (more than 3<sup>+</sup> edema) due to invalid information recorded by BIA method as well as those with kidney abnormalities such as polycystic kidney, renal atrophy, or hydronephrosis were also excluded from the study.

Sonographic measurements were performed in all the patients with Siemens Sonoline G20 with a 3-5 MHz by a single operator (MD) with 8 years of experience in abdominal sonography. The transducer was transversely positioned 1 cm above the umbilical scar on the abdominal midline, without exerting any pressure over the abdomen. The peri-renal fat was measured with a transducer longitudinally positioned on the axillary midline, with identification of the right kidney image. The peri-renal fat thickness was considered as the distance in millimeters between the lateral border of the kidney and the internal border of iliopsoas muscle surface adjacent to the middle third of the right kidney.

Measurement errors were avoided by performing three measurements for each patient and recording the mean value. The sonologist was blind to the measured BIA and Body Mass Index (BMI) indices. For BIA, all the patients stood with their feet in contact with the foot electrode and grabbed the hand electrodes, and an eight-polar tactile-electrode (Model Bios pace In body 720, Seoul, Korea) was utilized to carry out the measurements. The fat percent and fat mass, which were measured with the device, were recorded, and so were height and body weight to the nearest 0.1 cm and to the nearest 0.1 kg of the patients. BMI was calculated as weight divided by height squared ( $\text{kg/m}^2$ ) (normal range: 18.5 to 24.9  $\text{kg/m}^2$ ).

The results were expressed as mean  $\pm$  SD. All the statistical analyses were performed utilizing SPSS software (version 13.0; SPSS, Inc., Chicago, Ill). The Pearson correlation coefficient and linear regression tests were used to assess the simple relation between the variables. The level of statistical significance was defined as p value < 0.05.

Table 1. Bivariate Pearson correlation coefficient between BMI and electrical (BIA) and sonographic results according to gender\*

First variable	Second variable	Pearson correlation coefficient		
		Male	Female	Total
BMI ( $\text{kg/m}^2$ )	Fat percent (by BIA method)	0.667	0.742	0.643
	Fat mass (by BIA method)	0.832	0.857	0.834
	Visceral fat (by ultrasonography method)	0.462	0.432	0.462
	Subcutaneous fat (by ultrasonography method)	0.809	0.865	0.848
Fat percent	Fat mass (by BIA method)	0.889	0.874	0.870
	Visceral fat (by ultrasonography method)	0.506	0.537	0.538
	Subcutaneous fat (by ultrasonography method)	0.733	0.673	0.681
Fat mass (kg)	Visceral fat (by ultrasonography method)	0.567	0.404	0.544
	Subcutaneous fat (by ultrasonography method)	0.836	0.737	0.799
Visceral fat Thickness (mm)	Subcutaneous fat (by ultrasonography method)	0.554	0.583	0.580

\*All coefficients were significant at  $p < 0.05$

BMI, Body mass index; BIA, Bioelectric impedance analysis



## Results

This study recruited 106 patients, comprising 43 (41%) women and 63 (59%) men, with a mean age of  $58.8 \pm 1.1$  years. The mean BMI was  $26.48 \pm 0.33$  ( $25.89 \pm 0.36$  in men,  $27.33 \pm 0.61$  in women). The mean values of fat percent and fat mass obtained by the electric-method were  $31.07 \pm 0.81\%$  and  $22.12 \pm 0.68$  kg, respectively. The respective mean values of subcutaneous and visceral fat obtained by the sonography method were  $20.50 \pm 0.56$  mm and  $24.14 \pm 0.58$  mm. The Pearson correlation coefficients between BMI and the other variables in terms of age are shown in Table 1.

A comparison of the correlations between the electrical and sonographic variables and BMI calculation demonstrated a significant relation between subcutaneous fat thickness (mm) and BMI and between fat mass volume (kg) and BMI ( $\text{kg}/\text{m}^2$ ). It was also shown that a measurement of subcutaneous fat and fat mass to predict BMI for the estimation of body fat volume resulted in almost similar values. The most significant correlation was between subcutaneous fat (by sonography) and BMI ( $r = 0.848$ ,  $p$  value  $< 0.0001$ ), and between fat mass (BIA) and BMI ( $r = 0.834$ ,  $p$  value  $< 0.0001$ ). All the other correlations between the other variables and BMI were also significant. Generally, correlations between different variables did not differ significantly in both genders, which means that sonographic prediction was valid in both sexes to almost the same extent.

## Discussion

Our study compared alternative methods in the assessment of the distribution of adipose tissue. Utilization of non-invasive and less expensive methods may facilitate the detection of high-risk patients and allow earlier interventions.

Estimation of body composition and body fat distribution by a method other than BMI calculation can be a great help for the detection of cardiovascular diseases.

Among techniques for the assessment of fat tissue distribution, BIA has been used to quantify the percentage of lean and fat mass. Our results support the idea that this method is as useful as ultrasonography for identifying visceral fat. Such findings are in agreement with those of some previous studies.<sup>8-10</sup>

Similar to any other method, BIA has some advantages and limitations: Being inexpensive and non-invasive are some of its strong points, this method is highly sensitive and can easily be affected by changes in total body water and altered body temperature. Moreover, its sensitivity for the placement of electrodes (e.g., tall patients) limits its accuracy and utilization.<sup>3, 4</sup> Some other simple methods, like waist-hip ratio were not accurate enough to differ subcutaneous

from visceral fat and therefore, a poor predictor of change in visceral fat volume.<sup>5</sup>

Ultrasonography has been proven to be a practical, effective, and low-cost method to measure body fat and its distribution.<sup>6, 7</sup> However, ultrasonography accuracy is operator-dependent and needs a thorough knowledge of anatomic landmarks and a proper scanning technique.

## Conclusion

Our results suggest that both bioelectrical impedance and ultrasonography are useful for predicting the visceral and percutaneous fat volume. In conclusion, the accuracy and simplicity are factors that make ultrasonography one of the safest (albeit not the most perfect) methods in clinical practice for the measurement of body fat volume.

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