

# Effect of Obesity on the Ability of Physicians to hear Heart Murmurs

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## Abstract

**Objective:** There is a lack of heart auscultation studies in obese patients. Our aim was to evaluate the effects of obesity on the ability of physicians to hear heart murmurs.

**Methods:** 30 patients with body mass index (BMI)>30 kg/m<sup>2</sup> were auscultated by a cardiologist and a resident using electronic and acoustic stethoscopes. 15 patients were auscultated by one cardiologist and one resident and 15 patients-by another cardiologist and another resident using both stethoscopes for each auscultation. Auscultation data was verified by an echocardiogram: auscultation sensitivity and specificity was calculated. Echoscopic subcutaneous adipose tissue (SCAT) measurements at the listening site and body shape were included in the analysis.

**Results:** There does not appear to be a predictive relationship between BMI and SCAT. Although most of the patients had a rounded shape, it is not obvious that shape and BMI, when used together, allow one to predict SCAT. 85% of SCAT values were between 0.7 and 1.3. Sensitivity varied by stethoscope (p-value<0.0001), valve (p-value<0.0001), SCAT (p-value=0.0019). Specificity varied by valve (p-value=0.015).

**Conclusions:** There is an indication that auscultation sensitivity varies with SCAT. It is a hypothesis for later confirmation because there was a limited range of SCAT values.

**Keywords:** Heart murmurs; Auscultation; Obesity; Electronic stethoscope; Acoustic stethoscope

## Introduction

Obesity and overweightness represents a rapidly growing threat to the health of populations in an increasing number of countries [1]. The population's body mass index (BMI) has increased in many countries [2,3]. Obesity can make diagnosis more problematic [4].

The accuracy of auscultation largely depends on the physicians, their experience and the surrounding environment's ambient noise [5]. Although this is not the only prerequisite for a good diagnosis, obesity also plays a role in conduction of sound [6]. The auscultation method relies on the conduction of heart sound, from the heart to the stethoscope. The subcutaneous adipose tissue (SCAT) adds a layer of insulation, which means that in theory pathological heart sounds at an early stage of pathology may not be heard. There is a lack of heart auscultation studies in obese patients. Therefore, our aim was to evaluate the effects of obesity on the ability of physicians to hear heart murmurs.

## Material and Methods

It was a sub-study of study EM-05-012530-a pilot study to investigate the effect of the use of an electronic scope on the ability of physicians to hear heart murmurs, particularly for obese patients. It was a prospective observational cohort study. The patients arriving to Kaunas Clinical Hospital were considered for inclusion into this study if they had a BMI greater than 30 kg/m<sup>2</sup> (obese), were greater or equal to 18 years of age, were referred for an echocardiography and agreed to participate in the research study. Patients gave written informed consent for prospective inclusion in this study. Exclusion criteria were only these: investigator

believed subject should not be included (a severe status of patient) or was unsuitable for inclusion (echo-negative patient). The study was approved by the Ethics Committee of the Lithuanian University of Health Sciences, code: 30256989.

Each subject received four auscultation examinations. Two auscultations were done by a cardiologist using both an acoustic traditional stethoscope (3M Littman Cardiology III Mechanical Stethoscope) and an electronic stethoscope (3M Littmann 3200 Electronic Stethoscope). Two additional auscultations were done by a 3<sup>rd</sup> year medical resident also using both an acoustic traditional stethoscope and an electronic stethoscope. Half of the patients were auscultated by one cardiologist and one resident, and a half – by another cardiologist and another resident. Based on the randomization for each subject, the auscultation may begin with either the 3M Littmann 3200 Electronic or 3M Littmann Cardiology III Mechanical stethoscope. Each auscultation consisted of heart murmurs being listened to in the following sites: Aortic, Pulmonary, Tricuspid, Erb's, and Apex (Mitral). After the completion of all auscultations, the subject underwent an echocardiography. The echocardiography was done by a separate clinical team, which had no access to the information obtained from the auscultations completed for the study. In addition, each patient's SCAT echoscopic measurements were recorded for the five auscultation sites: a layer of the SCAT was measured by ultrasound at each of the following sites-Aortic, Pulmonary, Tricuspid, Erb's, and Apex (Mitral). An example of our used body shape classification is shown in figure 1.

## Statistical analysis

Correlation between SCAT measurements and BMI was investigated.

<b>Height</b> <input type="text" value="1"/> m. <input type="text" value="55"/> cm	<b>Weight</b> <input type="text" value="-"/> <input type="text" value="90"/> kg.	<b>BMI</b> $\frac{\text{Weight kg}}{\text{Height m}^2} = \boxed{37.5}$
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Indicate the body shape that best describes the subject:

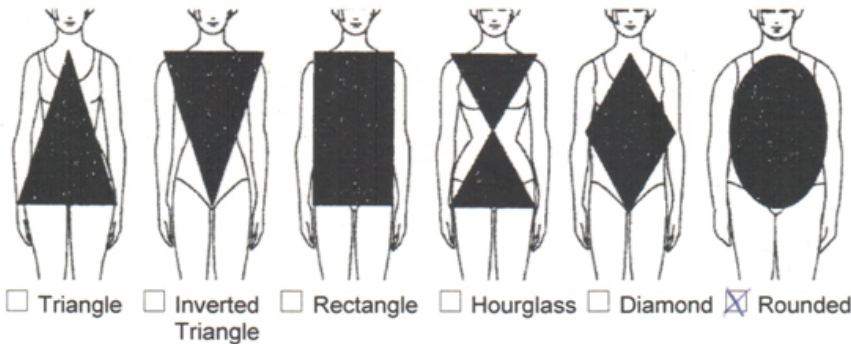


Figure 1: An example of our used body shape classification.

Body shape was included as a confounder. Auscultation data was verified by an echocardiogram: auscultation sensitivity and specificity was calculated. The effect of SCAT at the listening site on specificity and sensitivity of auscultation was investigated using a Generalized Mixed Model with physician type, stethoscope, valve and SCAT measurement in the full model. Patient was also in the model as a random effect. Frequency tables were also produced to visualize the effect. The analysis was conducted in the limited range of SCAT between 0.7 and 1.3, where the majority of the data were found. The initial models included the four variables and two-way interactions. Non significant variables ( $p\text{-value} > 0.05$ ) were then removed.

## Results

Thirty patients, 20 males (66.67%) and 10 females (33.33%) were included in the study. Their demographic data are presented in tables 1 and 2. Most common reasons for hospitalization were: dyspnea (25), chest pain (23) and an abnormal electrocardiogram (17). The measurements of SCAT at each site of auscultation are presented in table 3.

### Relationship between SCAT and BMI

Average SCAT is plotted against BMI in figure 2. There were two SCAT values that were far above the others. With the exception of these data, there does not appear to be a predictive relationship between the two variables. Thus, it does not look like BMI can be used as a more easily obtained measurement/surrogate. Also, it is not obvious that shape and BMI, when used together, allow one to predict SCAT. Average SCAT is shown in figure 2 but the findings do not change with SCAT at the various anatomical locations.

### Effect of SCAT on sensitivity and specificity of auscultation

There was not a very broad range of SCAT readings. Eighty-five percent of the values were between 0.7 and 1.3. Analysis of the effect of scat (with SCAT as a class variable) and other variables (physician, stethoscope and valve) on sensitivity and specificity was conducted within this restricted range of values.

Sensitivity varied by: Stethoscope ( $p\text{-value} < 0.0001$ ), valve ( $p\text{-value} < 0.0001$ ) and SCAT ( $p\text{-value} = 0.0019$ ). Also, the sensitivity differences between valves changed with SCAT ( $p\text{-value} = 0.0002$ ).

Stethoscope had no effect on specificity ( $p\text{-value} = 0.50$ ) or SCAT overall ( $p\text{-value} = 0.33$ ).

Specificity varied by: Value ( $p\text{-value} = 0.015$ ). Also, the specificity differences between valves changed with SCAT ( $p\text{-value} = 0.001$ ).

## Discussion

This study showed that there is an indication that sensitivity of auscultation in obese patients (for the detection of heart murmurs) varies with SCAT. Already in 1988, the study of 294 patients examined by pulsed Doppler echocardiography showed that the likelihood of missing regurgitant lesions by auscultation was increased by obesity [6]. But, since that time the new electronic stethoscopes became available. According to some publications [5,7], while technological advancements, such as echocardiography, may well have contributed to the demise of cardiac auscultation, technology in the form of integrated electronic auscultation

Variable	N	Mean	Standard Deviation	Minimum	Maximum
BMI (kg/m <sup>2</sup> )	30	34.5	4	30.7	46.6
Height in meters	30	1.7	0.1	1.5	1.9
Weight (kg)	30	98.8	13.7	71	130
Age (yr)	30	68.3	12.1	45	96

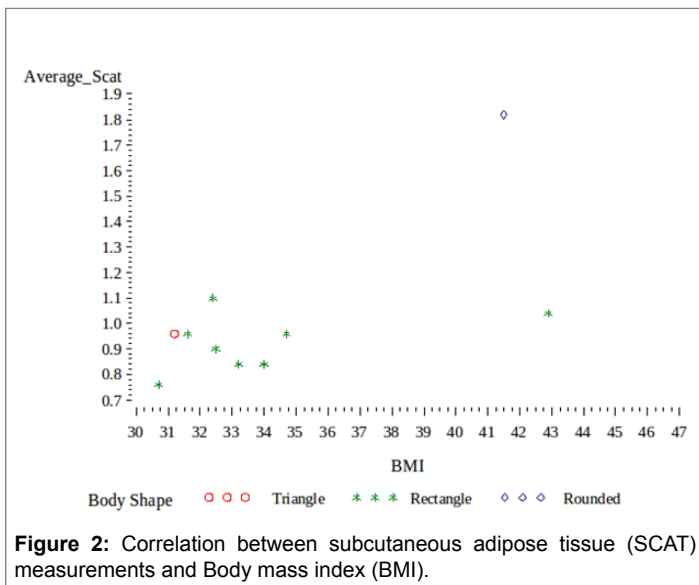
Table 1: Body mass index (BMI), height, weight and age of patients.

Body shape	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Triangle	1	3.33	1	3.33
Rectangle	8	26.67	9	30.00
Rounded	21	70.00	30	100.00

Table 2: Body shape of patients.

SCAT (cm) Location	N	Mean	Standard Deviation	Minimum	Maximum
Apex	30	1.15	0.28	0.8	2.1
Pulmonary	30	0.86	0.21	0.5	1.3
Erbs	30	1.06	0.3	0.7	2.2
Aortic	30	0.86	0.26	0.4	1.9
Tricuspid	30	1.02	0.44	0.5	2.6
Average SCAT	30	0.99	0.25	0.74	1.82

**Table 3:** The subcutaneous adipose tissue (SCAT) measurements at various listening sites.



**Figure 2:** Correlation between subcutaneous adipose tissue (SCAT) measurements and Body mass index (BMI).

may well revive its place in clinical medicine. In our research, we studied auscultations with a 3M Littmann Electronic stethoscope. There is a lack of heart auscultation studies with modern stethoscopes in obese patients. McCullough study [8] compared audiocardiography to senior attending physicians using conventional stethoscopes in patients with morbid obesity: acoustic cardiography performed with an electronic device was not helpful in assisting the cardiovascular examination of the morbidly obese. However, they assessed heart sounds (S3, S4), but not murmurs. We assessed the ability of physicians to hear heart murmurs in obese patients. Detection of murmurs varied not by clinicians, but by SCAT in our study. Analysis of the impact of all these variables (physician, stethoscope, valve, SCAT) on sensitivity and specificity was conducted, but statistically significant results were only these: sensitivity varied by stethoscope, valve and SCAT and specificity

varied by valve. Also, the sensitivity and specificity differences between valves changed with SCAT.

The population's BMI has increased in many countries [2,3]. So, our topic is really relevant to be investigated.

Our study did not appear to conclude a predictive relationship between BMI and SCAT. So, if SCAT has an effect on the ability to hear cardiac abnormalities it does not look like BMI can be used as a more easily obtained measurement/surrogate than SCAT. Although most of the patients had a rounded shape, it is not obvious that shape and BMI, when used together, allow one to predict SCAT.

## Conclusions

There is an indication that sensitivity of auscultation for the detection of heart murmurs varies with SCAT in obese patients. There does not appear to be a predictive relationship between BMI and SCAT. The analyses were exploratory and our conclusions are only hypotheses for later confirmation. There was a limited range of Scat values. More high BMI/high SCAT values are needed.

## Acknowledgments

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