**Original Research Article**

# A Correlation of Two new Anthropometric Indices with Pulmonary Function

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**Abstract**

**Background:** Sincebody mass index (BMI) fails to differentiate between muscle mass and fat, there is increasing evidence in emphasizing the search for an alternative to BMI. The existing alternatives namely waist-circumference, waist-hip-ratio, body roundedness index did not significantly correlate with pulmonary function. A body shape index (ABSI) and surface based body shape index (SBSI) are two new indices suggested as alternatives to BMI, which need to be explored. **Aim:** The aim of the study was to correlate ABSI and SBSI with spirometric parameters of pulmonary function. **Materials and Methods:** The study was done in 100 volunteers. Spirometric measurements namely, $FEV_1$/FVC and MVV were measured using a computerized spirometer. Anthropometric measurements such as height, weight, waist circumference, and vertical trunk circumference were calculated for estimating the ABSI and SBSI. The ABSI and SBSI were correlated with $FEV_1$/FVC and MVV. **Results:** ABSI and SBSI were found to be significantly and negatively correlated with MVV. ABSI and SBSI did not significantly correlate with $FEV_1$/FVC. **Conclusion:** This study is unique as it is a pioneering study in this part of the world, which correlates SBSI with spirometric parameters. Increase in ABSI and SBSI were found to decrease MVV. Both ABSI and SBSI outperformed BMI in correlation with MVV. This study has also paved way for future long term researches on body shape and pulmonary function, which has not been much reported, so that a combination of BMI along with indices measuring body shape (ABSI & SBSI) can be used in clinical practice as indicators of obesity.

**Keywords:** body mass index, spirometry, surface based body shape index

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## Introduction

Obesity has become a cumbersome problem all over the globe. Obesity is defined as abnormal or excessive fat accumulation that may impair health. Obesity is one of the major causes for respiratory distress, sleep apnea, hypertension, and coronary heart disease. There are many published articlesrelating obesity and anthropometric measurements with cardiovascular function. The relationship between obesity and respiratory function of an individual is often under-reported.

When the word “Obesity” is uttered, immediately one’s mind goes towards the conventionally used parameter, “Body Mass Index (BMI)” or “Quetlet’s Index”.

Of course, BMI is one of the most extensively used anthropometric parameters in the medical field. Although BMI is easier to calculate and it gives an overall idea about one’s weight to his height, it fails to distinguish between muscle mass and fat. It does not capture the distribution of lean mass and

adipose tissue. It grades super-fit athletes and body-builders as obese. Even in obese individuals, it fails to differentiate between central and peripheral accumulation of fat. As a result, BMI serves as an insufficient indicator in predicting obesity and obesity related risks.

Considering pulmonary function, the mass of the respiratory muscles increases the lung volumes whereas fat in the abdomen decrease the lung volumes causing restriction. Thus, muscle mass and fat mass have opposing effects on pulmonary function. BMI as a non-specific indicator of mass, does not differentiate between muscle mass and fat mass and hence cannot be solitarily used as an indicator for assessingpulmonary function.

Several studies had emphasized waist circumference (WC) and waist – hip ratio (WHR) as alternatives to BMI, which measure the degree of central obesity in obese individuals.[1-8]The advantage of waist circumference is that it better predicts the amount of intra abdominal or visceral fat, which is important when determining the patient's risk for obesity-related disease. In elderly population, WC is a better indicator of adiposity than is BMI. Waist circumference (WC) has emerged as a leading complement to BMI for indicating obesity risk. A number of studies have found that WC predicted mortality risk better than BMI.[3-8]A recent WHO report has summarized evidence for WC as an indicator of disease risk, and suggests that WC could be used as an alternative to BMI.[9] But, unlike BMI, the association of WC with FEV1/FVC is not significant.[1]

In the year 2012, a new index called as the A Body Shape Index (ABSI) was constructed by Nir Y. Krakauer, Jesse C. Krakauer of USA as an alternative to BMI.[10] ABSI is calculated using the formula:

$$ABSI = WC\,(m) \,/\, [BMI^{2/3} \times height^{1/2}(m)]$$

Being independent of BMI, ABSI helps in assessing the role of abdominal obesity over morbidity[11].ABSI satisfies the WHO recommendation concerning waist circumference inclusion into health risk evaluation.[10] High ABSI indicates that WC is higher than expected for a given height and weight and corresponds to a more central concentration of body volume. Applying ABSI along with BMI as a predictor variable separates the influence of the component of body shape measured by WC from that of body size. Marzena Malara et al has found ABSI to be a better predictor of health risk in young healthy sedentary men than BMI.[12]RyotaroBouchi et al has also concluded that ABSI appears to reflect visceral adiposity independently of BMI and also acts as a substantial marker of arterial stiffening in patients with type 2 diabetes.[13] A recent article published in January 2019has correlated ABSI with Pulmonary Function and it was found that ABSIhad a better correlation with spirometric parameters than BMI.[14]

A recent research article in the year 2015, suggests an alternative index tothe BMI known as the surface-based body shape index (SBSI).[15] It takes into account both body shape and body size and predicts mortality risk more accurately. It is calculated from 4 anthropometric determinants viz. body surface area (BSA), vertical trunk circumference (VTC), height (H) and waist circumference (WC).

$$SBSI = (H^{7/4})\,(WC^{5/6}) \,/\, [(BSA)\,(VTC)]$$

While the BSA measures the whole body, WC and VTC measure the trunk region, with WC measured horizontally, while VTC is measured vertically. More importantly, both WC and VTC are strongly associated with abdominal fat.

Until recently, there are no notable published research articles with regards to SBSI in this part of the world.

This study was carried out to investigate the relationship between the body shape indices (ABSI & SBSI)and Pulmonary Function.

Considering the respiratory parameters, Spirometric analysis of $FEV_1$/FVC and MVV was done. This study was limited to $FEV_1$/FVC and MVV due to the following reasons:

- $FEV_1$/FVC and MVV are considered to be the initial screening tool for pulmonary diseases and are useful to differentiate

between obstructive and restrictive lung diseases.
- MVV is an indicator to determine the exercise tolerance

**Materials and Methods**:

This was a cross-sectional study conducted between June 2017 and September 2017 in the research wing of the department of Physiology at the Chettinad Hospital & Research Institute – Chennai. The sample size of the study was 100 with the distribution of the sexes being equal. The participating subjects of the study included medical and paramedical students who were selected by the simple random method of sample collection.

The study was carried out following the approval of the ethical committee of the institute.An Informed consent was obtained from the participants prior to the commencement of the study.

The inclusion and exclusion criteria of the study included:

**Inclusion Criteria:**

- Age >18
- Height >140 cm
- Weight>40 kg

**Exclusion Criteria:**

- Smokers
- Volunteers with history of any respiratory complaints like coughing, shortness of breath, wheezes, fever, or upper respiratory tract infection.
- Volunteers with chronic respiratory illness like tuberculosis.
- Volunteers with thoracic spinal abnormalities.
- Volunteers who had undergone cardiac or thoracic surgery.

**Anthropometry**

Anthropometric measurements such as height, weight, waist circumference and vertical trunk circumferencewere measured.

1. Standing body height (H) of the subject was measured without shoes using a stadiometer.
2. Body weight (W) was measured barefoot with light clothing using a weighing machine of accuracy 0.1 kg.
3. Waist circumference (WC) was measured using a standard non-stretchable measuring tape, at the narrowest point between the iliac crest and ribcagewith the subject in a state of full expiration; based on WHO guidelines for measurement of Waist Circumference.
4. Vertical Trunk Circumference (VTC) is measured using a standard non-stretchable tape from the shoulder, through the crotch, and back to the shoulder with the subject in standing position, with the weight distributed equally on both feet and the arms hanging freely downwards.[16]

**Spirometry**

Considering the respiratory parameters, spirometric analysis of $FEV_1$/FVC and MVV was carried out. FEV1/FVC and MVV were taken using a digital computerized spirometer in the research laboratory that was well ventilated. The spirometer recordedthe indices by ultrasound transit time measurement. Its measurement accuracy of volume and flow was ±2 % . The mouthpiece part of the spirometer was sterilized with 0.3% chlorhexidine gluconate solution, 0.3% Cetrimide solution and 0.4% isopropyl alcohol after every use. The NDD's 'Easy On PC' software (Version 1.5x) was used for spirometric measurements.

Subject ID was fed into the system for identification of the subject. Height, Age and Weight of the subject were fed into the system for it to calculate the Predicted Values of the results.

For the measurement of $FEV_1/FVC$, the subjects were asked to take a deep inspiration and exhale air as forcefully and as rapidly as possible for about 5 seconds into the mouthpiece of the computerized spirometer. The flow volume loop; FEV1, FVC andFEV1**/** FVC were recorded. Motivational comments were used to extract the best out of the subject. For the measurement of MVV, the subjects were asked to inspire and expire forcefully and rapidly for 12 seconds through the mouthpiece of the spirometer. The subjects were asked to perform only after proper demonstration of the tests by the investigator. A nose clip was used in subjects who had an involuntary involvement of their nose during expiration.

**Results**

**Table 1.0 – Cumulative values of the Study Parameters**

| | Mean | SD | SE | Minimum | Maximum |
|---|---|---|---|---|---|
| ABSI | .083 | .004 | .000 | .072 | .094 |
| SBSI | .117 | .008 | .001 | .093 | .141 |
| FEV1/FVC | 98.476 | 6.315 | .622 | 81.000 | 115.000 |
| MVV | 117.481 | 26.597 | 2.621 | 54.500 | 185.100 |

**Table 2.0 – Correlation co-efficients**

| | ABSI | SBSI | FEV1/FVC | MVV |
|---|---|---|---|---|
| ABSI | 1 | .827** | .024 | -.347** |
| SBSI | ------ | 1 | .068 | -.386** |

1) ABSI with $FEV_1/FVC$
   ABSI was positively correlated with $FEV_1/FVC$. There is only about 2% correlation. The significance is so low that it can be considered that the association between ABSI and $FEV_1/FVC$ was negligible.
2) SBSI with $FEV_1/FVC$
   There was only a 6.8% positive correlation between SBSI and $FEV_1/FVC$. This finding was also not significant.
3) MVV with ABSI and SBSI

ABSI and SBSI are found to be significantly and negatively correlated with MVV. The correlation coefficients are found to be -0.347 and -0.386 respectively.

**Discussion**

Many researchers have studied the association between BMI and Pulmonary Function since 2006 after the pioneering study of Richard L Jones and Mary Magdalene.[17]The effects of obesity on spirometric values were not consistent in most of the studies. Some studies showed no association

between BMI and pulmonary function and some studies showed significant association.[17-24]

In this study, the correlation between ABSI and $FEV_1$/FVC was so low that it can be considered that the association between ABSI and $FEV_1$/FVC was negligible. However, ABSI failed to serve as a better indicator than BMI in many of the studies. ABSI showed the weakest predictive ability among BMI, WC, or waist-to-height ratio,body roundedness index (BRI) in assessment of diabetes mellitus.[25]ABSI demonstrated the lowest predictive power and had no significant correlation with cardiovascular disease compared with BRI, BMI, and WC[**26**]. The predictive ability of ABSI was not better than BMI with respect to type 2 diabetes, hypertension and cardiovascular disease in Chinese and Iranian populations.[12,26-28] Similarly, in this study, ABSI failed to outperform BMI, when it was correlated with $FEV_1$/FVC.

This study is unique as it is one of the pioneering studies in this context, which correlated SBSI with $FEV_1$/FVC and MVV as there are no studies associating SBSI with respiratory function in this part of the world.There aren't many studiesinvolving SBSI in medical literature till date and its association with other fields of medicine is also not well known.However, SBSI outperformed BMI, WC, waist-to-height ratio, waist-to-hip ratio (WHR), and ABSI in predicting all-cause mortality.[10] But, in this study, the correlation between SBSI and $FEV_1$/FVC was not significant and also SBSI failed to outperform BMI when correlated with $FEV_1$/FVC.However, SBSI correlated $FEV_1$/FVC better than ABSI.

There was a significant negative correlation between ABSI and SBSI with MVV. Increase in ABSI and SBSI were found to be associated with a decrease in MVV. Both ABSI and SBSI have outperformed BMI in correlation with MVV. The MVV test evaluates the respiratory endurance and is influenced by the respiratory muscle strength, the chest compliance, control of breathing and airway resistance. In the case of obese individuals, MVV is reduced mainly by the mechanical impact to the respiratory muscles, caused in particular by the excessive weight on the thorax. While doing the MVV test in this study, it was also found that MVV increases with motivation and psychological tuning of the subject as there was an increase in the MVV results following motivational comments. However, the correlation of ABSI and SBSI with MVV was not so high to determine exercise tolerance in subjects with different ABSI and SBSI.

The reason for not picking up a high correlation relating body shape and $FEV_1$/FVC in this study may be due to a number of reasons. As the number of subjects just being 100, a proper correlation between body shape and pulmonary function may not have been picked up. It wasn't possible to do the sub-categorization by sex to investigate the association of ABSI and SBSI with pulmonary function due to the small sample size. Also, the population in this study was ethnically and socially homogeneous, belonging to an age group of 18-26.

**Conclusion**

In this short-term study, there was a significant negative correlation of ABSI and SBSI with MVV. ABSI and SBSI did not significantly correlate with $FEV_1$/FVC. However, since this was a study with a small sample size, future studies correlating body shape and pulmonary function can be carried out. In this context, ABSI and SBSI can be correlated with all the spirometric parameters and the study can be carried out in a large population to confirm the correlation between body shape and pulmonary function. If an association is picked up, the combination of BMI, ABSI, SBSI, can be used to predict obesity and obesity related risks. Obesity related complications can be predicted well in advance, and hence diet and life-style modifications can be made much earlier. The measurement of waist circumference and vertical trunk circumference beyond routine weight and height can be feasible in clinical setting, with minimal personnel training.

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**Conflict of Interest :** Nil

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