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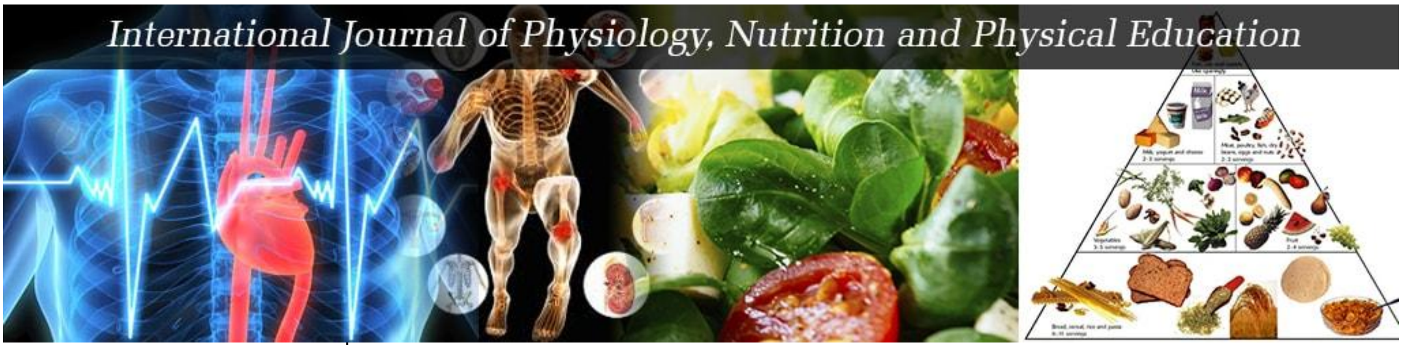


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# Association of body mass index among pulmonary function tests in obese and non obese subjects

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**Abstract**
Obesity is a global health hazard. As standards of living are continuing to rise, weight gain and obesity are posing a growing threat to health in countries all over the world. These obese individuals are at increased risk of morbidity and mortality because of its relationship with various metabolic disorders. The Efficiency and functional status of Lungs can be assessed by using these simple tests and effective for diagnosis of various lung diseases. To find out the association, including gender differences, between body mass index and lung functions identified obese and nonobese adults. By spirometric protocols. The Respiratory function was recruited in hundred obese adults and 100 non obese adults aged between 25-45 years, including both sexes. Among obese subjects significant correlation is found between BMI and pulmonary function value decreased response of FVC, FEV1 and FEV1%. Significant association was found between BMI and lung function in obese female and obese male. Finally signifying that decreases efficiency of lungs occurs in Obesity. The present work conclude that early detection of functional impairment of respiratory changes and its appropriate management is the only means by which the morbidity and mortality can be reduced.

**Keywords:** body mass index. obesity adults, pulmonary function tests, spirometric parameters

## Introduction

Obesity is a global problem and it is a significant contributor to morbidity and mortality. Unlike investigations conducted in adults, studies of physical activity and cardiorespiratory fitness in obese adolescents are still scarce and inconclusive. Obesity is currently one of the most severe public health problems worldwide, and has attracted the attention of many researchers around the world. Important function of the lung is to sustain the tension of Oxygen ($Po_2$) and Carbon dioxide ($Pco_2$) of arterial blood within the reference range [1]. Among the different systems affected by obesity, the respiratory system deserves special attention, as obesity can cause changes in respiratory function, exercise tolerance, pulmonary gas exchange, respiratory pattern, and strength and endurance of the respiratory muscles [2]. This is executed which uptake of oxygen from the inspired air and releases carbon dioxide from expired air. Thus adequate tissue oxygenation is balanced and accumulation of carbon dioxide is prevented by the lung [3]. The basic mechanisms involved in achieving this goal are by ventilation, diffusion and perfusion. Pulmonary ventilation refers to the moment of air in and out of lungs [4]. Its sufficient ventilation is influenced by mechanism of breathing, lung volume and capacities. These different parameters lung volumes and capacities are indices of static dimensions of the lungs at various stages of inflation [5]. The mechanics of breathing deal with static as well as dynamic mechanical properties of the respiratory apparatus [6].

Recent studies shows the effect of Physiology obesity on lung function. However, obesity has little direct effect on airway caliber [7]. Spirometric variables decrease in proportion to lung volumes, but are rarely below the normal range, even in the extremely obese, while reductions in expiratory flows and increases in airway resistance are largely normalized by adjusting lung volumes and also respiratory parameters indicate static element of the lungs at different stages of inhalation the static and dynamic mechanical stuff of the lungs depends on mechanism of respiration [8]. Assessment of maximal effort of inspiratories indicates strength of muscle of respiration and functional status of respiratory system. $FEV_1$ [9]. Obesity is a medical condition characterized by an excessive accumulation of fat on human body that causes a general increase in body mass [10]. In healthy Obesity and physical inactivity are two main factors that affect respirator function. Obese patients tend to have higher respiratory rate and lower lung volumes [11]. In addition, total respiratory compliance is reduced, because of increase in resistance due to fat accumulation [12]. People may be mildly hypoxemic possibly due to ventilation-perfusion mismatching where microatlectasis is likely to occur [13]. The prevalence of obesity is 400 million across the world as per WHO report 650 million 2016. Obesity rises along with age up to 50 or 60years old. The traditional sign of obesity is normal adiposity is BMI [14]. "Body Mass Index (BMI)" measured in $Kg/m^2$. A BMI of 20-25 Kg/m2 is considered as normal. If it is in between 25-29.9 $Kg/m^2$ is considered as overweight [15]. If it is more than 30$Kg/m^2$ then it is referred as "obese". Therefore, early detection of functional impairment respiratory changes and its appropriate management is the only means by which the morbidity and mortality can be reduced [16]. The present study was undertaken to evaluate the respiratory parameters in obese adults from Nellimarla in Vizianagaram district of Andhra Pradesh.

## Methodology

One hundred cases of obese participants and thirty non obese subjects age matched controls recruited from dept of Physiology Nimra Institute of Medical Sciences (NIMS), Vijayawada of Andhra Pradesh. The present study included both males and females, were estimated for Lung volumes and capacities.

Inclusion Criteria: The present study include those who having BMI (Body mass index) > 30$Kg/m^2$, Age between 25-45 years and Not suffering from any alternative disease or clinical manifestations. All the healthy subjects (controls) and Obese participants (cases) were subjected to general and physical examination. The cardiovascular sympathetic function methods were carried out morning, after familiarizing the subjects with the testing procedures.

The following method were performed to estimate the Respiratory functional status: Forced vital capacity (FVC), Forced expiratory volume in 1st second (FEV1) and FEV1%.

## Procedure

In every subject height in centimeters, weight in kilograms was measured. Subject was asked to inspire maximally through the mouth piece, expire maximally and inspire with maximum effort again. This method was explained to the subject and a demonstration of the maneuver was given. After preliminary trials, the test was showed three times and best reading was taken. The methods were performed with subjects in the standing position.

Following parameters were done to evaluate functional status of respiratory system: Forced Vital Capacity (FVC): Normal value in adult male: 4600ml. Forced Expiratory Volume in the first second ($FEV_1$): Normal value: 80-85% of FVC. Forced Expiratory Volume percent $FEV_1$%: The ratio of $FEV_1$/FVC is approximately 0.75-0.80. This is a very sensitive predictive indicator of airway obstruction than FVC or $FEV_1$ alone.

The above mentioned Respiratory function tests were conducted in 100 Obese (cases) and 100 Non obese (control group) and results were compared to study the effect of obesity on efficiency of Respiratory system. Statistical data have been showed by using a test of standard error of difference between two means (z-test).

## Results

The Respiratory function was recruited in hundred obese adults and 100 non obese adults aged between 25-45 years, including both sexes. Among obese subjects significant correlation is found between BMI and pulmonary function value decreased response of FVC, FEV1 and FEV1%. Significant association was found between BMI and lung function in obese female and obese male. Finally signifying that decreases efficiency of lungs occurs in Obesity. The present data reporting the above tests were associated between the cases (obese) and healthy age matched controls (non obese controls). Values are expressed as mean± SD in the tables. The Lung parameters were recorded with spirometer.

**Table 1:** Comparison of Spiro metric values for BMI of study sample among Obese and Non obese subjects.

| Parameters | Obese | Non Obese | P value |
|---|---|---|---|
| AGE (Mean ± SD) | 38.21±7.765 | 32.45±4.620 | <0.0001 |
| Height (Mean ± SD) | 161.21±4.871 | 160.51±3.932 | 0.2648 |
| Weight (Mean ± SD) | 84.14±8.624 | 60.12±6.681 | <0.0001*** |
| BMI (Mean ± SD) | 35.23±4.67 | 22.96±2.101 | <0.0001*** |
| Forced Vital Capacity (FVC) (Mean ± SD) | 2.770±0.402 | 2.423±0.391 | <0.0001*** |
| Forced Expiratory Volume in 1st second ($FEV_1$) (Mean ± SD) | 2.626±0.424 | 2.170±0.498 | <0.0001*** |
| Forced Expiratory Volume in 1st second percentage % ($FEV_1$) (Mean ± SD) | 81.252±16.478 | 90.712±9.627 | <0.0001*** |
| FEV1/FVC% (Mean ± SD) | 93.923±6.312 | 96.455±4.978 | 0.0019 |

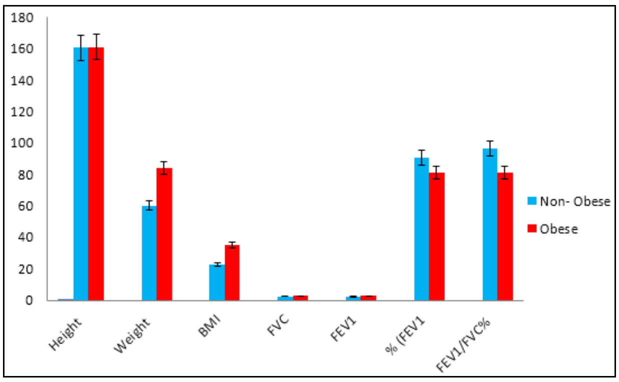


**Fig 1:** Association of spirometric values for BMI of study sample among Obese and Non obese subjects.

**Table 1:** Age distribution in obese and non-obese adults. The mean age for obese is 38.21 and for non-obese is 32.45. Height distribution in obese and non-obese adults. The mean height for obese is 161.21 and for non-obese is 160.51. Weight distribution in obese and non-obese adults. The mean weight for obese is 84.14 and for non-obese is 60.12. Above the table shows BMI distribution in obese and non-obese adults. The mean BMI for obese is 35.23 and for non-obese is 22.96. Above the table shows forced vital capacity in obese and non-obese adults. The mean FVC for obese is 2.770 and for non-obese is 2.423. Forced expiratory volume in 1st second ($FEV_1$) in obese and non-obese adults. Mean $FEV_1$ specially obese is 2.626 and for non-obese is 2.170. Forced expiratory volume in 1st second percentage ($FEV_1$%) in obese

and non-obese adults. The mean $FEV_1$% for obese is 81.252 and for non-obese is 90.712. The mean FEV1/FVC% for obese is 93.923 and for non-obese is 96.455.

**Age distribution:** P value and statistical significance: The two-tailed P value is less than 0.0001 by conventional criteria, this difference is considered to be extremely statistically significant. Confidence interval: The mean of obese minus non obese Equal's 5.76000 and 95% confidence interval of this difference: From 3.97819 to 7.54181. Intermediate values used in calculations: t= 6.3749, DF= 198 and standard error of difference = 0.904.

**Height distribution:** P value and statistical significance and two-tailed P value equals 0.2648 by conventional criteria, this difference is considered to be not statistically significant. Confidence interval: The mean of obese minus non obese equals 0.70000 and 95% confidence interval of this difference: From -0.53448 to 1.93448. Intermediate values used in calculations: t = 1.1182, DF = 198 and standard error of difference = 0.626.

**Weight distribution:** P value and statistical significance: The two-tailed P value is less than 0.0001 by conventional criteria, this difference is considered to be extremely statistically significant. Confidence interval: The mean of obese minus non obese Equal's 24.02000 and 95% confidence interval of this difference: From 21.86870 to 26.17130. Intermediate values used in calculations: t = 22.0183, DF = 198 and standard error of difference = 1.091.

**BMI distribution:** P value and statistical significance: The two-tailed P value is less than 0.0001 by conventional criteria, this difference is considered to be extremely statistically significant. Confidence interval: The mean of minus Group Two equals 12.26000 and 95% confidence interval of this difference: From 11.25016 to 13.26984. Intermediate values used in calculations: t = 23.9413, DF = 198 and standard error of difference = 0.512.

**Forced Vital Capacity (FVC):** P value and statistical significance: The two-tailed P value is less than 0.0001 by conventional criteria, this difference is considered to be extremely statistically significant. Confidence interval: The mean of Group One minus Group Two equals 0.34700 and 95% confidence interval of this difference: From 0.23641 to 0.45759. Intermediate values used in calculations: t = 6.1877, DF = 198 and standard error of difference = 0.056.

**Forced Expiratory Volume in 1$^{st}$ second ($FEV_1$):** P value and statistical significance: The two-tailed P value is less than 0.0001 by conventional criteria, this difference is considered to be extremely statistically significant. Confidence interval: The mean of Group One minus Group Two equals 0.45600 and 95% confidence interval of this difference: From 0.32702 to 0.58498. Intermediate values used in calculations: t = 6.9720, DF = 198 and standard error of difference = 0.065.

**Forced Expiratory Volume in 1$^{st}$ second percentage % ($FEV_1$)**: P value and statistical significance: The two-tailed P value is less than 0.0001 by conventional criteria, this difference is considered to be extremely statistically significant. Confidence interval: The mean of Group One minus Group Two equals -9.46000 and 95% confidence interval of this difference: From -13.22342 to -5.69658. Intermediate values used in calculations: t = 4.9570, DF = 198 standard error of difference = 1.908.

**FEV1/FVC %:** P value and statistical significance: The two-tailed P value equals 0.0019 by conventional criteria, this difference is considered to be very statistically significant. Confidence interval: The mean of Group One minus Group Two equals -2.53200 and 95% confidence interval of this difference: From -4.11726 to -0.94674. Intermediate values used in calculations: t = 3.1497, DF = 198 standard error of difference = 0.804

**Discussion**

Obesity presents the intriguing questions of whether and how to anticipate its effect on pulmonary function. Relating normal physiological function in relationship to body size seems appropriate. According to this, the larger the organism, the greater the amount of organ system function needed to maintain homeostasis. Most equations for predicting pulmonary function are based on data from normal subjects, using age and height as variables [17]. Chromiak JA, *et al.* Further by including body weight as a parameter to these equations the predictive ability can be improved, this study is an attempt to find the effect of gain of body weight on lung functions.[18] Weisberg SP, *et al.* shows Body mass index is a better indicator of accumulation of adipose tissue since it is calculated using height and weight of an individual [19]. Troosters T, *et al.* correlated with present study illustrated that the FVC was significantly in overweight subjects when compare to the normal subjects, Figure (1). The result of the present study was consistent observed that there was negative associated between the BMI and FVC in overweight when compared to the normal weight subjects [20]. They further state it was likely the cause of pulmonary function decline and respiratory function was determined by the interaction of lungs and chest wall and muscles, but no significant difference was observed in values of FVC in obese females (BMI> 30) when compared to the control group, this findings agreement with the results of Parameswaran K, *et al.* [21]

The FVC is the total volume of air that there is a exhaled during a forced exhalation. This is reduced in situations in which, is obstruction to the airways resulting in trapping of air. Kainu A. *et al.* represents $FEV_1$ is the volume of air is exhaled in the first and second during FVC maneuver [22]. This is useful for detect regularize airway obstruction reporting $FEV_1$/FVC% is the volume of air expired in the first and second, expressed as % of FVC. It is a very sensitive indicator of airway obstruction, than the FVC or $FEV_1$ alone. It is reduced in central also peripheral airway obstruction [23]. The present study results shows decrease in forced vital capacity (FVC), FEV1 and $FEV_1$% in obese subjects compared to non-obese controls. However they are not statistically significant. Obesity impairs pulmonary functions via several mechanisms. Guenette JA, *et al.* reporting obese individuals have increased demand for ventilation, breathing work load, respiratory insufficiency and closure of peripheral lung units. Obesity adversely affects chest wall mechanics and causes a decrease in total respiratory compliance, due to deposition of subcutaneous adipose tissue [24]. Donaldson GC, *et al.* shows there is also a decrease in the lung compliance due to increased pulmonary blood volume [25]. Respiratory muscle function might also be impaired in obesity due to the mechanical disadvantage induced by changes in chest wall configuration, fat deposition and increased energy expenditure to expand the lungs also an increase in intraabdominal adipose tissue which interferes with the mechanical properties of the chest wall causing decrease in compliance and preventing full excursion of the diaphragm. Morbid obesity may also induce restrictive disturbance of respiratory function related to reduce compliance of chest wall and pulmonary parenchyma.

**Conclusion**

Spirometry is useful clinical in respiratory medicine and a proper utilization of it requires a clear understanding between the subject, the technician, and the way in which the test is performed and how it is interpreted. Even though this type of study is carried in different parts of the world, they have used different various measures of adiposity to rule out the association between body differences in thoracoabdominal configuration could impact the function of respiratory muscles, the rib cage cross sectional area is smaller in females than males and the sex differences in the lung capacity can be explained by fewer total number of alveoli (small surface area) and smaller airway diameter relative to lung size in woman as compared to men. The effects of obesity on spirometric values are not consistent across all studies with some studies shown no effects and some other studies shown positive effects. The present study results shows low values of FVC, $FEV_1$ and $FEV_1$% in obese subjects than non-obese adults. Pulmonary functions tests in obese subjects may help in the early prediction of risk for a wide spectrum of disorders associated with respiratory insufficiency. The present study conclude early detection of functional impairment of respiratory changes and its appropriate management is the only means by which the morbidity and mortality can be reduced.

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