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A Comparative Study of PFT in Obese and Non-Obese Young Male Students

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Abstract

Background: *Obesity has been recognized as the main etiological factor for several metabolic diseases. They are also prone particularly to develop respiratory ailments. The male pattern of fat deposition around the thoracic wall and increased abdominal mass leads to reduced compliance and altered ventilation. The study aimed to determine whether significant changes occur in obese young male subjects as compared to normal subjects of the same age group.* ***Methods:*** *This study was conducted in the Department of physiology, RIMS, Adilabad. The subjects were classified as Normal if BMI was between 18.5 – 25.0 kg/m^2 Overweight BMI between 25 – 30 kg/m^2 Obese with BMI 30 – 35 kg/m^2. Pulmonary function tests were done with a computerized spirometer. The parameters were evaluated and compared Forced Vital Capacity FVC, Forced Expiratory Volume In 1 Sec – FEV$_1$, FEF 25 – 75% - FEF 25 – 75%, and Peak Expiratory Flow Rate (PEFR).* ***Results:*** *The Forced Vital capacity FVC (liters) was measured in all three groups. The highest mean FVC was in subjects of the normal BMI group and the lowest was found in the obese category. The ANOVA analysis between the group indicated that the values were significantly different between the group and the p values were less than 0.05. The FEV$_1$/FVC values were recorded in each group and the mean of each group was determined and denoted in table 4. The highest mean values 98.55 were in the obese category followed by the overweight category 96.29 and the least values were in the normal weight category 94.35. The p values were found to be significant.* ***Conclusion****: obesity affects the pulmonary functions by causing a reduction of FVC and FEV$_1$/FVC which are due to restrictive effects on the respiratory system. Obesity also increases the tone of the upper respiratory tract which leads to increase airway resistance. Obesity increases the requirement of oxygen and reduces the compliance of the chest wall.*

Keywords*: Obesity, BMI, Pulmonary Function Tests, Young Males*

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Introduction

The epidemic of obesity is now spreading to developing countries and is one of the causes of chronic diseases due to excessive accumulation of fat on the human body which increases the body mass. [1, 2] The estimated prevalence of overweight and obesity was estimated to be 1.35 billion in 2005 and may increase to 5.73 billion in 2030. [3] The incidence of overweight and obesity in India is a total of 36.9% population and 7.8% of the population between 35 – 44 years are either overweight or obese. [4] The scenario is further expected to worsen since the Indian population of 30–40 years range is rapidly increasing. Obesity has been linked to several conditions such as cardiovascular diseases, metabolic diseases, and altered pulmonary functions. [5] The major factor for obesity is the increased intake of refined foods with a sedentary lifestyle. [6] The effects of

obesity on pulmonary functions have not been fully elucidated probably because it takes a very long time for the effects to appear in subjects and effects also vary with population and race. It has been shown that obesity affects respiratory functions by altering the respiratory mechanics, decrease in respiratory muscle strength and endurance, decrease in pulmonary gas exchange and lower control of breathing, and finally limitation in performing exercises. [7-9] Upper body obesity poses a greater health hazard as compared to lower body obesity and the primary respiratory insufficiency in obesity is classified as restrictive. [10-12] Obesity develops slowly and over a period and once it is developed it becomes difficult to treat. In men, excess fat tends to accumulate in the upper abdomen. In women, the favored sites for the accumulation of fat are the buttocks, hips, and thighs. The site of fat accumulation is considered a predominant factor for metabolic disorders of obesity. However, the overall incidence of obesity was found to be higher among women than men of similar age groups. [13] In men, the incidence of obesity greatly increases in the late thirties and women increased risk at several stages in their lives, for example when entering marriage, during pregnancy, during menopause, and at retirement. The complex and poorly understood genetic phenomenon also determines the risk of obesity. Certain groups of people are at more risk of developing obesity than others, such as children in families where one or both parents are overweight or obese35. The risk of obesity is also associated with social class. [14] Studies have found evidence of restriction or reduction of total lung capacity in obese individuals greater and or equal to 20%. [15] This study was designed to evaluate the effects of obesity on lung functions in young male students and compare the results with that of normal subjects in this group of population.

Materials and Methods

The present study was conducted in the Department of Physiology, RIMS, Adilabad. Institutional Ethical committee permission was obtained for the study. Written consent was obtained from all the participants of the study.

Inclusion criteria

1. Normal/overweight/obese males aged 19 – 24.
2. Otherwise healthy subjects
3. Those willing to participate in the study.

Exclusion criteria

1. Not matching the inclusion criteria
2. With underlying medical conditions such as Asthma, hypertension, Cardiovascular disease, or endocrine disorders.
3. Smokers
4. Alcoholics
5. Those with rapid weight gain or loss before conduction the study.

All subjects were explained about the procedures to be undertaken and the purpose of the study. A brief history, general physical examination, and clinical examination of all the systems were done to exclude medical problems and to prevent confounding of results. A structured Performa was used to collect the relevant information that included measurement of height in centimeters, weight in Kilograms, and calculation of BMI. BMI was calculated as weight (in kilograms) divided by height (in square meters) (Quetelet's index). The subjects were classified as Normal if BMI was between 18.5 – 25.0 kg/m^2 Overweight BMI between 25 – 30 kg/m^2 Obese with BMI 30 – 35 kg/m^2. N=30 subjects were included in each group following the inclusion and exclusion criteria.

PFTs Were done by explaining the detailed procedure to the subject with a trial run of the procedure of spirometry. The measurements were done from 9 am to 11 am after light breakfast. Subjects were made to sit comfortably on a chair with back support. The subjects were instructed to breathe fully with deep inspiration. With closed nostrils, the lips seal was made around the mouthpiece of the spirometer and asked to forcefully expire as rapidly as possible. The best of the three efforts was taken as the final reading. The following parameters were recorded Forced vital capacity (FVC) in liters. Forced expiratory volume in first second. (FEV_1) in liters. Forced expiratory volume in the third second (FEV_3) in liters. Mean forced expiratory flow during the middle half of the FVC (FEF 25-75%) in liters/second. The obtained parameters were recorded in MS Excel spreadsheet and analyzed using SPSS version 19

on windows format. The descriptive statistics measured were frequency, Mean, standard deviation and inferential statistics were done by ANOVA for t values.

Results

A total of n=90 subjects were included in the study age range was from 19 – 24 years. They were divided into three groups based on the BMI categories. The mean age in all the groups was comparable and equal. The mean weight was found to be highest in the obese group. The mean height was highest in the normal group. Therefore, it appeared that the obese group was with persons with lesser height and greater body weight (Table 1)

Table 1: analysis of physical variables in different groups

Variable	*Normal [Mean ± SD]*	*Overweight [Mean ± SD]*	*Obese [Mean ± SD]*
Age (years)	21.5 ± 2.5	22.5 ± 1.5	22.0 ± 2.0
Weight (Kgs)	60.1 ± 3.5	70.2 ± 2.2	80.5 ± 3.5
Height (m)	1.70 ± 0.5	1.65 ± 0.65	1.60 ± 0.5
BMI Kg/m²	21.55 ± 1.85	28.48 ± 2.5	32.65 ± 1.5

The Forced Vital capacity FVC (liters) was measured in all three groups. The highest mean FVC was in subjects of the normal BMI group and the lowest was found in the obese category. The ANOVA analysis between the group indicated that the values were significantly different between the group and the p values were less than 0.05 (table 2).

Table 2: comparative analysis of FVC in different groups

Groups	*Frequency (n)*	*FVC*	*ANOVA*	
		Mean ± SD	*f value*	*P-value*
Normal weight	30	3.55 ± 0.51	2.56	0.044*
Overweight	30	2.28 ± 0.65		
Obese	30	1.95 ± 0.23		

* Significant

The FEV_1 (liters) values in the normal weight subjects were 3.01 ± 0.53 and in the overweight group, the values were 1.87± 0.36, and in the obese group with lowest values 1.49 ± 0.22. The ANOVA analysis revealed the p values were >0.05 hence no significant intra or intergroup difference (Table 3).

Table 3: comparative analysis of FEV_1 in different groups

Groups	*Frequency (n)*	*FEV_1*	*ANOVA*	
		Mean ± SD	*f value*	*P-value*
Normal weight	30	3.01 ± 0.53	0.984	0.156
Overweight	30	1.87 ± 0.36		
Obese	30	1.49 ± 0.22		

The FEV_1/FVC values were recorded in each group and the mean of each group was determined and denoted in table 4. The highest mean values 98.55 were in the obese category followed by the overweight category 96.29 and the least values were in the normal weight category 94.35. The p values were found to be significant.

Table 4: comparative analysis of in FEV_1/FVC different groups

Groups	*Frequency (n)*	*FEV_1/FVC*	*ANOVA*	
		Mean ± SD	*f value*	*P-value*
Normal weight	30	94.35 ± 0.64	3.12	0.023*
Overweight	30	96.29 ± 0.79		
Obese	30	98.55 ± 1.40		

* Significant

FEF 25-75% (L/sec) was determined in each group. The lowest mean values were found to be present in the obese group of subjects. The highest mean values were found in normal-weight subjects. The mean values of overweight subjects were found to intermediate between both groups. The values by ANOVA were not found to be significant.

Table 5: comparative analysis of in FEF 25–75% different groups

Groups	*Frequency (n)*	*FEF 25–75%*	*ANOVA*	
		Mean ± SD	*f value*	*P-value*
Normal weight	30	3.21 ± 0.41	0.872	0.918
Overweight	30	2.99 ± 0.27		
Obese	30	2.61 ± 0.35		

Discussion

The study was done to determine the changes in lung functions among different individuals based on BMI. N=90 healthy male college students were identified and selected for the study. We found a statistically significant decrease in pulmonary functions with parameters FEV_1/FVC and FVC. No significant changes between different groups as far as FEV_1 and FEF 25–75% are concerned. The usual type of male obesity is called android obesity with fat deposition in central areas around the chest and abdominal cavity. This fat deposition has a mechanical effect and leads to restriction of expansion of chest by preventing the descent of diaphragm due to increased abdominal visceral fat. The decrease in FVC and FEV_1/FVC indicates a restrictive effect on the respiratory system similar findings have been reported by several studies conducted in this field by different investigators. [16-19] The most frequently reported effect of obesity on lung function has been reported as a decrease in functional residual capacity (FRC). [20] this effect reflects a shift in the balance during inflation and deflation due to an increased load of adipose tissue mass around the rib cage and abdominal cavity. [21] The reduction of downward movement of the diaphragm is likely to decrease TLC by limiting the room for lung expansion on inflation. Secondly, the deposition of fat in subpleural spaces might also reduce the lung volume by reduction of hollow space of chest walls. However, shreds of evidence of respiratory muscle inspiratory and expiratory pressure have been found similar between obese and normal-weight subjects suggesting stiffening of the chest wall as the major determinant of TLC. One parameter likely to be affected by obesity is the resistance or upper airway tone which tends to increase with increasing BMI. Morbid obesity reduces the respiratory functions and reduces the compliance of the chest wall and pulmonary parenchyma. [22, 23] Pulmonary volume variables, such as forced expiratory volume in 1 s (FEV1) and forced vital capacity (FVC), tend to decrease with increasing BMI. The expiratory flow at 50% of the reduced vital capacity is low compared with the predicted value, based on the predicted vital capacity. Significant differences in expiratory flow at 25% of the reduced vital capacity persisted after normalization, suggesting the possibility of peripheral airway obstruction in obese men. Obese people tend to have an increased demand for ventilation and breathing workload, respiratory muscle inefficiency, decreased functional reserve capacity and expiratory reserve volume, and closure of peripheral lung units. [24, 25] These often result in a ventilation-perfusion (VA/Q) mismatch, especially in the supine position. In an upright non-obese individual, the distribution of regional ventilation is greatest in the lower, dependent lung zones and decreases toward the upper zones. In obese individuals, this distribution may be reversed. [26, 27] The limitations in the chest wall and diaphragm movements alter the configuration of the lungs and enhance basal air trapping at low lung volumes. Mild hypoxemia and increased alveolar-arterial oxygen difference are frequently reported, even in obese individuals. [28] Finally, it can be said that obesity has the potential to affect the respiratory wellbeing because it affects the oxygen demand and carbon dioxide production with stiffening of chest wall leading to increased mechanical work of breathing.

Conclusion

Within the confines of the present study, it can be concluded that obesity affects the pulmonary functions by causing a reduction of FVC and FEV_1/FVC which are due to restrictive effects on the respiratory system. Obesity also increases the tone of the upper respiratory tract which leads to increase airway resistance. Obesity increases the requirement of oxygen reduces the compliance of the chest wall all these lead to changes in Pulmonary function parameters in obese individuals.

Conflict of Interest: *None declared*
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