

EFFECT OF BMI ON PULMONARY FUNCTION TESTS IN YOUNG ADULTS

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Abstracts: Background: Obesity is a major health issue and there is steady trend of increasing obesity over the past several decades. Obesity can alter the respiratory function and may impair the health of an individual. **Objectives:** To evaluate the effect of BMI on pulmonary function. **Methods:** 20 overweight (BMI-25-29.99 kg/m²), 20 obese (BMI-30 or above 30 kg/m²) and 20 normal weight (BMI-18.5-24.99 kg/m²) young adults of both sexes between 18-25 years without any lung disease and non-smokers were recruited. Spirometry was performed in all subjects. The pulmonary function tests, FVC, FEV1, FEV1/FVC ratio and PEFR were compared by using suitable statistical methods (One way ANOVA test, Pearson correlation coefficient). **Results:** The results shows that as compare to normal weight subjects FVC, FEV1, PEFR decreases in overweight and obese subjects. **Conclusion:** Increase in BMI had an inverse relationship with FVC, FEV1 and PEFR in obese subjects when compared to the normal weight subjects.

Key Words: Body mass index (BMI), Obesity, Spirometry, Pulmonary function tests.

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Introduction:

Obesity is often defined simply as a condition of abnormal or excessive fat accumulation in adipose tissue to the extent that health may be impaired, once considered a problem related to affluence, obesity is now fast growing in many developing countries like India¹.

Obesity is associated with co-morbidities such as diabetes, hypertension and vascular dysfunction. Obesity in adults is defined by the World Health Organization (WHO) as having a body mass index (BMI) that is greater than or equal to 30 kg/m². The normal BMI range is between 18.5 and 24.99 kg/m². Currently, there are estimated to be one billion overweight adults, and at least 300 million of them suffer from clinical obesity².

Obesity can cause various deleterious effects to respiratory function, such as alterations in respiratory mechanics, decrease in respiratory muscle strength and endurance, decrease in pulmonary gas exchange, lower control of breathing, and limitations in pulmonary function tests and exercise capacity. These changes in lung function are caused by extra adipose tissue in the chest wall and abdominal cavity, compressing the thoracic cage, diaphragm, and lungs. The consequences are a decrease in diaphragm displacement, a decrease in lung and chest wall compliance, and an increase in elastic recoil,

resulting in a decrease in lung volumes and an overload of inspiratory muscles. These changes are worsened by an increase in the BMI².

Body weight and BMI can be easily measured and therefore are frequently used in large-scale epidemiologic studies³. Body mass index (BMI) has significant effect on all of the lung volumes. Studies have examined the relation between obesity and lung function using BMI as a measure of overall adiposity⁴.

Material and Methods:

20 overweight (BMI-25-29.99 kg/m²), 20 obese (BMI-30 or above 30 kg/m²) and 20 normal weight (BMI-18.5-24.99 kg/m²) young adults of both sexes between 18-25 years without any lung disease and non-smokers were recruited. Individuals with chest deformity and those having recent upper or lower respiratory infections were excluded. This study was approved by the institutional ethics committee (IEC) and an informed consent was obtained from the study participants. All participants provided information on age, family history, personal habits (alcohol intake, tobacco consumption, type and level of physical exercise, drug ingestion, known pathological conditions). A detailed physical examination was conducted to exclude cardiac or pulmonary diseases. Anthropometric variables like height and weight were obtained. The evaluation

of pulmonary function was performed by conventional spirometry using Spiro excel software in computerized spirometer. These tests were recorded at noon before lunch, as expiratory flow rates are highest at noon. For each volunteer three satisfactory efforts were recorded according to the norms given by American Thoracic Society. The directly evaluated parameters were FVC, FEV1, FEV1/FVC ratio, PEFR.

Statistical analysis: Mean and standard deviation of all subjects was calculated. Statistical analysis was done by one way ANOVA test and Pearson correlation coefficient using Graphpadprism version-5 software. $p < 0.05$ was considered as statistically significant.

Result:

Following observations were made from the study of pulmonary function tests in 20 overweight, 20 obese and 20 normal weight young adults.

Table 1: Comparison of physical parameters among overweight, obese and normal weight subjects of study

Physical parameters	Overweight	Obese	Normal weight	P value
	Mean±SD	Mean±SD	Mean±SD	
Age (years)	19.05±2.30	31.06±0.94	19.05±1.23	0.0022*
Weight (kg)	72.7±8.41	83.7±5.39	65.5±8.79	$P < 0.0001^*$
Height (cm)	165.15±8.20	164.1±4.45	172.9±7.06	0.0002*
BMI (kg/m ²)	26.56±1.30	31.06±0.94	21.81±1.58	$P < 0.0001^*$
* $P < 0.05$ -significant				

Anthropometric characteristics of the subjects are shown in the Table-1. Age, height, weight & BMI were significantly different among overweight, obese and normal weight group. The mean age of overweight, obese and normal subjects was 19.05±2.30, 31.06±0.94, and 19.05±1.23 years with a range from 18-25 years. The mean height of overweight, obese and normal weight group was 165.15±8.20, 164.1±4.45 and 172.9±7.06 cm

respectively. The mean weight of overweight, obese and normal group was 72.7±8.41, 83.7±5.39 and 65.5±8.79 kg respectively. The mean BMI of overweight, obese and normal weight group was 26.56±1.30, 31.06±0.94 and 21.81±1.58 kg/m² respectively.

Table 2: Comparison of pulmonary function tests in overweight, obese and normal weight subjects

PFT variables	Overweight (20 subjects)	Obese (20subjects)	Normal Weight (20 subjects)	P value
	Mean±SD	Mean±SD	Mean±SD	
FVC (lts)	3.14±0.73	3.51±0.41	3.68±0.42	0.0090*
FEV1 (lts)	2.36±0.61	2.82±0.30	2.90±0.33	0.0005*
FEV1/FVC (%)	76.12±15.08	81.37±6.38	78.9±2.22	0.2297
PEFR (lts/min)	287.68±167.46	402.04±94.89	424.73±63.36	0.0009*
* $P < 0.05$ -significant				

The observed values of various lung function parameters are provided in Table-2. In overweight & obese groups FVC, FEV1 and PEFR were decreased significantly ($P < 0.05$). FEV1/FVC ratio was not significant in overweight, obese and normal weight subject as $p > 0.05$.

TABLE 3: Correlation coefficient of BMI with PFT variables in obese subjects

	FVC	FEV1	FEV1/FVC%	PEFR
BMI	-0.3968	-0.4248	0.04605	-0.5151
P value	0.0833	0.0619	0.8471	0.0201*
* $P < 0.05$ -significant				

Table-3 shows that in obese group BMI showed significant negative correlation with FVC ($r = -0.3968$), FEV1 ($r = -0.4248$) and PEFR ($r = -0.5151$).

Discussion:

The researchers in this study compared and analysed the BMI, FVC, FEV1, FEV1/FVC ratio and PEFr in the normal, overweight and obese groups.

The present study showed that the FVC significantly reduces in overweight (mean±SD 3.14±0.73) and obese subjects (mean±SD 3.51±0.41) when compared to normal weight subjects (mean±SD 3.68±0.42) and there was negative correlation of BMI with FVC in obese subjects. The result of the present study was consistent with the study done by Chen Yue et al³, who observed negative correlation of BMI with FVC in overweight and obese subjects when compared to normal subjects. They also stated that intra abdominal pressure that has a mechanical effect on the diaphragm is suspected of being a major reason for the association of obesity with lung dysfunction. Similar findings were also seen in study done by Anuradha R. Joshi et al⁵, Shashi Mahajan et al⁶ and Nibedita Priyadarsini⁷.

The present study showed that the FEV1 significantly reduces in overweight (mean±SD 2.36±0.61) and obese subjects (mean±SD 2.82±0.30) when compared to normal weight subjects (mean±SD 2.90±0.33) and there was negative correlation of BMI with FEV1 in obese subjects. These findings tuned with the study done by Shashi Mahajan et al⁶, Dayananda G et al⁴ and Nibedita Priyadarsini et al⁷.

Low FVC & FEV1 value suggests restrictive lung patterns among obese persons. Fat deposits between the muscles and ribs may also decrease chest wall compliance thereby increasing metabolic demands & workload of breathing in obese⁷.

The present study showed no significant change in FEV1/FVC ratio in overweight (mean±SD 76.12±15.08) and obese subjects (mean±SD 81.37±6.38) when compared to normal weight subjects (mean±SD 78.9±2.22). Similar findings were also found with the study done by Shashi Mahajan et al⁶ and Nibedita Priyadarsini et al⁷.

The normal value of FEV1/FVC ratio may be due to the fact that inspiratory & expiratory muscle strength is normal in young individuals⁵.

The present study showed that the PEFr significantly reduces in overweight (mean±SD 287.68±167.46) and obese subjects (mean±SD 402.04±94.89) when compared to normal weight subjects (mean±SD 424.73±63.36) and there was negative correlation of BMI with PEFr in obese subjects. The result of the present study was consistent with the study done by Yogesh Saxena et al⁸ and Saraswathi Ilango et al⁹.

The truncal fat may compress the thoracic cavity and restrict the diaphragmatic movement resulting in reduced vertical diameter of the thoracic cavity. These changes may reduce the compliance of the lungs and the thoracic cavity and increase the load on the respiratory muscles. This may end up with the reduction in lung volumes and flow rates, especially PEFr⁹.

Conclusion:

Obesity influences the respiratory function enhancing dyspnoea and increasing both cardiac load and respiratory muscle fatigue of the thoracic wall and the diaphragm due to the higher pressure exerted by intrabdominal adipose accumulation.

In our study the results showed that increase in BMI had an inverse relationship with FVC, FEV1 and PEFr in obese when compared to the normal weight subjects. Thus it is evident from the present study that obesity significantly affects the pulmonary functions which may give rise to long term complications and may lead to early morbidity and mortality.

But these hazardous effects of gaining weight might be reversible and weight loss can improve lung function in obesity. Further research can be done to conclude this. In view of the fact that the present study comprised of a small group of subjects, further studies with more number of patients may be required to evaluate our observations.

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