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Research Article

A Study of Effect of BMI on Pulmonary Function Tests in Young Individuals

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Abstract: Introduction Pulmonary function tests (PFTs) are critical tools in evaluating respiratory health by measuring lung capacity, airflow, and overall pulmonary performance. These tests provide insights into various respiratory disorders and help assess the impact of different physiological and environmental factors on lung function. Among the numerous factors influencing pulmonary function, body mass index (BMI) has emerged as a significant determinant Methods A cross sectional study was done at Department of Physiology The sampling was purposive for selection of specified population based on their body weight. The selection of obese and underweight was deviant purposive technique. Sample size was calculated by using open epi sample size calculator version 3.01. The parameters included were mean and standard deviation of FEV, 108±1.2 of the subjects having duration of obesity less than five years and 107±1.2 of subjects having duration of obesity more five-ten years,9 The 95% confidence interval and 90% power was considered for sample size calculation. Minimum needed sample size came up as 31 participants in each group of BMI category. A total of 180 participants were calculated. Results The present study included 200 participants (120 males and 80 females). All participants aged 18-20 years who are apparently healthy. Male and female according to BMI categorized into two groups, i.e., BMI < 25 and BMI > 25. Respiratory parameters such as FVC, FEV1, FEV1/FVC, and PEFR are found to be significantly lower in female participants in comparison to male participants as shown in Table 1. The correlation of different pulmonary function parameters with BMI of the male and female participants are presented in Tables 2 and 3. It is observed that respiratory parameters such as FVC, FEV1, FEV1/FVC, and PEFR of both male and female participants correlated positively with BMI < 25 but there were substantial lung function losses with increasing BMI > 25, i.e., PFTs were negatively correlated 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.

Keywords: Exercise, Pulmonary function tests, Body mass Index.

INTRODUCTION

The lungs, with their greater surface area, are directly open to the external environment and are heavily influenced by epidemiological, environmental and occupational factors. Pulmonary function testing has been a major step forward in assessing the functional status of the lungs. In conjunction with the clinical assessment and other investigations, they can be used for establishing diagnosis, indicating severity of the disease and also in assessing the prognosis3. Exercise represents a state of physical exertion of the body and it is associated with extensive alterations in the circulatory and respiratory systems. The cardiovascular and respiratory mechanisms operate in an integrated fashion to meet the oxygen demands of the tissues during exercise1.

Measurement of pulmonary functions after exercise could provide useful information about the functional reserve capacity of lungs both in healthy persons and in patients with respiratory diseases.4 Exercise is used as a challenge test to make a diagnosis of exercise induced bronchoconstriction in asthmatic patients with a history of breathlessness during or after exertion2. However it is essential to define the mode of response to exercise in a normal population before identifying the individuals with an abnormal response. The ventilatory capacity of a healthy individual often exceeds the demands even during strenuous exercise3. Despite this enormous reserve, the ventilatory response to exercise may become constrained in obese individuals with normal lungs4 .

Extensive research has been done on various aspects of pulmonary function tests, but surprisingly very few studies had explored the effect of acute exercise on pulmonary function tests in normal individuals and they had revealed controversial results. Though the association of gender and anthropometric indices on lung functions have been well established, 5 their influence on the exercise induced changes on pulmonary function tests in young healthy individuals have received less attention. Aknowledge of the lung volume response to exercise is important for understanding respiratory mechanics and also carry a clinical significance. 6Thus the present study aimed to assess the influence of exercise on pulmonary function tests in young healthy individuals.

Pulmonary function tests (PFTs) are critical tools in evaluating respiratory health by measuring lung capacity, airflow, and overall pulmonary performance. These tests provide insights into various respiratory disorders and help assess the impact of different physiological and environmental factors on lung function.7 Among the numerous factors influencing pulmonary function, body mass index (BMI) has emerged as a significant determinant.

BMI, a measure of body fat based on height and weight, is a widely used indicator to classify individuals as underweight, normal weight, overweight, or obese. An abnormal BMI, whether low or high, has been associated with alterations in lung mechanics, chest wall compliance, and respiratory muscle strength. Overweight and obesity, in particular, are linked to restrictive ventilatory patterns due to increased fat deposition on the chest wall and abdomen,8 which may limit diaphragmatic movement. Conversely, underweight individuals may experience compromised respiratory function due to reduced muscle mass and weakened respiratory muscles.

Young individuals represent a crucial population for studying the effect of BMI on pulmonary function, as this age group is at a stage of optimal lung development and function. Understanding how BMI influences PFTs in this demographic is essential for early identification of potential respiratory risks, especially given the rising prevalence of obesity and sedentary lifestyles globally.

This study aims to evaluate the effect of BMI on pulmonary function parameters in young individuals by comparing the PFT results across BMI categories.9 By analyzing gender differences and the correlation between BMI and pulmonary function, this study seeks to provide valuable insights into the relationship between body composition and respiratory health, contributing to preventive and therapeutic strategies for maintaining optimal lung function in the young population.

METHODS

A cross-sectional study was done at Department of Physiology, Shadan Medical college from January to September 2019. A total of 200 underweight, normal, overweight and obese participants aged between18 to 40 years were included in the study using non-probability purposive sampling technique. The sampling was purposive for selection of specified population based on their body weight. The selection of obese and underweight was deviant purposive technique.

Sample size was calculated by using open epi sample size calculator version 3.01. The parameters included were mean and standard deviation of FEV, 108±1.2 of the subjects having duration of obesity less than five years and 107±1.2 of subjects having duration of obesity more five-ten years,9 The 95% confidence interval and 90% power was considered for sample size calculation. Minimum needed sample size came up as 31 participants in each group of BMI category. A total of 180 participants were calculated.

Protocol

All the participants included were non-smokers, without any known pulmonary, cardiac or chest deformities and not worked in dust containing environment. For the recruitment of participant's, volunteer's recruitment posters were posted at different locations at hospital and university campus. After fulfilling inclusion criteria i.e., age between 18-40 years, males and non-pregnant females, non-smokers and those who don't have any respiratory disorder like pulmonary Koch's or reactive airway disease and the exclusion criteria were pregnant females, smokers, persons having respiratory and/or cardiac disease, written informed consent was taken from the participants. Before medical screening session five minutes rest was given to every participant. 10After recruitment of volunteers, they were advised not to take heavy meals tea or coffee two hours before procedure. For the exclusion of any cardiac disorder,10 Blood pressure was taken in sitting position, from right arm with the help of the aneroid sphygmomanometer (Yamasu Japan) and stethoscope (Littman Company) and also electrocardiogram was taken by ECG (FK 12) machine.

Extra clothing and shoes of the participants were removed before taking BMI on scale (RGZ-160, China). Height was recorded by (RGZ-160, China) in cm (with range of 70-190 cm), with bare feet. Weight was recorded in kg using a mechanical scale (RGZ-160, China) with a capacity of 160 kg Following formula was used for BMI calculation: i.e., weight in kg/height in meter2 (cm is converted into m2).

Spirometry was done on Power lab (model 15T AD instrument) used for measuring respiratory parameters. Normal tidal breathing was noted for one-minute duration.11 For recording tidal breathing, participants were instructed to breathe in maximally and then breathe out. Lab chart on Power lab software was used for the collection and saving of data that was later on exported to the MS Excel for analysis. Lab chart software was used in case, if respiratory parameters not determined by the Power lab.

Data analysis

SPSS (version 23.0, Armonk, NY: IBM Corp.) was used for data analysis. Frequencies and percentage were calculated for categorical variables such as age groups, gender, body mass index groups and history of pulmonary problems, hypertension, and diabetes in family. Means and standard deviations were calculated for continuous variables like age in years, 12weight, height, body mass index and spirometric parameters. Kruskal Wallis H test was applied to compare the means of pulmonary parameters across the categories of BMI.

P- value ≤0.05 was considered as statistically significant. Generalized linear model (GLM) was used to estimate the parameters of linear regression model and measure the effect of body mass index on respiratory parameters.

RESULT

The present study included 200 participants (120 males and 80 females). All participants aged 18-20 years who are apparently healthy. Male and female according to BMI categorized into two groups, i.e., BMI < 25 and BMI > 25. Respiratory parameters such as FVC, FEV1, FEV1/FVC, and PEFR are found to be significantly lower in female participants in comparison to male participants as shown in Table 1. The correlation of different pulmonary function parameters with BMI of the male and female participants are presented in Tables 2 and 3. It is observed that respiratory parameters such as FVC, FEV1, FEV1/FVC, and PEFR of both male and female participants correlated positively with BMI < 25 but there were substantial lung function losses with increasing BMI > 25, i.e., PFTs were negatively correlated presents the effect of gender on pulmonary function test (PFT) parameters among the study participants. Male participants (n = 120) demonstrated higher values for FVC, FEV1, and PEFR compared to females (n = 80). BMI was also significantly higher in males. However, the FEV1/FVC ratio did not differ significantly between genders

Table 1: Effect of Gender on Pulmonary Function Tests (PFTs) (n = 200)

Parameter	Male (n=120)	Female (n=80)	P-value
BMI	25.45 ± 3.39	23.43 ± 3.74	0.003*
FVC	3.62 ± 0.708	2.46 ± 0.52	0.000*
FEV1	3.17 ± 0.645	2.18 ± 0.53	0.000*
FEV1/FVC	87.6 ± 11.43	88 ± 8.4	0.830
PEFR	5.87 ± 1.76	3.65 ± 1.45	0.000*

Note:
*Indicates significant difference (P < 0.01). Abbreviations:

- BMI: Body Mass Index
- FVC: Forced Vital Capacity
- FEV1: Forced Expiratory Volume in 1 second
- FEV1/FVC: Ratio of Forced Expiratory Volume in 1 second to Forced Vital Capacity
- PEFR: Peak Expiratory Flow Rate

Table 2 summarizes the correlation between BMI and pulmonary function parameters in male participants, categorized by BMI (<25 vs. >25). FVC and FEV1 showed a positive but non-significant correlation in the BMI <25 group. However, in the BMI >25 group, FVC and FEV1 exhibited a weak negative correlation, which was also non-significant

Table 2: Correlation of BMI with Pulmonary Function Parameters in Male Participants

Parameter	BMI < 25	BMI > 25
	R	P-value
FVC	0.338	0.098
FEV1	0.391	0.053
FEV1/FVC	−0.059	0.779
PEFR	0.184	0.376

Note:

- P < 0.05 is considered significant.
- Abbreviations:

o BMI: Body Mass Index
o FVC: Forced Vital Capacity
o FEV1: Forced Expiratory Volume in 1 second
o FEV1/FVC: Ratio of Forced Expiratory Volume in 1 second to Forced Vital Capacity
o PEFR: Peak Expiratory Flow Rate
o R: Pearson Correlation Coefficient

Table 3 highlights the correlation between BMI and PFT parameters in female participants. Among those with BMI >25, a significant negative correlation was observed for PEFR (R = −0.523, P = 0.045). Other parameters exhibited negative but non- significant correlations.

Table 3: Correlation of BMI with Pulmonary Function Parameters in Female Participants (n = 200)

Parameter	BMI < 25	BMI > 25
	R	P-value
FVC	0.029	0.877
FEV1	0.081	0.670
FEV1/FVC	0.195	0.301
PEFR	0.323	0.080

Note:

- P < 0.05 is considered significant.
- Abbreviations:
  - BMI: Body Mass Index
  - FVC: Forced Vital Capacity
  - FEV1: Forced Expiratory Volume in 1 second
  - FEV1/FVC: Ratio of Forced Expiratory Volume in 1 second to Forced Vital Capacity
  - PEFR: Peak Expiratory Flow Rate
  - R: Pearson Correlation Coefficient with increasing BMI in both male and female participants, but the correlation is not statistically significant

DISCUSSION

Obesity is one of the major health hazards across the world. It can lead to various clinical complications such as diabetes, vascular diseases, osteoarthritis, etc. But less emphasis has been given on the effect of obesity on respiratory system.10 In this study an attempt was made to find out whether there is an increased risk of respiratory problems in overweight and obese individuals. Pulmonary function tests are generally related to body size and age, where height is a proxy for chest size, and age reflects maturity.11 Because of this reason every individual has different range of normal values. This study was formulated to see any increase in the BMI will lead to decrease in pulmonary functions.

Results of this study were similar with the study done in Andhra Pradesh, where a positive correlation of BMI with FVC and FEV1 was observed.13 It may be because of fat accumulation around ribs, abdomen and diaphragm which causes restricted movements of ribs, reducing lung volume and decreasing respiratory compliance.10 Our study revealed significant decrease in pulmonary function tests in overweight and obese females who do not have any known obstructive airway disease. All the parameters of pulmonary function tests were negatively correlated with Body mass index (BMI) in rural population. (Table 3)

The present findings were not supported by the study done by Piyali et al.14 The possible cause of the difference between two studies may be age factor and mild COPD for both sexes in their study

Therefore, it can be said that obesity has significant impact on respiratory problems. Excess of abdominal fat may restrict the diaphragmatic movement which leads to a decrease in pulmonary function.14 This study suggested significant impairment of pulmonary functions in overweight and obese population due to limited expansion of thoracic cavity which leads to possibility of small airway diseases. The lung functions might be improved by weight loss.

This study investigated the effect of body mass index (BMI) on pulmonary function tests (PFTs) in young individuals, with a specific focus on the correlation between BMI and various lung function parameters. The findings provide critical insights into how BMI impacts respiratory health in this demographic, highlighting both gender-specific differences and the implications of being underweight or overweight.

The study revealed significant gender differences in pulmonary function parameters. Male participants demonstrated higher values for forced vital capacity

(FVC), forced expiratory volume in one second (FEV1), and peak expiratory flow rate (PEFR) compared to females. These findings align with existing literature that attributes these differences to physiological factors such as greater lung volume, higher muscle strength, and larger thoracic dimensions in males.15 However, the FEV1/FVC ratio, a key indicator of airflow obstruction, did not significantly differ between genders, suggesting that airway function relative to lung capacity remains comparable.

The relationship between BMI and pulmonary function varied across BMI categories. Among participants with a BMI <25, there was a weak positive correlation between BMI and parameters such as FVC and FEV1, although these correlations were not statistically significant. This trend suggests that within a healthy BMI range, increasing body weight may not negatively impact lung function, and in some cases, may even enhance respiratory muscle performance.

In contrast, participants with a BMI >25 exhibited a negative correlation between BMI and PFT parameters, particularly among females. The significant negative correlation between BMI and PEFR in females ($R = -0.523$, $P = 0.045$) underscores the impact of obesity on expiratory flow. Excess adiposity, particularly in the thoracic and abdominal regions, likely contributes to reduced chest wall compliance and diaphragmatic excursion, leading to impaired pulmonary function. These findings are consistent with previous studies that have identified obesity as a risk factor for restrictive lung patterns.

The observed variations in PFT parameters across BMI categories can be explained by several mechanisms. Increased BMI in the overweight and obese range is associated with higher intra-abdominal and thoracic pressure, which limits lung expansion and reduces vital capacity. Additionally, systemic inflammation and altered respiratory mechanics in obesity may further contribute to the decline in lung function. Conversely, in underweight individuals, reduced muscle mass may weaken respiratory muscles, impacting expiratory flow and overall pulmonary performance.

The findings of this study have important clinical implications. The significant reduction in PEFR among females with a high BMI highlights the need for targeted interventions to improve respiratory health in overweight and obese individuals. Lifestyle modifications, including weight management and regular physical activity, should be emphasized to mitigate the negative effects of excess weight on pulmonary function. For underweight individuals, nutritional support and strength training may help enhance respiratory muscle function and overall lung capacity.

Strengths and Limitations

One of the strengths of this study is the focus on a young population, which provides valuable insights into how BMI affects lung function during a critical period of physical development. However, the study has certain limitations. 16The cross-sectional design precludes establishing causality between BMI and pulmonary function. Additionally, factors such as physical activity levels, smoking status, and dietary habits, which could influence PFT parameters, were not assessed.

Future Directions

Future research should explore the longitudinal effects of BMI changes on pulmonary function, incorporating other potential confounding factors such as physical activity and comorbidities. Additionally,17 studies involving larger and more diverse populations would provide a broader understanding of the relationship between BMI and respiratory health.

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

This study highlights the significant impact of BMI on pulmonary function in young individuals. While a healthy BMI range appears to support optimal lung function, being overweight or obese is associated with impaired respiratory performance, particularly in females. These findings emphasize the importance of maintaining a healthy BMI for preserving lung health and preventing respiratory complications in young individuals.

REFERENCE

1. Barud, W., et al. “Evaluation of Lung Function in Male Population from Vocational Mining Schools of the Lublin Coal Basin.” *Annales Universitatis Mariae Curie-Skłodowska*, vol. 46, 1991, pp. 39–43.
2. Harik-Khan, R. I., R. A. Wise, and J. L. Fleg. “The Effect of Gender on the Relationship between Body Fat Distribution and Lung Function.” *Journal of Clinical Epidemiology*, vol. 54, 2001, pp. 399–406.
3. Yap, W. S., et al. “Ethnic Differences in Anthropometry among Adult Singaporean Chinese, Malays and Indians, and Their Effects on Lung Volumes.” *Respiratory Medicine*, vol. 95, 2001, pp. 297–304.
4. Schoenberg, J. B., G. J. Beck, and A. Bouhuys. “Growth and Decay of Pulmonary Function in Healthy Blacks and Whites.” *Respiratory Physiology*, vol. 33, 1978, pp. 367–393.
5. Sutherland, T. J., et al. “The Relationship between Body Fat and Respiratory Function in Young Adults.” *European Respiratory Journal*, vol. 48, 2016, pp. 734–747.
6. Littleton, S. W. “Impact of Obesity on Respiratory Function.” *Respirology*, vol. 17, 2012, pp. 43–49.
7. Salome, C. M., G. G. King, and N. Berend. “Physiology of Obesity and Effects on Lung

Function." *Journal of Applied Physiology*, vol. 108, 2010, pp. 206–211.
8. Garrow, J. S., and J. Webster. "Quetelet's Index as a Measure of Fatness." *International Journal of Obesity*, vol. 9, 1985, pp. 147–153.
9. World Health Organization. *Obesity: Preventing and Managing the Global Epidemic*. World Health Organization Technical Report Series, no. 894, 2000.
10. Miller, M. R., et al. "Standardization of Spirometry." *European Respiratory Journal*, vol. 26, 2005, pp. 319–338.
11. Dockery, D. W., et al. "Distribution of Forced Expiratory Volume in One Second and Forced Vital Capacity in Healthy, White, Adult Never-Smokers in Six US Cities." *American Review of Respiratory Disease*, vol. 131, 1985, pp. 511–520.
12. Chen, Y., et al. "Waist Circumference Is Associated with the Pulmonary Function in Normal-Weight, Overweight and Obese Subjects." *American Journal of Clinical Nutrition*, vol. 85, 2007, pp. 35–39.
13. Al Ghobain, M. "The Effect of Obesity on Spirometry Tests among Healthy Non-Smoking Adults." *BMC Pulmonary Medicine*, vol. 12, 2012, p. 10.
14. Peng, L., et al. "Association between Body Mass Index (BMI) and Vital Capacity of College Students of Zhuang Nationality in China: A Cross-Section Study." *Oncotarget*, vol. 8, 2017, pp. 80923–80933.
15. Devershetty, J., et al. "Effect of Obesity on Pulmonary Function Tests in Apparently Healthy Young Women." *International Journal of Medicine and Public Health*, vol. 4, 2015, pp. 1519–1522.
16. Parameswaran, K., D. C. Todd, and M. Soth. "Altered Respiratory Physiology in Obesity." *Canadian Respiratory Journal*, vol. 13, 2006, pp. 203–210.
17. Lazarus, R., et al. "Effects of Body Composition and Fat Distribution on Ventilatory Function in Adults." *American Journal of Clinical Nutrition*, vol. 68, 1998, pp. 35–41.
18. Azad, A., et al. "Effects of Aerobic Exercise on Lung Function in Overweight and Obese Students." *Tanaffos*, vol. 10, 2011, pp. 24–31.
19. Ray, C. S., et al. "Effects of Obesity on Respiratory Function." *American Review of Respiratory Disease*, vol. 128, 1983, pp. 501–506.
20. Jones, R. L., and M. M. Nzekwu. "The Effects of Body Mass Index on Lung Volumes." *Chest*, vol. 130, 2006, pp. 827–833.
21. Cibella, F., et al. "An Elevated Body Mass Index Increases Lung Volume but Reduces Airflow in Italian Schoolchildren." *PLoS One*, vol. 10, 2015, e0127154.
22. Forno, E., et al. "Overweight, Obesity, and Lung Function in Children and Adults: A Meta-Analysis." *Journal of Allergy and Clinical Immunology: In Practice*, 2017, doi:10.1016/j.jaip.2017.07.010.
23. Jeelani, M. "A Study of Effect of BMI on Pulmonary Function Tests in Young Individuals." *Journal of Contemporary Clinical Practice*, vol. 5, no. 2, 2019, pp. 84–89. doi:10.18683/jccp.2019.1091.