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Impact of Obesity on Pulmonary Function in Young Adult MBBS Students with Gender Differences

Kumar Varma Nagidi[1], P Ranjit Basha[2], P SambaSiva Rao[1]

[1] Assistant professor, Dept of Pulmonary Medicine, Government Medical College, Ongole
[2] Associate Professor, Dept of Pulmonary Medicine, Government Medical College, Ongole

Corresponding Author

Dr. P SambaSiva Rao*

Assistant professor, Dept of Pulmonary Medicine, Government Medical College, Ongole

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Abstract

Background of the study: Obesity adversely affects various organ systems, including pulmonary function. This study aimed to assess the impact of obesity on pulmonary function in young adult MBBS students and evaluate gender differences in this association.

Methods: A cross-sectional study was conducted among 120 MBBS students aged 18–25 years at Government Medical College, Ongole. Participants were divided into three groups based on their Body Mass Index (BMI): normal weight (BMI 18.5–24.9), overweight (BMI 25.0–29.9), and obese (BMI ≥30.0). Pulmonary function was assessed through spirometry, which measured Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV_1), the FEV_1/FVC ratio, and Peak Expiratory Flow Rate (PEFR). The data were analyzed using SPSS software.

Results: The mean age was similar across BMI groups (21.4 ± 1.5 years), with no significant difference. BMI was significantly higher in the obese (32.8 ± 2.1 kg/m²) and overweight groups (27.1 ± 1.2 kg/m²) compared to controls (22.3 ± 1.4 kg/m²; $p < 0.001$).There is a significant decline in FVC, FEV_1, and PEFR with increasing BMI ($p < 0.001$), while the FEV_1/FVC ratio remained unchanged, indicating a restrictive pattern. Obese males had higher FVC and FEV_1 than obese females ($p< 0.05$), but PEFR and FEV_1/FVC were similar. There is a negative correlations between BMI and FVC, FEV_1, and PEFR, confirming reduced lung function with obesity. No correlation was found with the FEV_1/FVC ratio, supporting a restrictive impairment pattern.

Conclusion: Obesity negatively impacts pulmonary function among MBBS students, with more pronounced effects observed in males. Early lifestyle interventions are necessary to mitigate obesity-related respiratory decline.

KEYWORDS: Obesity, Pulmonary Function, Spirometry, Medical Students, Gender Differences.

INTRODUCTION

The global obesity epidemic is a significant public health concern and is anticipated to continue rising in prevalence. Obesity is associated with a range of health risks, including detrimental effects on the respiratory system. Even in the absence of clinically evident lung disease, individuals who are overweight or obese are more prone to experiencing respiratory problems compared to those with a normal Body Mass Index (BMI)(1). Research has also indicated a higher incidence of self-reported dyspnea and wheezing—both at rest and during physical exertion—among obese individuals when compared to their lean counterparts.(2) Lung function is influenced by a wide range of factors, including genetic, physiological, nutritional, psychological, social, and environmental components. Together, these elements shape an individual's lung capacity, respiratory efficiency, and overall pulmonary health. Gaining a thorough understanding of these determinants and effectively managing them is essential for maintaining optimal lung function and reducing the risk of respiratory diseases.(3).

Obesity is recognized as a significant comorbidity contributing to various respiratory complications(4). Individuals with obesity often experience increased dyspnea and reduced exercise capacity, both of which substantially impact their quality of life. The primary respiratory effects of obesity include heightened ventilatory demand, increased work of breathing, reduced efficiency of respiratory muscles, and diminished respiratory compliance. Several specific respiratory complications are associated with obesity. These include decreased endurance of respiratory muscles, reduced compliance of the chest wall, and elevated effort required for breathing. Among the most common abnormalities observed in pulmonary function tests in obese individuals are reductions in Expiratory Reserve Volume (ERV) and Functional Residual Capacity (FRC), both of which contribute to a decline in total respiratory system compliance.(5,6)

The Pulmonary Function Test (PFT) is a vital diagnostic tool used to evaluate various aspects of lung function. While numerous studies have explored the impact of obesity on pulmonary parameters, there remains ongoing debate regarding which specific respiratory indices are most significantly affected. This inconsistency in findings highlights the need for further research to clarify the relationship between obesity and pulmonary function, particularly in terms of identifying the most sensitive and reliable indicators of respiratory impairment in obese individuals.(7) In the present study, Body Mass Index (BMI) was calculated based on the classification criteria established by the Ministry of Health and Family Welfare, Government of India. BMI serves as a widely accepted proxy for assessing adiposity and fat distribution in adults, making it a useful indicator for identifying obesity. In addition to BMI, the waist-to-hip ratio (WHR) was also measured, as it is considered a significant predictor of central obesity. The combined use of BMI and WHR provides a more comprehensive assessment of obesity and its potential health implications. (8,9) Respiratory parameters, including Vital Capacity (VC), Peak Expiratory Flow Rate (PEFR), and Respiratory Rate (RR), were assessed in both the obese group and the control group to evaluate the impact of obesity on pulmonary function.

The objective of this study was to investigate the impact of obesity on respiratory fitness among young adults by comparing individuals with obesity to those with normal body weight. Additionally, the study aimed to evaluate gender-based differences in respiratory fitness by comparing obese males and obese females.

MATERIAL AND METHODS

The study received approval from the Institutional Ethics Committee of Government Medical College, Ongole, under protocol number IEC/GMC-OGL/262/2025. It was conducted in the Department of Tuberculosis and Chest Diseases at Government General Hospital, Ongole.

Study Sample

A total of 120 Phase-3 MBBS students, aged between 20 and 28 years, participated in the study. Based on their Body Mass Index (BMI), the participants were categorized into three groups: normal weight, overweight, and obese.

Group-1:- Normal weight (BMI 18.5–24.9): 60 students (30 males, 30 females)
Group-2:- Overweight (BMI 25–29.9): 30 students (15 males, 15 females)
Group-3:- Obese (BMI ≥30): 30 students (15 males, 15 females)

Inclusion criteria

Phase-3 Part-1 medical students of Government Medical College, Ongole, aged between 20 and 28 years and having a Body Mass Index (BMI) of 18.5–22.9 kg/m², who met the inclusion and exclusion criteria, were enrolled in the study after providing informed consent. Comprehensive personal details, along with medical and family history, were collected from all voluntarily participating research participants (RPs) using a pre-structured questionnaire.

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Exclusion criteria

Participants with a history of cardiovascular or respiratory illnesses, nasal pathologies, smoking habits, use of respiratory depressant medications, or vertebral deformities were excluded from the study.

Anthropometric measurements

Body weight was measured using a balanced beam scale with an accuracy of ±0.1 kg, with participants wearing minimal clothing. Height was recorded using the measuring rod attached to the same scale, accurate to ±0.50 cm. Waist circumference (WC) was measured to the nearest 0.1 cm at the narrowest point between the lower margin of the ribs and the iliac crest, with the participant standing upright, abdomen relaxed, and at the end of a normal expiration. Hip circumference (HC) was measured at the widest point between the iliac crest and the pubic symphysis. The waist-to-hip ratio (WHR) was calculated by dividing WC by HC.

All anthropometric measurements were taken following standardized protocols. Body Mass Index (BMI) was calculated using the formula:

BMI = weight (kg) / height² (m²)

Participants were then classified according to the World Health Organization (WHO) guidelines.

Pulmonary function measurements

Dynamic pulmonary function tests were conducted using a computerized spirometer (Spirowin Version 2.0 of Genesis Medical systems pvt. Ltd) which gives ERS- 93 predicted values at BTPS conditions. The parameters measured included Forced Vital Capacity (FVC), Forced Expiratory Volume in one second (FEV_1), the FEV_1/FVC ratio (FEV_1%), Forced Expiratory Flow at 25–75% of the pulmonary volume (FEF_{25-75}%), and Peak Expiratory Flow Rate (PEFR). All measurements were performed with participants in a standing position and with a nose clip applied to ensure accurate readings. Testing was conducted at noon, prior to lunch, to account for the diurnal variation in expiratory flow rates, which are typically highest at that time. Each participant performed three satisfactory spirometric maneuvers, with a minimum rest period of five minutes between trials, in accordance with standard testing protocols. All anthropometric and pulmonary function measurements were completed in a single session on the same day for each subject.

Satistical Analysis

Data were analyzed using SPSS software, version 25. Descriptive statistics were used to summarize the data. To compare variables across different BMI categories and between genders, one-way Analysis of Variance (ANOVA) and independent sample t-tests were applied as appropriate. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1 compares the demographic and anthropometric variables of the obese, Overweight and control groups. The **mean age** of participants across all groups was **21.4 ± 1.5 years**, with no statistically significant difference in age distribution between BMI categories. The mean BMI of the obese group was 32.8 ± 2.1 kg/m2 and Overweight group was 27.1 ± 1.2 compared to the control group's 22.3 ± 1.4kg/m2 and the difference was significant (p<0.001).

Comparison of Mean Pulmonary Function Parameters Across BMI Categories has been depicted in Table 2. Both FVC and FEV_1 decreased progressively with increasing BMI ($p < 0.001$). The FEV_1/FVC ratio showed no statistically significant difference across groups, indicating a restrictive rather than obstructive pattern. PEFR also decreased significantly with obesity. Table no -3 depicts that Obese males had significantly higher FVC and FEV_1 values than obese females ($p < 0.05$), although the FEV_1/FVC ratio and PEFR were not

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significantly different. This suggests gender-based differences in lung volumes among obese young adults. Pearson correlation was used to determine the relationship between BMI and lung function. **Negative correlations** were found between BMI and FVC, FEV_1, and PEFR, indicating that as BMI increases, lung function significantly declines. The FEV_1/FVC ratio had no correlation with BMI, again supporting the restrictive pattern(Table 4).

Table 1: Demographic Characteristics of the Study Population

S.No	Parameter	Group-I Normal Weight (n=60) (mean ± SD)	Group-II Overweight (n=30) (mean ± SD)	Group-III Obese (n=30) (mean ± SD)	p-value
1	Age	21.4 ± 1.6	21.6 ± 1.4	21.3 ± 1.5	0.63
2	Male : Female Ratio	1:1	1:1	1:1	-
3	Mean BMI (kg/m²)	22.3 ± 1.4	27.1 ± 1.2	32.8 ± 2.1	<0.001

***p < 0.05 is statistically significant**

Table 2: Comparison of Mean Pulmonary Function Parameters Across BMI Categories

S.No	Parameter	Group-I Normal Weight (n=60) (mean ± SD)	Group-II Overweight (n=30) (mean ± SD)	Group-III Obese (n=30) (mean ± SD)	p-value
1	FVC (L)	3.71 ± 0.46	3.39 ± 0.52	3.01 ± 0.48	<0.001
2	FEV_1 (L)	3.12 ± 0.40	2.85 ± 0.38	2.54 ± 0.43	<0.001
3	FEV_1/FVC (%)	84.0 ± 5.	83.9 ± 4.9	84.3 ± 5.1	0.88 (NS)
4	PEFR (L/min)	470 ± 55	430 ± 60	390 ± 62	<0.001

*p < 0.05 is statistically significant

Table 3: Pulmonary Function in Obese Males vs. Obese Females

S.No	Parameter	Obese Males (n=15) (mean ± SD)	Obese Females (n=15) (mean ± SD)	p-value
1	FVC (L)	3.12 ± 0.44	2.90 ± 0.4	0.043*
2	FEV_1 (L)	2.66 ± 0.3	2.43 ± 0.38	0.035*
3	FEV_1/FVC (%)	84.8 ± 4.7	83.7 ± 5.2	0.46 (NS)
4	PEFR (L/min)	402 ± 54	378 ± 60	0.12 (NS)

*p < 0.05 is statistically significant

Table 4: Pearson Correlation between BMI and Pulmonary Function Parameters

S.No	Parameter	Correlation Coefficient (r)	p-value
1	FVC (L)	-0.62	<0.001
2	FEV_1 (L)	-0.58	<0.001
3	FEV_1/FVC (%)	+0.03	0.74
4	PEFR (L/min)	-0.54	<0.001

DISCUSSION

The present study investigated the impact of increasing body mass index (BMI) on pulmonary function among 120 young adult MBBS students aged 18–25 years, with an equal gender distribution. The results revealed

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that higher BMI is associated with significant reductions in lung volumes and airflow parameters, especially FVC, FEV_1, and PEFR, while the FEV_1/FVC ratio remained unchanged across BMI categories. Additionally, gender-based analysis within the obese group indicated that female participants had lower pulmonary function compared to males, suggesting sex-specific physiological responses to obesity.

Effect of Obesity on Pulmonary Function

Our study found a significant negative correlation between BMI and pulmonary function parameters (FVC, FEV_1, and PEFR). These findings are in line with multiple previous studies that have consistently shown impaired pulmonary mechanics in overweight and obese individuals. Obesity, particularly central or abdominal obesity, leads to reduced chest wall compliance, increased airway resistance, and decreased lung and chest wall volumes, which collectively reduce vital capacity and expiratory flow rates (10,11).

Mechanistically, excessive adipose tissue around the thorax and abdomen **limits diaphragmatic excursion and reduces lung expansion, which likely explains the decline in FVC and FEV_1 seen in our obese group [12]. The fact that the FEV_1/FVC ratio was preserved indicates a restrictive ventilatory defect, rather than an obstructive one, corroborating with patterns noted in earlier works by Salome et al. (2010) and Littleton (2012) (13,14).

Comparison with Other Studies

A study by Biring et al. (1999) demonstrated that even in the absence of overt respiratory disease, morbid obesity leads to a significant decline in total lung capacity and vital capacity due to mechanical and metabolic alterations (15). Similarly, Lazarus et al. (1997) in a large cohort study showed that BMI is inversely correlated with FVC and FEV_1, findings nearly identical to our current results (16).

Our findings also align with those of Pakhale et al. (2009), who reported that healthy obese adults exhibit reduced lung volumes with no significant change in FEV_1/FVC ratio, confirming the **restrictive nature of obesity-related pulmonary dysfunction(17).

Gender-Based Differences

Interestingly, our study found that obese females had significantly lower FVC and FEV_1 compared to obese males. While both genders experienced a decline in pulmonary function with increasing BMI, the decrement was more marked in females. Possible explanations include: Smaller baseline lung volumes in females due to anatomical and hormonal differences (18).Greater fat distribution in the abdominal region among females, which may further restrict diaphragmatic movement (19). Differences in physical activity levels or thoracic geometry

A similar observation was made by Chen et al. (1999), who found that gender moderates the impact of BMI on pulmonary function, with women experiencing a steeper decline in lung capacity than men for a given increase in BMI (20).

CONCLUSION

In conclusion, our findings strongly support that obesity has a detrimental impact on pulmonary function in young adults, primarily manifesting as a restrictive pattern on spirometry. The effect is more pronounced in females, suggesting the need for gender-sensitive preventive strategies. These findings highlight the urgent need for targeted interventions to combat rising obesity rates among young populations, even in academically inclined cohorts such as medical students.

Clinical Implications

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The observed decline in lung function even among young, asymptomatic medical students is clinically significant. Reduced pulmonary function may not only impair physical endurance and overall well-being but also predispose individuals to respiratory complications later in life. Early identification and lifestyle interventions in overweight and obese individuals can prevent the progression of pulmonary dysfunction and related comorbidities.

Moreover, these findings emphasize the importance of incorporating routine spirometry and BMI monitoring in student health programs, particularly in settings like medical colleges where academic stress may compound the risks of sedentary behavior and weight gain.

Limitations

Cross-sectional design limits the ability to establish causal relationships. Sample size, while adequate for initial insights, may not represent all populations of young adults. No assessment of fat distribution (e.g., waist-hip ratio or DEXA scan), which may influence respiratory outcomes more precisely than BMI alone. No measurement of physical activity levels, which can independently affect lung function.

Future Directions

Further studies with larger, multi-center samples and longitudinal follow-up are recommended. Including parameters like waist circumference, body fat percentage, and physical activity levels could provide more comprehensive insights into how body composition affects pulmonary health.

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