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A study of the Relation of Body Weight with Dynamic Lung Parameters in Young adults.

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Abstract

Background: Young adults are increasingly facing the epidemic of obesity and altered body composition, raising concerns about the effects of body fat on pulmonary function. Gender differences in lung parameters are present; however, the contribution of body weight and BMI to lung function remains unclear. Therefore, the current study tried to examine the relationship between body weight and dynamic lung parameters in young adults and also evaluate the gender-based differences. ***Methods:*** The study was an observational study and was done on a group of 100 young adults (48 male, 52 female). BMI was used to measure anthropometric dimensions. Pulmonary function tests were done to determine forced vital capacity [FVC], forced expiratory volume in 1 second [FEV1], FEV1/FVC ratio, and volume of peak expiratory flow [PEFR]. ANOVA and correlation analysis were used to analyse data regarding BMI categories. ***Results:*** Males had significantly higher FVC (4.01 ± 0.65 L), FEV1 (3.62 ± 0.59 L), and PEFR (8.72 ± 1.65 L/s) compared to females ($p < 0.001$), while the FEV1/FVC ratio was comparable between sexes. Across BMI categories, no significant differences were observed in any lung function parameters. Correlation analysis revealed weak, non-significant relationships between BMI and lung function indices ($r = -0.07$ to -0.11, $p > 0.05$). ***Conclusion:*** The present study concludes that Gender is a significant predictor of dynamic parameters of the lungs among young adults, but BMI has no significant correlation with pulmonary function among the young adults. Whereas there seems to be no difference among BMI groups in lung performance in young adults.

Keywords: Body mass index, Lung function, FVC, FEV1, PEFR, Young adults.

INTRODUCTION

The body weight of a person is one of the important parameters of overall health status and has a significant influence on the respiratory system function. The respiratory system, through its dynamic parameters including Forced Vital Capacity (FVC), Forced Expiratory Volume in the first second (FEV1), Peak Expiratory Flow Rate (PEFR), and FEV1/FVC ratio, is an important determinant of adequate oxygenation as well as ventilation. Body weight changes (underweight, overweight, obesity) are capable of affecting lung mechanics, chest wall compliance, and airway resistance, and hence changing dynamic lung parameters [1,2].

There are various adverse health consequences linked to obesity, including cardiovascular disease, diabetes, and respiratory dysfunction. Research has demonstrated that obesity alters the respiratory physiology by lowering lung volumes, diminishing the efficiency of the respiratory muscle, and adding to the work of breathing [3,4]. In particular, the deposition of excess fat in the abdomen and thorax limits the diaphragmatic movements and reduces chest wall compliance, leading to decreases in FVC and FEV1 [5].

On the other hand, underweight patients can also have weak respiratory muscles and low lung volumes, thus also impacting dynamic lung measures [6]. The young adults aged between 18 and 25 years old are a very crucial group of the population for assessing this relationship. Such an age group is typically devoid of chronic diseases that may confound the effect of body weight on the lungs, making it the most effective group for investigating the effects of body weight alone on the pulmonary dynamics [7]. Moreover, as the prevalence of overweight and obesity among young adults is increasing because of sedentary lifestyles, unhealthy diets, and more screen time, there is growing clinical and public health interest in learning more about this relationship [8,9].

Several cross-sectional and observational studies have shown a negative correlation between rising body mass index [BMI] and parameters of lung function. As an example, an increase in BMI has been associated with a decrease in FVC and FEV1, whereas PEFR generally decreases with an increase in body weight [10,11]. It has been clearly demonstrated that obesity has a restrictive influence on lung mechanics, but the degree of compromise could depend on the degree and distribution of adiposity [12]. Conversely, thin or anorexic people can also exhibit impaired lung activity, especially because of decreased muscle volume and suboptimal ventilatory dynamics [13].

Dynamic pulmonary parameters are diagnostic and monitoring tools in respiratory physiology and clinical practice. The standard test of the evaluation of these parameters is spirometry, which has quantitative information about the airways' functioning and ventilatory capacity. Spirometric indices, when interpreted with body weight, not only contribute to explaining the physiological effects of adiposity or leanness but also contribute to the early diagnosis of individuals who are prone to respiratory dysfunction [14]. The body composition of the South Asian population is somewhat different compared to that of Western populations, displaying more central adiposity at relatively low BMI. This puts people at risk of obesity related complications at an early age [15].

Nevertheless, there has been little research specifically on young adults in this region to establish how body weight contributes to the dynamic lung functions. Therefore, this study was designed to evaluate the relationship between body weight and dynamic lung parameters of young adults. The results of this study can lead to enhanced understanding of respiratory physiology in relation to anthropometry and determining optimal weight for respiratory functions.

MATERIALS AND METHODS

This was a cross-sectional observational study conducted in the Department of Physiology of Maheshwara Medical College, Patancheru, Hyderabad. Institutional Ethical clearance was obtained for the study after duly following the protocol for human research based on the Helsinki declaration. All procedures were explained to participants in the vernacular language. Written consent was obtained from participants of the study before enrolment.

Study Population

A total of 100 healthy young adults aged 18–25 years were recruited for the study. Both males and females were included to ensure adequate representation. Subjects were primarily undergraduate medical students and volunteers from the same age group.

A sample size was estimated based on the primary objective of assessing the correlation between body mass index (BMI) and dynamic lung function parameters. Assuming a moderate correlation coefficient ($r = 0.30$) between BMI and pulmonary function indices, with a two-sided significance level (α) of 0.05 and a statistical power of 80% ($\beta = 0.20$), the minimum required sample size was calculated to be 84 participants using Fisher's Z-transformation for correlation studies. To compensate for possible incomplete data and improve the precision of subgroup analyses according to sex and BMI categories, 100 participants were enrolled in the study.

Inclusion Criteria

1. Aged from 18 to 25 years
2. Males and Females
3. No history of any chronic illness
4. Non smokers
5. Voluntarily willing to participate in the study

Exclusion criteria

1. History of respiratory diseases
2. History of Cardiovascular Disease
3. Hypertension, diabetes mellitus
4. Recent history of respiratory illness within the past 4 weeks
5. Spinal thoracic deformities can affect lung function

Anthropometric Measurements: Body weight was measured using a calibrated digital weighing scale with participants in light clothing and without shoes. Height was recorded using a stadiometer with participants standing erect, barefoot, with heels together. Body Mass Index [BMI] was calculated using the Quetelet formula: BMI = weight [kg] / height [m]^2
Participants were categorized according to the World Health Organization [WHO] classification for Asian populations [16]:

- Underweight: BMI < 18.5 kg/m^2
- Normal weight: BMI 18.5–22.9 kg/m^2

- Overweight: BMI 23.0–24.9 kg/m²
- Obese: BMI ≥ 25.0 kg/m²

Pulmonary Function Testing: Dynamic lung parameters were assessed using a computerized spirometer [conforming to American Thoracic Society guidelines]. Each participant was instructed and trained to perform spirometry according to standard procedures [17]. The following indices were recorded:

- Forced Vital Capacity (FVC]
- Forced Expiratory Volume in 1 second (FEV1]
- FEV1/FVC ratio (%)
- Peak Expiratory Flow Rate (PEFR)

Each participant performed at least three acceptable maneuvers, and the best effort was considered for analysis. All measurements were performed at room temperature under similar conditions to minimize variability.

Statistical Analysis: All the available data were segregated, finalized, and uploaded to an MS Excel spreadsheet and analyzed by Statistical Package for Social Sciences [SPSS] version 26.0 in Windows format. The descriptive statistics were calculated as mean, standard deviation, frequency, and percentage. The categorical variables were analyzed using ANOVA for comparison of lung functions between different BMI groups, and Pearson's correlation coefficient was applied to assess the relationship between BMI and lung function parameters. The values of p less than 0.05 were considered significant.

RESULTS

A total of 100 young adult participants of both sexes were included in the study. The baseline characteristics of the participants are given in Table 1. The overall mean age of the cohort was 21.5 ± 2.1 years. The age distribution was comparable between males (21.8 ± 2.2 years] and females (21.3 ± 2.0 years).

The characteristics of males showed that they were taller and heavier, with a median height of 170.2 ± 6.8 cm and a weight of 68.5 ± 11.2 kg, as compared to females, whose median height was 158.8 ± 7.1 cm and a weight of 57.5 ± 10.8 kg. The mean BMI was 23.2 ± 3.8kg/m^2, and there was minimal variation between genders. As per the WHO criteria for the Asian population, 50% of the participants of this study had a normal BMI.

Overweight was 22% of participants, and 16% were obese, showing that about one third of the study subjects were above the normal weight category. There were 12% of participants classified as underweight and a slightly higher prevalence in females 15.4%) compared to males (8.3%). These results indicate a wide range of BMI distribution in the sample of young adults, which is suitable to test the correlation between weight and lung function.

Table 1: Baseline Characteristics of the Study Participants (N=100)

Characteristic	Overall (N=I00)	Male (n=48)	Female (n=52)
Age (years), mean ± SD	21.5 ± 2.1	21.8 ± 2.2	21.3 ± 2.0
Height (cm), mean ± SD	164.3 ± 9.5	170.2 ± 6.8	158.8 ± 7.1
Weight (kg), mean ± SD	62.8 ± 12.4	68.5 ± 11.2	57.5 ± 10.8
Body Mass Index (kg/m^2), mean ± SD	23.2 ± 3.8	23.6 ± 3.5	22.8 ± 4.0
BMI Category (WHO Asian Criteria), n (%)			
Under weight (< 18.5 kg/m^2)	12 (12.0)	4 (8.3)	8 (15.4)
Normal (18.5—22.9 kg/m^2)	50 (50.0)	24 (50.0)	26 (50.0)
Overweight (23.0—24.9 kg/m^2)	22 (22.0)	12 (25.0)	10 (19.2)
Obese (≥ 25.0 kg/m^2)	16 (16.0)	8 (16.7)	8 (15.4)

The analysis of spirometry-based parameters is given in Table 2. A critical analysis of the table shows that the mean FVC was 3.52 ± 0.78 L; however, males demonstrated significantly higher values (4.01 ± 0.65 L) compared to females (3.06 ± 0.58 L, and p < 0.001).

The FEV1/FVC ratio was almost similar between males and females (90.2% in males vs. 90.6% in females, and p = 0.68), indicating the proportional expiratory function relative to lung volume was preserved across both sexes.

The peak expiratory flow rate (PEFR) in males and females was analyzed, with males having slightly higher expiratory flow rates (8.72 ± 1.65 L/s) compared to females (7.04 ± 1.52 L/s), and the difference was statistically significant. The overall results show that the absolute lung volumes and flow rates were higher in males, and the efficiency of expiration relative to lung size was constant in both genders.

Table 2: Dynamic Lung Parameters in the Study Population (N=I00)

Pulmonary Function Parameter	Overall (N=100) Mean ± SD	Male (n=48) Mean ± SD	Female (n=52) Mean ± SD	P value
FVC (L)	3.52 ± 0.78	4.01 ± 0.65	3.06 ± 0.58	<0.001*
FEVI (L)	3.18 ± 0.71	3.62 ± 0.59	2.78 ± 0.52	<0.001*
FEVI/FVC Ratio (%)	90.4 ± 5.2	90.2 ± 5.5	90.6 ± 4.9	0.68
PEFR (Us)	7.85 ± 1 82	8.72 ± 1.65	7.04 ±1.52	<0.001*
FVC Forced Vital Capacity, FEV1: Forced Expiratory Volume in 1 second; PEFR: Peak expiratory flow rate, p-value from independent t-test comparing males and females *Significant				

Table 3 compares lung function parameters among underweight, normal, overweight, and obese participants. Mean FVC values ranged from 3.25 ± 0.71 L in the underweight group to 3.61 ± 0.75 L in the normal BMI group, with slight decreases observed in overweight (3.55 ± 0.80 L) and obese participants (3.42 ± 0.80 L). FEV1 showed a similar trend, being lowest in underweight (2.95 ± 0.66 L) and obese groups (3.05 ± 0.74 L) compared to normal BMI participants (3.28 ± 0.69 L).

The FEV1/FVC ratio remained relatively stable across all BMI categories, ranging between 89.2% and 90.8%, showing no significant association with body weight status. PEFR values also did not vary significantly, though slightly higher mean values were observed in the normal and overweight categories compared to the underweight and obese groups. Importantly, none of the differences across BMI groups reached statistical significance ($p > 0.05$), indicating that within this young adult population, BMI did not have a measurable impact on lung volumes or expiratory flows.

Table 3: Comparison of Dynamic Lung Parameters Across BMI Categories

Pulmonary Function Parameter	Underweight (n=12) Mean ± SD	Normal (n=50) Mean ± SD	Overweight (n=22) Mean ± SD	Obese (n=16) Mean ± SD	p-value (ANOVA)
FVC (L)	3.25 ± 0.71	3.61 ± 0.75	3.55 ± 0.80	3.42 ±0.80	0.45
FEVI (L)	2.95 ± 0.66	3.28 ± 0.69	3.20 ±0.75	3.05 ±0.74	0.38
FEVI/FVC Ratio (%)	90.8 ± 4.8	90.8 ± 5.4	90.1 ± 5.0	89.2 ±5.1	0.72
PEFR (L/s)	7.45 ± 1.70	8.02 ± 1.8	7.80 ± 1.85	7.55 ± 1.90	0.65
p-value from one-way Analysis of Variance (ANOVA) comparing the four BMI groups.					

The relationship between BMI and lung parameters is given in Table 4. A critical analysis of the parameters in the table shows that there exists a weak negative correlation across all parameters as per Pearson's correlation coefficient 'r' values. The FVC showed a correlation of -0.08 ($p = 0.43$), showing no significant correlation between BMI and lung capacity. Similarly, FEV1 had a weak negative correlation ($r = -0.09$, $p = 0.38$). The ratio of FEV1/FVC also showed a similar tendency ($r = -0.11$, $p = 0.28$). There was no correlation between PEFR and BMI, with non-significant r and p values as given in the table. These findings showed that although obese participants might have lower function values as compared to normal weight, the lack of statistical significance indicates that BMI alone may not be a strong indicator of pulmonary function in healthy young adults.

Table 4: Pearson's Correlation Coefficients (r) between Body Mass Index and Dynamic Lung Parameters

Pulmonary Function Parameter	Correlation with BMI (r)	p-value
FVC (L)	-0.08	0.43
FEVI (L)	-0.09	0.38
FEVI/FVC Ratio (%)	-0.11	0.28
PEFR (L/s)	-0.07	0.5

DISCUSSION

The current study assessed the correlation between body weight and the dynamic pulmonary factors in young adults with attention to gender differences and body mass index (BMI) categories. The results showed that there are distinct sex-related differences in lung volumes and flow rates, whereas BMI demonstrated weak and statistically insignificant correlations to pulmonary function. Baseline data about the participants revealed that the mean BMI was within normal range in 50% of participants, but over one-third of the students were categorized as overweight and obese. These tendencies indicate the growing proportions of the higher BMI groups in young adults in India, which align with other sources pointing to the growing prevalence of overweight and obesity among urban youth groups [18,19].

Such demographic characteristics offered a proper platform to examine the potential role of BMI on lung functioning. The gender disparities that were evident in the parameters of lung functions were observed in the results of this study. FVC, FEV1, and PEFR were found to be much higher in males than in females, with FEV1/FVC being similar in both groups.

These results are consistent with the previous research that ascribes the increased volumes of the lungs in males to bigger thoracic size, greater muscle mass, and hormonal effects, which play a role in respiratory mechanics [20,21]. The match in the FEV1/FVC ratios indicates that, though there is a difference between the sexes in terms of absolute lung function, airway patency, and lung size, these differences do not affect their respective genders.

In comparison of the lung function in relation to the BMI groups, no statistically significant differences could be determined in FVC, FEV1, PEFR, or FEV1 1/FVC ratios. The mean values of obese subjects were slightly lower than those of the normal BMI groups; the difference was not significant. This is contrary to other studies, which found the decline of lung function as BMI increased, especially among the obese, where surplus fatness might impair the flexibility of the chest wall and diaphragmatic movement [1,22]. The reason why the discrepancy might have happened could be that the study population was relatively young and healthy, and the obesity exposure time might not have been long enough to cause the respiratory compromise to measurable levels.

The correlation analysis also confirmed the non-significant relationship between BMI and the lung parameters, which was weak, with all correlation coefficients being near zero. This aligns with results of recent studies in young adults, where BMI was found to have low predictive power on lung function compared to other anthropometric measurements like the waist-to-hip ratio or fat distribution [6]. There is a possibility that central obesity and not BMI as such may have a greater influence on pulmonary mechanics because abdominal fat build-up directly interferes with diaphragmatic movements and lung volume [23]. The findings of our study also indicate that the lung functions of various BMI groups in young adults were relatively intact, possibly because of the enhanced cardio-respiratory reserve and reduced exposure time to the mechanical and inflammatory action of obesity.

Nevertheless, as age progresses, obesity-induced changes, including systemic inflammation, oxidative stress, and restrictive ventilatory defects, can be intensified, causing major lung dysfunction [24, 25]. Longitudinal studies are thus required in order to monitor these changes with time. Finally, our study highlights that gender has a decisive effect on lung function in young adults, but BMI does not seem to be an independent predictor in the young age group. However, with the increasing number of overweight and obesity, preventive strategies and regular check-ups should not be ignored to prevent respiratory complications in the long term.

CONCLUSION

The present study showed that gender has a significant impact on dynamic lung parameters, and its values were found to be higher in males than in females, while the FEV1/FVC ratio was found to be the same in both groups. BMI, on the other hand, did not significantly affect pulmonary function, and no significant correlations were found between BMI and lung parameters. These results indicate that in young healthy adults, the difference in the functioning of the lungs is mainly sex-specific, both in anatomical and physiological aspects, than body weight. Nevertheless, as the prevalence of overweight and obesity increases, long-term follow-up is essential to determine the possible respiratory effects in later adulthood.

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