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Study of Effect of Obesity On Pulmonary Function Test

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ABSTRACT

Background: Obesity is known to influence respiratory mechanics, yet the extent to which excess body weight alters spirometric indices remains incompletely defined in the general adult population. This study evaluated the impact of obesity on pulmonary function parameters using standardized spirometry.
Material and Methods: A cross-sectional study was conducted among 120 adults aged 18–60 years, divided into non-obese (n = 60) and obese (n = 60) groups based on BMI using WHO Asian cut-offs. Anthropometric variables, including waist–hip ratio, were recorded, and pulmonary function testing was performed according to ATS/ERS 2019 guidelines. Spirometric indices were compared between groups, and correlations between BMI and lung function were assessed.
Results: Baseline age and sex distribution were similar across groups, while BMI and waist–hip ratio were significantly higher among obese individuals. Obese participants demonstrated lower mean FVC (2.96 ± 0.62 L vs 3.42 ± 0.58 L), FEV_1 (2.48 ± 0.49 L vs 2.94 ± 0.51 L), FEV_1/FVC (83.6 ± 6.1% vs 86.1 ± 5.3%), PEFR (381.7 ± 58.9 L/min vs 432.8 ± 62.4 L/min), and $FEF_{25–75}$% (2.68 ± 0.48 L/s vs 3.12 ± 0.54 L/s), all with statistically significant differences. Normal spirometry was more frequent in the non-obese group (93.3%) than the obese group (70%), whereas restrictive defects were more common among obese adults (25% vs 5%). BMI showed significant negative correlations with FVC (r = –0.42), FEV_1 (r = –0.39), FEV_1/FVC (r = –0.18), PEFR (r = –0.36), and $FEF_{25–75}$% (r = –0.33).
Conclusion: Obesity is associated with substantial reductions in multiple spirometric indices and higher prevalence of restrictive ventilatory patterns. Increasing BMI correlates negatively with lung function, highlighting the need for respiratory evaluation and weight management strategies in obese individuals.

Keywords*: Obesity; Pulmonary function test; Spirometry; Body mass index.*

INTRODUCTION

The global prevalence of overweight and obesity has risen markedly over recent decades, producing a large burden of metabolic and cardiorespiratory morbidity. Population-specific considerations have prompted recommendations that Asian populations use lower BMI thresholds to identify increased risk, since cardiometabolic complications occur at lower BMI in many Asian groups [1,2].

Excess adiposity influences respiratory function through multiple mechanisms. Central and thoraco-abdominal fat reduce chest wall and lung compliance and limit diaphragmatic descent, causing decreased lung volumes—most consistently a reduction in forced vital capacity (FVC) and total lung capacity—while airway resistance and work of breathing may be increased. These mechanical effects commonly produce a pattern on spirometry that is compatible with restrictive ventilatory impairment in adults with obesity [3,4].

Epidemiological and clinical studies examining spirometric indices in obese adults report variable findings but a consistent trend: higher BMI is frequently associated with lower absolute and percent-predicted values of FVC and forced expiratory volume in one second (FEV_1), reductions in peak expiratory flow (PEF), and attenuated mid-expiratory flows ($FEF_{25–75}$%). Some population analyses indicate that increasing BMI is more strongly related to a restrictive-only pattern than to

obstructive defects, whereas the relationship between BMI and the FEV_1/FVC ratio is less consistent across disease groups and populations [3–5].
Despite these general trends, the association between adiposity and pulmonary function is not uniform across age groups, ethnicities, fat distribution patterns, or coexisting cardiopulmonary disease. Recent large cross-sectional analyses emphasize that central adiposity and fat mass (rather than BMI alone) may better predict restrictive changes, and longitudinal data suggest that changes in adiposity over time alter spirometric trajectories [5,6]. Therefore, locally derived data remain important to characterize the magnitude and pattern of spirometric impairment associated with obesity in specific populations.

Given the clinical implications—reduced exercise capacity, increased dyspnea, and worse perioperative respiratory risk—understanding how obesity affects routine pulmonary function testing is essential for clinicians and public-health planning. The present cross-sectional study was designed to compare spirometric indices between obese and non-obese adults and to examine the relationship between BMI and commonly used lung function parameters.

MATERIAL AND METHODS

Study Design and Setting: This investigation was conducted as a cross-sectional, observational study in a tertiary-care medical institute during which eligible participants were consecutively enrolled.

Study Population: Adults aged 18–60 years attending routine health examinations were screened for inclusion. Participants were stratified into two groups based on Body Mass Index (BMI) calculated using the WHO Asian cut-offs:

- **Non-obese group:** BMI < 25 kg/m²
- **Obese group:** BMI ≥ 25 kg/m²

Sample Size: The sample size was determined considering an expected mean difference of approximately 8–10% in FEV_1/FVC ratio between obese and non-obese individuals, with a standard deviation of 15% reported by earlier regional studies. Using a two-sided α of 0.05 and power of 80%, the minimum required number per group was calculated as 46. To compensate for possible exclusions and suboptimal spirometry attempts, the final sample size was set at 60 participants per group (total = 120).

Inclusion Criteria

- Adults between 18 and 60 years
- Ability to perform acceptable and reproducible spirometry
- Willingness to provide informed consent

Exclusion Criteria

- History of smoking or exposure to occupational respiratory hazards
- Prior diagnosis of asthma, COPD, interstitial lung disease, or other chronic pulmonary conditions
- Recent upper or lower respiratory tract infection (within preceding 3 weeks)
- Cardiovascular or neuromuscular disorders interfering with spirometry
- Pregnancy

Anthropometric Measurements: Height was recorded using a stadiometer with participants standing erect without footwear. Weight was measured to the nearest 0.1 kg using a calibrated digital scale. BMI was calculated as weight (kg) divided by height squared (m²). Waist and hip circumferences were measured using a non-stretchable measuring tape, and the waist-to-hip ratio was computed for analysis of central adiposity.

Pulmonary Function Testing: Spirometry was carried out using a computer-based spirometer. Participants performed at least three acceptable and two reproducible manoeuvres. The best values for Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV_1), FEV_1/FVC ratio, Peak Expiratory Flow Rate (PEFR), Forced Expiratory Flow at 25–75% of FVC ($FEF_{25-75}\%$) were used for analysis. Tests were conducted in the sitting position, with a nose clip applied, and calibration checks were performed daily.

Data Collection and Statistical Analysis: Demographic and clinical variables were recorded using a structured proforma. Spirometric indices were expressed as absolute values and percent predicted values. Data analysis was performed using standard statistical software. Continuous variables were summarized as mean ± standard deviation. Intergroup comparisons were made using the Student's *t*-test. A p value < 0.05 was considered statistically significant.

RESULTS

A total of 120 participants were included in the analysis, comprising 60 individuals in the non-obese group and 60 in the obese group. The baseline characteristics of both groups are summarized in Table 1. The mean age was comparable between groups, and the sex distribution did not differ significantly. As expected, weight, BMI, and waist–hip ratio were substantially higher among obese participants ($p < 0.001$ for each).

Significant differences in spirometric performance were observed between the two groups (Table 2). Mean FVC and FVC (% predicted) were markedly lower in the obese group (2.96 ± 0.62 L and 82.7 ± 10.3%, respectively) compared with the non-obese group (3.42 ± 0.58 L and 92.4 ± 8.9%). A similar trend was noted for FEV_1, with obese individuals demonstrating reduced absolute and percent-predicted values ($p < 0.001$).

The FEV_1/FVC ratio was modestly but significantly lower among obese participants (83.6 ± 6.1%) relative to non-obese subjects (86.1 ± 5.3%, $p = 0.01$). Peak expiratory flow rate and mid-expiratory flow ($FEF_{25–75}$%) also showed significant reductions in the obese group, indicating small-airway involvement.

When spirometry results were categorized (Table 3), the proportion of normal ventilatory patterns was higher in the non-obese group (93.3%) than in the obese group (70%). Restrictive defects were more common among obese participants (25%) compared with the non-obese group (5%), a difference that was statistically significant. Obstructive patterns were infrequent and comparable in both groups.

BMI demonstrated significant negative correlations with most spirometric parameters (Table 4). The strongest inverse associations were observed with FVC ($r = –0.42$, $p < 0.001$) and FEV_1 ($r = –0.39$, $p < 0.001$). Mid-expiratory flow and peak expiratory flow also declined progressively with increasing BMI. The FEV_1/FVC ratio showed a weaker but statistically significant correlation ($r = –0.18$, $p = 0.04$).

Table 1. Baseline Characteristics of Study Participants

Parameter	**Non-obese (n = 60)**	**Obese (n = 60)**	***p*-value**
Age (years), mean ± SD	36.8 ± 9.4	38.2 ± 8.7	0.41
Male : Female ratio	28 : 32	30 : 30	0.72
Height (cm), mean ± SD	164.6 ± 7.8	163.9 ± 8.1	0.62
Weight (kg), mean ± SD	61.4 ± 7.2	84.6 ± 9.8	<0.001
BMI (kg/m²), mean ± SD	22.6 ± 1.8	31.5 ± 3.2	<0.001
Waist–Hip Ratio, mean ± SD	0.83 ± 0.05	0.94 ± 0.07	<0.001

Table 2. Comparison of Pulmonary Function Test Parameters between Groups

Spirometric Index	**Non-obese (n = 60) Mean ± SD**	**Obese (n = 60) Mean ± SD**	***p*-value**
FVC (L)	3.42 ± 0.58	2.96 ± 0.62	<0.001
FVC (% predicted)	92.4 ± 8.9	82.7 ± 10.3	<0.001
FEV_1 (L)	2.94 ± 0.51	2.48 ± 0.49	<0.001
FEV_1 (% predicted)	89.7 ± 9.1	78.3 ± 9.8	<0.001
FEV_1/FVC (%)	86.1 ± 5.3	83.6 ± 6.1	0.01
PEFR (L/min)	432.8 ± 62.4	381.7 ± 58.9	<0.001
$FEF_{25–75}$% (L/s)	3.12 ± 0.54	2.68 ± 0.48	<0.001

Table 3. Distribution of Spirometry Patterns

Spirometry Pattern	**Non-obese (n = 60)**	**Obese (n = 60)**	***p*-value**
Normal	56 (93.3%)	42 (70.0%)	0.002
Restrictive	3 (5.0%)	15 (25.0%)	0.003
Obstructive	1 (1.7%)	3 (5.0%)	0.31

Table 4. Correlation of BMI with Pulmonary Function Parameters

Parameter	**Correlation Coefficient (r)**	***p*-value**
FVC (L)	–0.42	<0.001
FEV_1 (L)	–0.39	<0.001
FEV_1/FVC (%)	–0.18	0.04
PEFR (L/min)	–0.36	<0.001
$FEF_{25–75}$% (L/s)	–0.33	<0.001

DISCUSSION

In this cross-sectional study, obese adults showed significantly lower FVC, FEV_1, PEFR, and $FEF_{25–75}$% compared with non-obese participants, a higher prevalence of restrictive spirometric patterns, and consistent inverse correlations between BMI and multiple spirometric indices. These findings align with a substantial body of work indicating that increased adiposity—particularly central or trunk fat—adversely affects lung volumes and airflow measurements through mechanical and possibly inflammatory mechanisms.

Mechanistically, accumulation of adipose tissue in the abdominal and thoracic regions reduces chest wall and diaphragm compliance, restricts vertical diaphragmatic excursion, and reduces end-expiratory lung volume; these changes most directly lower FVC and other volume-related indices, producing a restrictive pattern on spirometry [7,8]. Our observed predominance of restrictive defects among obese participants (25% vs 5% in non-obese) is concordant with prior reports that obesity more often manifests with restrictive abnormalities than with classical obstructive patterns in otherwise healthy adults [8,9].

The inverse correlations between BMI and FVC ($r = -0.42$) and FEV_1 ($r = -0.39$) in our cohort are consistent with population and body-composition studies that show increasing fat mass, particularly trunk or central adiposity, is associated with lower FEV_1 and FVC after adjustment for confounders [7,10]. Qvarfordt and colleagues demonstrated that fat mass and trunk fat have stronger associations with reduced FEV_1 and FVC than does BMI alone, suggesting that measures of regional adiposity can improve risk stratification beyond BMI [7]. This supports our complementary observation that waist–hip ratio was substantially higher in the obese group and may have contributed to the greater functional impairment. The reductions in peak and mid-expiratory flows (PEFR and $FEF_{25–75}$%) we observed indicate that airflow, including flows reflecting small-airway function, is compromised with increasing adiposity. Several recent cross-sectional analyses and pediatric/adolescent studies have reported similar decreases in mid-expiratory flows with higher BMI, suggesting both mechanical load and altered airway mechanics may play roles [8,11]. While obesity frequently produces a restrictive pattern, obesity-related small-airway dysfunction has also been described and may relate to airway dysanapsis, bronchial inflammation, or reduced lung elastic recoil [8].

Longitudinal and interventional data add clinical context to our cross-sectional findings. Weight change studies show that loss of adiposity is associated with slowing of spirometric decline or modest improvements in lung function, which implies at least partial reversibility of the obesity-related impairment [12]. Peralta et al. found that changes in weight were associated with changes in trajectories of FEV_1 and FVC in large cohorts, supporting the concept that adiposity is a modifiable determinant of pulmonary function over time [12].

Not all studies are uniform; some analyses report non-linear relationships (for example, low BMI also linked to lower lung volumes) or population differences that reflect age, sex, ethnicity, muscle mass, and comorbidities [11,13]. These discrepancies emphasize the importance of controlling for confounders and, where feasible, measuring regional fat distribution or fat mass rather than relying solely on BMI. Our study controlled for basic demographics and excluded known pulmonary disease and smokers, but we did not perform body-composition imaging or measure TLC and RV—measurements that would better characterize the restriction and permit separation of true parenchymal restriction from extrapulmonary (chest-wall/diaphragmatic) effects.

Strengths of the present study include standardized spirometry according to ATS/ERS guidelines and explicit exclusion criteria to reduce confounding from smoking and known respiratory disease. Limitations include the cross-sectional design, which precludes causal inference; reliance on BMI and waist–hip ratio without direct body-composition measures; and absence of static lung volumes (TLC, RV) or gas-transfer testing to confirm restrictive physiology. The sample was drawn from a single tertiary-care center and may not be representative of all demographics or ethnic groups.

CONCLUSION

This study demonstrates that excess body weight is associated with measurable deterioration in pulmonary function. Individuals with obesity exhibited significantly reduced values of FVC, FEV_1, PEFR, and mid-expiratory flow rates compared with non-obese participants, indicating the presence of both restrictive and small-airway ventilatory impairment. The higher frequency of restrictive patterns among obese individuals further supports the adverse mechanical effects of increased adiposity on respiratory physiology. The inverse correlations observed between BMI and spirometric indices emphasize that rising body mass contributes progressively to functional decline. These findings highlight the need for routine respiratory assessment in obese adults and underscore the importance of weight reduction strategies as part of comprehensive respiratory health promotion.

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