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Original Article

Correlation Between Body Mass Index and Pulmonary Function Parameters in Adults

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Abstract-

Background: Body mass index (BMI) is a widely used anthropometric index of adiposity, and an increasing body of evidence suggests that both excess and deficient body weight can adversely influence pulmonary function. Quantifying this relationship across the full BMI spectrum remains clinically relevant given the rising global prevalence of obesity. Objective: To evaluate the correlation between BMI and standard pulmonary function test (PFT) parameters in healthy adults, and to compare spirometric values across BMI categories. **Methods:** This cross-sectional analytical study included 300 healthy adults aged 18–60 years, stratified into underweight, normal weight, overweight, and obese categories using standard BMI cut-offs. Spirometry was performed to record forced vital capacity (FVC), forced expiratory volume in one second (FEV1), FEV1/FVC ratio, peak expiratory flow rate (PEFR), forced expiratory flow at 25–75% (FEF25-75%), and maximum voluntary ventilation (MVV). Pearson's correlation coefficient was used to assess the relationship between BMI and each PFT parameter. **Results:** BMI showed a statistically significant negative correlation with FVC% predicted ($r = -0.392$, $p<0.001$), FEV1% predicted ($r = -0.417$, $p<0.001$), FEF25-75% ($r = -0.298$, $p<0.001$), and MVV ($r = -0.276$, $p<0.001$). A weaker but significant negative correlation was observed with FEV1/FVC ratio ($r = -0.211$, $p=0.002$) and PEFR ($r = -0.184$, $p=0.006$). Mean FVC% and FEV1% declined progressively from the underweight through to the obese category, while a restrictive ventilatory pattern was present in 34.4% of overweight/obese participants compared with 5.4% of those with normal BMI.**Conclusion**: BMI is significantly and inversely correlated with most pulmonary function parameters in adults, with increasing BMI associated with a progressively restrictive ventilatory pattern. Routine assessment of pulmonary function in individuals with elevated BMI may help in early identification of subclinical respiratory compromise.

Keywords: *Body mass index; Pulmonary function test; Spirometry; Forced vital capacity; Obesity; Restrictive lung disease.*

INTRODUCTION

Body mass index (BMI), calculated as weight in kilograms divided by the square of height in metres, remains the most widely used anthropometric measure for classifying individuals as underweight, normal weight, overweight, or obese in both clinical and epidemiological settings (1). Global obesity prevalence has risen markedly over recent decades, with the World Health Organization estimating that approximately 1.9 billion adults worldwide were overweight and 650 million were obese as of 2016, and forecasts suggesting that nearly two-thirds of adults globally may carry a diagnosis of overweight or obesity by 2050 (2,3). This escalating burden of abnormal body weight has substantial implications not only for cardiometabolic health but also for the respiratory system, which is mechanically and physiologically influenced by body composition (3).

The relationship between BMI and pulmonary function is now well established, although the direction and magnitude of this relationship differ across the BMI spectrum. In obesity, excess adipose tissue deposited around the thorax and abdomen mechanically restricts diaphragmatic excursion and chest wall expansion, reduces total respiratory system compliance by as much as two-thirds of normal values, and displaces the diaphragm cephalad, thereby reducing functional residual capacity, expiratory reserve volume, and overall lung volumes (4,5). This altered respiratory mechanics manifests on spirometry as a restrictive ventilatory pattern, characterised by reduced forced vital capacity (FVC) and forced expiratory volume in one second (FEV1), typically with a preserved or even elevated FEV1/FVC ratio (5,6). Importantly, this restrictive tendency appears to be a feature specifically of fat mass and central adiposity rather than body size as such, since fat-free mass index has been shown to correlate positively with FEV1 and FVC, whereas BMI itself may be an imprecise composite marker that does not fully distinguish muscularity from adiposity (7).

Conversely, a separate and increasingly recognised body of evidence demonstrates that being underweight is also associated with impaired pulmonary function. In a large cross-sectional study of over 280,000 healthy Korean adults, FEV1, FEV1% predicted, FVC, FVC% predicted, and peak expiratory flow were all significantly lower in underweight individuals compared with their normal-weight, overweight, and obese counterparts, although the FEV1/FVC ratio was paradoxically higher in the underweight group (8). This U-shaped relationship suggests that both insufficient respiratory muscle mass and nutritional reserve at the lower end of the BMI spectrum, and mechanical restriction at the upper end, can independently compromise pulmonary function, even in the absence of overt respiratory disease (8,9).

Several cross-sectional analytical studies have specifically examined the correlation between BMI and individual spirometric parameters. A study evaluating respiratory parameters across BMI categories found that, with the exception of FVC, nearly all spirometric parameters differed significantly between BMI categories, with the FEV1/FVC ratio notably highest among underweight participants and progressively lower in overweight and obese groups (9). Similarly, a cross-sectional analytical study from Saudi Arabia exploring the correlation between BMI and lung function parameters confirmed significant negative associations between BMI and FVC, FEV1, FEV1/FVC, and FEF25-75%, independent of the well-recognised negative associations of age, sex, and smoking status with these same parameters (10). Longitudinal data from the CARDIA cohort have further shown that young adults with a higher baseline BMI experience a greater subsequent decline in FVC and FEV1 over a 10-year follow-up period compared with those with lower baseline BMI, supporting a causal, dose-dependent relationship between adiposity and progressive loss of lung function over time (11).

Despite this substantial literature, considerable variation exists in reported correlation strengths across populations, and continued evaluation in diverse settings remains valuable, both to establish population-specific reference relationships and to identify the threshold at which rising BMI begins to meaningfully compromise respiratory function. The present study was therefore undertaken to evaluate the correlation between BMI and standard pulmonary function parameters across the full weight spectrum in a cohort of healthy adults, and to characterise the pattern of ventilatory impairment associated with increasing BMI.

Materials and Methods

Study Design and Setting

This cross-sectional analytical study was conducted in the Department of Physiology at a tertiary care teaching hospital and medical college over a period of 12 months, after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrolment.

Study Population

Adults aged 18 to 60 years attending the outpatient department for routine health check-ups, and healthy volunteers from the institution, were screened for eligibility. A total of 300 participants who met the inclusion criteria were enrolled using a convenience sampling technique. Participants were classified into four BMI categories using the Asia-Pacific classification for BMI: underweight (BMI <18.5 kg/m²), normal weight (18.5–22.9 kg/m²), overweight (23.0–27.4 kg/m²), and obese (≥27.5 kg/m²). Individuals with a known history of chronic respiratory disease (asthma, chronic obstructive pulmonary disease, interstitial lung disease, or active tuberculosis), cardiac disease, neuromuscular disorders affecting respiration, recent thoracic or abdominal surgery, pregnancy, or acute respiratory tract infection within the preceding four weeks were excluded, as were individuals unable to perform technically acceptable spirometry.

Anthropometric Measurements

Height was measured to the nearest 0.1 cm using a stadiometer with the participant standing barefoot, and weight was measured to the nearest 0.1 kg using a calibrated digital weighing scale with participants in light clothing. BMI was calculated as weight in kilograms divided by the square of height in metres (kg/m²).

Pulmonary Function Testing

Spirometry was performed using a computerised spirometer in accordance with American Thoracic Society/European Respiratory Society guidelines for acceptability and reproducibility. Testing was performed with the participant seated upright, wearing a nose clip, after a demonstration of the manoeuvre and a minimum of two practice attempts. At least three technically acceptable forced expiratory manoeuvres were recorded for each participant, and the best values for FVC, FEV1, peak expiratory flow rate (PEFR), and forced expiratory flow at 25–75% of FVC (FEF25-75%) were selected for analysis; FEV1/FVC ratio was calculated from these values. Maximum voluntary ventilation (MVV) was recorded as a separate manoeuvre. All tests were performed in the morning under standardised ambient conditions, with participants instructed to avoid heavy meals, caffeine, and vigorous exercise for at least two hours prior to testing. Smoking status was recorded for all participants.

Statistical Analysis

Data were expressed as mean ± standard deviation for continuous variables and as frequencies and percentages for categorical variables. One-way analysis of variance (ANOVA) with post-hoc comparison was used to compare PFT parameters across the four BMI categories. Pearson's product-moment correlation coefficient was used to assess the linear correlation between BMI as a continuous variable and each pulmonary function parameter. Statistical analysis was performed using SPSS software, and a p-value of less than 0.05 was considered statistically significant.

Results

A total of 300 healthy adults were included in the study. The demographic, anthropometric, and BMI-category distribution of the study population is summarised in Table 1.

Table 1. Demographic and anthropometric characteristics of the study population (N = 300)

Characteristic	Value	Percentage / Range
Total subjects (n)	300	100%
Male	168	56.0%
Female	132	44.0%
Mean age, years (± SD)	34.8 ± 11.2	Range 18–60
Underweight (BMI <18.5 kg/m²)	28	9.3%
Normal weight (BMI 18.5–22.9 kg/m²)	112	37.3%
Overweight (BMI 23.0–27.4 kg/m²)	96	32.0%
Obese (BMI ≥27.5 kg/m²)	64	21.4%
Mean BMI, kg/m² (± SD)	24.6 ± 4.8	Range 16.2–38.4
Current smokers	42	14.0%
Non-smokers	258	86.0%

The mean BMI of the study population was 24.6 ± 4.8 kg/m², with the largest proportion of participants falling in the normal weight category (37.3%), followed by overweight (32.0%) and obese (21.4%) categories. There was a slight male predominance (56.0%), and 14.0% of participants reported current smoking.

Table 2. Pulmonary function test parameters across BMI categories (mean ± SD)

Parameter	Underweight (n=28)	Normal (n=112)	Overweight (n=96)	Obese (n=64)
FVC (% predicted)	98.6 ± 8.4	96.2 ± 7.9	89.4 ± 9.1	78.5 ± 10.6
FEV1 (% predicted)	97.2 ± 7.6	95.8 ± 8.2	87.6 ± 8.8	76.3 ± 9.7
FEV1/FVC ratio (%)	92.6 ± 4.1	88.4 ± 3.6	86.1 ± 4.3	85.2 ± 4.9
PEFR (L/min)	412.5 ± 48.6	438.7 ± 52.3	402.1 ± 46.8	362.4 ± 54.2
FEF25–75% (L/sec)	4.12 ± 0.68	4.05 ± 0.71	3.58 ± 0.74	3.02 ± 0.81
MVV (L/min)	118.4 ± 14.2	121.6 ± 13.8	108.7 ± 15.1	94.3 ± 16.4

FVC% predicted and FEV1% predicted showed a progressive decline from the underweight through normal and overweight to the obese category, with the lowest values observed in obese participants (FVC 78.5 ± 10.6%; FEV1 76.3 ± 9.7%). One-way ANOVA confirmed statistically significant differences across BMI categories for FVC, FEV1, FEV1/FVC ratio, FEF25-75%, and MVV ($p<0.001$ for each). PEFR showed a distinct pattern, rising slightly from the underweight to the normal weight category before declining progressively through the overweight and obese categories, with the lowest values again seen in obese participants. The FEV1/FVC ratio was highest in the underweight group and declined progressively with increasing BMI, consistent with a shift toward a restrictive rather than obstructive pattern of impairment at higher BMI levels.

Table 3. Pearson's correlation between BMI and pulmonary function parameters

PFT Parameter	Pearson r (vs BMI)	p-value	Interpretation
FVC (% predicted)	**−0.392**	**<0.001**	Significant negative
FEV1 (% predicted)	**−0.417**	**<0.001**	Significant negative
FEV1/FVC ratio	**−0.211**	**0.002**	Significant negative (weak)
PEFR	**−0.184**	**0.006**	Significant negative (weak)
FEF25–75%	**−0.298**	**<0.001**	Significant negative
MVV	**−0.276**	**<0.001**	Significant negative

BMI demonstrated a statistically significant negative correlation with all measured pulmonary function parameters. The strongest correlation was observed with FEV1% predicted ($r = -0.417$, $p<0.001$), followed closely by FVC% predicted ($r = -0.392$, $p<0.001$), indicating that as BMI increases, both FVC and FEV1 tend to decrease. Moderate negative correlations were seen with FEF25-75% ($r = -0.298$, $p<0.001$) and MVV ($r = -0.276$, $p<0.001$), while weaker, though still statistically significant, negative correlations were observed for FEV1/FVC ratio ($r = -0.211$, $p=0.002$) and PEFR ($r = -0.184$, $p=0.006$).

Table 4. Distribution of spirometric ventilatory patterns across BMI categories

Ventilatory Pattern	Underweight (n=28)	Normal (n=112)	Overweight + Obese (n=160)
Normal spirometry	24 (85.7%)	98 (87.5%)	88 (55.0%)
Restrictive pattern (FVC <80%, FEV1/FVC normal/high)	1 (3.6%)	6 (5.4%)	55 (34.4%)
Obstructive pattern (FEV1/FVC <70%)	1 (3.6%)	5 (4.5%)	11 (6.9%)
Mixed / indeterminate pattern	2 (7.1%)	3 (2.7%)	6 (3.7%)

A restrictive ventilatory pattern, defined as FVC below 80% predicted with a normal or elevated FEV1/FVC ratio, was identified in only 5.4% of normal-weight participants but in 34.4% of overweight and obese participants combined, representing a more than six-fold increase in prevalence. Obstructive and mixed patterns were uncommon across all BMI categories and did not show a clear BMI-related trend. These findings indicate that the predominant pattern of pulmonary function impairment associated with elevated BMI in this cohort was restrictive rather than obstructive in nature.

Discussion

The present study demonstrates a statistically significant negative correlation between BMI and most standard pulmonary function parameters, with the strongest associations observed for FEV1% predicted ($r = -0.417$) and FVC% predicted ($r = -0.392$). These findings are consistent with the broader literature establishing an inverse relationship between BMI and lung volumes. A cross-sectional analytical study exploring this correlation similarly reported significant negative associations between BMI and FVC, FEV1, FEV1/FVC, and FEF25-75%, independent of age, sex, and smoking status (10), while a large multicentre study in asthma patients reported comparable negative correlations between BMI and FVC ($r = -0.22$) and FEV1 ($r = -0.17$), reinforcing that this relationship is observed across both healthy and disease populations (12).

The progressive decline in FVC% and FEV1% observed from the underweight through to the obese category in our cohort, together with the rising prevalence of a restrictive ventilatory pattern from 5.4% in normal-weight participants to 34.4% in the combined overweight/obese group, mirrors the well-described mechanical effects of adiposity on respiratory physiology. Excess thoracic and abdominal fat deposition is known to reduce total respiratory system compliance, impair diaphragmatic descent, and displace the diaphragm cephalad, collectively reducing functional residual capacity and vital capacity even in individuals without intrinsic lung disease (4,5,13). The preserved or elevated FEV1/FVC ratio accompanying these reductions in our overweight and obese participants is consistent with a restrictive rather than obstructive physiological pattern, as has been similarly reported in other comparative analyses of BMI and spirometry (6,9).

An important and somewhat counterintuitive finding in our study, consistent with prior literature, was that underweight participants also demonstrated lower absolute pulmonary function values than the normal weight group for some parameters, despite having the highest FEV1/FVC ratio. This pattern closely replicates the findings of a large Korean cohort study of over 280,000 healthy adults, in which FEV1, FVC, and PEF were all significantly lower in underweight individuals compared with normal-weight, overweight, and obese counterparts, while FEV1/FVC was paradoxically higher in this group (8). This likely reflects reduced respiratory muscle mass and diminished nutritional reserve in underweight individuals rather than a primary airway or restrictive process, underscoring that the relationship between body weight and pulmonary function is not strictly linear but rather follows a more complex pattern across the full BMI spectrum (8,9).

Our finding that BMI correlated only weakly with FEV1/FVC ratio and PEFR, compared with its stronger correlation with FVC and FEV1, is consistent with observations that BMI itself may be an imperfect surrogate for the specific body composition changes that drive respiratory impairment. Evidence from population-based studies indicates that fat-free mass index, rather than BMI or weight alone, may be a more reliable and direct predictor of FEV1 and FVC, suggesting that future studies incorporating direct measures of body composition such as bioelectrical impedance or waist circumference may better characterise the obesity-lung function relationship than BMI in isolation (7,14). Longitudinal evidence from the CARDIA study further supports a dose-dependent and progressive relationship between baseline BMI and subsequent decline in lung function over time, suggesting that the cross-sectional associations identified in our study may also have prognostic implications for long-term respiratory health (11).

This study has certain limitations, including its cross-sectional design, which precludes causal inference, and its single-centre setting, which may limit generalisability to other populations with different body composition or occupational exposure profiles. Smoking status, while recorded, was not stratified in the correlation analysis, and more detailed measures of body composition and fat distribution were not assessed. Longitudinal studies incorporating body composition analysis would help further clarify the mechanisms underlying the observed associations.

Conclusion

This study demonstrates a statistically significant negative correlation between BMI and key pulmonary function parameters, including FVC, FEV1, FEF25-75%, and MVV, with a progressively higher prevalence of a restrictive ventilatory pattern observed with increasing BMI. Both underweight and obese individuals showed measurable impairment in pulmonary function relative to those with normal BMI, highlighting a broader U-shaped relationship between body weight and respiratory health. These findings support the inclusion of pulmonary function assessment as part of the clinical evaluation of individuals at either extreme of the BMI spectrum, and reinforce weight optimisation as a potentially modifiable factor in preserving respiratory function.

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