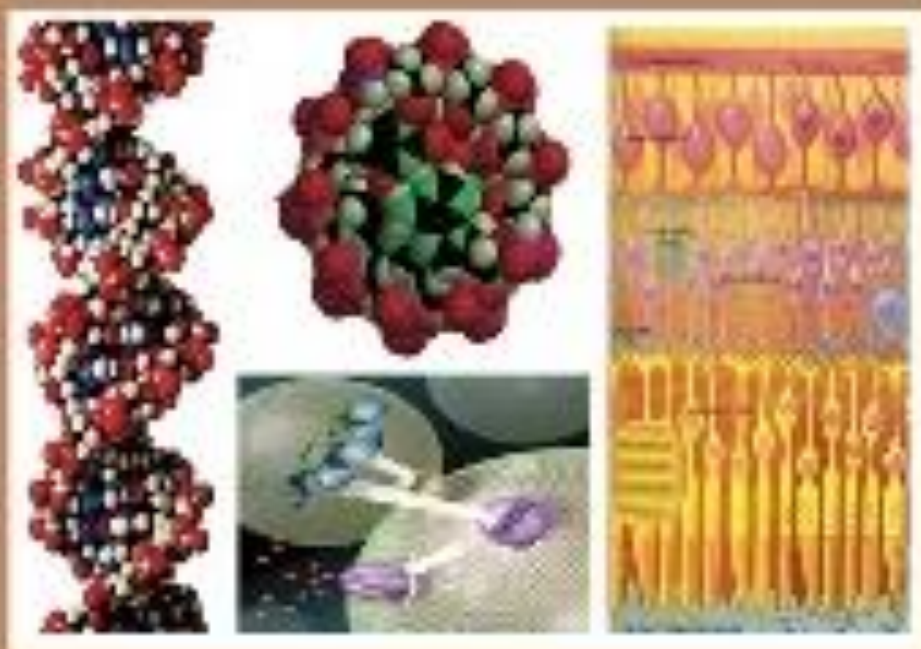




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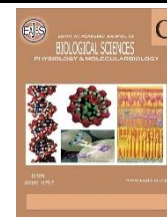
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Does BMI Predict Variations in Pulmonary Function? Findings from A Cross-Sectional Study”

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ABSTRACT

Background: Obesity, known to influence pulmonary function through mechanical and physiological mechanisms. However, the relationship between body mass index (BMI) and specific spirometric parameters remains inconsistent across populations. **Objectives:** Study aimed to evaluate the association between BMI and lung function by assessing correlations with spirometric indices and comparing pulmonary function across different BMI categories. **Methods:** A cross-sectional analysis was conducted on 99 adult participants who underwent spirometry. Lung function parameters – including forced vital capacity (FVC), Forced expiratory volume in 1 second (FEV1), FEV1/FVC ratio, slow vital capacity (SVC), maximal voluntary ventilation (MVV), and mid-expiratory flow (FEV25-75%) - were measured. Pearson's correlation was used to assess associations between BMI and pulmonary indices; one way ANOVA was employed to compare variables across BMI groups. **Results:** BMI was positively and significantly correlated with FVC ($r = 0.26, p < 0.05$), FVC% predicted ($r = 0.21, p < 0.05$), FEV1 ($r = 0.35, p < 0.01$), and FEV1% predicted ($r = 0.29, p < 0.05$). No significant correlations were observed between BMI and MVV, SVC, SVC/FVC, or FEF 25-75%. With BMI categories, no statistical differences were observed in lung function indices ($p > 0.05$), although overweight/obese individuals showed slightly higher mean FVC and FEV1 values. **Conclusions:** BMI demonstrated a modest positive correlation with selected lung function parameters (FVC, FEV1), suggesting that moderate increase in BMI do not adversely affect spirometric measures in younger adults. These findings highlight the need for further research considering age, fat distribution, and body composition when evaluating the impact of adiposity on respiratory function.

INTRODUCTION

Obesity is a global health concern (GBD 2021; Risk Factor Collaborators, 2021) that has shown to affect multiple physiological systems, including respiratory function. The mechanical effects (Wang *et al.*, 2023; Collins *et al.*, 1995) of increased adiposity such as reduced chest wall compliance, altered diaphragm position and changes in lung and airway dynamics—can influence lung volumes and airflow. While several studies have explored these effects, the relationship between body mass index (BMI) and spirometric indices remains inconsistently reported across populations and BMI categories.

Some previous research have suggested that mild to moderate increase in BMI (Jones and Nzekwu 2006; Kim *et al.*, 2024), particularly in overweight individuals, may be associated with slightly higher absolute lung volumes, possibly due to increased thoracic muscle mass and larger body size. Conversely, higher degrees of obesity (Abdullah *et al.*, 2024; Comes *et al.*, 2022; Dixon and Peters 2018; Mehari *et al.*, 2015; Steier *et al.*, 2014; Santamiria *et al.*, 2007; Sharma SK *et al.*, 2008) have been linked to a restrictive ventilatory defect (Jones and Nzekwu 2006; Dixon and Peters 2018; Steier *et al.*, 2014), characterized by reduced forced vital capacity (FVC) and forced expiratory volume in the first second (FEV1), largely as a consequence of mechanical restriction and altered respiratory mechanics. However, findings across studies vary, and the extent to which BMI correlates with specific spirometric parameters such as FVC, FEV1, mid-expiratory flows (FEF25–75%), and maximal voluntary ventilation (MVV) remains an area of ongoing investigation.

Given these mixed observations, we conducted the present study to evaluate the association between BMI and key spirometric lung function parameters in a sample of adults. Specifically, we aimed to: (i) assess the correlation between BMI and lung function indices including FVC, FEV1, FEF25–75%, MVV, and slow vital capacity (SVC); (ii) compare lung function profiles across BMI categories (underweight, normal weight, overweight and obese).

MATERIALS AND METHODS

The study was conducted in the Department of Physiology, SCB Medical College and Hospital (SCBMCH), Cuttack. A total of 200 subjects were recruited from the local community using a convenience sampling method. Of the 200 subjects, 20 dropped out due to unwillingness to participate, 27 were smokers, 30 were unable to perform the pulmonary function test (PFT), and 33 had other comorbid conditions. Thus, a total of 101 subjects were excluded from the

study. 99 healthy male subjects were included in the final analysis. The study was carried out between January 2024 and July 2024, based on pre-defined inclusion criteria.

This study was conducted in accordance with the ethical guidelines of the institute. All participants were informed about the study design and written informed consent was collected. The objective of the study was to investigate the correlation between BMI and various parameters of pulmonary function.

The study included 99 males aged between 18 and 49 years. A thorough medical history was obtained to rule out any cardiorespiratory disorders such as bronchial asthma, chronic obstructive pulmonary disease (COPD), upper respiratory tract infections, and tuberculosis, past cardiovascular diseases, neuromuscular disorders, mental illness, and renal dysfunction, which could interfere with study participation.

Basic demographic and clinical information, including age, anthropometric measurements (weight and height), smoking status, respiratory symptoms, biomass exposure, and family history of chronic bronchitis, emphysema, or COPD, were collected using a structured questionnaire specifically designed for the study.

All participants underwent pulmonary function testing (without bronchodilator) using the Helios 701 spirometer. Participants were instructed to refrain from consuming tea, coffee, or engaging in strenuous physical activity for at least four hours before the test. They were seated comfortably for 10 minutes prior to testing and were given detailed instructions about the procedure. The following PFT parameters were measured: Forced Expiratory Volume (FEV), FEV1, Maximum Voluntary Ventilation (MVV), Slow Vital Capacity (SVC), FEV1/FVC ratio, Forced Expiratory Flow at 25–75% of pulmonary volume (FEF25–75), FVC%, FEV1%, SVC/FVC, SVC%, and the difference between FVC and SVC (Diff FVC–

SVC). Data were collected, cleaned, and statistically analyzed using STATA software.

RESULTS

A total of 99 male participants aged 18–49 years were included in the final analysis. The mean ($\pm$ SD) age of participants was 32.8 ± 7.4 years, and the mean BMI was 24.6 ± 3.2 kg/m² (Table 1). Based on BMI classification, 12 (12.1%) were underweight,

48 (48.5%) were of normal weight, and 39 (39.4%) were overweight or obese. The distribution of variables such as age, height, weight, and body mass index was found to be not normally distributed. So were variables SVC, FEV₁/FVC and FEF_{25-75%}. However, MVV and SVC percent were found to be normally distributed. Overall, most of the parameters were not normally distributed.

Table 1: Shows the baseline characteristics and normality check of the study participants.

Variable	Mean	SD	Median	IQR	P value for normality
Age	33.25	15.63	27	20-46	<0.001
Weight	60.24	13.58	59	50-67	<0.001
Height	1.61	0.10	1.6	1.54-1.67	0.006
BMI	24.6	3.2	22.98	20.29-25.43	<0.001
FVC	2.72	0.82	2.7	2.2-3.06	0.056
FVC%	78.85	13.93	80	67-88	0.131
FEV ₁	2.15	0.74	2.1	1.55-2.64	0.391
FEV ₁ %	72.01	16.94	76	60-86	0.015
FEV ₁ /FVC	90.69	13.21	94	84-99	<0.001
MVV	81.36	29.44	81	64-102	0.230
SVC	2.65	0.84	2.58	2.08-3.15	0.008
SVC%	78.55	14.21	78	68-88	0.701
SVC/FVC	0.99	0.16	1.00	0.95-1.07	<0.001
FEF _{25-75%}	4.68	11.98	2.46	1.25-4.04	<0.001
Diff _{FVC-SVC}	0.07	0.44	0.00	-0.12-0.17	<0.001

Pearson's correlation analysis revealed that BMI was positively and significantly correlated with FVC ($r = 0.26$, $p < 0.05$), FVC% predicted ($r = 0.21$, $p < 0.05$), FEV₁ ($r = 0.35$, $p < 0.01$), and FEV₁% predicted ($r = 0.29$, $p < 0.05$). No significant correlations were observed for SVC, MVV, SVC/FVC, or FEF_{25-75%}. These findings suggest that higher BMI values are associated with slightly greater lung volumes, though the effect sizes are modest.

Table 2: Correlation of Body mass index with spirometry findings (n=99)

Variable	Correlation coefficient	P value
FVC	0.2388 ¹	0.017*
FVC%	0.3510 ¹	<0.001**
FEV ₁	0.2112 ¹	0.035*
FEV ₁ %	0.2408 ²	0.016*
FEV ₁ /FVC	-0.0498 ²	0.624
MVV	0.1939 ¹	0.054
SVC	0.1486 ²	0.142
SVC%	0.1628 ¹	0.108
SVC/FVC	-0.1711 ²	0.090
FEF _{25-75%}	0.0925 ²	0.363
Diff _{FVC-SVC}	0.1685 ²	0.096

¹ Pearson's correlation coefficient. ² Spearman rank correlation coefficient.

* Significant at 0.05 levels. ** Significant at 0.01 levels.

Table 3 shows no statistically significant difference between the different groups of Body mass index for any of the spirometry lung values ($p>0.05$). There was

no statistically significant difference between SVC and FVC even for overweight/obese persons as compared to normal/underweight ($p>0.05$).

Table 3: Lung volumes in different categories of obesity.

BMI category	Parameter	FVC	FVC %	FEV ₁	FEV ₁ %	FEV ₁ /FVC	SVC	SVC %	SVC/FVC	MVV	FEF ₂₅₋₇₅ %
Underweight	Mean	2.23	66.9	1.794	62.9	94.6	2.23	69.8	1.01	72.13	7.93
	SD	0.50	14.81	0.45	14.79	15.72	0.53	9.36	0.17	14.44	19.72
Normal	Mean	2.71	78.49	2.12	70.90	89.20	2.63	79.63	0.99	78.39	4.18
	SD	0.74	13.74	0.71	17.90	14.43	0.74	14.23	0.16	26.34	9.18
Overweight	Mean	2.75	81.55	2.23	75.72	92.91	2.68	80.68	0.99	85.00	6.49
	SD	0.71	13.18	0.64	13.48	7.88	0.64	12.42	0.13	26.78	18.04
Obese	Mean	2.89	81.77	2.27	74.12	89.65	2.83	78.38	0.98	86.53	2.69
	SD	1.02	12.69	0.94	18.16	13.98	1.15	16.43	0.17	38.99	1.75
p-value		0.573	0.232	0.262	0.321	0.625	0.209	0.203	0.195	0.583	0.583

Figures 1 and 2 show that there is positive linear relationship of FVC and FEV₁ with body weight. As the body weight increases the FVC and FEV₁ are also shown to increase. Correlation was found to be poor

but was statistically significant at $p=0.05$ levels (Table 2). FVC% and FEV₁% were also found to have similar pattern of correlation (Table 2).

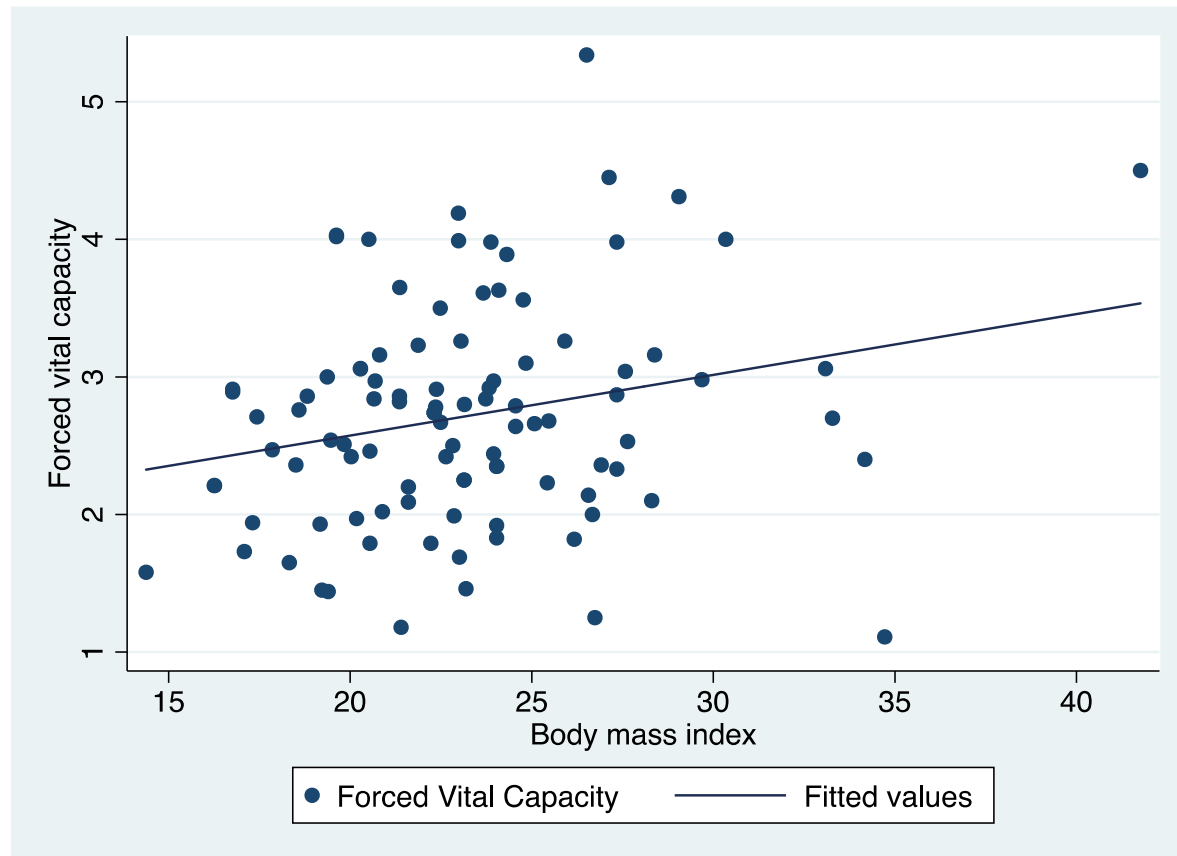


Fig 1: Forced vital capacity vs Body mass index among study participants (n=99)

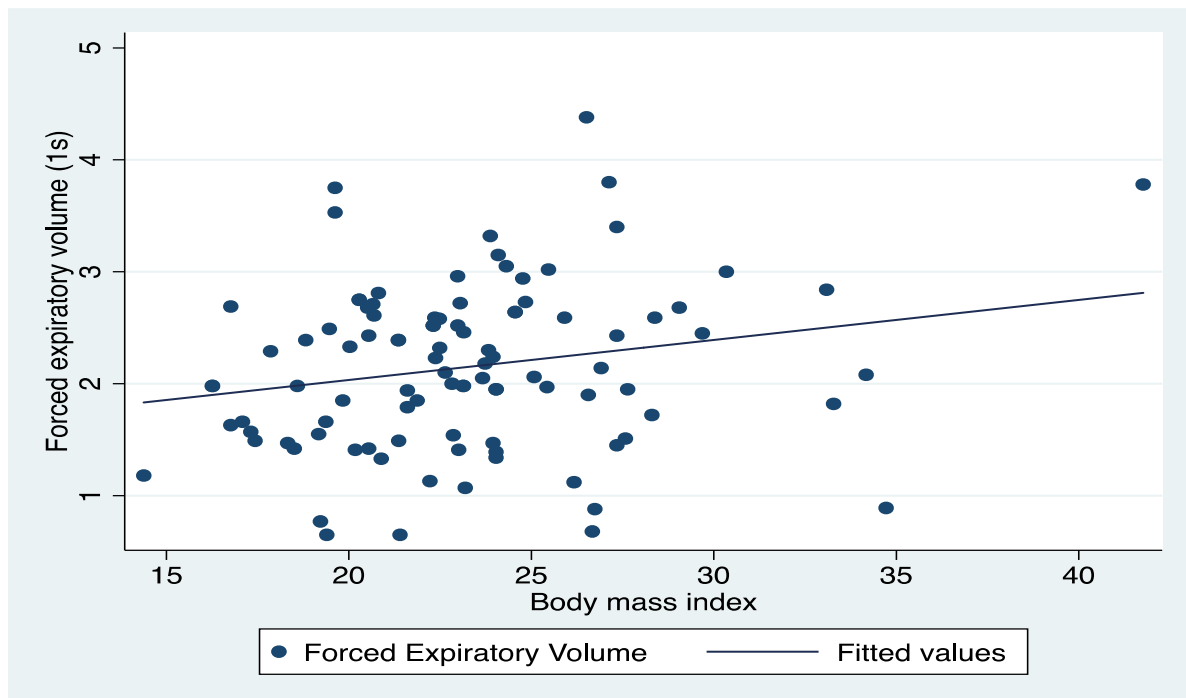


Fig 2: Forced Expiratory Volume (1s) vs Body mass index among study participants (n=99)

DISCUSSION

In the present study involving 99 participants, we investigated the relationship between body mass index (BMI) and various lung function parameters obtained from spirometry. Overall, our results indicate a modest but statistically significant positive correlation of BMI (Wang *et al.*, 2023; Jones and Nzekwu 2006; Kim *et al.*, 2024; Abdullah *et al.*, 2024) with FVC, FVC%, FEV1, and FEV1%, while no significant associations were observed for other lung function parameters such as MVV, SVC, SVC/FVC, and FEF25–75%.

The positive correlation of BMI (Wang *et al.*, 2023; Jones and Nzekwu 2006; Kim *et al.*, 2024; Abdullah *et al.*, 2024) with FVC and FEV1 aligns partially with previous studies reporting that moderate increases in BMI, particularly in overweight individuals, may be associated with higher absolute lung volumes compared to underweight individuals (Qvarfordt *et al.*, 2024). This could be due to greater chest wall and respiratory muscle mass contributing to increased ventilatory capacity. However, despite this correlation, the magnitude of association

observed in our study was small (correlation coefficients around 0.21–0.35), indicating that BMI alone explains only a limited portion of the variance in lung volumes.

When comparing lung function across BMI categories, we found no statistically significant differences in FVC, FVC%, FEV1, FEV1%, or other spirometry indices ($p > 0.05$). Interestingly, although overweight and obese participants had slightly higher mean values for FVC and FEV1 than underweight and normal-weight groups, these differences did not reach statistical significance. This finding contrasts with some prior studies which have reported restrictive ventilatory patterns or lower lung volumes in obesity, possibly due to mechanical limitation of the diaphragm and reduced chest wall compliance. The lack of significant differences in our study may be attributed to the relatively small number of obese participants and the overall young mean age of the study cohort (mean age ~33 years), which may have limited the manifestation of obesity-related restrictive changes.

Similarly, SVC and FVC were comparable across BMI groups, and the

difference between SVC and FVC (Diff FVC–SVC) was minimal and not significant even in overweight/obese individuals. This suggests an absence of significant dynamic airway collapse or flow limitation during forced expiration in this population, which is consistent with the absence of significant obstructive changes in FEV1/FVC ratios across BMI categories.

Our findings also showed that BMI had no significant correlation with mid-expiratory flows (FEF25–75%) or maximal voluntary ventilation (MVV), parameters often considered sensitive indicators of small airway function and ventilatory endurance, respectively. This suggests that BMI might have limited impact on these aspects of pulmonary physiology in relatively healthy adults.

Strength and limitations:

Strength of this study is the comprehensive assessment of both absolute and percent-predicted spirometric indices in relation to BMI across a reasonably sized sample. However, several limitations should be noted. The cross-sectional design prevents causal inference. The study population was predominantly young adults with few participants in the obese category, potentially limiting the power to detect significant differences. Furthermore, body composition was assessed solely using BMI, which does not distinguish between fat mass and lean mass; future studies incorporating measures like waist circumference or body fat percentage may provide better insights.

Conclusion:

In conclusion, BMI showed a small but statistically significant positive association with selected lung function indices (FVC, FEV1, FVC%, FEV1%), whereas no significant impact was observed on other parameters or across BMI categories. These findings suggest that in young to middle-aged adults, moderate increases in BMI may not adversely affect spirometric lung volumes, although further studies with larger and more diverse populations are warranted to explore the effects of higher degrees of obesity (Abdullah *et al.*, 2024;

Comes *et al.*, 2022; Dixon and Peters 2018; Mehari *et al.*, 2015; Steier *et al.*, 2014; Santamiria *et al.*, 2007; Sharma *et al.*, 2008) and age-related changes.

Declarations:

Ethical Approval and Consent to Participate: The study protocol was applied for ethical clearance from the institute, but was waived for retrospective nature of the study, as well as for the data were anonymous and collected without any intervention.

Competing interests: The authors do not have any relevant financial or non-financial interests to report.

Availability of Data and Materials: All data generated or analyzed during this study are included in this published article.

Authors' Contributions: Dr. Madhuri Panigrahi conceptualized and designed the study, analyzed the data, and prepared the manuscript. Dr. Birajman Lakra contributed to data collection, statistical analysis, and manuscript revision. Dr. Santosh Kumar Panda provided radiological guidance and assisted in interpretation.

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