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Original Research Article

Comparison of Pulmonary Function Test Parameters between Normal-Weight and Overweight Medical Students of Sri Krishna Medical College, Muzaffarpur

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Abstract

Background: Overweight and obesity are rising sharply among young adults and are increasingly linked to impaired respiratory mechanics. Whether a modestly elevated body mass index (BMI) measurably reduces lung function in apparently healthy young Indians remains insufficiently explored, particularly in this region.

Aim: To record and compare pulmonary function test (PFT) parameters — forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), FEV1/FVC ratio and peak expiratory flow rate (PEFR) — between normal-weight and overweight medical students, and to evaluate the effect of increased BMI on lung function.

Materials and Methods: In this cross-sectional comparative study, 120 healthy medical students aged 18–30 years were recruited by simple random sampling: 60 normal-weight (BMI 18.5–24.99 kg/m²) and 60 overweight (BMI 25.0–29.99 kg/m²). Anthropometry was recorded and spirometry was performed in the standing position with a calibrated SPIROLAB spirometer; the best of three acceptable manoeuvres was analysed. Inter-group comparisons used the independent two-tailed Student t-test (SPSS 15.0); $p < 0.05$ was considered significant.

Results: FVC (2.93±0.46 vs 2.71±0.39 L; $p = 0.006$), FEV1 (2.50±0.63 vs 2.31±0.24 L; $p = 0.033$) and PEFR (409.29±65.41 vs 337.04±85.09 L/min; $p < 0.001$) were all significantly lower in overweight students, whereas the FEV1/FVC ratio was significantly higher (84.88±14.10 vs 90.94±7.84%; $p = 0.004$). On age stratification, the FVC difference was significant above 20 years ($p = 0.003$) and the PEFR difference was significant in both age strata ($p = 0.022$ and $p < 0.001$).

Conclusion: Even a moderate increase in BMI is associated with significant reductions in FVC, FEV1 and PEFR, together with an elevated FEV1/FVC ratio indicative of an early restrictive ventilatory pattern. Weight management in young adults may help preserve pulmonary health and reduce future respiratory morbidity.

Keywords: Body Mass Index; Medical Students; Obesity; Overweight; Peak Expiratory Flow Rate; Pulmonary Function Test; Spirometry.

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Introduction

Excess body weight has become one of the most pressing public-health concerns of the present century. Overweight and obesity, once considered problems of affluent societies, are now recognised as a worldwide epidemic affecting adults, adolescents and children alike [1,2].

The World Health Organization has identified raised BMI as a leading contributor to global mortality, and recent Indian data show a steady climb in the prevalence of overweight among young adults, fuelled by sedentary lifestyles, calorie-dense diets and reduced physical activity. Medical students, despite their health awareness, are not spared: long study hours and erratic schedules predispose them to weight gain during their training years.

Body mass index, calculated as weight in kilograms divided by the square of height in metres, remains the most practical anthropometric index for classifying body habitus. According to the WHO classification, a BMI of 18.5–24.99 kg/m² denotes normal weight, 25.0–29.99 kg/m² overweight, and

30 kg/m² or more obesity. Beyond its metabolic and cardiovascular consequences, excess adiposity exerts well-documented effects on the respiratory system [3,4]. Fat deposited over the chest wall and within the abdominal cavity reduces chest-wall compliance, impedes diaphragmatic descent, increases the work of breathing and may impair respiratory-muscle performance [5]. The net result is a measurable deterioration of ventilatory function that can begin long before clinical symptoms appear. Spirometry is the simplest, most reproducible and most widely available tool for detecting such early changes [6]. Forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), the FEV1/FVC ratio and the peak expiratory flow rate (PEFR) together characterise the mechanical performance of the lungs, chest wall and respiratory muscles, and standardised testing protocols allow meaningful comparison between individuals and groups [7,8]. Several studies conducted elsewhere have reported an inverse relationship between BMI and spirometric indices; however, the magnitude and pattern of this relationship vary with age, sex, ethnicity and the degree of adiposity, and data from young adults in this part of the country remain scarce.

The present study was therefore undertaken among medical students of Sri Krishna Medical College, Muzaffarpur, to record PFT parameters in normal-weight and overweight students, to compare these parameters between the two groups, and to examine the effect of increased BMI on pulmonary function.

Materials and Methods

Study Design and Setting: This cross-sectional comparative study was conducted in the Department of Physiology, Sri Krishna Medical College and Hospital, Muzaffarpur, between May 2022 and July 2024. The Institutional Ethics Committee approved the study protocol. Written informed consent was obtained from each participant before the procedure, and the purpose of the procedure was explained.

Participants: Sixty normal-weight and sixty overweight healthy medical students aged 18–30 years were enrolled by simple random sampling. Participants of either group were required to be healthy and free from any acute illness at the time of testing. Students with chest-wall deformities; known respiratory disease such as chronic obstructive pulmonary disease, bronchiectasis or interstitial lung disease; upper or lower respiratory tract infection within the preceding three months; chronic exposure to substances known to alter pulmonary function; hypertension, diabetes mellitus or thyroid disorders; and smokers and alcohol users were excluded.

Data Collection and Procedure: A brief clinical history and examination preceded testing. Standing height was measured to the nearest centimetre with the subject barefoot against a wall-mounted tape, and weight was recorded to the nearest 0.1 kg on a standardised digital scale with the subject in light clothing, after voiding and fasting. BMI was derived as weight (kg)/height² (m²); students with BMI 18.5–24.99 kg/m² formed the normal-weight (control) group and those with BMI 25.0–29.99 kg/m² the overweight (study) group. Spirometry was performed between 10 and 11 a.m. after a light breakfast to minimise diurnal variation, in a quiet room with the subject standing. The manoeuvre was first demonstrated and practised. With a nose clip in place, each subject inhaled maximally, sealed the lips around a disposable mouthpiece and blasted the breath out as hard and as completely as possible. Three acceptable manoeuvres — free from hesitation, coughing in the first second, leakage, early termination or mouthpiece obstruction — were recorded 5–10 minutes apart on a calibrated SPIROLAB spirometer, and the best curve was retained for analysis [7]. FVC (L), FEV1 (L), FEV1/FVC (%) and PEFR (L/min) were the parameters studied.

Statistical Analysis: Data are expressed as mean ± standard deviation for continuous variables and as numbers and percentages for categorical data. Inter-group comparisons of metric parameters were made with the independent two-tailed Student t-test, and a p-value below 0.05 was taken as statistically significant. Analyses were performed using SPSS version 15.0, and tables and graphs were prepared in Microsoft Word and Excel.

Results

The two groups were age matched. The majority of participants belonged to the 18–20 year band in both the normal-weight (70.0%) and overweight (51.6%) groups (Table 1, Figure 1).

Table 1: Age-wise distribution of normal-weight and overweight subjects.

Age (years)	Normal weight, n (%)	Overweight, n (%)
18–20	42 (70.0)	31 (51.6)
21–22	15 (25.0)	19 (31.6)
23–30	3 (5.0)	10 (16.7)
Total	60 (100.0)	60 (100.0)

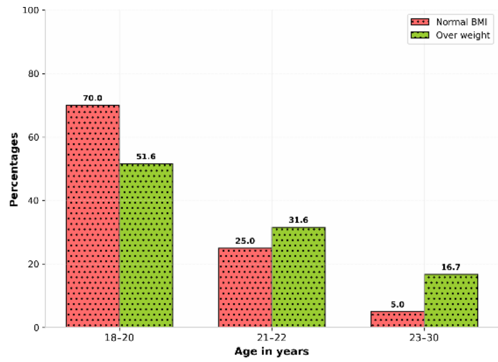

Figure 1: Age-wise distribution of normal-weight and overweight subjects.

Anthropometric characteristics across the three age bands are shown in Table 2 and Figure 2. Mean weight rose significantly with age (66.86±10.15, 75.88±7.31 and 78.69±9.31 kg; $p < 0.001$), as did mean BMI (23.09±3.35, 25.30±2.71 and 26.44±2.82 kg/m²; $p < 0.001$), whereas mean height did not differ significantly between the age groups ($p = 0.112$).

Table 2: Mean weight, height and BMI according to age of the subjects.

Age (years)	Weight (kg)	Height (cm)	BMI (kg/m²)
18–20	66.86±10.15	170.23±6.51	23.09±3.35
21–22	75.88±7.31	172.65±5.09	25.30±2.71
23–30	78.69±9.31	172.46±4.91	26.44±2.82
p value	<0.001**	0.112	<0.001**

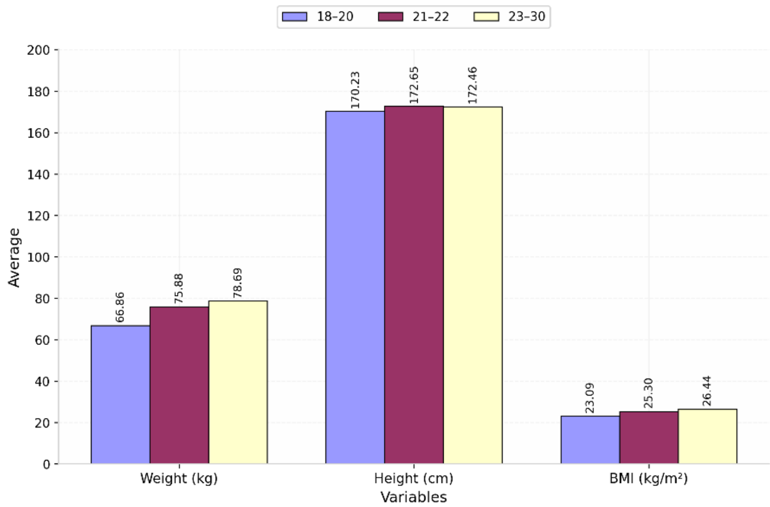

Figure 2: Correlation of mean weight, mean height and mean BMI according to age.

Comparison of the spirometric parameters between the two groups (Table 3, Figure 3) showed that overweight students had a significantly lower FVC than their normal-weight counterparts (2.71±0.39 vs 2.93±0.46 L; $p = 0.006$) and a significantly lower FEV1 (2.31±0.24 vs 2.50±0.63 L; $p = 0.033$). The FEV1/FVC ratio was significantly higher in the overweight group (90.94±7.84 vs 84.88±14.10%; $p = 0.004$). The most striking difference was observed for PEFR, which was markedly reduced in overweight students (337.04±85.09 vs 409.29±65.41 L/min; $p < 0.001$).

Table 3: Mean ± SD of pulmonary function test variables in normal-weight and overweight subjects.

PFT variable	Normal weight	Overweight	p value
FVC (L)	2.93±0.46	2.71±0.39	0.006**
FEV1 (L)	2.50±0.63	2.31±0.24	0.033*
FEV1/FVC (%)	84.88±14.10	90.94±7.84	0.004**
PEFR (L/min)	409.29±65.41	337.04±85.09	<0.001**

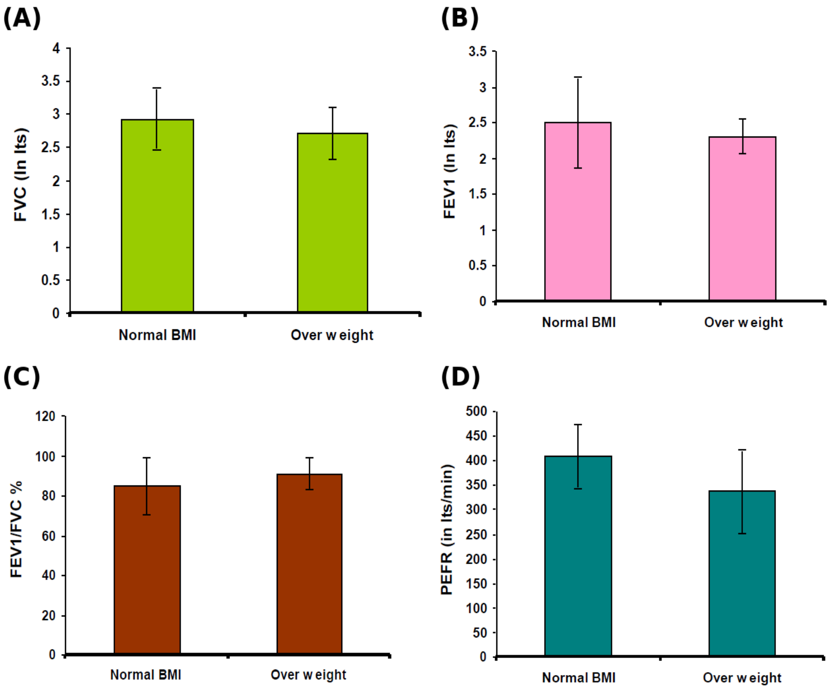

Figure 3: Mean ± SD of PFT variables in normal-weight and overweight subjects: (A) FVC, (B) FEV1, (C) FEV1/FVC ratio, (D) PEFR.

On stratifying the subjects at 20 years of age (Table 4, Figure 4A), FVC did not differ significantly between the groups below 20 years (2.95±0.53 vs 2.78±0.48 L; p = 0.151), but was significantly lower in overweight students above 20 years (2.65±0.28 vs 2.90±0.25 L; p = 0.003).

Table 4: Comparison of FVC between normal-weight and overweight subjects according to age.

Age (years)	Normal weight FVC (L)	Overweight FVC (L)	p value
<20 years	2.95±0.53	2.78±0.48	0.151
>20 years	2.90±0.25	2.65±0.28	0.003**

The FEV1/FVC ratio was higher in the overweight group in both age strata, although the difference did not reach statistical significance in either (<20 years: 90.11±8.68 vs 84.48±14.33%, p = 0.056; >20 years: 91.84±6.88 vs 85.82±13.93%, p = 0.054) (Table 5, Figure 4B).

Table 5: Comparison of FEV1/FVC (%) between normal-weight and overweight subjects according to age.

Age (years)	Normal weight FEV1/FVC (%)	Overweight FEV1/FVC (%)	p value
<20 years	84.48±14.33	90.11±8.68	0.056
>20 years	85.82±13.93	91.84±6.88	0.054

PEFR was significantly lower in overweight students in both age strata — 360.69±90.82 vs 405.57±72.35 L/min (p = 0.022) below 20 years and 311.78±71.71 vs 417.97±45.97 L/min (p < 0.001) above 20 years (Table 6, Figure 4C).

Table 6: Comparison of PEFR (L/min) between normal-weight and overweight subjects according to age.

Age (years)	Normal weight PEFR (L/min)	Overweight PEFR (L/min)	p value
<20 years	405.57±72.35	360.69±90.82	0.022*
>20 years	417.97±45.97	311.78±71.71	<0.001**

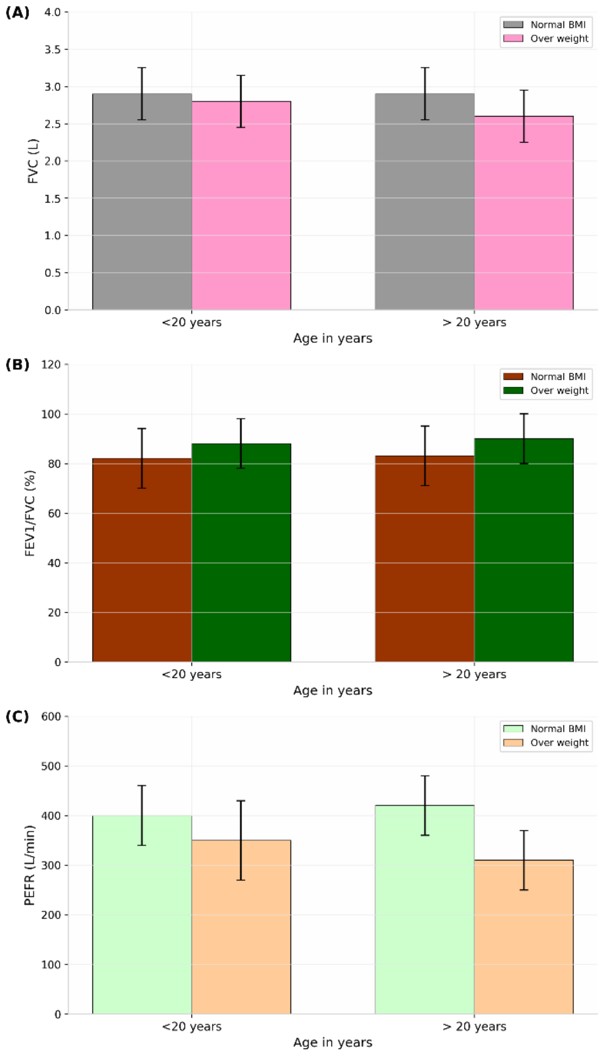

Figure 4: Age-stratified comparison of normal-weight and overweight subjects: (A) FVC (L), (B) FEV1/FVC (%), (C) PEFR (L/min). *p < 0.05, **p < 0.01 (independent two-tailed Student t-test).

Discussion

The two groups in the present study were comparable with respect to age and height, while weight and BMI differed significantly, confirming that the groups were appropriately constituted for examining the influence of excess body weight on pulmonary function. The principal finding was that every spirometric index examined was adversely associated with raised BMI: FVC, FEV1 and PEFR were all significantly lower in overweight medical students, and the FEV1/FVC ratio was significantly higher, a constellation consistent with a restrictive ventilatory tendency.

The significant reduction of FVC among overweight subjects agrees closely with the observations of Chen and colleagues, who studied Canadian adults aged 18–79 years and reported an inverse association between BMI and FVC when overweight and obese subjects were compared with normal-weight individuals [9]. Those authors attributed the decline largely to the mechanical loading of the thorax and abdomen, noting that raised intra-abdominal pressure impedes diaphragmatic excursion. Our findings also parallel those of Joshi et al., who examined 132 student volunteers aged 18–21 years and found a significant negative correlation between body fat percentage and FVC [10]. They proposed that central fat deposition restricts diaphragmatic descent and reduces chest-wall compliance, thereby increasing the work of breathing — mechanisms that plausibly explain the lower FVC in our overweight group as well. The age-stratified analysis adds a nuance: the FVC difference was not significant below 20 years of age but became highly significant above 20 years. A similar absence of FVC differences at younger ages was reported by Kamel in a cross-sectional survey of schoolchildren aged 6–12.5 years, in whom normal-weight and obese children had comparable baseline FVC values [11]. Conversely, Collins and colleagues, studying adults over 20 years, demonstrated a significant inverse relationship between several adiposity indices and FVC [12], mirroring our observation in the older stratum. It is conceivable that the cumulative duration and progressive central redistribution of adiposity with age are required before the mechanical disadvantage becomes spirometrically manifest. FEV1 was likewise significantly lower in the overweight group overall. Dayananda reported comparable findings in young men aged 18–25 years, in whom overweight and obese subjects showed significantly reduced FEV1 and PEFR alongside higher BMI and waist–hip ratio; he reasoned that intra-abdominal and truncal fat accumulation in males restricts rib-cage flexibility and thoracic compliance [13]. Alghadir and Aly similarly documented significantly diminished FEV1 in overweight Saudi boys aged 6–13 years relative to normal-weight peers [14].

When our data were stratified by age, however, the inter-group FEV1/FVC difference lost significance in both strata, an outcome that echoes several earlier reports. Panwar et al., classifying 100 medical students by BMI, found no notable FEV1 difference between obese and non-obese participants [15]; Boran and colleagues, in a cross-sectional study of 100 children aged 7–15 years, likewise detected no significant FEV1 difference between moderately obese and normal-weight children and concluded that anthropometric indices had little bearing on ventilatory function [16]; Saxena et al. [17] and Ajmani et al. [18] reached similar conclusions in healthy adults. The discrepancy between the pooled and stratified results in our study likely reflects the loss of statistical power when the sample is split, rather than a true absence of effect.

The significantly higher FEV1/FVC ratio in overweight students deserves emphasis. Because FVC fell proportionately more than FEV1, the ratio rose — the classic signature of a restrictive rather than an obstructive pattern. This indicates that early adiposity-related lung impairment in young adults is restrictive in character, driven by the mechanical constraints imposed on the chest wall and diaphragm rather than by airway narrowing.

PEFR showed the largest and most consistent deficit among overweight students, being significantly lower in both age strata, with the divergence widening after 20 years. Gundogdu and Eryilmaz, studying 1,439 Turkish children, found PEFR values significantly lower in the obese group and a negative correlation between BMI and peak flow, interpreting PEFR as an objective index of airflow resistance that is increased by obesity [19]. El-Baz and colleagues reported significantly reduced PEFR in obese Egyptian children, suggestive of a mild airway obstructive component superimposed on the mechanical restriction [20]. In healthy non-smoking Saudi adults, Al-Ghobain likewise found significantly lower PEFR in obese subjects and attributed it to obesity-related increases in airway and total respiratory resistance [21]. Adipose tissue is metabolically active, and beyond its direct mechanical effects it may modulate respiratory function through low-grade systemic inflammation; the concordant evidence from abdominal-obesity cohorts such as EPIC-Norfolk [22] and longitudinal data from the CARDIA study [23] further supports a causal link between increasing adiposity and declining ventilatory function, as do paediatric observations by Li and co-workers [24].

The strengths of this study include standardised spirometric technique with calibration, uniform timing of testing to control diurnal variation, strict exclusion criteria eliminating confounding by smoking and cardiopulmonary disease, and age-matched groups. Its limitations are the modest, single-centre sample drawn exclusively from medical students — which restricts generalisability — and the reliance on BMI alone without complementary adiposity measures such as waist circumference or body fat percentage. Larger multi-centre studies incorporating body-composition analysis and longitudinal follow-up would help clarify the trajectory of these early changes.

Conclusion

Spirometry is a simple, non-invasive and clinically valuable tool for detecting early impairment of lung mechanics. In this comparative study of healthy medical students, FVC, FEV1 and PEFR were all significantly reduced in overweight individuals relative to their normal-weight counterparts, while the FEV1/FVC ratio was significantly elevated, indicating an early restrictive ventilatory pattern. Every lung-function index examined thus showed a statistically significant inverse relationship with rising BMI.

These findings suggest that even moderate overweight in young adulthood can compromise pulmonary function and, if unchecked, may contribute to long-term respiratory morbidity. Routine spirometric screening of overweight young adults, together with timely counselling on weight management and physical activity, is therefore advisable.

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