International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

General Obesity, Not Central Adiposity, Predicts Lower Peak Expiratory Flow Rate in Healthy Young Adults

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Received: 20-02-2026
Accepted: 10-05-2026
Available online: 05-06-2026

ABSTRACT

Background: Obesity imposes mechanical and inflammatory burdens on the respiratory system, but the stage at which lung function begins to decline in healthy young individuals is not well defined. This study investigated the association of BMI and WHR with Peak Expiratory Flow Rate (PEFR) – a simple measure of large airway function – in healthy young adults.
Methods: This community-based cross-sectional study was conducted in a South Indian town over 4 months. We recruited 150 healthy young adults (18-30 years) and divided them equally into normal weight, overweight, and obese groups (n=50 each) using Asia-Pacific BMI criteria. PEFR (L/min) was measured using a Wright's peak flow meter, taking the best of three attempts. BMI and WHR were recorded. Groups were compared using one-way ANOVA with Tukey's post-hoc test, and correlations were assessed using Pearson's coefficient.
Results: A U-shaped relationship was observed. The overweight group had the highest mean PEFR (494.0±112.4 L/min), followed by the normal weight group (476.8±106.2 L/min), while the obese group had the lowest (423.8±106.9 L/min). The difference between groups was significant (F=5.68, p = 0.004). The obese group had significantly lower PEFR than both the normal weight (p = 0.04) and the overweight (p = 0.004) groups. No difference was found between the normal weight and overweight groups (p = 0.71). BMI showed a weak negative correlation with PEFR (r = -0.191, p = 0.02). WHR also showed a negative correlation, but it was not statistically significant (r = -0.052, p = 0.53).
Conclusion: Overweight does not impair PEFR, but overt obesity (BMI ≥25 kg/m²) is associated with a significant reduction in PEFR in healthy young adults. Overall fat mass (BMI) appears to be a more important determinant of large airway flow than central fat distribution at this age. PEFR is a simple, low-cost screening tool for detecting early pulmonary dysfunction in obese youth.

Keywords*: Peak Expiratory Flow Rate (PEFR), Obesity, Body Mass Index (BMI), Waist-to-Hip Ratio (WHR), Pulmonary function, Young adults.*

INTRODUCTION

The global rise in overweight and obesity is a major public health challenge [1]. BMI and WHR are valuable not only for predicting cardiovascular risk but also for assessing respiratory health [2]. Because Asian populations develop health problems at lower BMIs, we used the Asia-Pacific BMI criteria (normal 18.5-22.9, overweight 23-24.9, obese ≥25 kg/m²) [3-6]. These criteria have been shown to be more sensitive than the WHO criteria for predicting hypertension in Asian populations [7]. However, BMI alone has limitations, and measuring central adiposity provides additional information [8,9].

Obesity affects lung function through several mechanisms: restriction of chest wall movement, reduced lung compliance, and airway inflammation. While comprehensive pulmonary function tests such as FEV1 are the gold standard, they are not always practical for large-scale screening. Cardiorespiratory fitness, measured as VO_2 max, also declines with increasing BMI [11].

Peak Expiratory Flow Rate (PEFR) is a simple, portable test that measures the maximum flow rate achieved during a forced expiration from total lung capacity. It provides a reliable assessment of large airway function.

The relationship between obesity and PEFR in young healthy adults remains debated. Some studies report a positive correlation between BMI and PEFR within the normal weight range [10,12], while others have observed a clear decline in PEFR with obesity [18]. We conducted this study to clarify this relationship by evaluating PEFR across three distinct BMI categories and to assess the influence of both BMI and WHR. We hypothesized that severe obesity (BMI ≥25 kg/m²) would be associated with reduced PEFR. Previous studies have shown that obesity reduces lung volumes, particularly expiratory reserve volume, which directly affects expiratory flow rates [13]. Abdominal fat also pushes the diaphragm upward, making deep breathing difficult [16].

AIM AND OBJECTIVES

Aim: To determine the influence of general and central adiposity on PEFR in healthy young adults.

Objectives:

1. To compare PEFR values among normal-weight, overweight, and obese young adults.
2. To determine the correlation between BMI and PEFR.
3. To determine the correlation between WHR and PEFR.

MATERIALS AND METHODS

Study design and setting: This was a community-based cross-sectional descriptive study conducted in a South Indian town over 4 months.

Participants: A total of 150 healthy young adults aged 18-30 years were randomly selected from the community. Based on Asia-Pacific BMI criteria [6], they were equally divided into three groups (n=50 each): normal weight (18.5-22.9 kg/m²), overweight (23-24.9 kg/m²), and obese (≥25 kg/m²). All groups were matched for age and sex (25 males and 25 females per group). Only healthy individuals without any known acute or chronic illness were included.

Exclusion criteria: Individuals with a history of smoking, tobacco chewing, alcohol use, or any diagnosed illness – including hypertension, diabetes mellitus, cardiac, pulmonary, liver, thyroid, or neoplastic disorders – were excluded. Those with prior myocardial infarction, stroke, peripheral vascular disease, or those taking medications that could alter cardiac or pulmonary function were also excluded.

Ethical approval and informed consent: The Institutional Ethical Committee approved the study protocol. Written informed consent was obtained from all participants after a full explanation of the study's nature, purpose, and confidentiality measures.

Methodology: Height (cm) and weight (kg) were measured using a stadiometer and digital weighing scale, respectively. BMI was calculated as weight/height² (kg/m²). Waist and hip circumferences (cm) were measured with a non-flexible tape, and WHR was calculated. For PEFR measurement, we used a Wright's peak flow meter. Each participant was instructed to take a deep breath, seal their lips tightly around the mouthpiece, and blow out as hard and fast as possible. The maneuver was demonstrated, and participants were allowed to practice before the actual recording. Three attempts were made with 2-minute intervals, and the highest value (L/min) was recorded. Mouthpieces were changed for each participant.

Statistical analysis: Data were analyzed using SPSS version 23. Continuous variables are presented as mean ± standard deviation (SD). One-way ANOVA was used to compare PEFR across the three groups, followed by Tukey's post-hoc test for pairwise comparisons. Pearson's correlation coefficient (r) was calculated to assess linear relationships between obesity markers (BMI, WHR) and PEFR. A p-value <0.05 was considered statistically significant.

RESULTS

Participant characteristics: Table 1 shows the baseline characteristics of the 150 participants. Age and sex were well matched across groups. BMI and WHR progressively increased as expected.

Table 1: Baseline Characteristics of Study Participants (N=150)

Variable	Normal-Weight (n=50)	Overweight (n=50)	Obese (n=50)
Age (years)	23.34 ± 4.07	24.12 ± 3.74	24.06 ± 3.86
Sex (Male, n, %)	25 (50%)	25 (50%)	25 (50%)
Body Mass Index (BMI, kg/m²)*	20.77 ± 1.2	24.01 ± 0.65	29.02 ± 2.49
Waist-Hip Ratio (WHR)*	0.86 ± 0.07	0.93 ± 0.09	1.11 ± 0.21

Data are mean ± SD unless otherwise specified. *$p < 0.001$ for inter-group differences by study design.

PEFR across BMI groups: The overweight group had the highest mean PEFR (494.0±112.4 L/min), followed by the normal weight group (476.8±106.2 L/min), while the obese group had the lowest (423.8±106.9 L/min). The difference between groups was significant (F=5.68, $p = 0.004$) (Table 2).

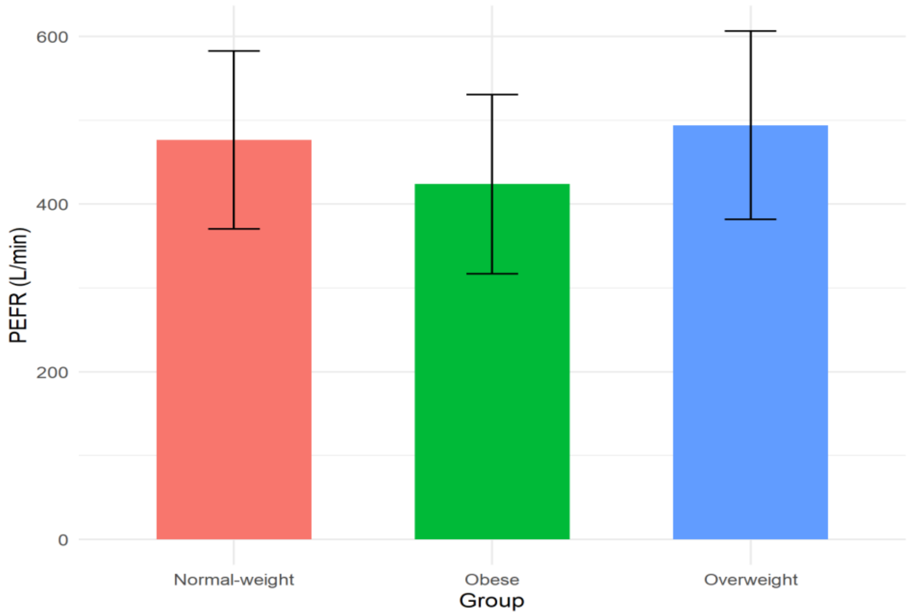

*Figure 1- Mean PEFR (± SD) in normal-weight, overweight, and obese young adults. *p = 0.04, **p = 0.004 vs. obese group (Tukey post-hoc).*

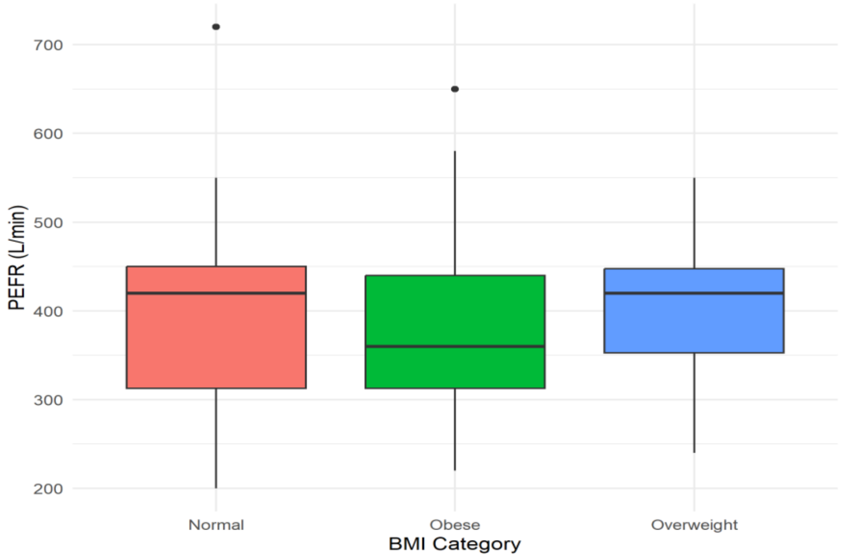

Figure 2- Box plot showing distribution of PEFR (median, interquartile range, outliers) across BMI categories. The obese group shows significantly lower values.

Table 2: Comparison of PEFR across Groups

Variable	Normal-Weight (n=50)	Overweight (n=50)	Obese (n=50)	F-value	p-value*
PEFR (L/min)	**476.8 ± 106.16**	**494.0 ± 112.39**	**423.8 ± 106.88**	**5.68**	**0.004**

Data are mean ± SD. One-way ANOVA.

Post-hoc comparisons: Table 3 shows that the obese group had significantly lower PEFR than both the normal weight (p = 0.04) and the overweight (p = 0.004) groups. No difference was found between the normal-weight and overweight groups (p = 0.71).

Table 3: Post-Hoc Analysis (Tukey) for PEFR

Comparison (PEFR)	Mean Difference (L/min)	95% CI for Difference	p-value*
Overweight vs. Normal-weight	**17.2**	**-33.8 to 68.2**	**0.71**
Obese vs. Normal-weight	**-53.0**	**-104.0 to -2.0**	**0.04**
Obese vs. Overweight	**-70.2**	**-121.2 to -19.2**	**0.004**

Tukey's post-hoc test. Statistically significant comparisons are bolded.

Correlations: Table 4 shows a weak negative correlation between BMI and PEFR (r = -0.191, p = 0.02). Table 5 shows a negative correlation between WHR and PEFR that was not statistically significant (r = -0.052, p = 0.53).

Table 4: Correlation of BMI with PEFR (N=150)

Variable 1	Variable 2	Pearson's r	p-value*
Body Mass Index (BMI)	**Peak Expiratory Flow Rate (PEFR)**	**-0.191**	**0.02**

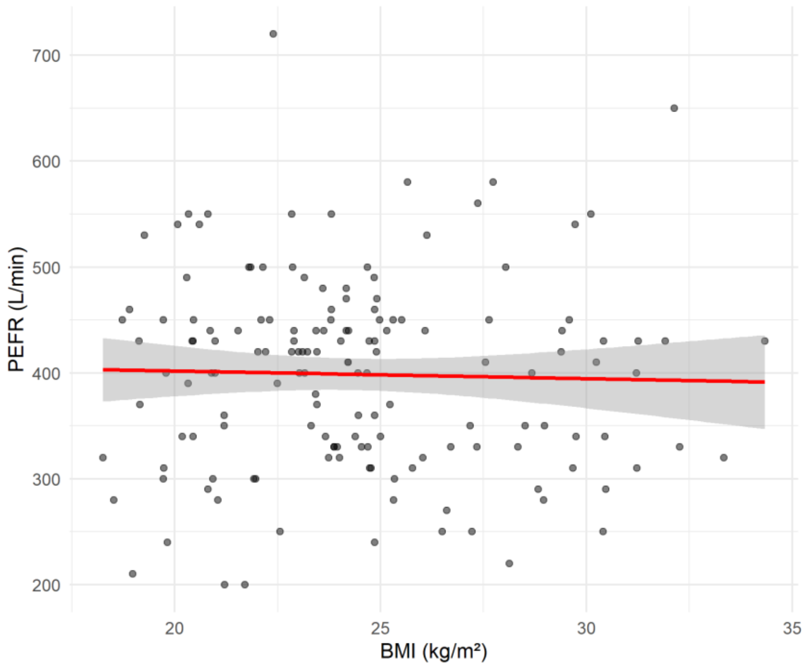

Figure 3- Weak but significant negative correlation between BMI and PEFR (r = −0.191, p = 0.02). Regression line with 95% CI.

Table 5: Correlation of WHR with PEFR (N=150)

Variable 1	Variable 2	Pearson's r	p-value*
Waist-to-Hip Ratio (WHR)	**Peak Expiratory Flow Rate (PEFR)**	**-0.052**	**0.53**

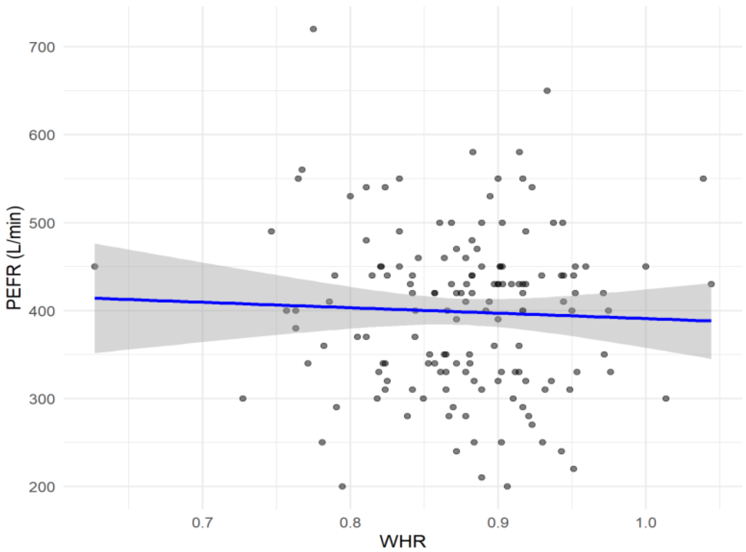

Figure 4- Non-significant negative correlation between WHR and PEFR (r = −0.052, p = 0.53). Regression line shown for completeness.

DISCUSSION

We observed a non-linear, inverted-U relationship between adiposity and PEFR. Overweight individuals had slightly higher PEFR than normal weight individuals, although this difference was not significant. However, obese individuals had significantly lower PEFR than both other groups. This pattern suggests a threshold effect: mild weight gain may initially increase PEFR, possibly due to increased respiratory muscle strength, but once the BMI exceeds 25 kg/m², the mechanical disadvantages become dominant [16].

This inverted-U pattern has been reported in other studies of young adults. A modest increase in body mass may enhance respiratory muscle strength [8,9]. However, as obesity becomes more severe, the restrictive effects of chest wall and abdominal fat deposition reduce lung volumes, particularly expiratory reserve volume, which directly impacts PEFR [14]. Our findings are consistent with studies showing a clear decline in dynamic lung function with obesity [17]. It is also worth noting that obesity increases the risk of sudden cardiac death, highlighting the systemic nature of adiposity-related harm [21].

The weak negative correlation between BMI and PEFR, though modest, is clinically relevant as it confirms the detrimental effect of overall fat mass on expiratory flow rates. The lack of a significant correlation with WHR is interesting; it contrasts with some reports [19] but agrees with others [18,15]. In this young cohort, total fat mass (captured by BMI) may be a more potent mechanical restrictor of diaphragmatic excursion than the specific pattern of central fat distribution. The inflammatory consequences of central adiposity may take longer to become apparent [20].

Limitations and future directions: The cross-sectional design limits causal inference. PEFR is an effort-dependent maneuver, and despite training, some variability is expected. Future studies should include a full panel of pulmonary function tests (FEV1, FVC, ERV) and more precise measures of body composition (e.g., DEXA) to confirm these findings.

CONCLUSION

In healthy young adults, being overweight does not impair PEFR, but the transition to obesity (BMI ≥25 kg/m² in this Asian cohort) is associated with a significant decline in PEFR. Overall fat mass (BMI) appears to be a more important determinant of early mechanical pulmonary impairment than central fat distribution at this age. PEFR is a simple, cost-effective, non-invasive test that can be used to screen obese young adults for early pulmonary dysfunction and to motivate weight loss.

DECLARATION

Conflict of Interest: The authors declare no conflict of interest.

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