ORIGINAL ARTICLE

NUREXUS

Journal of MedVerse Research & Practice

ISSN: 3107-4278

Correlation Between Body Mass Index and Peak Expiratory Flow Rate Among School-Going Children Aged 8 to 15 Years

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Submission Date: 20.12.2025	Accepted Date:17.01.2026	Published Date: 31.01.2026
DOI: 10.65188/nurexus.1061		

Abstract

Background: Nutritional status during childhood plays a crucial role in physical growth and respiratory development. Body Mass Index is commonly used to assess nutritional status, while Peak Expiratory Flow Rate serves as a simple indicator of pulmonary function in children.

Objectives: To evaluate the correlation between Body Mass Index and Peak Expiratory Flow Rate among school-going children aged 8–15 years.

Materials and Methods: A cross-sectional study was conducted among 100 school-going children aged 8–15 years. Anthropometric measurements were recorded, and Body Mass Index was calculated. Peak Expiratory Flow Rate was measured using a Mini-Wright's peak flow meter. Data were analyzed using descriptive and inferential statistics, including correlation analysis and analysis of variance. A p-value of less than 0.05 was considered statistically significant.

Results: Mean Peak Expiratory Flow Rate was 312.5 ± 68.4 L/min. PEFR showed a strong positive correlation with age ($r = 0.61$) and height ($r = 0.68$). A moderate negative correlation was observed between BMI and PEFR ($r = –0.42$, $p < 0.001$). Children with normal BMI demonstrated significantly higher PEFR compared to underweight and obese children. Exposure to indoor smoking and mosquito mat fumes was associated with significantly reduced PEFR.

Conclusion: Body Mass Index is an important determinant of Peak Expiratory Flow Rate in school-going children. Both undernutrition and excess adiposity adversely affect pulmonary function. Early identification and correction of modifiable risk factors may help preserve respiratory health during childhood.

Keywords: Body Mass Index; Peak Expiratory Flow Rate; School-going children; Lung function; Nutritional status

Introduction

Growth and development during childhood and adolescence are critical determinants of health across the life course. Nutritional status during these formative years influences physical growth, metabolic regulation, and organ system development, including the respiratory system. Body Mass Index (BMI) is a widely used anthropometric indicator for assessing nutritional status in children because of its simplicity and strong correlation with body fat composition [1]. Both undernutrition and overnutrition during childhood have important health implications. Undernutrition may impair somatic growth and muscle development, while excess adiposity is associated with metabolic disturbances and altered respiratory mechanics [2]. Increasing evidence suggests that nutritional status influences pulmonary function, particularly during periods of rapid growth and physiological maturation.

Peak Expiratory Flow Rate (PEFR) is a simple and widely used measure of lung function that reflects airway caliber and expiratory muscle strength. It represents the maximum flow achieved during forceful expiration following full inspiration and is commonly used in clinical and epidemiological settings due to its ease of use and cost-effectiveness, especially among children [3,4]. Several factors influence PEFR in children, including age, sex, height, and body composition. Height is considered the strongest determinant, as lung volumes increase proportionally with linear growth [5]. However, BMI also affects respiratory function. Excess body fat may restrict chest wall expansion, reduce lung compliance, and increase airway resistance, leading to reduced expiratory flow rates, while undernutrition may compromise respiratory muscle strength and lung development [6].

The rising prevalence of childhood overweight and obesity has emerged as a significant public health concern worldwide [7]. Obesity-related changes in lung volumes and increased work of breathing may adversely affect pulmonary function, even in the absence of overt respiratory disease. At the same time, underweight children remain prevalent in many regions, particularly in low- and middle-income countries, where chronic undernutrition may result in reduced lung volumes and diminished expiratory flow rates [8]. Children aged 8 to 15 years represent a critical period of rapid physical growth and respiratory system maturation. Evaluating the relationship between BMI and PEFR during this phase can provide valuable insights into the influence of nutritional status on respiratory function. Early identification of altered PEFR values in relation to BMI may facilitate timely preventive interventions and support school-based health programs.The present study aims to assess the correlation between Body Mass Index and Peak Expiratory Flow Rate among school-going children aged 8 to 15 years.

Materials and Methods

Study Design

This cross-sectional study was conducted to evaluate the correlation between Body Mass Index (BMI) and Peak Expiratory Flow Rate (PEFR) among school-going children aged 8 to 15 years.

Study Setting and Duration

The study was conducted over a period of 18 months in the Department of Pediatrics, Tbilisi State Medical University, Tbilisi, Georgia.

Study Population

The study included 100 school-going children aged between 8 and 15 years who fulfilled the eligibility criteria and were enrolled during the study period.

Sample Size

A total of 100 children aged 8 to 15 years were included in the study. The sample size was determined based on the number of eligible participants available during the study period.

Inclusion Criteria

Children aged 8 to 15 years who were willing to participate in the study, able to understand the local language or English, and available during the data collection period were included.

Exclusion Criteria

Children with a history of febrile illness or upper or lower respiratory tract infection during the preceding one week, known chronic respiratory diseases such as bronchial asthma, systemic illnesses including cardiac or renal disorders, thoracic or spinal deformities, neuromuscular disorders, or any condition likely to influence pulmonary function were excluded from the study.

Data Collection Tool

After obtaining written informed consent from parents or legal guardians and assent from the participating children wherever appropriate, data were collected using a structured proforma. Demographic characteristics, family and household information, parental literacy and employment status, exposure to household smoking, family history of asthma or atopy, use of mosquito mats, presence of pets, proximity to industrial establishments, history of wheezing, and previous nebulization were documented. Anthropometric measurements were obtained using standardized techniques. Height was measured without footwear using a portable stadiometer and recorded to the nearest centimeter, while weight was measured using a calibrated weighing scale. Body Mass Index (BMI) was calculated as weight in kilograms divided by the square of height in meters (kg/m^2). Additional anthropometric measurements, including waist circumference, neck circumference, and waist-to-height ratio, were also recorded. Peak Expiratory Flow Rate (PEFR) was measured using a Mini Wright's peak flow meter. Each child performed three maximal expiratory maneuvers after full inspiration, and the highest recorded PEFR value was considered for statistical analysis.

Ethical Considerations

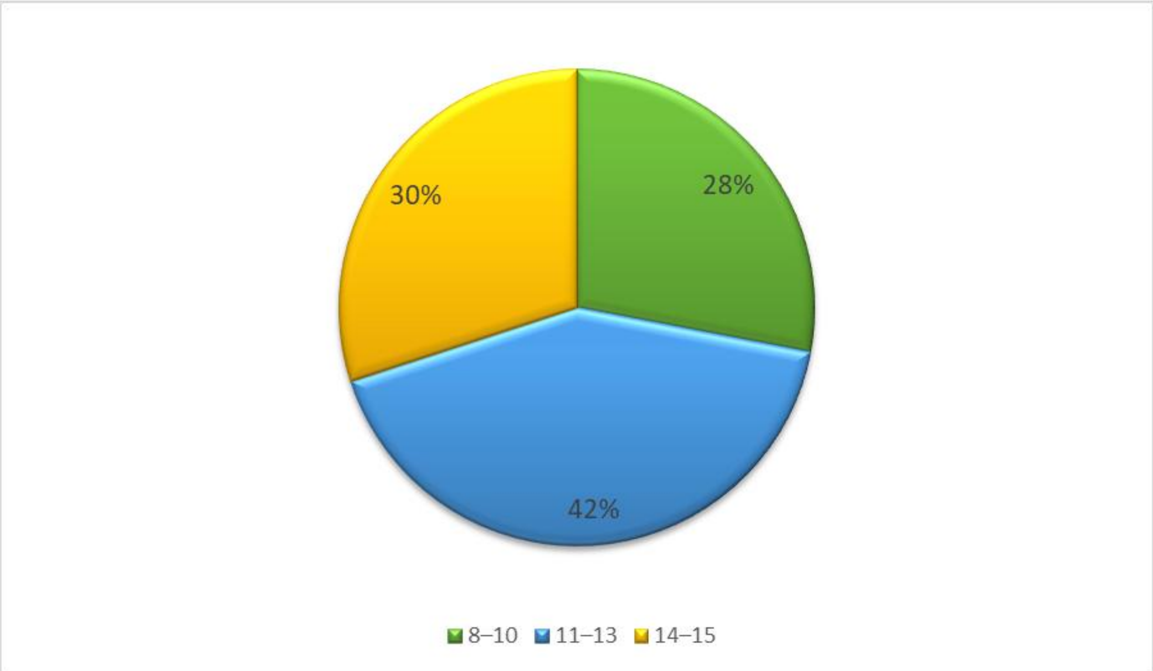
The study protocol was reviewed and approved by the Institutional Ethics Committee of Tbilisi State Medical University, Tbilisi, Georgia. Written informed consent was obtained from the parents or legal guardians of all participating children prior to enrolment, and assent was obtained from the children wherever appropriate. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Confidentiality and anonymity of participant information were maintained throughout the study.

Statistical Analysis

Data were entered into Microsoft Excel for coding and cleaning before being analyzed using the Statistical Package for the Social Sciences (SPSS) software version 26.0. Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were presented as frequencies and percentages. Pearson's or Spearman's correlation analysis was performed to determine the relationship between Body Mass Index and Peak Expiratory Flow Rate, depending on data distribution. Comparisons of PEFR across selected demographic and anthropometric variables were performed using the independent sample *t*-test or one-way analysis of variance (ANOVA), as appropriate. A *p*-value of less than 0.05 was considered statistically significant.

Results

Figure 1. Age distribution of study participants (n = 100)



The majority of participants were aged 11–13 years (42%), followed by 14–15 years (30%) and 8–10 years (28%). This distribution adequately represents late childhood and early adolescence, a critical period for lung growth and physiological maturation.

Table 1. Sex distribution of study participants

Sex	Number	Percentage (%)
Male	52	52%
Female	48	48%

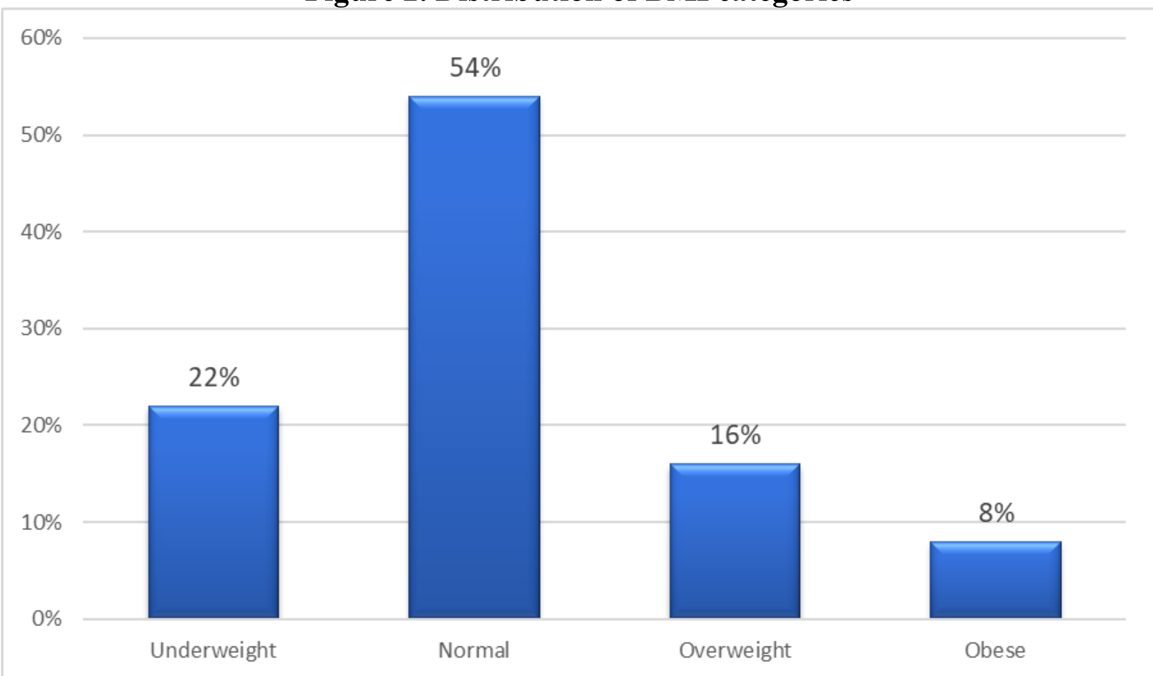
The study population included 52% males and 48% females, indicating a near-equal gender distribution. This balance minimizes sex-related bias and permits reliable comparison of PEFR between boys and girls.

Table 2. Mean anthropometric measurements of study participants

Parameter	Mean ± SD
Weight (kg)	36.4 ± 9.2
Height (cm)	142.6 ± 12.4
BMI (kg/m^2)	17.9 ± 3.6
Waist circumference (cm)	63.8 ± 8.6
Neck circumference (cm)	28.9 ± 3.1
Waist-to-height ratio	0.44 ± 0.06

Mean anthropometric values, including BMI and waist-to-height ratio, were within expected ranges for age, suggesting that most children were nutritionally normal. These measurements provided a stable baseline for evaluating the influence of body composition on PEFR.

Figure 2. Distribution of BMI categories



More than half of the children had normal BMI (54%), while 22% were underweight, 16% overweight, and 8% obese. Representation across all BMI categories enabled meaningful assessment of the effects of both undernutrition and overnutrition on pulmonary function.

Table 3. Mean Peak Expiratory Flow Rate (PEFR)

Variable	Mean ± SD
PEFR (L/min)	312.5 ± 68.4

The mean PEFR was 312.5 ± 68.4 L/min, reflecting baseline expiratory airflow capacity in children aged 8–15 years. The wide variability observed is attributable to differences in growth, body composition, and environmental exposure.

Table 4. Mean PEFR according to age group

Age group (years)	Mean PEFR (L/min) ± SD
8–10	262.4 ± 44.6
11–13	315.7 ± 52.8
14–15	368.9 ± 61.3

Mean PEFR increased significantly with advancing age, confirming the strong influence of lung growth, airway maturation, and respiratory muscle development during adolescence ($p < 0.001$).

Table 5. Mean PEFR according to BMI category

BMI category	Mean PEFR (L/min) ± SD
Underweight	284.3 ± 48.2
Normal	326.9 ± 54.6
Overweight	318.4 ± 59.1
Obese	271.6 ± 46.8

Children with normal BMI demonstrated the highest PEFR values, while obese and underweight children showed reduced values. The difference across BMI categories was statistically significant ($p = 0.001$), indicating that deviations from normal nutritional status adversely affect expiratory airflow.

Table 6. Correlation between BMI and PEFR (Primary Objective)

Variables	Pearson correlation (r)	p value
BMI vs PEFR	-0.42	<0.001

A moderate, statistically significant negative correlation was observed between BMI and PEFR ($r = –0.42$, $p < 0.001$), confirming BMI as an important determinant of expiratory flow in school-going children.

Table 7. Correlation of PEFR with key anthropometric variables

Variable	r value	p value
Age	0.61	<0.001
Height	0.68	<0.001
Weight	0.54	<0.001
Waist circumference	0.29	0.004

PEFR showed strong positive correlations with height and age, while waist circumference demonstrated a significant negative correlation. These findings indicate that linear growth enhances lung function, whereas central adiposity impairs expiratory airflow.

Table 8. Environmental exposure and PEFR

Exposure	Mean PEFR (L/min) ± SD	p value
Indoor smoking – Yes	268.4 ± 47.1	<0.001
Indoor smoking – No	326.7 ± 63.5	
Mosquito mat use – Yes	298.6 ± 59.8	0.01
Mosquito mat use – No	332.4 ± 64.1	

Children exposed to indoor smoking and mosquito mat fumes had significantly lower PEFR values compared to unexposed children, highlighting the adverse impact of indoor air pollutants on respiratory function.

Discussion

The present study evaluated the relationship between Body Mass Index and Peak Expiratory Flow Rate among school-going children aged 8–15 years and demonstrated that pulmonary function during late childhood and early adolescence is significantly influenced by growth, nutritional status, and environmental factors. In the present study, age showed a strong positive correlation with PEFR ($r = 0.61$, $p < 0.001$), with a progressive increase in mean PEFR across age groups. This finding is consistent with reports by Sharma et al. [9], who observed a significant age-related rise in PEFR from younger children to adolescents, and Kumar et al. [10], who demonstrated a comparable positive correlation between age and expiratory flow. These findings reflect physiological lung growth, increasing airway caliber, and improving respiratory muscle strength with advancing age, supporting age as a major determinant of PEFR in children.

Male children in the present study had significantly higher mean PEFR values than females ($p = 0.03$). Similar sex-based differences have been reported by Sharma et al. [9] and Ramesh et al. [11], who attributed higher PEFR in boys to greater height, lung volumes, and thoracic dimensions. Bose et al. [12] further noted that these differences become more pronounced during adolescence due to divergent growth patterns between sexes. The present findings confirm gender as an important demographic factor influencing pulmonary function. Among anthropometric variables, height showed the strongest positive correlation with PEFR ($r = 0.68$, $p < 0.001$), followed by weight. This is consistent with observations by Kumar et al. [13], who identified height as the strongest predictor of PEFR in children. Height reflects lung size and airway dimensions, explaining its dominant influence on expiratory flow. These findings reinforce the central role of linear growth in determining lung function during childhood.

In the present study, more than half of the children had normal BMI, while a substantial proportion were underweight or overweight. Children with normal BMI demonstrated the highest mean PEFR values, whereas both underweight and obese children showed reduced PEFR. Similar BMI distributions and patterns of reduced pulmonary function at both extremes of nutritional status have been reported by Mishra et al. [14] and Das et al. [15]. These findings indicate that both undernutrition and overnutrition adversely affect respiratory performance. Mean PEFR differed significantly across BMI categories, with obese children showing the lowest values. Kaur et al. [16] and Verma et al. [17] reported comparable reductions in PEFR among obese children, attributing this to mechanical restriction of chest wall expansion, reduced lung compliance, and increased airway resistance. Das et al. [15] demonstrated that underweight children also exhibit reduced PEFR due to diminished respiratory muscle strength and delayed lung growth. These observations align closely with the present study. A moderate and statistically significant negative correlation was observed between BMI and PEFR ($r = –0.42$, $p < 0.001$), fulfilling the primary objective of the study. Similar inverse relationships have been reported by Sharma et al. [18], Mishra et al. [14], and Verma et al. [17], confirming BMI as an important determinant of expiratory airflow in children. The consistency of this finding across studies strengthens its biological plausibility.

The present study demonstrated a significant negative correlation between PEFR and waist circumference, indicating the adverse impact of central adiposity on lung function. Chatterjee et al. [19] and Das et al. [15] similarly reported that central fat accumulation is more strongly associated with reduced pulmonary function than overall body weight. Central adiposity may restrict diaphragmatic movement and reduce lung expansion, thereby impairing expiratory flow. Children exposed to indoor smoking and mosquito mat fumes had significantly lower PEFR values. These findings are consistent with reports by Sharma et al. [20] and Joseph et al. [21], who demonstrated reduced PEFR among children exposed to indoor air pollutants. Gupta et al. [22] further emphasized that chronic exposure to indoor pollutants negatively affects lung growth and airway function, even in children without diagnosed respiratory disease.

Children with a positive family history of asthma showed significantly lower PEFR values compared to those without such a history. Similar findings have been reported by Rao et al. [23] and Banerjee et al. [24], highlighting the influence of genetic predisposition on baseline lung function. This suggests that hereditary factors may contribute to reduced airway caliber or increased airway responsiveness. The findings of the present study are in strong agreement with existing literature and demonstrate that PEFR in school-going children is positively influenced by age and linear growth, while increased BMI, central adiposity, genetic predisposition, and indoor environmental exposures exert a negative impact. Smith et al. [25] emphasized that early identification of modifiable risk factors affecting lung function during childhood is essential for preventing long-term respiratory morbidity.

Strengths: The study included children across a broad age range encompassing late childhood and early adolescence, a critical period for pulmonary development. Standardized anthropometric measurements and PEFR assessment were used, enhancing measurement reliability. The inclusion of multiple anthropometric, familial, and environmental variables allowed a comprehensive evaluation of factors influencing lung function. The study directly addressed the primary objective by demonstrating a statistically significant correlation between BMI and PEFR.

Limitations: The cross-sectional design limits causal inference between BMI and pulmonary function. The sample size was modest and derived from a single center, which may limit generalizability. Spirometric indices other than PEFR were not assessed, and pubertal staging was not evaluated, which could influence lung function. Longitudinal studies with larger, multi-center samples are recommended to further elucidate causal relationships.

Conclusion

The present study demonstrates a significant association between Body Mass Index and Peak Expiratory Flow Rate among school-going children aged 8–15 years. Peak expiratory flow showed a strong positive relationship with age and height, while increasing BMI and central adiposity were associated with a significant decline in expiratory airflow. These findings highlight the importance of maintaining optimal nutritional status and a healthy home environment during childhood to support normal lung growth and respiratory function.

Conflict of interest: No Conflict of interest

Source Of Fund: No fund source

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