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Original Research Article

ANTHROPOMETRIC PARAMETERS AS PREDICTORS OF PEAK EXPIRATORY FLOW RATE IN PRIMARY SCHOOL CHILDREN

Nikitha Raj S N[1], *Muganagowda Patil*[2]

[1]*Assistant Professor, Department of Pediatrics, MVJMC & RH, Bengaluru, India.*
[2]*Professor and HOD, Department of Pediatrics, JJMMC, Davanagere, India.*

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Corresponding Author:
Dr. Nikitha Raj S N,
Assistant Professor, Department of Pediatrics, MVJMC & RH, Bengaluru, India.
Email: snnikitharaj@gmail.com

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ABSTRACT

Background: Peak Expiratory Flow Rate (PEFR) is an important indicator of pulmonary function and airway obstruction in children. Anthropometric characteristics influence lung development; therefore, establishing predictive relationships between body measurements and PEFR is clinically valuable.
Objectives: To assess PEFR among apparently healthy children aged 6–12 years, determine its correlation with anthropometric parameters, and derive predictive equations for estimating PEFR.
Materials and Methods: A Descriptive cross-sectional study was conducted among 250 primary school children in Davanagere city. Children who met the inclusion criteria were enrolled. Anthropometric measurements including height, weight, chest circumference, body mass index (BMI), and body surface area (BSA) were recorded. PEFR was measured using a standardized peak flow meter, and the best of three readings was considered for analysis. Statistical analysis was performed using SPSS version 20 with Pearson correlation and regression models.
Results: The mean age of participants was 8.67 ±1.93 years. PEFR increased significantly with age ($p < 0.001$). All anthropometric parameters showed significant positive correlation with PEFR ($p < 0.001$). Height exhibited the strongest correlation ($r = 0.864$), followed by weight ($r = 0.828$), BSA ($r = 0.821$), chest circumference ($r = 0.807$), and BMI ($r = 0.401$). Multiple regression equations were successfully developed to predict PEFR for both sexes.
Conclusion: PEFR increases with age and is strongly associated with key anthropometric parameters, particularly height and weight. The predictive equations derived from this study provide useful reference values for clinical assessment of pediatric respiratory function.
Keywords: Peak expiratory flow rate, anthropometry, predictive equations.

INTRODUCTION

Obstructive airway diseases are increasingly affecting children worldwide, with bronchial asthma emerging as a significant chronic inflammatory condition that profoundly impacts a child's quality of life. Early detection of airway obstruction is crucial for effective management, and Peak Expiratory Flow Rate (PEFR) stands out as a vital tool in this regard. This simple, non-invasive, rapid, reproducible, and cost-effective method measures respiratory function in liters per minute (L/min), evaluating the strength and speed of expiration from total lung capacity. Widely used in respiratory medicine, PEFR is instrumental in detecting airway obstruction, tracking asthma progression, and assessing therapeutic interventions.[1] The Global Initiative for Asthma (GINA) guidelines also recommend PEFR monitoring to evaluate treatment response, identify symptom triggers, and establish baseline values for action plans, with low PEFR variability indicating good asthma control.[2]

Forced Expiratory Volume in first second (FEV1), the gold standard for lung function assessment, is impractical in primary schools and homes due to its cost, portability issues, and the need for trained

personnel. Spirometry is challenging for young children, while PEFR, using a peak flow meter, is simpler and suitable for school-aged children after minimal training. However, PEFR is less sensitive in detecting treatment responses to inhaled corticosteroids, often missing minor airway changes and potentially misrepresenting spirometry results. While PEFR is convenient for routine outpatient assessments, especially in resource-limited settings, its findings should be confirmed with spirometry whenever possible, with treatment decisions based on spirometry results.[3] Several studies have highlighted PEFR as a feasible alternative for large-scale field assessments and home monitoring, particularly in resource-limited settings where spirometry is impractical.[4] This makes PEFR the preferred choice for community-based screening and generating normative reference values for pediatric populations. Pulmonary development is intricately linked to physical growth, making anthropometric measurements crucial for interpreting lung function. Factors like height, weight, body composition, environment, genetics, and chest dimensions influence airway size and lung capacity. These measurements strongly correlate with lung function parameters and are essential for developing predictive equations for diverse populations. Height emerges as the most significant predictor, highlighting the robust relationship between stature and lung size. Given the variability in pulmonary norms across regions and ethnicities, establishing region-specific reference values is vital for accurate clinical assessment. This study aims to determine normative peak expiratory flow rate (PEFR) values among primary school children aged 6-12 years and explore their correlation with anthropometric determinants such as height, weight, chest circumference, body surface area, and body mass index. Additionally, the study seeks to derive predictive equations that correlate PEFR values with age and anthropometric parameters.

MATERIALS AND METHODS

A school-based descriptive cross-sectional study was conducted in Davanagere city over a 12-month period. The study population comprised 250 apparently healthy primary school children aged 6–12 years. These children were selected from two randomly chosen schools in the city. The sample size was determined using the formula $n = Z1^2S^2/d^2$, which resulted in the inclusion of 250 participants. Eligibility criteria included being a school-going child within the specified age range, being available at the time of data collection and willing to participate. Children with any respiratory illnesses, systemic diseases, infections causing generalized fatigue such that their ability or willingness to cooperate with the study process is compromised, or those lacking parental consent were excluded from the study. Ethical approval was obtained from the Institutional Ethics Committee of JJM Medical College, Davanagere, and permission was secured from the respective school authorities before data collection commenced.

Data collection involved interviewing and screening eligible students, followed by a thorough physical and systemic examination. The data were meticulously recorded in a pre-designed proforma. The study utilized structured questionnaires, a standard weighing machine, measuring tape, wall-mounted stadiometer, peak flow meter with disposable mouthpieces, stethoscope, and examination torch as tools.

The following parameters were assessed for all study subjects: Height: Measured in centimeters using a wall-mounted stadiometer, without shoes and in light clothing. Weight: Measured in kilograms using a standard weighing machine, with shoes removed and minimal clothing. Chest Circumference: Measured in centimeters using a measuring tape at the level of the nipples. Body Surface Area (BSA): Calculated using Mosteller's formula: $\sqrt{\{(\text{Weight} \times \text{Height}) \div 3600\}}$. Body Mass Index (BMI): Calculated using the formula : Weight (kg) / Height^2 (m). Peak Expiratory Flow Rate (PEFR): Measured using the EU scale Cipla Peak Flow Master meter.

The procedure of measuring PEFR was thoroughly explained and demonstrated to each child before testing. The measurement steps included: Moving the pointer to the bottom of the scale. Standing upright and loosening tight clothing. Holding the peak flow meter horizontally without covering the slot. Taking a deep breath through the mouth. Sealing lips tightly around the mouthpiece. Blowing out as fast and hard as possible in a single sharp blast. Each child was allowed 2–3 practice attempts, after which three consecutive readings were recorded. The best value was considered the PEFR. If significant variation was observed between readings, the procedure was re-demonstrated, and measurements were repeated. On average, 40 samples were collected per day over six school visits.

Data analysis was performed using SPSS version 20. Descriptive statistics summarized participant characteristics, with mean and standard deviation for quantitative variables and frequency and proportions for qualitative variables. Pearson correlation examined the relationship between PEFR and anthropometric variables. Linear and multiple regression analyses created predictive equations, with a significance level of $p < 0.05$. Data were entered into Microsoft Excel and analyzed in SPSS. The Chi-square test assessed variable associations, and the unpaired sample t-test compared group means. A p-value < 0.005 was statistically significant, and $p < 0.001$ was highly significant.

RESULTS

This school-based descriptive cross-sectional study conducted in Davanagere city included 250

apparently healthy primary school children aged 6–12 years. The participants had a mean age of 8.67 ± 1.94 years, ranging from 6 to 12 years. The age and gender distribution revealed that the 9–12 years age group had the highest number, comprising 28.4% females and 25.2% males. In contrast, the 6–8 years age group had 24% males and 22.4% females. The mean height was 125.14 ± 14.17 cm, and the mean weight was 27.47 ± 7.91 kg, resulting in a mean BMI of 17.18 ± 1.69 kg/m² and a mean body surface area (BSA) of 0.97 ± 0.20 m². The mean chest circumference (CC) was recorded at 63.49 ± 7.81 cm, and the mean best peak expiratory flow rate (PEFR) was 194.99 ± 56.13 L/min, with a range of 110–350 L/min.

The study also explored the relationship between PEFR and various demographic and physiological factors. The mean PEFR for the 6–8 years age group was 146.84 ± 30.30 L/min, which was significantly lower than the 236.67 ± 36.49 L/min observed in the 9–12 years age group, with a p-value of 0.001. PEFR showed a gradual increase with advancing age. While males had a slightly higher mean PEFR of 199.18 ± 57.00 L/min compared to females' 190.93 ± 55.19 L/min, this difference was not statistically significant, with a p-value of 0.246. Additionally, a significant difference in PEFR was found based on BMI categories. Participants with a BMI < 18.5 kg/m² exhibited a mean PEFR of 185.40 ± 55.20 L/min, compared to 227.46 ± 46.59 L/min for those with a BMI of 18.5–24.9 kg/m², with a p-value of 0.001. PEFR increases as BMI increases in both genders.

All anthropometric variables showed a positive and statistically significant correlation with PEFR ($p < 0.001$) in both genders. For males, the highest correlation was observed between PEFR and height ($r = 0.866$), followed by body surface area (BSA) and PEFR ($r = 0.855$), weight and PEFR ($r = 0.839$), and chest circumference (CC) and PEFR ($r = 0.797$). For females, the highest correlation was also with height ($r = 0.871$), followed by weight and PEFR ($r = 0.831$), BSA and PEFR ($r = 0.801$), and CC and PEFR ($r = 0.828$). Overall, the descending order of correlation with PEFR was height ($r = 0.864$) > weight ($r = 0.828$) > BSA ($r = 0.821$) > chest circumference ($r = 0.807$) > BMI ($r = 0.401$). In general, the descending order of correlation was height, weight, BSA, chest circumference, and BMI.

Simple linear regression equations (Table 1) were meticulously derived for both boys and girls, utilizing a comprehensive array of variables including age, height, weight, BMI, BSA, and chest circumference. Among these, age and height emerged as the most influential, boasting the highest coefficient of determination (R^2). Specifically, for every unit increase in height, PEFR escalates by 3.567 units in males and 3.311 units in females. Similarly, a unit increase in weight results in a PEFR rise of 6.556 units for males and 5.395 units for females. Notably, BMI contributes significantly, with a unit increase leading to a PEFR increase of 9.726 units in males and a remarkable 16.28 units in females. BSA shows an even more pronounced impact, with a unit increase causing a PEFR surge of 263.8 units in males and 204.8 units in females. Chest circumference also plays a vital role, with a unit increase resulting in a PEFR increase of 6.192 units for males and 5.519 units for females. Lastly, age remains a critical factor, with a unit increase leading to a PEFR increase of 26.12 units in males and 25.06 units in females.

The multiple regression analysis (Table 2) further underscored the robust predictive capabilities of these equations, with R^2 values of 0.841 for boys and 0.862 for girls. These findings unequivocally demonstrate that PEFR can be reliably predicted using age and anthropometric parameters across both genders, highlighting the strength and reliability of the correlation.

The scatter plots (figure 1) illustrate a positive linear relationship between PEFR and all the anthropometric variables studied. As age and height progress, PEFR increases progressively, with data points strongly clustering around the regression line, indicating a strong predictive value. A significant positive association was observed between PEFR and weight, with PEFR values increasing as body weight increased. However, the scatter of points was slightly wider than that seen with age and height, suggesting moderate variability. Similarly, PEFR showed a positive linear relationship with body surface area (BSA), with an upward trend in values as BSA increased, though with moderate dispersion around the regression line. In the case of chest circumference (CC), PEFR increased proportionately with increasing chest circumference, demonstrating a significant correlation, but with comparatively less tight clustering than age and height, indicating a slightly weaker yet meaningful association. In contrast, the scatter plot of PEFR versus BMI shows a wider spread of data points, reflecting a comparatively weaker correlation. Overall, the graphical representation supports the statistically significant positive correlations observed in the study.

Table 1: Simple regression equations for predicting PEFR

Sl no	Male	Female	Total
Height	PEFR=3.567 (Ht)-246.1 R^2=0.750	PEFR=3.311(Ht)-224.4 R^2=0.759	PEFR=3.423(Ht)-233.4 R^2=0.746
Weight	PEFR=6.556 (Wt)+19.65 R^2=0.704	PEFR=5.395 (Wt)+42.24 R^2=0.690	PEFR=5.872(Wt)+33.67 R^2=0.685
BMI	PEFR=9.726(BMI)+30.97 R^2=0.077	PEFR=16.28(BMI)-86.98 R^2=0.261	PEFR=13.35 (BMI)-34.34 R^2=0.160
BSA	PEFR=263.8 (BSA)-57.64	PEFR=204.8(BSA)-7.307	PEFR=229.5 (BSA)-27.79

	R^2=0.731	R^2=0.642	R^2=0.674
CC	PEFR=6.192 (CC)-193.1 R^2=0.634	PEFR=5.519 (CC)-160.1 R^2=0.685	PEFR= 5.799 (CC)-173.2 R^2=0.651
Age	PEFR =26.12 (Age)-25.21 R^2=0.795	PEFR=25.06 (Age)-28.38 R^2=0.775	PEFR=25.45 (Age)-25.71 R^2=0.775

Table 2: Multiple regression equation for predicting PEFR

	Prediction Equations	R2
Boys	PEFR =113.784 + (16.707×Age in years) * + (1.178× Height in cm)* – (1.337 ×Weight in Kg) + (110.604 × BSA in m^2) – (0.768× CC in cm)	0.841
Girls	PEFR = 223.330+ (15.378×Age in years) * + (2.589×Height in cm)* – (1.513× Weight in Kg)* – (5.410×BSA in m^2)+ (0.028×CC in cm)	0.862

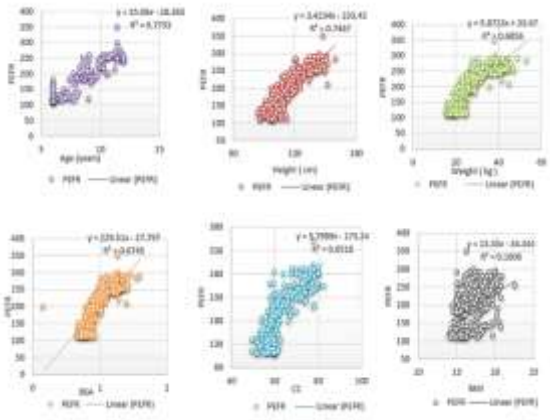

Figure 1: Scatter plot between PEFR and Anthropometric parameters

DISCUSSION

PEFR is a simple, reproducible, and practical tool for assessing airway function, particularly in children where spirometry may not always be feasible. Interpretation of PEFR requires comparison with age, sex and anthropometric-based reference standards. PEFR monitoring is equivalent to symptom-based asthma plans, as airflow limitation is detected objectively when PEFR falls below 80% of the reference value. Since PEFR varies significantly between regional and ethnic groups within the same country, the availability of regional reference values is essential for appropriate assessment and diagnosis.[5] The present study was undertaken to derive normative PEFR standards in apparently normal school children aged 6–12 years in Davanagere, establish prediction equations, and evaluate the correlation of PEFR with anthropometric parameters.

A statistically significant increase in PEFR was observed with advancing age. PEFR increased linearly with age, demonstrating a strong positive correlation in both genders. Similar findings were reported by Malik SK et al,[6] Deshpande JN et al,[7] Primhak RA et al,[8] Carson JWK et al,[9] Sachin Pawar et al,[10] and Abraham B et al,[11] who identified age as a significant determinant of PEFR. The progressive rise in PEFR with age can be attributed to increasing lung volume, airway caliber, and expiratory muscle strength during growth. The strong coefficient of determination for age in the present study further underscores its predictive significance.

With respect to gender, boys had marginally higher values, but the difference was not statistically significant. Comparable observations were made by Pagadpally Srinivas,[12] and Abraham B et al,[11] while Sachin Pawar et al,[10] and Srivastava S et al,[13] reported significant gender differences. The absence of significant gender variation in the present study may be explained by similar somatic growth patterns in pre-adolescent children, suggesting that anthropometric determinants may exert greater influence than sex in this age group.

All anthropometric parameters—height, weight, body surface area (BSA), chest circumference (CC), and BMI—showed positive and statistically significant correlations with PEFR ($p < 0.001$). Among males, height had the highest correlation ($r = 0.866$), followed by BSA, weight, and CC. Among females, height again had the strongest association ($r = 0.871$), followed by weight, CC, and BSA. Overall, the descending order of correlation was height, weight, BSA, CC, and BMI. Similar patterns were reported by Pagadpally Srinivas,[12] observed good correlation of PEFR with height, chest circumference, weight, and BMI. Abraham B et al,[11] reported strong positive correlation with height, weight, and CC but weaker correlation with BMI, consistent with the comparatively lower correlation of BMI observed in the present study. Sachin Pawar et al,[10] and Srivastava S et al,[13] also documented significant correlations between PEFR and anthropometric variables and derived regression equations for prediction. The consistent identification of height as the strongest predictor across studies highlights the influence of thoracic size and lung growth on expiratory flow rates.

The present study derived both simple and multiple regression equations separately for boys and girls. Multiple regression analysis demonstrated high predictive value ($R^2 = 0.841$ for boys and $R^2 = 0.862$ for girls), indicating that PEFR can be reliably estimated using age and anthropometric parameters. These findings reinforce that PEFR is closely linked to physical growth in children. The strong correlation with height emphasizes stature as a primary determinant of lung capacity, while the contributions of weight and BSA reflect the influence of body composition on respiratory mechanics.

Given that PEFR interpretation depends on comparison with predicted normal values, the establishment of region-specific prediction equations is of considerable clinical importance. Variations in environmental, nutritional, and genetic factors may influence pulmonary function; therefore, locally derived normative standards enhance diagnostic accuracy. The predictive equations generated in this study provide practical tools for clinicians to estimate expected PEFR values, facilitate early identification of airflow limitation, and support monitoring and management of pediatric airway diseases such as asthma. Overall, the findings are consistent with previously published literature and reaffirm that age and height are the most robust predictors of PEFR, followed by weight, BSA, and chest circumference, while BMI shows comparatively weaker association.

CONCLUSION

Peak expiratory flow rate (PEFR) is a reliable, inexpensive, and practical method to assess airway function in children. It increases with age and is strongly associated with height and weight. The regression equations developed from this study can serve as reference standards for evaluating respiratory health in primary school children. Predictive regression equations for boys and girls showed good predictive accuracy and can estimate expected PEFR values based on anthropometric parameters. These region-specific reference values can help pediatricians objectively evaluate and monitor children with airway diseases and in school-based respiratory screening programs.

Limitations: The study's findings may not be applicable to broader populations due to its restricted sample size and age range. Further multicentric studies with larger sample sizes are needed for validation and wider applicability.

REFERENCES

1. Bedi U, Dang BK. A study of peak expiratory flow rate in normal healthy children of Punjab. Int J Med and Dent Sci 2016; 5(1): 1042-1047. DOI: https://doi.org/10.19056/ijmdsjssmes/2016/v5i1/83573 PMid:26901817
2. Global Initiative for Asthma. Global Strategy for Asthma Management and Prevention 2025. [Internet]. [cited 2026 Feb 20]. Available from: https://ginasthma.org/
3. Sangeetha Ramdas, Rose Tresa George, Shiji. K. Jacob. A Comparison between PEFR and FEV1 in children with bronchial asthma attending a tertiary care centre in Kerala. Int J Acad Med Pharm.2024; 6 (6); 751-754
4. Swaminathan S, Venkatesh P, Mukunthan R. Peak expiratory flow rate is south Indian children. Indian pediatrics.1993;30(2): 207-211
5. John JM. Regression equations for Peak expiratory flow rates for children(8- 12 years) in Ernakulam district. Med J DY Patil Vidyapeet.2018;11:3-8.
6. Malik Sk, Jindal SK, shada PK, et al. Peak expiratory flow rate of healthy school boys from Punjab. Indian pediatrics. 1981;18:517-521.
7. Deshpande JN, Dahat HB, Shirole CD, et al. Pulmonary function and their correlation with anthropometric parameters in rural children. Indian J pediatrics. 1983; 50(405): 375-378.
8. Primhak RA, Biggins JD et al. Factors affecting the peak expiratory how rate in children. Br J Dis chest 1984;78(1):26-35.
9. Carson JWK, Hoey H, Taylor MRH. Growth and other factors affecting peak expiratory flow rate. Arch Dis Child. 1989;64:96-102.
10. Sachin Pawar, Vinod shende, Satish Waghmare, et al. Anthropometric parameters as predictors of Peak expiratory flow rate in Central Indian children 5-15 years. Asian Medical Journals. 2014;1(1): 6-12.
11. Abraham B, Baburaj S, Patil RB, Et al. "peak expiratory flow rate nomogram in relation to anthropometric determinants of south Indian school children. Indian J Child Health. 2014;1(2):45-48.
12. Pagadpally Srinivas. Factors affecting Peak expiratory flow rate and derive predictive equation in children of 6-12 years of age of karaikal. Journal of Evolution of Medicine and Dental Sciences. 2013;2(6):557-571.
13. Srivastava S, Agarwal D. Correlates of Peak expiratory Flow rate and deriving the prediction of equation in school going children of Lucknow. International Journal of Community Medicine and Public Health. 2017;4 (10) 3550-3553.
14. John JM. Regression equations for Peak expiratory flow rates for children (8- 12 years) in Ernakulam district. Med J DY Patil Vidyapeet.2018;11:3-8.