

## Original Article

## Peak expiratory flow rate nomogram in relation to anthropometric determinants of South Indian school children

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Received – 10 July 2014

Initial Review – 30 July 2014

Published Online – 18 August 2014

### Abstract

**Background:** The predictive normal value of peak expiratory flow rate (PEFR), used in monitoring of healthy and asthmatic children, is correlated with height, but it may vary with other anthropometric measurements and ethnic differences. **Purpose:** To study the correlation of PEFR with age, sex, body mass index (BMI), chest circumference (CC), and MUAC and to formulate PEFR nomograms in relation to these anthropometric variables in a rural school going children of age group 6-12 years in southern India. **Methods:** A descriptive cross-sectional study was conducted in 2000 children consist of 993 boys and 1007 girls who fulfilled the selection criteria from eight randomly selected government schools from a rural area. PEFR was measured age wise using Mini-Wright peak flow meter and the highest among the three values was taken. PEFR nomograms were formulated, and its correlation with BMI, height, weight, CC, and MUAC were estimated using linear regression analysis. **Results:** PEFR has strong ( $p < 0.001$ ) positive correlation with age, height, weight, MUAC, and CC, but it has poor correlation with BMI ( $p = 0.985$ ) which showed flat regression line with narrow 95% confidence limits. **Conclusion:** In this study, PEFR has nonsignificant correlation with BMI but has strong positive correlation with other anthropometric measurements. This underlines the need of a local reference nomogram as anthropometric measurements affect the PEFR reference values.

**Key words:** *Body mass index, Height, Mid-upper arm circumference, Peak expiratory flow rate nomogram*

Peak expiratory flow rate (PEFR) is a useful guide for monitoring the ventilatory function of healthy and asthmatic children. The PEFR is the maximal rate that a person can exhale during a short maximal expiratory effort after a full inspiration. It can be measured with the help of an instrument called peak flow meter. It is a simple, low cost, reliable way of monitoring PEFR in children and adults with bronchial asthma, and other obstructive airway diseases [1]. PEFR provides a simple quantitative and reproducible measure of resistance and severity of airflow obstruction [2]. In a child with bronchospasm, the PEFR value decreases. PEFR is useful for monitoring changes or trends in a patient's asthma control; however, a more reliable test, like spirometry

is required to confirm or exclude airflow limitation due to significant testing variability.

In areas where prevalence of asthma-related hospital admissions are high, PEFR can be used for screening and monitoring its severity. Asthma management depends partially on the ability of the patients to recall the frequency and severity of symptoms; however, there can be a wide variation in perception of these symptoms to its subjective nature. PEFR monitoring provides additional information by objective measurement of airflow obstruction, and can be performed by children even up to 3 years of age [3]. Many studies have shown that pulmonary function values differ due to racial and

ethnic differences [4]. Within India also, pulmonary function vary due to ethnic differences. Therefore, it is important to establish reference values for different regions of every country. In India, it is necessary to have region-specific study relating to PEFR and anthropometry in growing children, as the mosaic of Indian population is spread in a varied and complex geography [5]. Besides the availability of a nomogram in school-going children of age group above 5 years, will help in the school screening programs.

The relationship of PEFR with height and age has been studied in western countries, but the variations with body mass index (BMI) and mid-upper arm circumference (MUAC) have not been well-explored [6]. The available studies in India as per our present knowledge are based on urban areas. The data from the children of rural areas are very limited [7,8]. Hence, the present study was designed to develop a PEFR nomogram in relation to BMI and other anthropometric measurements in a rural school going children of age group 6-12 years in South India.

## METHODS

A descriptive cross-sectional study was conducted in the Department of Pediatrics of Dr SMCSI Medical College, Karakonam, Trivandrum, Kerala during the period from December 2012 to July 2013 after getting ethical clearance from the Institutional Ethical Committee. Children between age 6 and 12 years were included in the study. Eight government schools were randomly selected from the rural areas of Trivandrum district of Kerala. After taking permission from school authorities, written information of the study and consent forms were distributed to all the parents of children who fulfilled the inclusion criteria.

A detailed history and clinical examination were done to select the children based on inclusion criteria. Those children with bronchial asthma, heart diseases, and clinically evident skeletal deformity were excluded along with those who had respiratory infections within past 3 weeks. Of the total population of 2956 students, 2000 children were selected using stratified random sampling technique based on age group and gender. Weight, height, MUAC, and chest circumference (CC) were measured using standard techniques. BMI was calculated using the formula  $\text{weight}/\text{height}^2$  in which weight is in kg and height is

in meter. PEFR was measured using Mini-Wright's peak flow meter after demonstrating the technique. The child was comfortably seated, and the average of three values was recorded.

## Statistical Analysis

Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented as Mean  $\pm$  SD (Min-Max) and results on categorical measurements are presented in number (%). Significance is assessed at 5% level of significance. Analysis of variance (ANOVA test) and student 't' test has been used to find the significance of PEFR between age, BMI, CC and MUAC. Pearson correlation has been used to find a relationship between PEFR and anthropometric parameters along with prediction equations by regression analysis. The statistical software SPSS 16.0 was used for the analysis of the data and Microsoft word and Excel have been used to generate graphs and tables.

## RESULTS

During study period, a total of 2000 school children of the age group between 6 and 12 years was recruited. Of these, 993 were boys, and 1007 were girls. The anthropometric variables in relation to PEFR of children in different age group are shown in Table 1. The mean PEFR for boys was  $201.13 \pm 44.39$  L/min, and that of girls was  $194.01 \pm 47.94$  L/min. Mean PEFR value of boys was marginally higher than that of girls; however, this difference was not statistically significant ( $p > 0.05$ ).

Correlation of PEFR based on age was studied, and there was a strong positive significant ( $p < 0.001$ ) correlation ( $r = 0.87$ ) between age and PEFR. Regression model summarizes that R square = 0.766 (76.6% of variability in PEFR is accounted for age). The regression equation for PEFR =  $19.758$  (age in years) +  $9.206$  (means for every 1 year increase in age, PEFR increases by  $19.758$  L/min).

There was no significant correlation between PEFR and BMI ( $p > 0.05$ ), it was difficult to formulate a nomogram. Though formulated, it had very narrow confidence limits (95%) (Fig. 1). There was a strong positive correlation ( $r = 0.96$ ) between height and PEFR. Regression model summarizes that R square =

Table 1: Anthropometry and body composition profile

Age (year)	N	PEFR (in L/min)		Height (in cm)		Weight (in kg)		BMI		MUAC (in cm)		CC (in cm)	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
6	196	124.6	13.7	110.3	3.9	21.0	3.5	17.2	2.8	14.8	1.0	44.4	1.4
7	255	153.2	24.4	117.9	5.2	23.8	3.6	17.2	2.6	15.3	1.1	45.1	2.3
8	238	156.2	16.5	119.5	4.0	24.3	3.2	17.0	2.2	18.2	2.2	46.1	1.0
9	227	192.0	21.7	129.8	5.1	28.8	5.0	17.0	2.4	17.8	2.0	47.7	1.4
10	382	213.2	17.2	135.9	5.0	31.3	4.7	16.9	2.2	18.4	1.4	49.0	1.8
11	254	221.7	21.3	139.3	6.1	31.8	5.4	16.3	1.8	19.3	1.9	51.0	5.4
12	448	245.1	26.1	146.7	7.6	37.5	7.0	17.3	2.3	20.4	2.6	55.1	7.2
Total	2000	195.9	45.3	131.3	13.4	29.7	7.5	17.0	2.4	18.1	2.7	49.2	5.6

PEFR: Peak expiratory flow rate, BMI: Body mass index, MUAC: Mid-upper arm circumference, CC: Chest circumference

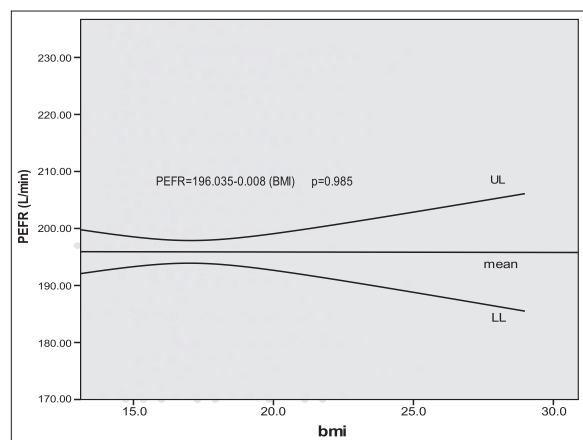


Figure 1: Peak expiratory flow rate nomogram in relation with body mass index

0.919 (91.9% of the variability in PEFR is accounted for height). The regression equation for PEFR = 3.233 (height in cm) – 228.546 (means for every 1 cm increase in height, PEFR increases by 3.233 L/min). The PEFR nomogram with height is shown in Fig. 2.

There was a strong positive correlation (r = 0.791) between weight and PEFR. Regression model summarizes that R square = 0.625 (62.5% of variability in PEFR is accounted for weight). The regression equation for PEFR = 4.787 (weight in kg) + 53.919 (means for every 1 kg increase in weight, PEFR increases by 4.787 L/min). PEFR with weight nomogram is shown in Fig. 3.

With CC, there was a strong positive correlation (r = 0.727) with PEFR. Regression model summarizes that R square = 0.528 which implies that 52.8% of the variability in PEFR is accounted for CC. The regression equation for PEFR = 5.884 (CC in cm) – 93.562 (means for every 1 cm increase in CC, PEFR increases by 5.884 L/min). The CC PEFR nomogram is shown in Fig. 4.

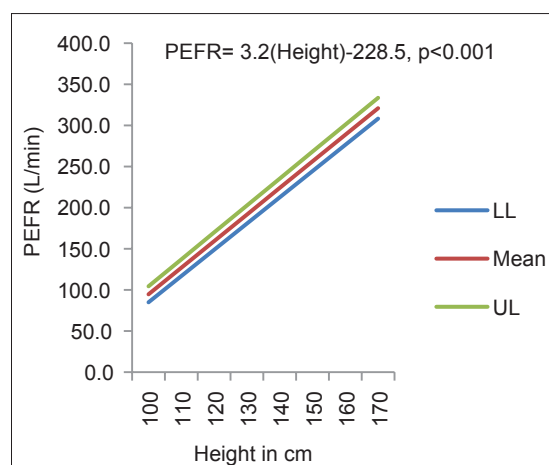


Figure 2: Peak expiratory flow rate nomogram in relation with height

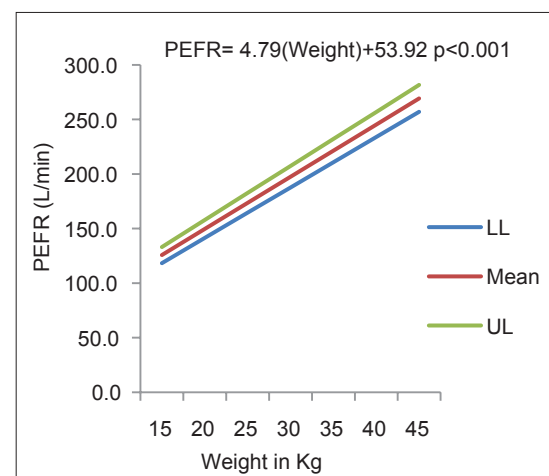


Figure 3: Peak expiratory flow rate nomogram in relation with weight

There was a strong positive correlation (r = 0.653) between MUAC and PEFR. Regression model summarizes that R square = 0.427 (42.7% of the variability in PEFR is accounted for MUAC). The regression equation for PEFR = 11.14 (MUAC in cm)

– 5.951 (means for every 1 cm increase in MUAC, PEFR increases by 11.14 L/min). The PEFR nomogram with MUAC is shown in Fig. 5.

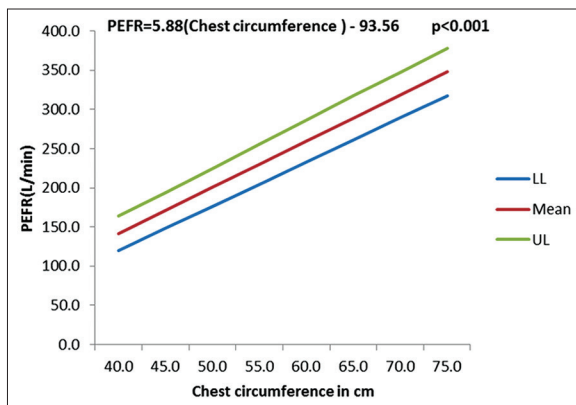
**DISCUSSION**

In this study, we tried to formulate the PEFR nomograms in respect to various anthropometric variables in children of southern Kerala. In our study, PEFR was found to have significant correlation with age, height, weight, CC, and MUAC but no correlation with BMI. PEFR values of boys were marginally higher than that of girls ( $p > 005$ ). In the present study,

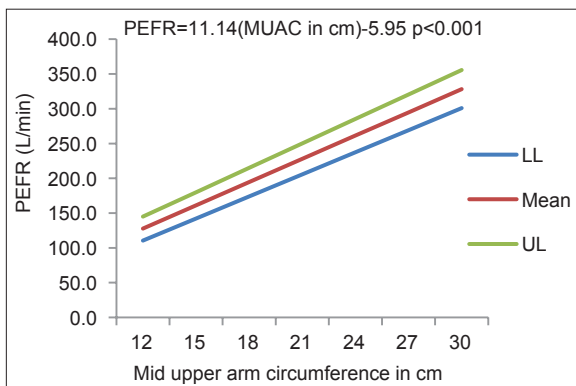
PEFR values of children were found to be lesser than that of other South Indian, North Indian, and Western children as shown in Table 2. It may be due to the fact that measured anthropometric parameters are less in children of Southern India compared to other parts of India [9].

Pande et al. have done a study in Delhi and Andhra Pradesh, which showed that age, sex, height, and weight were independent predictors of PEFR. The PEFRs of children from both parts of the country were similar, and were lower than those reported for American white children [12]. Swaminathan et al. [3] constructed a nomogram relating PEFR to height for healthy South Indian children which was similar to the nomogram prepared by us. In Caucasian and North Indian children, Chowgule et al. showed that the lung function variables have a linear positive correlation with height and age [4]. Boys show higher values for lung function variables than girls except for mid expiratory flow rates where girls have higher values.

A study done by Deutsch et al. also showed similar findings in which the highest correlation was found to be with a height [13]. A study of PEFR nomogram in Libyan school children also revealed that the PEFR in children was significantly related to height ( $r = 0.74$ ), age ( $r = 0.7$ ) and weight ( $r = 0.6$ ):  $p < 0.001$ . The PEFR nomogram in Libyan children ranged from 70 L/min to 540 L/min, and it was different from British standard [14]. The mean PEFR of the boys was significantly higher than that for the girls ( $p < 0.001$ ). The mean PEFR of the boys was significantly higher than that for the girls ( $p < 0.001$ ). In our study, the PEFR ranged from 124 L/min to 196 L/min and height showed the maximum variance in lung function parameters. Hence, for clinical evaluation of child’s lung function, height is the most significant independent parameter in comparison to age and weight. Similar study by Sharma et al. [7] in Indian children and another study by Primhak et al. [15] in British children also showed similar findings.



**Figure 4: Peak expiratory flow rate nomogram in relation with chest circumference**



**Figure 5: Peak expiratory flow rate nomogram in relation with mid-upper arm circumference**

**Table 2: Comparison of PEFR (L/min) of the present study with other studies**

Height Cm	Present study		Swaminathan et al. [3]		Malik et al. [1]		Paramesh et al. [10]	Parmar et al. [11]	
	Boys	Girls	Boys	Girls	Boys	Girls	Common value	Boys	Girls
120	160	150	205	193	222	216	200	212	211
140	230	215	286	272	320	314	300	318	317

PEFR: Peak expiratory flow rate

## CONCLUSION

This study has shown a preliminary local reference value of PEFr for school-going children of South Kerala. PEFr has very good correlation with height but has no significant correlation with BMI in children 6-12 years of age group. Further studies are needed including large sample size and region wise comparisons including racial, socioeconomic, and genetic factors.

## ACKNOWLEDGMENT

The authors are very thankful to the Department of Pediatrics and Management of Dr SMCSI Medical College for the support during the period of study. Authors also thank Mrs. Rani and Mr. Sanu Johnson for the computer support for the study.

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*Funding: None; Conflict of Interest: None Stated*

**How to cite this article:** Abraham B, Baburaj S, Patil RB, Mohandas MK, Ruhman S, Raj S. Peak expiratory flow rate nomogram in relation to anthropometric determinants of South Indian school children. *Indian J Child Health.* 2014;1(2):45-8.