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PEAK EXPIRATORY FLOW RATE OF RURAL SCHOOL CHILDREN OF PONDICHERRY

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ABSTRACT

Peak expiratory f low rate (PEFR) recording is an essential measure in the management and evaluation of asthmatic children. The PEFR can be measured by a simple instrument— peak expiratory flow meter. Aim of the study is to measure the Peak expiratory flow rate (PEFR) of healthy school children and to find out the correlation between PEFR values and anthropometric parameters, to create a nomogram of PEFR for children and formulate a regression formula for PEFR. The PEFR was measured in 2000 healthy rural school children between the age group of 8 years and 12years living in Pondicherry, India using the Mini-Wright peak flow meter. All measurements were obtained in a standing position and the best out of three trials was recorded. Demographic profile and anthropometric measurements like weight, height, were recorded and body surface area (BSA) and body mass index (BMI) were calculated. Of the 2450 students screened, 2000 were included in the study. Out of which1312 were boys and 688 were girls. Significant linear correlation was seen in PEFR with age, height, weight, BMI and BSA ($r = 0.990$, $r = 0.991$, $r = 0.983$, $r = 0.774$ & $r = 0.987$ respectively at $p < 0.001$). Nomogram was plotted based on the observed values of PEFR in the study population. Prediction equations were

derived for PEFR for the following variants like age, height, weight, BMI, BSA, boys and girls are as follows PEFR=(AgeX25.654)-18.222,PEFR =(HtX4.112)-325.519, PEFR =(WtX6.914)+11.965, PEFR =(BMIX43.161)-507.304, PEFR =(BSAX287.929)-81.741, PEFR =(HtX4.108)-324.859 & PEFR = (HtX4.121)-326.935 respectively Significant correlation was noted between PEFR and demographic profile like age sex and anthropometric parameters like height, weight and BMI and BSA. PEFR is a reliable measurement, which can be used routinely and regularly in rural areas for assessment of airway obstruction and prediction formula derived for use in this population.

Keywords: Peak expiratory flow rate, Children, Anthropometry, Nomogram

INTRODUCTION

The peak flow meter is a useful instrument for routine monitoring of the peak expiratory flow rate (PEFR) in healthy and asthmatic children **[1, 2, 3]**. Ventilation function studies in adult population from different parts of India are well documented **[4, 5]** but the similar data in children are limited **[6, 7]**. The measured PEFR is compared with the predicted PEFR of the subjects which is matched to the same sex, age, body size and ethnic group. This parameter is used to screen and monitor the severity of asthma in the community, particularly when the prevalence of asthma and asthma-related hospital admissions are rising **[5, 6]**. Studies relating to PEFR and anthropometry among growing children are necessary in India as the mosaic of Indian population spreading over such a differing geography is varied and complex. The present study was designed to measure the PEFR in rural school children of Pondicherry state, to assess correlation of anthropometry with PEFR and create normal reference value for children in rural areas of pondicherry and to derive prediction formula for this population.

Peak expiratory flow rate (PEFR) measurement is a simple test of respiratory function, which can be easily measured and correlated well with other lung function measurements. Personal best PEFR is found to be a useful tool in asthma management plan **[8]**. A mini-Wright's peak flow meter (mWPFM) is used to measure PEFR, which is easy to use, reliable, cheap and portable. The dial range is 0–1000 L/min though the American Thoracic Society recommends a range of 100 to <850 L/Min **[9, 10]**.

MATERIAL AND METHODS

The three schools situated in different villages of Pondicherry selected randomly. Healthy children between the age of 8 and 12

years were included in the study. Exclusion criteria were: children below 8 years and above 12 years of age; children having acute respiratory infections within 7 d of the study; children with major medical illness, recurrent cough or chest infection or chest deformity; children with family history of asthma; children taking bronchodilator metered-dose inhaler (MDI); children with rhonchi or wheeze on auscultation or other findings suggestive of any chronic illness. Ethical clearance was obtained from the ethical committee of Sri Lakshmi Narayana Institute of Medical Sciences (SLIMS), Puducherry.

Considering the mean & standard deviation of PEFR values for rural school children as 201.13 ± 44.39 L/min (for boys) and 194.01 ± 47.94 L/min (for girls) **[11]**, with alpha error as 5% and power as 80%, the minimum sample size required was 1322 (661 boys and 661 girls) **[12]**. Finally a sample of 2000 was taken.

A basic physical examination was also done to omit children based on the exclusion criteria. Data collection was done by the trained interns of Pediatric Department of Sri Lakshmi Narayana Institute of Medical Sciences (SLIMS), Puducherry. Anthropometric measurements for the children in inclusion criteria are taken. Weight was measured using standard weighing scale in kilogram wearing only school uniform, after removing footwear and other accessories.

The weighing machine was put on an absolutely flat surface and was calibrated before taking measurements. Accuracy of the machine was ±50 g. Any fraction of weight thus measured was corrected to the nearest kilogram. Height was measured with a stadiometer without footwear and child standing erect with heel, calf, buttocks, shoulder blade and occiput touching the stadiometer. The measured height was then corrected to the nearest centimeter. Body mass index (BMI) Body surface area (BSA) were calculated from weight and height using the formula given below

$$\textbf{BMI} = \frac{\textbf{Weight in kg}}{(\textbf{Height in m})^2} \times 100$$

$$\textbf{BSA} = \frac{\sqrt{\textbf{Wt}} \times \sqrt{\textbf{Ht}}}{\sqrt{3600}}$$

Peak expiratory flow rate was measured in L/min, in standing position using mini Wright's peak flow meters (mWPFM), with a disposable mouth-piece. Accuracy of the flow meters was ±10 L/min. The flow meters were compared with the meter available in the Department of chest Medicine in Sri Lakshmi Narayana Institute of Medical Sciences (SLIMS), Puducherry.

Training for recording the PEFR value was taken from the same department by the re-searcher and assistants. Students were repeatedly demonstrated and explained the procedure till they understood the correct method. They were allowed to make as many attempts as required till three values within ±20 L/min were obtained. From these three values, highest value was chosen.

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Statistical Analysis

Statistical analyses were performed using SPSS version 20. Quantitative variables were described by mean and standard deviation. Qualitative variables were expressed by frequency distribution. Comparison of quantitative variables between two groups was analyzed using independent sample t test and that of more than two groups were analyzed using ANOVA. Correlations between two quantitative variables were analyzed using Pearson correlation formula. A multivariate analysis of linear regression was done for the prediction of PEFR taking height and weight as independent variables. A p value of 0.05 was taken as the level of significance.

RESULTS

Of the 2450 students screened, 2000 were included in the study. Out of which 1312 were boys and 688 were girls. Significant linear correlation was seen in PEFR with age, height, weight, BMI and BSA ($r = 0.990$, $r=991$, $r = 0.983$, $r = 0.774$ & $r = 0.987$ respectively, $p < 0.001$). Nomograms were plotted based on the observed values of PEFR in the study population. Prediction equations were derived for PEFR for the following variants like age, height, weight, BMI, BSA, Boys and Girls are as follows

PEFR=(AgeX25.654)-18.222,

PEFR = (HtX4.112)-325.519,

PEFR=(WtX6.914)+11.965,

PEFR=(BMIX43.161)-507.304,

PEFR=(BSAX287.929)-81.741,

PEFR=(HtX4.108)-324.859&

PEFR=(HtX4.119)-326.571 respectively.

Table 1: Mean and Standard deviation of Demographic data, anthropometry and PEFR values

GENDER		AGE	HEIGHT	WEIGHT	BMI	BSA	PEFR VALUES
FEMALE	N	688	688	688	688	688	688
	Range	4	27	17	2.87	0	111
	Minimum	8	124	24	15.50	1	189
	Maximum	12	151	41	18.37	1	300
	Mean	9.89	136.55	32.41	17.2429	1.10	235.86
	Std. Deviation	1.440	8.945	5.250	.65720	.127	37.171
MALE	N	1312	1312	1312	1312	1312	1312
	Range	4	27	17	3.25	0	112
	Minimum	8	124	24	15.12	1	188
	Maximum	12	151	41	18.37	1	300
	Mean	10.06	137.41	32.91	17.2919	1.12	239.58
	Std. Deviation	1.398	8.761	5.186	.65659	.125	36.323
Total	N	2000	2000	2000	2000	2000	2000
	Range	4	27	17	3.25	0	112
	Minimum	8	124	24	15.12	1	188
	Maximum	12	151	41	18.37	1	300
	Mean	10.00	137.12	32.74	17.2751	1.11	238.30
	Std. Deviation	1.414	8.832	5.212	.65705	.126	36.650

Table 2: Mean and variance of PEFR with Age

AGE	N	Mean	Std. Deviation	95% Confidence Interval for Mean		Minimum	Maximum
				Lower Bound	Upper Bound		
8	400	191.60	1.336	191.47	191.73	188	194
9	400	210.36	.841	210.28	210.45	208	212
10	401	234.68	.820	234.60	234.76	234	236
11	399	259.76	4.859	259.29	260.24	254	268
12	400	295.17	4.342	294.74	295.59	288	300
Total	2000	238.30	36.650	236.70	239.91	188	300

ANOVA; F value=73158.184; p value<0.001.

Table 3: Correlation of PEFR with Age

Correlations			
		AGE	PEFR VALUES
AGE	Pearson Correlation	1	.990**
	Sig. (2-tailed)		.000
	N	2000	2000
PEFR VALUES	Pearson Correlation	.990**	1
	Sig. (2-tailed)	.000	
	N	2000	2000

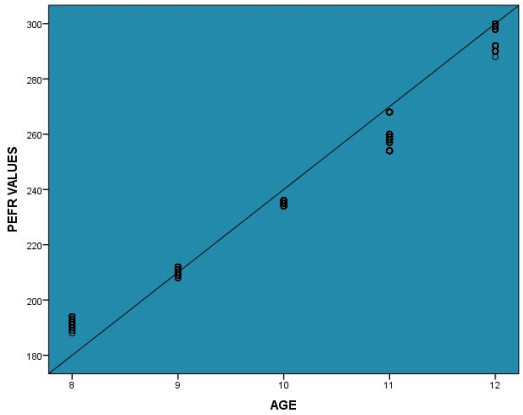

Figure 1: Peak expiratory flow Rate Nomogram in Relation with Age

Table 4: Mean and variance of PEFR with Height

HEIGHT (Cms)	N	Mean	Std. Deviation	95% Confidence Interval for Mean		Minimum	Maximum
				Lower Bound	Upper Bound		
<130	783	200.78	9.451	200.12	201.44	188	212
130-140	508	237.29	8.942	236.51	238.07	208	254
140-150	548	276.33	17.489	274.86	277.80	257	300
>150	161	294.55	4.109	293.91	295.19	290	300
Total	2000	238.30	36.650	236.70	239.91	188	300

ANOVA; F value=73158.184; p value<0.001

Table 5: Correlation of PEFR with Height

Correlations			
		HEIGHT	PEFR VALUES
HEIGHT	Pearson Correlation	1	.991**
	Sig. (2-tailed)		.000
	N	2000	2000
PEFR VALUES	Pearson Correlation	.991**	1
	Sig. (2-tailed)	.000	
	N	2000	2000
Correlation is significant at the 0.01 level (2-tailed).			

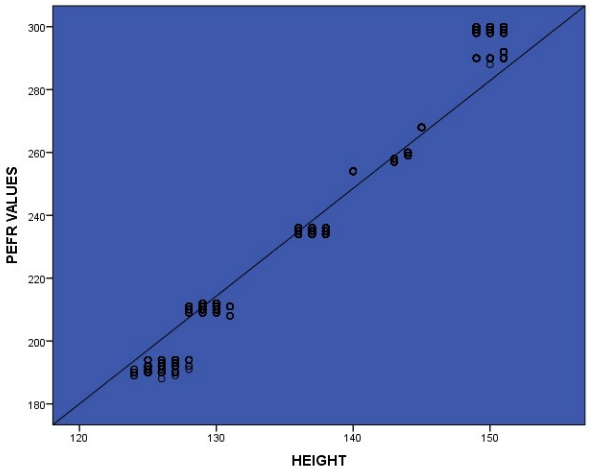

Figure 2: Peak expiratory flow rate nomogram in relation with height

Table 6: Mean and variance of PEFR with Weight

Weight (Kgs)	N	Mean	Std. Deviation	95% Confidence Interval for Mean		Minimum	Maximum
				Lower Bound	Upper Bound		
<30	800	200.98	9.452	200.33	201.64	188	212
30-35	401	234.68	.820	234.60	234.76	234	236
35-40	678	274.29	17.994	272.94	275.65	254	300
>40	121	295.39	4.432	294.59	296.19	290	300
Total	2000	238.30	36.650	236.70	239.91	188	300

ANOVA; F value=5427.902; p value<0.001

Table 7: Correlation of PEFR with Weight

Correlations			
		WEIGHT	PEFR VALUES
WEIGHT	Pearson Correlation	1	.983**
	Sig. (2-tailed)		.000
	N	2000	2000
PEFR VALUES	Pearson Correlation	.983**	1
	Sig. (2-tailed)	.000	
	N	2000	2000
**. Correlation is significant at the 0.01 level (2-tailed).			

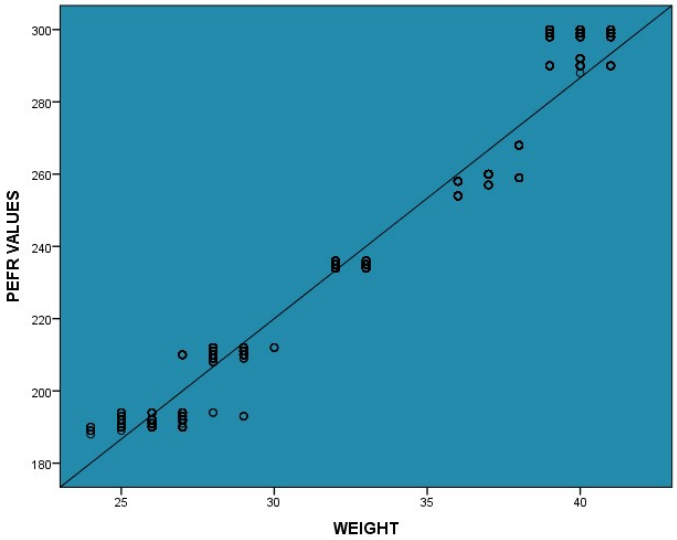

Figure 3: Peak Expiratory Flow Rate Nomogram in Relation with weight

Table 8: Mean and variance of PEFR with BMI

Descriptive Statistics			
	Mean	**Std. Deviation**	**N**
BMI	**17.2715**	**.65839**	**2500**
PEFR VALUES	**238.33**	**36.685**	**2500**

Table 9: Correlation of PEFR with BMI

Correlations			
		BMI	**PEFR VALUES**
BMI	**Pearson Correlation**	**1**	**.775****
	Sig. (2-tailed)		**.000**
	N	**2500**	**2500**
PEFR VALUES	**Pearson Correlation**	**.775****	**1**
	Sig. (2-tailed)	**.000**	
	N	**2500**	**2500**
****. Correlation is significant at the 0.01 level (2-tailed).**			

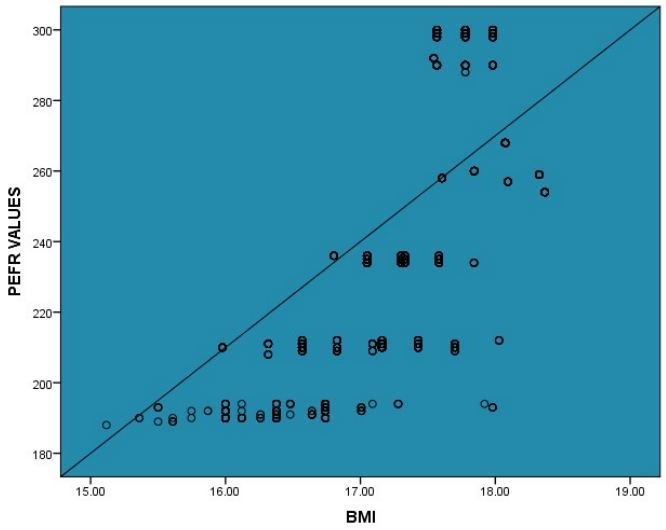

Figure 4: Peak Expiratory Flow Rate Nomogram in Relation with BMI

Table 10: Mean and variance of PEFR with BSA

Descriptive Statistics			
	Mean	Std. Deviation	N
BMI	17.2751	.65705	2000
PEFR VALUES	238.30	36.650	2000

Table 11: Correlation of PEFR with BMI

Correlations			
		BMI	PEFR VALUES
BMI	Pearson Correlation	1	.774**
	Sig. (2-tailed)		.000
	N	2000	2000
PEFR VALUES	Pearson Correlation	.774**	1
	Sig. (2-tailed)	.000	
	N	2000	2000
**. Correlation is significant at the 0.01 level (2-tailed).			

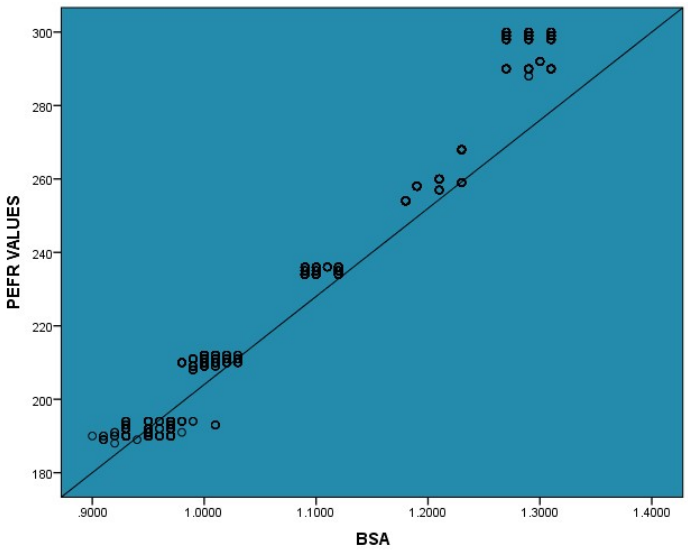

Figure 5: Peak Expiratory Flow Rate Nomogram in Relation with BSA

Table 12: Predictive equations and correlation coefficient of Demographic and Anthropometric data with PEFR

Variable	Predictive equation	R Value	R^2
Age	PEFR=(AgeX25.654)-18.222	0.990	0.980
Height	PEFR =(HtX4.112)-325.519	0.991	0.982
Weight	PEFR =(WtX6.914)+11.965	0.983	0.967
BMI	PEFR=(BMIX43.161)-507.304	0.774	0.559
BSA	PEFR=(BSAX287.929)-81.741	0.987	0.975
Boys	PEFR=(HtX4.108)-324.859	0.991	0.981
Girls	PEFR=(HtX4.119)-326.571	0.991	0.982

DISCUSSION

Peak expiratory flow rate measurement is a simple test of respiratory function, which is used to measure airway obstruction **[13]**. This can be used for monitoring PEFR, to assess the airflow as an indicator of asthma - diagnosis and management **[14]**. There are different studies conducted throughout India and foreign countries that showed the correlation

between PEFR and age, sex, race, geographic area and anthropometric parameters.

This cross-sectional study conducted in South India on 2000 children (1312-boys and 688- girls) showed a high positive correlation of PEFR with age, height, weight, BMI, & BSA ($r = 0.990$, r=991, $r = 0.983$, $r = 0.774$ & $r = 0.987$ respectively, $p < 0.001$). This is similar to studies conducted by Mohammedzadeh et al. at Babol, Iran, and Garg et al. at Ghaziabad city, Uttar Pradesh **[15, 16, 17]**. and few other studies **[18, 19, 20]**. The PEFR value in the present study was found to be different as compared to other studies conducted in foreign countries and different regions of India. This shows a need for creating a nomogram for the children in the Urban Jabalpur district in middle India, which can be used as a reference.

In the present study, it was found that body mass index has slight low positive correlation with PEFR ($r = 0.775$, $p < 0.001$) compared to that of height ($r = 0.991$, $p < 0.001$), weight ($r = 0.983$,$p < 0.001$) and BSA($r = 0.987$, $p < 0.001$). This is similar to the findings of Pramanik *et al* **[21]**; however Choudhuri *et al*. found similar correlation of PEFR with height, weight and BMI **[22]**. In the present study, the mean PEFR value of the boys and girls was found to be similar, but was not statistically significant (p 0.679). This is similar to the findings of the studies conducted by Abraham et al and Amiry *et al* **[11, 23]**. An another study conducted by Budhiraja et al. on 600 normal urban and rural school children in Ludhiana district of North India in the age group 6–15 y, showed significantly higher value of PEFR in boys, as compared to that of girls ($p < 0.05$)24. Height and weight have been used either alone or in combination to create regression formula in various studies, like in the present one **[18, 19, 21, 25 and 26]**.

CONCLUSIONS

The present study showed that there is a significant correlation of PEFR with age & anthropometric parameters like height, weight, body mass index and body surface area. Using the data obtained from the rural school children of puducherry the nomogram and formula is created for that population for the future.

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