PEAK EXPIRATORY FLOW RATE AMONG HEALTHY SCHOOL CHILDREN AGED 8-13 YEARS IN PUDUCHERRY, SOUTH INDIA
Venkateswara Babu R1, Sivaganes Devaraj V2, Sabarigirivasan Harish V. K3

1Associate Professor, Department of Respiratory Medicine, Indira Gandhi Medical College and Research Institute (IGMC & RI), Puducherry.
2Undergraduate Student, Indira Gandhi Medical College and Research Institute (IGMC & RI), Puducherry.
3Assistant Professor, Department of Respiratory Medicine, Indira Gandhi Medical College and Research Institute (IGMC & RI), Puducherry.

ABSTRACT

BACKGROUND
The aim of this study was to measure the peak expiratory flow rate (PEFR) among healthy school going children in 8-13 years age group. Further, the study aimed to examine the correlation between PEFR and anthropometric parameters including height, and weight stratified by age and sex, to create nomogram of PEFR and formulate regression formula for PEFR.

MATERIALS AND METHODS
A cross-sectional study was conducted on school going healthy children of 8-13 years age group at a selected school in Pondicherry using simple random sampling method. After baseline data collection, including height and weight, using standard method, PEFR was measured using mini-Wright peak flow meter. For the study, the highest of three measurements were recorded.

RESULTS
The study included 643 healthy students, out of which 391 and 252 were boys and girls respectively. The findings showed that the age (β=7.83, p<0.001), height (β=0.84, p=0.036) and weight (β=0.79, p=0.015) are the significant predictors of PEFR values for girls while age (β=10.03, p<0.001) and height (β=1.36, p<0.001) but not weight (β=0.36, p=0.255) for boys. Nomograms were plotted based on the PEFR values observed in the study population. Predicted equations for PEFR accounting all the three- age, height and weight: PEFR (L/min) = -74.947 + 10.028 * Age (in years) + 1.361 * Height (in cm) + 0.358 * Weight (in Kg) in boys and PEFR (L/min) = -9.465 + 7.825 * Age (in years) + 0.840 * Height (in cm) + 0.797 * Weight (in Kg) in girls.

CONCLUSION
The present study showed a significant correlation between anthropometric parameters including weight and height with PEFR across age and sex among 8 to 13 years healthy school children. The equation would be helpful in evaluation of children with airway diseases.

KEYWORDS
Peak Expiratory Flow Rate, Children, Anthropometry, Nomogram, South India, Puducherry.

HOW TO CITE THIS ARTICLE: Babu RV, Devaraj VS, Harish VKS. Peak expiratory flow rate among healthy school children aged 8-13 years in Puducherry, South India. J. Evid. Based Med. Healthc. 2019; 6(11), 852-858. DOI: 10.18410/jebmh/2019/179

BACKGROUND
The global prevalence of Asthma is increasing steadily, especially its burden among children has emerged as an important public health issue. According to the recent report, the prevalence ranged from 1% to 18% of the population in different countries, while in India it is roughly estimated to be between 10 -15% in 5-11 y old children. This percentage is in a rising trend due to high environmental pollution and other causes. Although prevalence is substantial, asthma, especially obstructive airway disease in children remains underdiagnosed and undertreated.

Although there are several diagnostic tools to measure the lung function, such as a spirometer, pneumotachometers, turbines, and anemometer, peak flow meter has been found to be widely accepted in clinical practice since it is simple, non-invasive, economical, fast and it measures the strength and expiratory flow in L/min. PEFR is the maximum respiratory flow rate during a forced exhalation, starting from full lung inhalation which enable patients to understand their lung functioning and their response towards treatment. In fact, The National Asthma...
Education and Prevention Program Expert Panel Reports and Global Initiative for Asthma guidelines advocate the use of PEF for diagnosis, treatment and management, especially in children for more than 5 years. For this purpose, evaluation of observed PEF requires knowledge of its range in healthy subjects of the same sex, age, and body size. Several studies have been conducted in developed countries to examine the normal PEF values and from India, many from the northern and eastern part of India to date, only a few studies have been carried out to estimate the normal values of PEF in southern Indian children.

In southern India, the studies that were conducted also reported an inconsistent association between PEF values and selected anthropometric values such as height and weight. Southern studies reported a positive correlation between PEF values with age, height, and weight in both sexes while the highest correlation was obtained for height. Especially height influences the pulmonary functions amongst boys while age and weight for girls. However, in contrast, Pulickal reported a linear but insignificant association between height and PEF for both boys and girls. On the other hand, Ahmed et al. Reported a significant association between PEF and height for both sexes. However, to our knowledge, none have been carried amongst children of Puducherry. With this background, the present study had been carried out with the following aims and objectives.

**Aims and Objectives**

1. To examine the PEF stratified by age and sex in the school going children in 8-13 years age group.
2. To correlate the PEF and height in the school going children.
3. To associate the PEF and weight in the school going children.

**MATERIALS AND METHODS**

This cross-sectional study was conducted at one secondary school selected in the urban area of Puducherry between August and September 2017. The target population for the study was school going children aged 8 and 13 years residing in Puducherry.

**Inclusion Criteria**

The study had included only healthy children with age between 8 and 13 years.

**Exclusion Criteria**

The following children were excluded from the study: 1) children who are known asthmatics and with chronic respiratory disorders b) children with history of respiratory infections in the past 2 weeks c) children with a family history of asthma and d) the children who refuse or cannot perform the test.

**Data Collection**

Out of five communes in Puducherry, one commune was selected by simple random sampling technique using the lottery method. From the selected commune, one school was selected using simple random sampling. Prior Permission was obtained from the School Principal while informed Consent was obtained from the School principal, class teachers and parents before commencing the study. Children in the age group of 8-13 years were randomly selected for the study. Children with asthma, chronic respiratory disorders and recent respiratory infection in the past 2 weeks were excluded. After selecting the children, age and sex were recorded. A basic physical examination was done to exclude children based on the exclusion criteria.

Anthropometric measurements of the students were taken. The Standing height was measured by Stadiometer without footwear, standing erect with a heel. Weight was measured by electronic weighing machine wearing only school uniform after removing footwear and other accessories. The weighing balance was calibrated before taking measurements while the accuracy of the machine was ±50 g.

Peak Expiratory Flow Rate (PEFR) was measured using Mini-Wright’s peak flow meter (mWPFM) (Clement Clarke International Ltd, U. K). The accuracy of the flow meters was ±10 L/min. The PEFR manoeuvre was explained and demonstrated to the children. All children were tested in the standing position. The mouthpiece of the Mini –Wright’s peak flow meter was placed in the child’s mouth and sealed through lips. The child was asked to take a deep breath to total lung capacity. After holding the breath for 1-2 seconds, the child was asked to blow into the Mini-Wright’s peak flow meter as hard and fast in a single exhalation. These steps were repeated two more times. The highest value from the three attempts was recorded as the child’s PEFR in L/min. Disposable mouthpieces were used for each subject. The PEFR was recorded at a fixed time (10.00 am to 1 pm) of the day throughout the study.

**Ethical Committee Clearance**

Permission was obtained from the Institutional Research and Ethics Committee. Permission was also obtained from the Department of School Education, Puducherry to conduct the study among the school children.

**Statistics**

The data were analysed using International Business Machines (IBM) SPSS (IBM Corp., Armonk, NY, USA). Continuous variables, including age, height, weight and BMI were reported as means ± standard deviation while for categorical variables, including sex was presented as percentage in each subgroup. Means for height, weight, age, and forced expiratory volume in 1 second were stratified by sex. To test for differences in measurements between boys and girls, the ‘t-test’ was used. To examine the relationship between dependent and independent variables and PEF correlation coefficient were calculated. Multivariate regression was done for the prediction of PEFR taking weight, age and height as independent variables. A p value of <0.05 was considered as the level of significance.
RESULTS
A total of 643 healthy school children from Puducherry were selected for the present study out of which 391 and 252 boys and girls respectively with rate of 1.55. Distributions of age and anthropometric data by sex of the study population are shown in Table 1. There were no significant differences between boys and girls in body height and weight from ages 8 to 9 years and 12 years. Weights were significantly higher for girls than for boys for in the age 10-11 years (p<0.05).

Data shows mean (standard deviation), **p<0.001, *p<0.05, NS- Not Significant.

There were also significant differences in PEFR values between boys and girls in 20-29 (210.71 ± 46.33 vs. 195.43 ± 39.32 L/min, p=0.008) and 30-39 kg (250.42 ± 50.58 vs. 222.44 ± 47.73, p<0.001) weight groups. The other weight groups were insignificant (p>0.05) (Table 4).

The correlation coefficients between peak expiratory flow rate obtained by mini peak flow meter and anthropometric parameters such as height and weight were examined. The correlation was more similar for height (boys: r = 0.576 vs 0.556: girls), and age (boys: r=0.478 vs 0.543: girls) than weight (boys: r=0.478 vs 0.506: girls). In girls, weight had better correlation compared to boys, but height was highly correlated in both the groups (Table 5). However, despite subtle differences, all correlations were found to be positive and significant (p<0.001).
In developing the multiple regression model, we included age, height, and weight in the model as independent variables to predict PEFR. The age (β=7.83, p<0.001), height (β=0.84, p=0.036) and weight (β=0.79, p=0.015) are the significant predictors of PEFR values for girls while age (β=10.03, p<0.001) and height (β=1.36, p<0.001) but not weight (β=0.36, p=0.255) for boys in the sex-specific model. The model showed that for girl’s age and height while for boy’s height was the significant predictor. From this model, regression equations were formed:

**The Regression equation for Boys**
PEFR (L/min) = -74.947 + 10.028 * Age (in years) + 1.361 * Height (in cm) + 0.358 * Weight (in Kg)

**The Regression equation for Girls**
PEFR (L/min) = -9.465 + 7.825 * Age (in years) + 0.840 * Height (in cm) + 0.797 * Weight (in Kg)

**DISCUSSION**

Peak expiratory flow rate measurement is a simple tool to examine obstructive changes in the airway. This can be used for monitoring PEFR, to assess the airflow as an indicator of asthma diagnosis and management in daily practice of respiratory medicine. Several studies have been conducted in the past both in developed and developing countries including India and showed significant association between PEFR rate and age, sex, geographic area and anthropometric parameters including height, and weight. Evidence has consistently showed that a significant regional, geographical and communities differences residing within the same country in terms of lung function parameters. In view of the above, the study has been conducted in Puducherry, given that to our knowledge none had previously attempted created nomograms in healthier population.

This cross-sectional study conducted in Southern India, especially in Puducherry, a Union Territory, on 643 healthy school students (391 boys and 252 girls). The findings showed that the age (β=7.83, p<0.001), height (β=0.84, p=0.036) and weight (β=0.79, p=0.015) are the significant predictors of PEFR values for girls while age (β=10.03, p<0.001) and height (β=1.36, p<0.001) but not weight (β=0.36, p=0.255) for boys. These findings are similar to the studies conducted elsewhere. Panda et al. showed that age, sex, height, weight were significant predictors of PEFR in a study conducted in Delhi and Andhra Pradesh. Similarly, our study findings are correlated with the studies conducted among Caucasians and North Indians where lung function variables found to be positively and linearly correlated with PEFR. The possible mechanism behind this relationship would be due to increase in muscle mass and rapid growth of airway passage as weight increases among boys.

In the present study, the mean PEFR value of the boys and girls was found to be different where boys showed significantly higher value than girls (p<0.01). The lower
PEFR value among girls is possibly due to a smaller chest size. Our findings are in contrast to the previous south Indian study from Trivandrum Kerala by Abraham et al. Who reported marginally higher mean PEFR for boys than that of girls but insignificant (p<0.05) in the age group between 6 and 12 years. Yet, our findings are in line with the study conducted by Budhiraja et al. On healthy school children considering both urban and rural in the district of Ludhiana between the age group 6 and 15y, which showed significantly higher value of PEFR in boys than that of girls (p<0.05). Similar studies conducted by Sharma in Indian children while study by Primhak et al, in British children reported similar findings. Even among study conducted in Libyan children, the mean PEFR of the boys was significantly higher than girls and while height showed maximum variance in the lung parameters while interestingly age is the predictor for such difference. In the present study PEFR values of children were comparable to the previous studies conducted in other North, Western and South Indian children as shown in the Table 7.

<table>
<thead>
<tr>
<th>Study</th>
<th>Variables</th>
<th>Samples</th>
<th>Regression Equation</th>
<th>p Value</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present Study</td>
<td>Age, Height, Weight</td>
<td>Boys</td>
<td>PEFR (L/min) = -74.947 + 10.028 * Age (in years) + 1.361 * Height (in cm) + 0.358 * Weight (in Kg)</td>
<td>0.000**</td>
<td>37.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Girls</td>
<td>PEFR (L/min) = -9.465 + 7.825 * Age (in years) + 0.840 * Height (in cm) + 0.797 * Weight (in Kg)</td>
<td>0.001**</td>
<td>35.5</td>
</tr>
<tr>
<td>Meenakshi et al 2012</td>
<td>Age</td>
<td>Boys</td>
<td>PEFR = 27.422 +Age * 17.289</td>
<td>0.001**</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Girls</td>
<td>PEFR=83.88 + Age * 7.399</td>
<td>0.05*</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Height</td>
<td>Boys</td>
<td>PEFR = -166.592 +Height * 2.653</td>
<td>0.001**</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Girls</td>
<td>PEFR=-50.24 + Height * 1.501</td>
<td>0.01**</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Weight</td>
<td>Boys</td>
<td>PEFR = 71.519 + Weight * 4.202</td>
<td>0.000**</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Girls</td>
<td>PEFR=115.801 + Weight * 1.406</td>
<td>0.02*</td>
<td>-</td>
</tr>
<tr>
<td>Durairaj et al 2017</td>
<td>Age</td>
<td>Boys</td>
<td>PEFR = 34.48 + Age * 24.42</td>
<td>0.001**</td>
<td>30.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Girls</td>
<td>PEFR = 21.40 + Age * 23.65</td>
<td>0.001**</td>
<td>58.5</td>
</tr>
<tr>
<td></td>
<td>Height</td>
<td>Boys</td>
<td>PEFR = -228.63 + Height * 3.82</td>
<td>0.001**</td>
<td>28.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Girls</td>
<td>PEFR=-250.71 + Height * 3.91</td>
<td>0.001**</td>
<td>57.8</td>
</tr>
<tr>
<td></td>
<td>Weight</td>
<td>Boys</td>
<td>PEFR = 12.21 + Weight * 9.91</td>
<td>0.001**</td>
<td>26.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Girls</td>
<td>PEFR = 13.16 + Weight * 9.21</td>
<td>0.001**</td>
<td>49.8</td>
</tr>
<tr>
<td>Mittal et al 2013</td>
<td>Age, Height, Weight</td>
<td>Boys</td>
<td>PEFR (L/min) = -150.38 + 9.17 * Age (in years) + 1.75 * Height (in cm) + 1.74 * Weight (in Kg)</td>
<td>-</td>
<td>96.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Girls</td>
<td>PEFR (L/min) = -177.06 + 0.86 * Age (in years) + 2.59 * Height (in cm) + 1.49 * Weight (in Kg)</td>
<td>-</td>
<td>94.9</td>
</tr>
<tr>
<td>Pandhi et al 2018</td>
<td>Height</td>
<td>Boys</td>
<td>PEFR = -276.61 + 4.50 * Ht</td>
<td>-</td>
<td>87.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Girls</td>
<td>PEFR = -393.87 + 5.20 * Ht</td>
<td>-</td>
<td>85.3</td>
</tr>
<tr>
<td></td>
<td>Weight</td>
<td>Boys</td>
<td>PEFR = 170.43 + 5.22 * Wt</td>
<td>-</td>
<td>86.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Girls</td>
<td>PEFR = 127.98 + 5.86 * Wt</td>
<td>-</td>
<td>85.7</td>
</tr>
</tbody>
</table>

Table 7. Comparative Pearson Correlation Coefficient Between Peak Expiratory Flow Rate (PEFR) Values Recorded by Mini Peak Flow Meter in Relation to Age, Height and Weight Observed by Different Workers Using Regression

Dependent variable: PEFR (L/min), **p<0.001, *p<0.05, NS- Not Significant.
Limitations of the study include the following: Firstly, the information were collected from the children rather than the parents. Secondly, the study is limited to one single school from Puducherry, but future studies should attempt to include more schools that should represent Puducherry. Thirdly, many factors that influence PEFR had not been captured in this study therefore future studies need to identify the several factors that would influence this difference in the PEFR between boys and girls. The study did not account BMI as part of anthropometric parameters, but future study should include BMI as an indicator to predict PEFR. Finally, the sample size in this study was comparatively small, therefore further studies need to include larger sample size and region wise comparison including socioeconomic and genetic factors. However, despite these limitations, this is the first study that attempted to capture the peak expiratory flow rate to measure airway obstruction among healthy school children in Pondicherry.

CONCLUSION
The present study showed a significant correlation between anthropometric parameters including weight and height with PEFR across age and sex among 8 to 13 years healthy school children. Multiple regression equation was used to calculate PEFR in children using height, weight, and age. Based on the data obtained from these children, the study developed normogram for future preliminary reference for Puducherry. The equation would be helpful in evaluation of children with airway diseases.

Acknowledgement
The study was done as an STS (short term studentship) project of Indian Council of Medical Research (ICMR). The authors would like to thank ICMR. The authors are thankful to Dr. Bahurupi Yogesh Arvind, Assistant professor, Department of Community Medicine, for helping with the statistical analysis.

REFERENCES


