

## Research Article

# Comparison of peak expiratory flow rate in healthy urban and rural school children in and around Bangalore: a cross sectional study

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### ABSTRACT

**Background:** Among the chronic airway disease affecting children bronchial asthma is an important entity. It is a disease which is associated with fluctuation in the airway caliber and one of the earliest signs of attack is a fall in peak expiratory flow rate. Peak expiratory flow rate (PEFR) measurement is a simple and a reliable way of detecting airway obstruction. In the study determination of PEFR of children in relation to the other anthropometric parameters, gender, environmental parameters and socioeconomic status was evaluated. Comparison of PEFR of urban and rural children was done to see for any significant difference.

**Methods:** A cross sectional study was done comparing a total of 563 children in the age group of 6 to 14 years from both urban and rural limits of Bangalore (290 from urban and 273 from rural). Mini Wright Peak Flow Meter was used to record PEFR.

**Results:** Positive co-relation was found between anthropometric variables like height, weight and body surface area with PEFR. P value showed significant difference between those who were exposed to pets than those who were not. P value difference was not significant between the urban and the rural children. With better socioeconomic status children had better PEFR.

**Conclusions:** There is no significant difference between PEFR of urban and rural children. It does not vary between boys and girls significantly. It varies with the built of the body. Pet exposure has a significant effect on PEFR values in children. Children from lower socioeconomic status have a lower PEFR compared to those from higher socioeconomic status.

**Keywords:** PEFR, Urban, Rural, Fuel, Pet exposure, Socioeconomic status

### INTRODUCTION

Diseases affecting the respiratory tract are the most common cause of death in both the developed and the developing world. Among the chronic airway disease affecting children bronchial asthma is an important entity. The prevalence as well as mortality and morbidity due to asthma has been increasing with increasing industrialization. It is a common respiratory disease of childhood which is associated with fluctuation in the airway caliber and one of the earliest signs of attack is a

fall in peak expiratory flow rate. Peak expiratory flow rate (PEFR) measurement is a simple, reproducible and a reliable way of judging the degree of airway obstruction in various obstructive pulmonary diseases, especially asthma. Peak flow, is the maximal rate at which a person can exhale during a short maximal expiratory effort after a full inspiration. In patients with asthma, the predicted PEFR correlates reasonably well with the predicted value for the forced expiratory volume in first second (FEV1). Serial PEFR monitoring is a convenient method for investigating and diagnosing asthma. A variation of

greater than 20 percent of baseline indicates airway reactivity. Monitoring the PEFR is useful for detecting changes or trends in a patient's asthma control, although significant variability of the test makes it important to confirm or exclude airflow limitation with a more reliable test, such as spirometry.<sup>1</sup> The simplicity and the cost of the instrument make it a simple tool which can be used by patients to measure the airflow obstruction early in cases of reactive airway disease and predict any deterioration before the acute event sets in.<sup>2</sup> Normal predictive values are essential for clinical interpretation of lung function tests. Normograms predicting PEFR from anthropometric measurements are available for various populations groups.<sup>3</sup>

### ***Need for the study***

During epidemiological studies it is important that the population from which PEFR standards are derived is an appropriate one since predicted normal values are affected by many factors including ethnic, regional and environmental influences. Comparison of PEFR of urban and rural children will be useful in determining whether the factors affecting PEFR are causing significant differences in their measured values.<sup>4</sup>

### ***Aims and objectives***

To objectively assess the Peak expiratory flow rate in healthy school children between the age group of 6 -14 years using Mini-Wright peak flow meter.

- a. Compare PEFR of urban and rural<sup>5</sup> children for any significant differences.
- b. To find out the relationship between variables like age, sex, weight, height, arm span, body surface area, body mass index with peak flow rates of the children.
- c. To find out the relationship between environmental factors like exposure to pets, cooking fuel and socioeconomic status with peak flow rates of the children.

## **METHODS**

This was a prospective cross sectional study which was done in the 5 different schools in Bangalore City and rural areas around Bangalore. It was done between October 2011 and Nov 2012 a period of thirteen months. Considering the age (6-14 years) and socioeconomic status (higher, middle and lower class) the students from five different schools in Bangalore city and rural areas were included in the study. The investigator cross checked her own peak flow readings to demonstrate the reproducibility of PEFR every time before determining the children's PEFR at schools. Permission was obtained from Principals/Headmasters of the institute. From each school targeted samples were selected randomly based on their roll numbers after examining the students in the class. Information regarding students was taken from the

teachers of students belonging to Class I to Class III and directly from the students of Class IV and above.

These children were interviewed to rule out the following,<sup>6</sup>

- a. H/o acute respiratory tract infection within preceding three weeks.
- b. H/o chronic respiratory disease, asthma
- c. H/o skeletal deformities of thorax
- d. H/o cardiac and neurological disease
- e. H/o smoking in adolescents

Students who fulfilled the inclusion criteria were separated, proper clinical examination was conducted and questionnaires were appropriately filled up. Height was measured by stadiometer, arm span was measured across the back using measuring tape and weight was recorded by bathroom scale without shoes and minimum clothes. Accuracy of the weighing machine was  $\pm 500$  grams. Any fraction of weight thus measured was corrected to the nearest kilogram.

BMI was calculated by using following formulae.

$$\text{BMI} = \text{weight (kg)} / \text{height (m)}^2$$

Body surface area using the Mosteller formula

$$\text{BSA (m}^2\text{)} = ([\text{Height (cm)} \times \text{Weight (kg)}] / 3600)^{1/2}$$

Mini Wright Peak Flow Meter (mWPFM) (60-800L/min) was used to record PEFR (L/min).

Before asking to perform peak flow (10 students in each group), students were demonstrated how to use mWPFM correctly. For each determination the child was instructed to make a maximal inspiratory effort and then to make the maximal and most rapid expiratory effort possible, in standing position. Most of the students were given trial 2-4 times then serial 3 blows for PEFR were registered in individual sheet after the child had become familiar with the technique. Disposable mouth piece were used for recording of PEFR.

### ***Statistical analysis***

Descriptive statistics reported using numbers and percentage for the categorical variable and mean  $\pm$  standard deviation or median (Range) for the continuous variable. Independent t-test or Wilcoxon rank sum was done to test the association area wise, with demographical and clinical variables. Pearson's correlation co-efficient was done to compare the PEFR with demographical and clinical variables. Multiple linear regressions was done to assess the factor associated with PEFR over age and gender after adjusting separately for height, weight, BSA, BMI and AS. Analysis was done using STATA-IC version 12 software and  $P < 0.05$  is considered as significant.

## RESULTS

**Table 1: Study population as per urban and rural school.**

	Number (Percentage)
Area	
Urban	290 (51.50)
Rural	273 (48.50)
Sex	
Male	244 (43.30)
Female	319 (56.70)
Smokers in family	
Yes	184 (32.70)
No	377 (67.00)
Pets	
Yes	144 (25.6)
No	416 (73.9)
SES	
1.00	71 (12.60)
2.00	107 (19.00)
3.00	120 (21.30)
4.00	197 (35.00)
5.00	68 (12.10)
Fuel	
Gas	401 (71.2)
Others	160 (28.4)

**Table 2: Mean of the parameters.**

Descriptive	Mean ± S.D
Age	9.93 ± 2.63
Height	131.79 ± 15.45
Wt	28.84 ± 11.25
BSA	1.01 ± 0.25
BMI	16.03 ± 3.27
AS	131.12 ± 14.22
PEFR	271.13 ± 75.20

**Table 3: Area, gender, pets and fuel comparison with PEFR.**

	PEFR	P value
Area		
Urban	272.33 ± 77.32	0.697
Rural	269.85 ± 73.01	
Sex		
Male	267.79 ± 65.90	0.357
Female	273.68 ± 81.62	
Pets		
Yes	259.65 ± 80.49	0.043
No	274.31 ± 72.61	
Fuel		
Gas	274.15 ± 78.65	0.078
Others	261.81 ± 63.84	

**Table 4: PEFR Correlation with age, height, weight, BSA and AS**

	Mean± SD	Rural	Mean±SD	Urban
Age	10.09 ± 2.63	r=0.772	9.78 ± 2.61	r=0.807
PEFR	269.85 ± 73.01	p=<0.001	272.33± 77.32	p=<0.001
Height	131.51 ± 15.54	r=0.831	132.04± 15.40	r=0.844
PEFR	269.85 ± 73.01	p=<0.001	272.33± 77.32	p=<0.001
Wt	28.07 ± 10.70	r=0.770	29.57 ± 11.72	r=0.758
PEFR	269.85 ± 73.01	p=<0.001	272.33 ± 77.32	p=<0.001
BSA	0.99 ± 0.24	r=0.808	1.02 ± 0.25	r=0.765
PEFR	269.85 ± 73.01	p=<0.001	272.33 ± 77.32	p=<0.001
BMI	15.61 ± 2.79	r=0.557	16.43 ± 3.62	r=0.366
PEFR	269.85 ± 73.01	p=<0.001	272.33 ± 77.32	p=<0.001
AS	130.25 ± 14.29	r=0.821	131.94 ± 14.13	r=0.848
PEFR	269.85 ± 73.01	p=<0.001	272.33 ± 77.32	p=<0.001

Total 563 children were studied from both Bangalore urban and rural limits. 290 children belonged to schools in urban Bangalore and 273 belonged to schools of villages around Bangalore.

**Table 5: Multiple regression with age and gender adjusted for height.**

	PEFR OR (95% C.I)	p-value
Age	6.88 (4.33 – 9.44)	<0.001
Sex	12.72 (5.98 – 19.45)	<0.001
Height	3.12 (2.68 – 3.55)	<0.001

**Table 6: Multiple regression with age and gender adjusted for weight.**

	PEFR OR (95% C.I)	p-value
Age	13.76(11.73 – 15.81)	<0.001
Sex	16.37 (9.23 – 23.52)	<0.001
Weight	2.17 (2.31 – 3.28)	<0.001

**Table 7: Multiple regression with age and gender adjusted for BSA.**

	PEFR OR (95% C.I)	p-value
Age	12.41(10.25 – 14.57)	<0.001
Sex	16.11 (9.04 – 23.19)	<0.001
Weight	140 (-16.60 – 15.01)	<0.001

**Table 8: PEFR compared with socio-economic status.**

SES	PEFR	p-value
1	293.66 ± 107.45	0.006
2	260.14 ± 83.25	
3	283.42 ± 52.38	
4	262.69 ± 70.00	
5	267.65 ± 63.08	

**Table 9: PEFR derived from this study as compared to other studies.**

	120 cm Boys	120 cm Girls	140 cm Boys	140 cm Girls
Sen et al	246	211	314	265
Swaminathan et al	205	193	286	272
Taskande et al	217.49	174.94	311.49	251.74
Carson et al	250	244	344	332
Parmesh et al	200		300	
Present study	226	218	325	312

Peak expiratory flow rate readings were taken from 563 healthy children between the age of 6-14 years in Bangalore and surrounding villages and compared to look for any significant differences. The study was done in these children after ruling out any significant illness. This study found the values of PEFR (liter/minute) in boys and girls of urban and rural schools in relation to height, weight, age, body surface area, body mass index and arm span. Details of family with regard to smokers in family, cooking fuel, pets at home, socioeconomic status was also collected to assess the impact of all these different parameters on the PEFR of an urban in comparison to a child in a rural school.

## DISCUSSION

The study was aimed at finding out, if there was any significant difference in the peak flow rates of urban and rural children due to their different environment and differences in various anthropometric parameters and exposure to environmental pollution and allergens. The children from these schools had different environmental factors with schools from rural areas being located away from the main roads and children having come from lower socioeconomic backgrounds. Children from urban schools on the other hand had their school locations closer to the main roads and they were mostly from higher socioeconomic backgrounds. Difference between PEFR of urban and rural children was not statistically significant as also proven by studies done by Paramesh et al<sup>7</sup>, Glew et al<sup>8</sup> and Pasek et al<sup>9</sup> in different parts of the world. In contrast certain studies done in North India by Budhiraja et al<sup>10</sup> showed a significant difference between urban and rural children, with urban children having better PEFR. However in adult studies done by Dhillon et

al rural adults had better PEFR in comparison to their urban counterparts.

Age was found to have a positive correlation with PEFR. With increase in age in children PEFR increases however in adult studies the PEFR decreases after 30 yrs.<sup>11</sup>

PEFR values of girls (in relation to height) were always lower than that of the boys however there is no statistically significant difference. This was similar to the findings of studies done by Malik et al<sup>12</sup> and Paramesh et al.<sup>7</sup> However, certain other studies observed higher PEFR in boys in comparison to girls.<sup>2,12</sup>

Correlation was found between PEFR and various anthropometric parameters like height, weight, arm span, body surface area and body mass index which were also found in other studies by Mohammadzadeh et al<sup>13</sup>, Malik et al<sup>14</sup>, Paramesh et al<sup>7</sup>. The most significant correlation was between height and PEFR (Malik et al<sup>14</sup>). As the height correlates the best it can be used to predict PEFR of children. Several recent studies had also shown the highest correlation coefficient between PEFR with height, which was also proven in our study where the highest correlation was found between the two.<sup>7,15</sup>

In addition to height the arm span was also measured which showed the next best correlation after height. Arm span has a merit that it can replace height in subjects or patients, in whom height cannot be measured accurately.

Body surface area has a good correlation with PEFR and it has a better correlation in comparison to weight in our study.

Mean PEFR derived in this study is comparable to that in other studies done in West Bengal, Maharashtra, Bangalore and studies done in Dublin<sup>16</sup> (western data). Studies done in Chennai show lesser values in comparison to our study and studies done from other states. Hence the authors had recommended developing PEFR charts for different states.

In addition data was collected about exposure to smokers in family, cooking fuel, pet exposure and socioeconomic status.

Significant differences between PEFR of children exposed to pets against those not exposed were found. PEFR of children with no pet exposure was better than the exposed group. Studies done on veterinary doctors exposed to animals (Krakowiak et al<sup>17</sup>) showed that this group is more prone for obstructive airway diseases like asthma. Exposure to animals showed a drop in their recorded PEFR and an improvement in the same was observed during periods of abstinence from work (away from animals). This would be of significance to detect early reactive airway changes in children who have been exposed to pets and are symptomatic.

Significant differences were found in the PEFR of higher socioeconomic status and those belonging to lower socioeconomic status. Those belonging to lower socioeconomic status had lower PEFR as compared to those with higher socioeconomic status. Similar results were reported by Sharma et al<sup>18</sup> which showed lower PEFR in lower socioeconomic status. In those belonging to lower class the family size is large. Most of them do not have access to good nutrition and are living in unhygienic surroundings, resulting in lower body proportions when compared with that of well-nourished children. This was considered to be the reason for lower PEFR in this group.

No significant difference in PEFR of the groups exposed to smokers in family and to those with no smokers in the families was found.

Also no significant difference in PEFR was found between families using gas as cooking fuel against those with other modalities of fuel used for cooking. Studies show adverse effects mainly on preschool children exposed to burning of fossil fuel<sup>19</sup> and also exacerbation of asthma symptoms in the same.

## CONCLUSIONS

PEFR forms an important simple bedside tool to assess for obstructive changes in the airway which can form a pediatrician's guide in daily practice of respiratory medicine. PEFR does not vary significantly between urban and rural children despite varying environmental factors. As age increases there is an increase in the peak flow readings in children. Its values do not vary significantly in boys and girls. It shows good correlation with height, arm span, weight, body surface area and body mass index. Children have a varying growth pattern in each region. Hence it is desirable to have standard values for children of each geographical location for comparison. However our study shows that PEFR values obtained from children in and around Bangalore are comparable to those in other states in India and the West. PEFR has correlation with socioeconomic status, as better nutrition improves overall lung functioning. Pet exposure affects PEFR, which can be used as a guide in monitoring these children for detection of early obstructive airway changes and to prevent the same.

There is no significant difference between PEFR of urban and rural children. The PEFR does not vary between boys and girls significantly. PEFR varies with the built of the body. Pet exposure has a significant effect on PEFR values in children. Those from lower socioeconomic status have a lower PEFR compared to those from higher socioeconomic status.

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