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Original Research Article

Measurement of peak expiratory flow rate values in healthy school going children between 6 and 12 years attending urban schools in Chennai

Prabakar Durairaj[1], Sasivarathan Raju[2]*, Sivaraman Thirumalaikumarasamy[1]

[1]Department of Pediatrics, Institute of Child health, Chennai, Tamil Nadu, India
[2]Department of Pediatrics, Government Mohan Kumaramangalam Medical College, Salem, Tamil Nadu, India

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***Correspondence:**
Dr. Sasivarathan Raju,
E-mail: drprabakar73@gmail.com

ABSTRACT

Background: Peak expiratory flow rate (PEFR) is an important tool in monitoring patient's changes in asthma. Bronchial asthma is among the commonest disorders in childhood. Here authors planned to measure PEFR in healthy school going children between 6 and 12 years and correlate PEFR against various parameters such as height, weight, sex, age and chest circumference.
Methods: The study was conducted from February 2005-August 2006 among healthy children between 6 and 12 years of age attending urban schools of both sexes in Chennai. The schools were selected randomly.
Results: PEFR values were measured in a large number of children between 6 and 12 years and varied significantly between boys and girls in the age group 6 to 12 years. Among all the study variables, height had shown the maximum positive correlation to PEFR in both boys and girls. The co-efficient of regression derived for height was found to be highly statistically significant both in boys and girls.
Conclusions: Significant correlations were found between PEFR and biological variables like age, weight, height and chest circumference. The correlation is more robust with regard to height. Boys have more PEFR values than girls across all age groups.

Keywords: Peak expiratory flow rate, School going children, Urban schools in Chennai

INTRODUCTION

Peak expiratory flow rate (PEFR) is the maximum or peak flow rate that produced during a forceful exhalation. It depends on the voluntary effort and muscular strength of the patient.[1] This is a suitable method in investigation and diagnosis of obstructive airway diseases disorders.[2] PEFR values decrease in children with bronchospasm. This is a better tool in monitoring patient's changes in asthma.[3] Bronchial asthma is among the commonest disorders in childhood, associated with frequent fluctuations of airway caliber.[4] For clinical analysis of lung function test predictive normal values are important. Nomograms predicting PEFR from anthropometric measurements are available for different population groups.[5] In lung function test, epidemiology takes an vital role to ensure that population from which regression equation was derived as many variables can affect PEFR.[5]

Ideally children of different countries, belonging to different races should have different nomograms.

Unfortunately, specific nomograms showing PEFR values for normal children are not available in all parts of India. If such data for children in different areas of India will be available, it would be immensely helpful in diagnosing, monitoring and managing asthma in children, which has been in an increasing trend in recent times.

So, authors planned to measure PEFR in healthy school going children between 6 and 12 years and correlate PEFR against various parameters such as height, weight, sex, age and chest circumference.

METHODS

This was a descriptive study and designed in urban schools in Chennai. The study was conducted from February 2005 to August 2006 among healthy children between 6 and 12 years of age attending urban schools of both sexes in Chennai. The schools were selected randomly.

Proper consents of the school authorities, parents and children were taken before study. Children were interviewed history of wheeze, nocturnal cough, allergy, TB contact, acute respiratory tract illness in the preceding 7 days, asthma, tuberculosis, allergy from their families, presence of any major illness affecting CVS, respiratory system, CNS, GIT, cough with/without fever, structural anomalies of chest, chest retractions, rales and wheeze on auscultation to exclude from this study.

PEFR was measured by mini-Wright peak flow meter made in England (Clement Clarke). When a child blows through the mouth piece, the piston of the instrument is pushed forward and it drives an independent sliding indicator (pointer) along a slot marked with a scale graduated 60-800 L/minute. The indicator records the maximum movement of the piston and remains in that position until returned to zero by the operator. The mouthpiece is detachable. The instrument is cleaned regularly during use.

All the children in the specified age group attending the school who satisfy the study criteria were studied. A questionnaire was sent on the previous day to the parents in which information regarding the family history and the past history of the child were collected.

The children were taken as a group into a separate place for examination. The age to the completed years and sex of each child was noted.

The following measurements were taken:

- Weight to the nearest Kilogram while standing with light clothing
- Height to the nearest centimeter while standing without shoes
- Chest circumference in maximum inspiration to the nearest centimeter.

The child was clinically examined for the presence of cough, fever, chest retractions, chest deformities, wheezing, rales or any major illness affecting the cardiovascular, respiratory, gastrointestinal and central nervous systems.

The procedure of PEFR measurement using the mini Wright peak flow meter was demonstrated to the child. The child was given two trials and the next three readings were noted down. The best of three readings was taken as the PEFR of the child. If the difference between any two readings was large, the probability of a faulty procedure was considered. The procedure was demonstrated again to the child and a new set of readings was taken. During the procedure if a child develops cough, child was considered as having a respiratory problem and therefore excluded from the study.

Statistical analysis

Statistical analysis was done using the SPSS (Statistical Package for Social Science). Statistical methods used were Karl Pearson's correlation coefficient, student t-test, p-value and linear regression analysis. Linear regression analysis was performed using age, weight, height and chest circumference as independent variables and PEFR as the dependent variable. Since the difference in PEFR between boys and girls at any given height in the age group studied was small but statistically significant, data was analyzed both as a whole sample and separately for boys and girls.

RESULTS

The study sample consisted of 1470 healthy children aged 6 to 12 years attending school in Chennai. 735 boys and 735 girls were studied totally. The children came from a mixed background although most of them were from a lower socioeconomic status.

Table 1 shows the statistical descriptions of all the variables studied. Among all variable analyzed, the PEFR value is the prime variable. The mean PEFR values were higher in boys when compared to girls across all the age groups.

The correlation between the independent variables such as age, height, weight and maximum chest circumference and the dependent variable i.e. PEFR was assessed both individually and as a group. The correlation analysis was done separately for boys and girls and for the whole sample also.

The presence of a linear correlation was observed between all the four independent variables and the dependent variable. The coefficient of correlation (r) was calculated for all the variables. The statistical significance of the correlation was assessed using the p-value.

Table 2 shows linear positive correlation between the study variables such as age, weight, height and chest circumference and the outcome variable PEFR in the whole study sample and the individual sexes.

Table 1: Distribution of variables according to the age of the participants.

Age	Weight (in Kg)		Height (in cm)		Chest circumference (in cm		PEFR (in L/min)	
	Girls (n=735)	Boys (n=735)	Girls (n=735)	Boys (n=735)	Girls (n=735)	Boys (n=735)	Girls (n=735)	Boys (n=735)
6	18.9±0.6	18.5±0.7	106.2±2	106.9±2.4	53.2±0.6	53.2±0.7	165.9±4.7	176.5±5.2
7	19.5±0.9	20.2±0.7	113.9±2.3	113.8±1.9	54±0.9	53.4±0.8	185.5±3.4	202.2±4.4
8	20.1±1.4	21.4±1.1	115.8±2	120±2	55.4±1.2	56.6±0.9	212.4±3.6	244.6±5.6
9	23.8±1.6	25.2±1.3	124.8±2.4	130.6±3.2	59.8±1.6	59.3±1.2	226±6.8	251.6±8.1
10	24.7±1.3	25.0±1.3	130.9±1.9	131.9±1.2	61.2±1.4	61.1±0.8	262.9±6.4	272.9±4.5
11	29.0±1.3	28.7±1.4	134.1±1.6	135.7±1.6	64.6±0.8	65±0.7	281.7±5.4	307.6±8.4
12	32.1±1.5	32.0±1.8	142.1±2.1	144.9±1.4	69.4±1	68.4±1.9	305.7±9	324.8±6.8

Table 2: Co-efficient of correlation for study variables.

Study variable	Outcome variable (PEFR)					
	Girls		Boys		Total	
	Coefficient of correlation (r)	Statistical significance (p)	Coefficient of correlation (r)	Statistical significance (p)	Coefficient of correlation (r)	Statistical significance (p)
Age	0.787	<0.001	0.781	<0.001	0.785	<0.001
Weight	0.711	<0.001	0.701	<0.001	0.712	<0.001
Height	0.849	<0.001	0.848	<0.001	0.847	<0.001
Chest circumference	0.69	<0.001	0.689	<0.001	0.689	<0.001

Table 3: Regression analysis of variables to PEFR.

Variables	Samples	Regression equation	t-value	P value	R^2
Age	Girls	PEFR = 21.40+23.65 (age in years)	23.48	<0.0001	58.5%
	Boys	PEFR = 34.48+24.42 (age in years)	17.84	<0.0001	30.3%
	Whole sample	PEFR = 27.94+24.04 (age in years)	33.78	<0.0001	43.1%
Weight	Girls	PEFR = 13.16+9.21(weight)	33.66	<0.0001	49.8%
	Boys	PEFR = 12.21+9.91 (weight)	16.37	<0.0001	26.8%
	Whole sample	PEFR = 11.21+9.63(weight)	33.78	<0.0001	39.4%
Height	Girls	PEFR = -250.71+3.91 (height)	58.49	<0.0001	57.8%
	Boys	PEFR = -228.63+3.82 (height)	17.21	<0.0001	28.8%
	Whole sample	PEFR = -244.83+3.91 (height)	33.49	<0.0001	43.3%
	Girls	PEFR = -119.71+5.95 (CC)	34.85	<0.0001	62.4%
	Boys	PEFR = -178.25+7.26 (CC)	15.15	<0.0001	23.8%
	Whole sample	PEFR = -145.41+6.54 (CC)	26.43	<0.0001	32.3%

There is highly statistically significant positive correlation between the variables as suggested by the r-value and the p-value (p <0.001). The table shows that the higher values of age, weight, height and chest circumference are statistically significantly associated with the higher values of PEFR within the age group studied. In other words, as the age, weight, height and chest circumference increased, the values of PEFR also increased and vice versa. Though the correlation between age, weight, chest circumference and PEFR was found to be significantly positive, highest positive correlation was obtained for height and PEFR in whole sample (r = 0.847) and also both in boys (r = 0.848, p<0.001) and girls (r = 0.849, p<0.001).

Regression analysis was done for all the variables studied in the whole sample and also separately for boys and girls. The regression or prediction equations were obtained for all the independent variables i.e. age, weight, height and chest circumference after calculating the

regression coefficient. The significance of the regression co-efficient was evaluated with the help of t-value. The statistical significance was given by the p-value, which was found to be <0.001 for all the regression coefficients derived. The variabilities in the PEFR values were explained by the R-square values.

Table 3 shows regression analysis of age to PEFR and that the co-efficient of regression derived were highly statistically significant. 43.1%, 39. 4% of variability in PEFR was explained by age alone in the whole study sample, whereas it explained 30.3% of variability in boys and 58.5% of variability in PEFR among girls. The co-efficient of regression derived was statistically significant. Weight alone explained 39.4% of variability in PEFR in the whole study sample, 26.8% of variability among boys and 49.8% of variability among girls.

A statistically significant co-efficient of regression was obtained for chest circumference. Of all the study variables, this had shown the least positive correlation with PEFR. 32.3% of the variability in PEFR was explained by chest circumference in the whole sample and 23.8% and 62.4% of variability in the boys and girls groups respectively.

Among all the study variables, height had shown the maximum positive correlation to PEFR in both boys and girls. The co-efficient of regression derived for height was found to be highly statistically significant both in boys and girls. 43.3% of variability in PEFR could be explained by height alone in the whole study sample, whereas 28.8% and 57.8% of variability in PEFR were explained by height in boys and girls respectively.

Of all the 4 study variables, height showed the maximum positive correlation to PEFR both in boys and girls. Age had the second highest positive correlation in the age group studied, so a common regression equation derived consisting of both height and age. Both height and age together explained about 79.9% and 81.4% of the variability in PEFR in boys and girls.

Common regression equation using height and age as study variables as follows.

Girls: PEFR = -35.72+0.736 (height)+19.95 (age)

Boys: PEFR = -27.05+0.735 (height)+20.65 (age)

But since height showed maximum positive correlation and also the best co- efficient of regression, a regression equation was used based on height to draw a line diagram with height in x-axis and PEFR in y-axis. The PEFR value predicted from the equation or derived from the graph can be used as the normal baseline value for that particular child with a specific height.

The 80% of derived value gives the lower limit of the range in PEFR, which a normal child can have. A child with a PEFR less than 80% of the normal for his particular height is diagnosed to have obstructive airways disease. Further confirmation of asthma in that child can be obtained from observing the diurnal variation in PEFR >20% and the documentation of increase in PEFR from its baseline by more than 15-20% after a dose of inhaled bronchodilator.

DISCUSSION

The early detection of asthmatic exacerbations by means of objective measurement can provide a solution to these problems and stimulate the development of self-management and self-control techniques. The lack of perception of degree of pulmonary obstruction is an important cause for delay in the initiation of treatment. This is supported by recent reports of failure of parents to recognize the severity of the episode resulting in death of some children before arriving at the hospital, especially in children with difficult to control asthma. Early recognition of these asthmatic exacerbations can be made by measuring PEFR and also it is a useful tool in assessing the response to therapy.

Pande et al reported age, sex, height, and weight were independent predictors of PEFR. The PEFRs of children from both north and south parts of the country were similar, and were lower than those reported for western countries.[6] Though many types of peak flow meters are available to measure the peak expiratory flow rate, the mini Wright peak flow meter is now internationally accepted as the ideal instrument to measure the PEFR in children.

Various studies done in different parts of the globe showed that there was significant racial and ethnic difference in PEFR. In the present study, PEFR values were measured in a large number of children between 6 and 12 years, so that resulting PEFR values would have a higher significance. So, the final average values of PEFR derived would be better representation of the widely variable peak expiratory flow rates that occur in different children belonging to the same age group. The study showed that PEFR values varied significantly between boys and girls in the age group 6 to 12 years.

Deutsch and colleagues reported the highest correlation with a height.[7] The variability in PEFR in any child is explained by height to the maximum extent 43.3% in whole sample, 57.8% in boys and 28.8% in girls age explained the variability in PEFR in any child up to 43.1% in whole sample and 30.3% in boys and 58.5% in girls. Both height and age could explain the variability in PEFR up to 60%. Thus, showing that PEFR and thereby the pulmonary function is mainly dependent on height. This finding is similar to that given in many studies done both in India and western countries.[8-13] This is probably dependent on the fact that lung volumes correspond well to height in child.

In the present study, children have PEFR values slightly lower when compared with children in western countries.[11,13,14] Most of western studies show that height is the main predictor of lung function in normal children. So most of the authors have derived a regression or prediction equation for PEFR based on height alone, while some authors have given prediction equation based on both height, and age.[4,5,8,9,15] Most of the studies show that there is statistically significant difference between boys and girls and therefore different regression equations are given for boys and girls.[8-10,15] Reddy et al also reported PEFR levels were higher in boys than girls and this was more significant during puberty.[5] Present study also showed similar findings, so different regression equations are derived for both boys and girls based on height alone, since age also seems to explain the variability in PEFR to a significant extent, a regression equation is given including both height and age as the independent variables.

Table 4 shows the PEFR values of both boys and girls at various heights in a study from South India, a North Indian study and present study.[8-10] These PEFR values have been derived from prediction equations put forward in the studies.

Table 4: Comparative analysis of PEFR in children of different studies.

Height (cm)	Sex	Swaminathan et al[8]	Malik et al[9,10]	Present study
110	Boys	164.25	173.21	191.57
	Girls	154.19	167.2	179.39
120	Boys	205.05	222.41	229.99
	Girls	193.39	216.2	218.49
130	Boys	245.85	271.61	267.97
	Girls	232.59	265.2	257.59
140	Boys	286.65	320.81	306.17
	Girls	271.79	314.2	296.69

In this study, PEFR values were higher when compared to both the previous studies. The difference is more in the lower age group and gradually decreases as the child's height increases. At a height of 140 cm, the boys and girls in our study have PEFR values slightly lower than those in the North Indian study but still higher than those in the South Indian study. This concluded that the lung volumes in children of the present study were better than in children of the previous studies.[8-10]

CONCLUSION

Large population size helped to establish reference values for PEFR in south Indian children at Chennai aged between 6 and 12 years. Baseline values of PEFR, established can be useful in diagnosing and following asthmatic children. Prediction formulas derived from statistical analysis can serve the same purpose.

Significant correlations were found between PEFR and biological variables like age, weight, height and chest circumference. The correlation is more robust with regard to height. Boys have more PEFR values than girls across all age groups. Regression analysis gives prediction of PEFR based on the height and also for age and height.

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