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A cross sectional descriptive study to assess peak expiratory flow rate in healthy school going children between 6 to 12 yrs of age from Bhilai (C.G.), India

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Abstract
Introduction: Asthma is the most common chronic inflammatory disease in children and is major global health problem which exerts a substantial burden on family, health care services and on society as a whole. Prevalence of asthma in children is increasing day by day globally supported by different studies in different countries. Pulmonary function tests of various types are utilized clinically and epidemiologically to measure functional status in order to assess the disease.
Materials and Method: The present Cross-sectional prospective study was carried out to determine PEFR in healthy school going children between 6 to 12 years of age from Bhilai, Chhattisgarh during study Period July.2015 - Jun.2016. Healthy children attending schools from Bhilai (C.G.), India within 5 km radius of C.M. Hospital Bhilai (C.G.) India, were enrolled for the study. Total 1470 children were included in the study. The procedure of PEFR measurement using the Mini Wright peak flow meter was demonstrated to the child to measure PEFR.
Observations: The mean PEFR values were higher in boys when compared to girls across all the age groups. Linear positive correlation was found between the study variables age, height, weight and chest circumference and the outcome variable PEFR both in boys and girls. The correlation is highly statistically significant in both the study groups. 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).
Conclusion: In our study, baseline values of PEFR, established can be useful in diagnosing and following asthmatic children. Significant correlations are found between PEFR and biological variables like age, weight, height and chest circumference in the current study.

Keywords: PEFR, School children, Asthma

Introduction
Asthma is the most common chronic inflammatory disease in children and is major global health problem which exerts a substantial burden on family, health care services and on society as a whole.(1) Prevalence of asthma in children is increasing day by day globally supported by different studies in different countries.

Pulmonary function tests of various types are utilized clinically and epidemiologically to measure functional status in order to assess the disease.(2) Pulmonary function testing in a child differs from that in adult, largely because of the volume change that occurs from birth through the period of growth to the adulthood.(3) However, most of them are cumbersome, expensive and difficult to obtain reproducible results in children.

Pulmonary function is known to vary with age, sex, height, weight, race and geographic locations.(4) India being a subcontinent, changes in pulmonary functions can occur between children of South Indian origin and children of other regions.

Asthma is a leading cause of chronic respiratory illness in childhood.(5) The prevalence of asthma is steadily increasing in developing as well as developed countries due to environmental pollutions as result of industrialization. Also it has increased the rate of hospitalization and leading to increased morbidity and mortalities. The world health organization estimates the number of DALYs (disability adjusted life years) lost due to asthma about 15 millions of years, which corresponds to 1% of global loss of DALYs due to illness.(6)

Hence the diagnosis of childhood asthma or wheezing complex should be made early and early intervention and treatment should be initiated to prevent chronic morbidity and acute life threatening complications.

Easily available, cost effective diagnostic modalities are necessary for early diagnosis of asthma. Thus A. S. Paul stated that peak expiratory flow rate measured by peak flow meter is the simplest test of respiratory function in diagnosis and prognosis of asthma.(7)

PEFR usually varies according to many independent variables including gender, age, weight, height and chest circumference.(8)

Ideally children of different countries and different regions belonging to different races should have different nomogram. Unfortunately specific nomogram showing PEFR values for normal children are not available in all parts of India. If such nomogram for children in different parts of India is made available, it would be immensely helpful in diagnosing, monitoring and managing asthma in children which has been an increasing trend in recent times.

Hence the present study was done to measure PEFR of school children from Chhattisgarh state and to derive prediction formula for this population. So that it's proper implementation and early interventions would improve the quality of life of these asthmatic children of this region.

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

Materials and Method

The present Cross-sectional prospective study was carried out to determine PEFR in healthy school going children between 6 to 12 years of age from Bhilai, Chhattisgarh during study Period July 2015 – June 2016. Healthy children attending schools from Bhilai (C.G.), India within 5 km radius of C.M. Hospital Bhilai (C.G.) India, were enrolled for the study.

Inclusion Criteria

- All healthy school going children between 6 to 12 years of age.
- Those children whose parents gave consent for participating in study.

Exclusion Criteria

- History of wheeze, nocturnal cough, allergy, TB contact.
- History of acute respiratory tract illness in the preceding 7 days.
- Family history of asthma, tuberculosis, allergy.
- Presence of any major systemic illness affecting CVS, RS, CNS,GIT
- Presence of cough with/without fever.
- Presence of structural anomalies of chest, chest retractions.
- Presence of rales, wheeze on auscultation.
- Those children whose parents did not permitted their children to participate in study.

The sample size was in range of 500 to 1600 for various studies on this topic. Average of this sample size is around 1400. Total 1470 children from age group 6-12 years were included in the study. Out of these 735 were boys and 735 were girls. To avoid error from sampling variation in each age group constant no. i.e. 105 were taken.

Ethical clearance from institutional Ethics Committee was obtained. The necessary permission to carry out the study was obtained from Head Master of schools and their co-operation was sought. Random five schools were selected and approximately 250-300 children of each school with those having odd roll number selected for study. They were explained regarding nature of the study and requirement of place for examination of study participants. List of all children were obtained from schools. A time schedule was prepared for the study participants, so that they could participate in the study conveniently. A questionnaire along with consent form was sent on the previous day to the parents in whom information regarding the family history and the past history of the child were collected. Data was collected on next day on average 30-40 children per day. History taking included present illness, past history, family history followed by clinical examination. 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. Anthropometric measurements like weight, height and chest circumference were taken.

The procedure of Peak Expiratory Flow rate measurement using the Mini Wright peak flow meter was demonstrated to the child to measure PEFR.

The following measurements were taken

- Weight to the nearest Kilogram while standing with light clothing.
- Height to the nearest Centimetre while standing without shoes.
- Chest circumference in maximum inspiration to the nearest centimeter.
- To measure PEFR using the Mini Wright peak flow meter.

Statistical analysis: Statistical analysis was done using the SPSS (Statistical Package for Social Science). Statistical methods used were correlation coefficient, student t test, p-value and linear regression analysis. Linear regression analysis was performed. Correlation was established between variables to see the significant level. Data was analyzed both as a whole sample and separately for boys and girls. \`P\` value <0.05 is considered as statistically significant.

Observations

Table 1: Weight of girls across different age levels

Age in years	Weight (kg)		
	N	Mean	SD
6	105	18.9	0.6
7	105	19.5	0.9
8	105	20.2	1.4
9	105	23.8	1.6
10	105	24.7	1.3
11	105	29.0	1.3
12	105	32.1	1.5

Mean (SD) of weight for 6, 7, 8, 9, 10, 11 and 12 years of girls were 18.9(0.6), 19.5(O.9), 20.2(1.4), 23.8(1.6) 24.7(1.3) 29.0(1.3), 32.1(1.5) respectively.

Table 2: Weight of boys across different age levels

Age in years	Weight (kg)		
	N	Mean	SD
6	105	18.5	0.7
7	105	20.2	0.7
8	105	21.4	1.1
9	105	25.2	1.3
10	105	25.0	1.3
11	105	28.7	1.4
12	105	32.0	1.8

Mean (SD) of weight for 6, 7, 8, 9, 10, 11 and 12 years of boys were 18.5(0.7), 20.2(0.7), 21.4(1.1), 25.2(1.3) 25.0(1.3) 28.7(1.4), 32.0(1.8) respectively.

Table 3: Height of girls across different age levels

Age in years	Height (cm)		
	N	Mean	SD
6	105	106.2	2.0
7	105	113.9	2.3
8	105	115.8	2.0
9	105	124.8	2.4
10	105	130.9	1.9
11	105	134.1	1.6
12	105	142.1	2.1

Mean (SD) of height for 6, 7, 8, 9, 10, 11 and 12 years of gms were 106.2(2.0), 113.9(2.3), 115.8(2.0), 124.8(2.4), 130.9(1.9), 134.1(1.6), 142.1 (2.1) respectively.

Table 4: Height of boys across different age levels

Age in years	Height (cm)		
	N	Mean	SD
6	105	106.9	2.4
7	105	113.8	1.9
8	105	120.0	2.0
9	105	130.6	3.2
10	105	131.9	1.2
11	105	135.7	1.6
12	105	144.9	1.4

Mean (SD) of height for 6, 7, 8, 9, 10, 11 and 12 years of boys were 106.9(2.4), 113.8(1.9), 120.0(2.0), 130.6(3.2), 131.9(1.2), 135.7 (1.6), 144.9 (1.4) respectively.

Table 5: Chest circumference of girls across different age levels

Age in years	Chest circumference (cm)		
	n	Mean	SD
6	105	53.2	0.6
7	105	54.0	0.9
8	105	55.4	1.2
9	105	59.8	1.6
10	105	61.2	1.4
11	105	64.6	0.8
12	105	69.4	1.0

Mean (SD) of Chest circumference for 6, 7, 8, 9, 10, 11 and 12 years of girls were 53.2(0.6), 54.0(0.9), 55.4(1.2), 59.8(1.6), 61 .2(1.4), 64.6(O.8), 69.4(1.0) respectively.

Table 6: Chest circumference of boys across different age levels

Age in years	Chest circumference (cm)		
	N	Mean	SD
6	105	53.2	0.7
7	105	53.4	0.8
8	105	56.6	0.9
9	105	59.3	1.2
10	105	61.1	0.8
11	105	65.0	0.7
12	105	68.4	1.9

Mean (SD) of Chest circumference for 6, 7, 8, 9, 10, 11 and 12 years of boys were 53.2(0.7), 53.4(0.8), 56.6(0.9), 59.3(1.2), 61.1(O.8), 65.0(0.7), 68.4(1.9) respectively.

Table 7: PEFR of girls across different age levels

Age in years	PEFR(L/min)		
	N	Mean	SD
6	105	165.9	4.7
7	105	185.5	3.4
8	105	212.4	3.6
9	105	226.0	6.8
10	105	262.9	6.4
11	105	281.7	5.4
12	105	305.7	9.0

Mean (SD) of PEFR for 6, 7, 8, 9, 10, 11 and 12 years of boys were 165.9(4.7), 185.5(3.4), 212.4(3.6), 226.0(6.8), 262.9(6.4), 281.7(5.4) and 305.7(9.0) respectively.

Table 8: PEFR of boys across different age levels

Age in years	PEFR(L/min)		
	n	Mean	SD
6	105	176.5	5.2
7	105	202.2	4.4
8	105	244.6	5.6
9	105	251.6	8.1
10	105	272.9	4.5
11	105	307.6	8.4
12	105	324.8	6.8

Mean (SD) of PEFR for 6, 7, 8, 9, 10, 11 and 12 years of boys were 176.5(5.2), 202.2(4.4), 244.6(5.6), 251.6(8.1), 272.9(4.5), 307.6 (8.4), 324.8(6.8) respectively.

Tables 1 to 8 shows the statistical descriptions of all the variables studied. Among all variables analyzed, the PEFR value is the prime variables. 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.

Table 9: Co-efficient of correlation for study Variables in girls and boys

Study variable	Outcome variable (PEFR)	
	Coefficient of Correlation (Girls)	Coefficient of correlation (Boys)
Age	0.787	0.787
Weight	0.711	0.711
Height	0.849	0.849
Chest circumference	0.690	0.690

r >0.8= strong relation between two variables

r = 0.3 to 0.7=significant correlation between two variables.

Table show linear positive correlation between the study variables age, height, weight and chest circumference and the outcome variable PEFR both in boys and girls. The correlation is highly statistically significant in both the study groups.

The above Tables show that the higher values of age, weight, height and chest circumference and 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).

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 variability in the PEFR values was explained by the R-square values.

Table 10: Regression analysis of age to PEFRR

	Regression Equation	t value	p value	R^2
Girls	PEFR=21.40+23.65 x (age in years)	23.48	<0.0001	58.5%
Boys	PEFR=34.48+24.42 x (age in years)	17.84	<0.0001	30.3%

Regression analysis of age to PEFR and that the coefficient of regression derived were highly statistically significant. 43.139.4% of variability in PEFR was explained by age alone in the whole study sample. Whereas it explained 30.3% of variability in boys and 58.6% of variability in PEFR among girls.

Table 11: Regression analysis of weight to PEFR

	Regression Equation	t value	p value	R^2
Girls	PEFR=13.16+9.21x (wt in Kg.)	33.66	<0.0001	49.8%
Boys	PEFR=12.21+9.91 (wt.in Kg.)	16.37	<0.0001	26.8%

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.

Table 12: Regression analysis of chest circumference to PEFR

	Regression Equation	t value	p value	R^2
Girls	PEFR= 119.71+5.95 x (Chest circumference in cm)	34.85	<0.0001	62.4%
Boys	PEFR= 178.25+ 7.26 (Chest circumference in cm)	15.15	<0.0001	23.8%

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 group of boys and girls respectively.

Table 13: Regression analysis of height to PEFR

	Regression Equation	t value	p value	R^2
Girls	PEFR= -250.71 +3.91x (height in cm.)	58.49	<0.0001	57.8%
Boys	PEFR=-228.63+3.82x (height in cm.)	17.21	<0.0001	28.8%

Of 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:

Girls

PEFR = -35.72+0.736 x (Ht. in cm.) + 19.95 x (Age in yrs.)

Boys

PEFR = -27.05 + 0.735 x (Ht in cm.) + 20.65 x (Age in yrs.)

But since height showed maximum positive correlation and also the best coefficient 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. Two separate nomogram were derived for boys and girls as the mean PEFR values derived from regression equations showed significant difference between them. 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 Mean -2SD 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 -2SD of the normal for his particular height is considered for obstructive airways disease.

Discussion

Asthma is a leading cause of chronic respiratory illness in childhood[5]. The prevalence of asthma is steadily increasing in developing as well as developed countries due to environmental pollutions as result of industrialization. Also it has increased the rate of hospitalization and leading to increased morbidity and mortalities. 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. Early recognition of these asthmatic exacerbations can be made by measuring PEFR and also it is useful in assessing the response to therapy.[(9)]

The peak flow meter has been used in the clinical practice and in the epidemiological surveys for estimating ventilatory capacity and has proved to be practical aid in the investigations of chest conditions.[(10)] 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. The mini Wright peak flow meter is cheap, easily available small, portable requires no power supply and can be used without lengthy preparations is now being used extensively in western countries for all asthmatic children. It plays a very important role in home monitoring of asthmatics. The daily monitoring of the disease is made easy by observing the daily variations in PEFR that serve as a guide to the severity of asthma, the effectiveness of current therapy and the need for any additional treatment.[(11,12,13)]

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% sin 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.[(14-20)] This is probably dependent on the fact that lung volume corresponds well to height in child.

In the present study, children have PEFR values slightly lower when compared with children in western countries.[(21-23)] 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,[(24-27)] while some authors have given prediction equation based on both height, and age.[(28,29)] 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.[(14,15,16, 24, 25,27)] 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.

Magna Manjareeka et al[30] studied the assessment of peak expiratory flow rate in preadolescent children of sub tribal communities in Odisha. Total of 1000 tribal children were selected from standard 4 and 5, of which 868 participants were included in the study. The mean ± SD age in years of the boys and girls were 9.87 ± 1.5 and 9.75 ± 1.2, respectively. The mean ± SD of PEFR in L/min was significantly (P <0.001) more in boys (255.34 ± 65.60) than in girls (210.59 ± 55.70). The boys showed a better correlation of PEFR with weight, height and chest circumference than the girls. PEFR values significantly differed between the sub tribal groups (P <0.001). The anthropometric variables showed a positive correlation with PEFR in all the sub tribes. While Santala and Munda sub tribes showed maximum correlation of PEFR with weight and height, the chest circumference was well correlated with PEFR in Soura and Bonda sub tribes.

Correlation coefficient between various anthropometric variables and PEFR observed by Magna Manjareeka et al[30] and showing nearly similar findings with the current study. **Meenakshi Sharma et al[10]** studied the peak expiratory flow rates in children of western Rajasthan 7-14 years of age. One hundred and eighty- eight apparently healthy school children (112 Male, 76 Female) from age group 7-14 years were included in the study. Positive correlation was seen between age, height, weight, Body surface area, and PEFR.

A statistically significant co-efficient of regression was obtained for all study variables. Of 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.

In present study, positive correlation was found between PEFR and anthropometric variables. The norms established in the present study can very well serve the purpose of physiologists as well as clinician of this region. Physicians usually refer to common international references for obtaining different normal values, but it has been shown that PEFR values vary with racial, socioeconomic and genetic features, and with lifestyle. Therefore, it would be more appropriate for each country to have its own region reference values.

Conclusion

In our study, baseline values of PEFR, established can be useful in diagnosing and following asthmatic children. Significant correlations are found between PEFR and biological variables like age, weight, height and chest circumference in the current study. The correlation is more robust with regard to height. Boys have more PEFR values than girls across all age groups. The Mean-2SD 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 -2SD of the normal in the nomogram for his particular height is considered for obstructive airways disease. Normogram as a cost effective tool can be used for daily routine practice to reduce morbidity among these children.

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