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Assessment of Peak Expiratory Flow Rate in School Children and Its Correlation with BMI, BSA, and Family History of Obstructive Diseases

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ABSTRACT

INTRODUCTION

Pulmonary function tests of various types are utilized clinically and epidemiologically to measure functional status of lungs and to assess their diseases. Peak expiratory flow rate is defined as the maximum airflow achieved during a forceful expiration after taking maximal inspiration. It is measured in Litres/min. It has received general acceptance as an useful index of ventilatory capacity. Asthma is the most common chronic inflammatory disease in children and is a major global health problem which exerts a substantial burden on the family, health care services and on the society as a whole. With increasing incidence of respiratory diseases in children, it is also essential to have a normal range of PEFR in children of different ages and its relation to body size, as measured by Body Mass Index (BMI) and Body Surface Area (BSA).

MATERIALS & METHODS

This was a prospective cross sectional study was carried out in various primary and secondary schools is the city of Cuttack to assess the pulmonary function in children and its relation to B.S.A, B.M.I & family history of obstructive diseases over a period of one year and eight months. Studies of lung function assessment have been performed for diagnosis, treatment & follow up of respiratory morbidity. Measurement of PEFR is of value for the identification of chronic obstructive lung disease and for assessment and follow up of patients with asthma. Different normal values of PEFR have been obtained in populations of different locality.

Results

In the present study, PEFR was measured in 950 primary and secondary school children. The children were between the age group of 6 to 14 years. Among them 507 were boys and 443were girls. The PEFR is significantly ($p<0.05$) higher in boys than girls in all ages, except at 12years of age , where the values are comparable in both sexes. The rate of increase in PEFR is comparatively higher in boys than girls. The difference is statistically significant as p value is < 0.05 in all height intervals except in interval of 110-119 cm ($p>0.05$). The PEFR value to be highest in normal B.M.I. range (18.0-24.99) both in boys and girls. Boys have significantly ($p<0.05$) higher PEFR than girls. As there are only two subjects in B.M.I. range by 30.0-34.99, the results are inconclusive.

Conclusion

Diagnosis and Management of bronchial asthma requires periodic assessment of pulmonary function especially ventilatory functions. The peak expiratory flow rate (PEFR) measurement is a very simple, reliable, reproducible ventilatory function test. PEFR can be performed by using mini –Wright's peak flow meter (a cheap, portable instrument). Reference values to be used in a locality should be evaluated. Personal best PEFR reading is as reliable as other pulmonary function tests.

Keyword: *Pulmonary function tests, Peak expiratory flow rate, Asthma.*

1. INTRODUCTION

Pulmonary function tests of various types are utilized clinically and epidemiologically to measure functional status of lungs and to assess their diseases [1] . Pulmonary function testing in a child differs from that in adult, largely because of the volume changes that occurs from birth, through the period of growth to adulthood. These differences influence the technique, methodology and interpretation of pulmonary function tests [2] . However, most of them are cumbersome, expensive and provide difficulty in obtaining reproducible results in children[3].

Peak expiratory flow rate is defined as the maximum airflow achieved during a forceful expiration after taking maximal inspiration [4]. It is measured in Litres/min. It has received general acceptance as an useful index of ventilatory capacity [5] . The peak expiratory flow rate (PEFR) measurement is a simple, reproducible and reliable way of judging the degree of airway obstruction in various obstructive pulmonary diseases, especially asthma; even in children [6].

Asthma is the most common chronic inflammatory disease in children [7] and is a major global health problem which exerts a substantial burden on the family, health care services and on the society as a whole [8,9]. Prevalence of asthma in children is increasing day by day globally. This is supported by different studies in different countries [10,11,12]. So all simple devices and skill should be applied to prevent and treat such a chronic pulmonary disease. During the past decade, understanding of asthma self management has developed greatly, and there is a general agreement that more effective methods of educating patients are needed to reduce morbidity and mortality from the disease [13,14,15].

As per the recommendation of National Asthma Education and Prevention Programme (NAEPP), regular use of peak flow meter is helpful for better control of asthma. PEFR is a good indicator for early detection of deteriorating ventilatory function of lungs. It is especially useful in situations where repeated testing or home monitoring is required [16]. It provides a good subjective index to confirm diagnosis, to start treatment, to control or alter medication and monitor response to treatment. PEFR can be used not only to see the airway obstruction, but also to classify its severity and as a guideline for admission and discharge of asthma patients [17]. [18]

With increasing incidence of respiratory diseases in children, it is also essential to have a normal range of PEFR in children of different ages and its relation to body size, as measured by Body Mass Index (BMI) and Body Surface Area (BSA). PEFR is a dynamic lung function test and it is effort dependant. The subject must be encouraged to perform the manoeuvre as vigorously as possible. In children it needs cooperation and encouragement. PEFR reflects the status of larger airways and mechanics of respiration, which are sometimes affected by certain progressive neurological diseases. As no physician can understand the status of diabetes mellitus without doing simple blood sugar test, no clinician can manage a patient with potential renal failure without an estimation of blood urea level;in the same way, PEFR can be used for management of asthma[19,20].

Thus it is an endeavour to study the change in the parameter of lung function in different age, sex, height, weight, BSA and BMI. It also includes study of any change in readings of PEFR in subjects having family history of asthma or other obstructive diseases. Attempt has been made to derive and analyze various statistically significant relationship of PEFR to different parameters.

2. MATERIALS & METHODS

This was a prospective cross sectional study was carried out in various primary and secondary schools is the city of Cuttack to assess the pulmonary function in children and its relation to B.S.A, B.M.I & family history of obstructive diseases over a period of one year and eight months.

Studies of lung function assessment have been performed for diagnosis, treatment & follow up of respiratory morbidity. Measurement of PEFR is of value for the identification of chronic obstructive lung disease and for assessment and follow up of patients with asthma. Different normal values of PEFR have been obtained in populations of different locality.

INCLUSION CRITERIA

Normal healthy children in age group of 6yrs to 14yrs were selected for the study.

EXCLUSION CRITERIA

- History of any respiratory disease requiring hospitalization during previous 2 years and any respiratory illness at the time of test.
- Any persistent respiratory diseases like asthma, persistent cough, dyspnoea, wheezing or nasal catarrah
- Uncooperative children

The consent taken from parents and principal of the schools before initiated of the Study.

The instrument that was used was Mini Wright's Peak Flow Meter of brand Cipla was used for the study. It is a light plastic cylinder & is provided with a slot contain a pointer. Beside the slot, there is a graduated scale in which the values are expressed in Liters/min. The end opposite to the mouthpiece contains many holes for escape of air. The interior of the instrument consists of a spring piston that slides freely or a rod within the body of the instrument. The piston drives the sliding pointer along the slot marked with the graduated scale. The graduation is from 60L/min to 800L/min. The pointer records the maximum movement of the piston remaining in that position until returned to zero by the operator.

1251 students participated in the study and out of them 950 students were selected according to the exclusion criteria.

In each student, height was measured without any shoes and weight was recorded only with school uniform. Body Mass Index and Body Surface Area were calculated from height and weight of the subject by using the following formulae

Before measuring PEFR, the test procedure was explained to the subjects and a demonstration of maneuver was given to each of the subjects. The subjects were made relaxed before taking the reading.

<u>Instructions for using Peak flow meter</u>

- The marker is moved to the bottom of the numbered scale.
- The subject was asked to sit erect with back supported. As PEER is dependent upon a complete inhalation and exhalation with maximal force, therefore sitting erect is required.
- The subject was asked to take full inspiration.
- The subject was asked to put the mouthpiece of peak flow meter into his mouth between teeth and close his lips around the mouthpiece. He was also instructed not to put his tongue into the mouthpiece.
- Then he was asked to hold the cylinder of Peak flow meter without touching the slot or graduated scale and blow out as hard and as fast as he can through the mouthpiece.
- The nearest peak flow meter calibration in L/min was recorded.During the tests, the subjects were adequately encouraged to perform at their optimal level. The test was repeated 3 times in each subject and best of the three readings was considered for analysis. After use in each subject, the Wright's peak flow meter's mouthpiece was cleaned by immersing in a sterilizing solution. The water was shaken off and allowed to dry naturally.

3. RESULTS

In the present study, PEFR was measured in 950 primary and secondary school children. The children were between the age group of 6 to 14 years. Among them 507 were boys and 443were girls. Statistical analysis was done using Microsoft excel program in computer. Pearson's correlation coefficient test was used to find the relationship between various variables and PEFR.

TABLE 1: PEFR (L/min) VALUES IN GIRLS AND BOYS IN RELATION TO AGE.

	BOYS		GIRLS		
Age (yrs)	MEAN ± S.D	n	MEAN±S.D	P.VALUE	
6	52	196.5±31.37	48	190.4±25.84	0.025
7	57	220.4±27.53	49	202.8±23.54	0.040
8	62	238.8±29.68	51	223.9±29.67	0.038
9	51	258.7±28.70	50	236.2±27.54	0.024
10	55	280.0±39.81	47	256.9±47.52	0.011
11	59	285.76±41.74	49	273.8±41.67	0.004
12	58	299.20±24.21	52	296.5±23.58	0.061
13	55	363.27±31.56	49	305.1±28.29	0.001
14	58	405.27±30.81	47	328.2±31.7	0.004

The above table shows that the PEFR value increases with increase in age. The PEFR is significantly ($p<0.05$) higher in boys than girls in all ages, except at 12years of age , where the values are comparable in both sexes. The difference was more significant at 13 year age ($p=0.001$).

TABLE 2: PEFR (L/min) VALUES IN BOYS AND GIRLS IN RELATION TO HEIGHT INTERVAL

	BOYS		GIRLS		
HEIGHT INTERVAL	n	MEAN±S.D	n	MEAN±S.D	P VALUE
(CM)					
100-109	3	186.6±24.94	1	170.0±0	0.05
110-129	33	189.1±24.55	33	184.2±26.63	0.083
120-129	79	227.4±30.74	83	206.4±28.55	0.033
130-139	138	270.0±29.43	103	234.3±28.20	0.031
140-149	113	283.2±34.73	105	272.3±30.96	0.05
150-159	87	330.0±19.5	181	290.6 ±26.17	0.05
160-169	50	381.6±20.95	31	327.4±18.65	0.031
170-179	4	405.0±58.94	5.	350.0±22.44	0.023

The above table shows that the PEFR value increases with increase in height. The rate of increase in PEFR is comparatively higher in boys than girls. The difference is statistically significant as p value is < 0.05 in all height intervals except in interval of 110-119 cm ($p>0.05$)

TABLE- 3: PEFR (L/min) VALUES IN BOYS AND GIRS IN RELATION TO WEIGHT INTERVAL

WEIGHT INTERVAL	BOYS		GIRLS		
(Kg)	n	MEAN±S.D	n	MEAN±S.D	P VALUE
10-19	18	174.4±24.31	19	173.7±24.34	0.312
20-29	139	230.7±35.72	130	220.9±35.25	0.007
30-39	203	277.6±40.75	161	252.1±39.73	0.019
40-49	83	316.5±34.47	83	290.5±38.31	0.005
50-59	50	366.0±30.59	41	308.5±27.85	0.006
60-69	14	406.9±22.32	8	327.1±17.49	0.003

The above table shows that the PEFR value increases as the weight increases. The PEFR value is comparatively higher in boys than girls. The difference is statistically significant as the p value is <0.05 in all ranges except in 10-19 Kg interval ($p>0.05$)

TABLE 4: PEFR (L/min) VALUES FOR BOYS AND GIRLS IN RELATION TO B.S.A.

	BOYS		GIRLS		
B.S.A INTERVAL	n	MEAN±S.D	n	MEAN±S.D	P VALUE
($M^{2)}$					
0.70-0.99	121	225.2±21.21	107	220.2±70.71	0.050

1.00-1.29	249	279.7±12.82	216	261.2±14.14	0.023
1.30-1.59	114	330.6±34.73	107	321.3±42.43	0.027
1.60-1.89	13	405.4±20.80	11	330.8±35.36	0.050

The above table shows that PEFR increases as Body Surface Area increases and it is comparatively higher in boys than in girls. The difference is statistically significant as P value is <0.05.

TABLE 5: PEFR (L/min) VALUES IN BOYS & GIRLS IN RELATION TO B.M.I.

	BOYS		GIRLS		
BMI INTERVAL	n	MEAN±S.D.	n	MEAN±S.D	P VALUE
10.0-17.99	330	260.4±14.45	270	255.5±7.07	0.049
18.0-24.99	166	296.3±49.50	163	274.7±19.86	0.025
25.0-29.99	10	264.1±21.21	8	256.8±28.28	0.039
30.0-34.99	1	300.0±0	1	250.0±0	--

The above table shows the PEFR value to be highest in normal B.M.I. range (18.0-24.99) both in boys and girls. Boys have significantly (p<0.05) higher PEFR than girls. As there are only two subjects in B.M.I. range by 30.0-34.99, the results are inconclusive.

TABLE 6: COMPARISION OF PHYSICAL CHARACTERISTICS AND PEFR OF BOYS AND GIRLS

VARIABLES	BOYS	GIRLS
Age (years)	10±5.166	10±4.66
Weight (Kg)	37.5±24.76	28.5±14.85
Height (cm)	140.5±40.33	133.0±39.5
B.S.A (m^2)	1.2±0.58	1.03±0.064
B.M.I (Kg/m^2)	17.6±2.34	15.65±0.91
PEFR (L/min)	276.8±96.07	248.4±106.07

The above table shows the summary of the mean values of the anthropometric parameters and PEFR. The physical characteristics (height, Weight, B.S.A, B.M.I.) of boys are significantly (p<0.05) higher than that of girls. The mean value of PEFR of boys is also significantly (p<0.05) higher than that of girls.

Table 6:- PEARSON'S PRODUCT MOMENT CORRELATION COEFFICIENT OF PEFR WITH VARIOUS PHYSICAL CHARACTERISTICS

VARIABLES	BOYS	GIRLS	
Age	0.78	0.76	
Weight	0.73	0.70	
Height	0.85	0.84	
B.S.A	0.79	0.78	
B.M.I	0.29	0.32	P<0.05

The above table shows that all the physical characteristics including age have good correlation with PEFR in both boys and girls, except BMI which has poor correlation. Among physical characteristics, height has best correlation with PEFR. The results are statistically significant as p<0.05.

Table 7:-PEFR (L/min) VALUES IN BOYS & GIRLS IN RELATION TO FAMILY HISTORY OF OBSTRUCTIVE AIRWAY DISEASE.

POSITIVE	NEGATIVE	P-VALUE	
BOYS	265.5±21.21	290.8±14.14	0.832
GIRLS	237.59±53.06	258.65±51.41	0.064

The above table shows that there is no significant difference in PEFR value between boys and girls having family history of obstructive airway disease from those not having family history of obstructive airway disease.

4. DISCUSSION

In my study, the average PEFR in boys was 276.8±96.07 and in girls was 248.4±106.07 L/min. The higher value in boys as compared to girls could be due to the fact that they were taller and heavier. My findings corroborates with the findings of Parmar et al, from India [(21)]. In India also, the PEFR values in South Indian children is lower than present study PEFR value. Most studies, like the present study, show the sex difference in normal PEFR. But Paramesh H didn't find any difference in PEFR between boys & girls[(22)].

The values in relation to age are again more in boys than girls. However, the factors that determine PEFR are predominantly expiratory muscle effort, lung elastic recoil pressure and airway size (Primhak et al, 1984) [(23)]. The muscle effort in turn depends on the physical strength and physical activity. It is possible that lower value in girls were due to physiological reasons and better performance of the boys. In my study, relation of PEFR with age is statistically significant (p<0.05) and has good correlation (r=0.78 in boys and r= 0.77 in girls). My findings are similar to Rajesh Sharma et al (2002), Anil Taksande et al (2006) [(24,25)].

In previous studies, it was seen that height had provided a good basis for prediction of normal values of PEFR. In my study, PEFR increases with increase in height in both boys and girls as shown in Table 2. It is statistically significant (p<0.05). I also found the correlation between height and PEFR to be highest both in boys (r=0.85) and girls (r=0.84) as shown in Table VIII. This observation is similar to studies by Sagher Rushdi, 1999[(26)].

Other investigators (Iraj Mohammadzadeh, 2008) also found the superiority of height as an independent parameter which correlates well with PEFR, and with other ventilatory functions of lungs. Pulmonary measurements such as FVC, FEV_1,PEFR (which are volumetric) were best correlated with height (Primhak et al, 1984) [(23)]. One study (Chowgule et al, 1995) concluded that for clinical evaluation of child's lung function, height was the best independent parameter in comparision to age and weight [(27)].

Various recent studies also consider height as an important variable for PEFR measurement in children. This is probably due to the fact that linear growth is best associated with growth of lungs (Ganong 23 rd edn.) [(28)]. Moreover, the superiority of the correlation coefficient for height can be confirmed by simple inspection of a scatter diagram. Hence, there was no disagreement regarding positive correlation of PEFR with Height. Standing height is the best predictor of PEFR in children (Wall et al, 1982) [(29)]. Therefore , height should have the first preference, as it is easy to measure, more accurate and it has highly significant correlation with PEFR. In the present study, I found a greater increase in PEFR beyond 11 years in girls and 13 years in boys. This finding is similar to Singh H D & Peri S (1978) [(30)].

According to Table 3 & 4, PEFR has significant association with Body Surface Area and Body weight (p<0.05). But the correlation of PEFR with B.S.A (r=0.79 in boys & 0.76 in girls) was more significant than that of weight (r =0.73 in boys and 0.70 in girls). On the other hand, the level of significance of correlation of PEFR with B.S.A & body weight were less than that of height. Such results may be due to wide variations in weight and height within same age groups.

Body Mass Index (B.M.I) which is an important variable to measure over weight in children had significant (p<0.05) and positive correlation (r=0.29 in boys and 0.32 in girls) with PEFR as shown in Table 5 & 6. In my study, the subjects are growing children. So BMI increases as age increases. Hence, with increase in BMI, PEFR has also increased. This is in accordance to the study by Dhungel KU et al, 2008[(31)]. As the population of overweight and obese children (BMI>23) is less in my study, the effect of obesity on PEFR could not be concluded from these findings. It is a well known fact that less physical activity is related to fat deposition in body and poor lung growth. So it can be presumed that PEFR will increase with increase in B.M.I. up to a certain level, after which PEFR will decrease.

In this study, I tried to find out whether family history of asthma or other obstructive diseases affects PEFR in asymptomatic children belonging to same family. The result, as shown in Table VIII, is that, there is no variation in PEFR in relation to family history and the results are not statistically significant (p>0.5). This is as per the study by Primhak et al, 1984[23].

5. CONCLUSION

PEFR can be used to assess airflow obstruction and reversibility, which are characteristic of asthma both as a diagnostic as well as a tool for prognosis following a bronchodilator therapy. The test is useful, quick , reliable and easily reproducible even in small settings especially in children who find it difficult to comply to the instructions in spirometry. It can also be used as a tool for further amplify research in this field covering a bigger population by doing a field study. It can also be used as a screening tool to initiate timely intervention

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