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EVALUATION OF REGRESSION EQUATIONS FOR PEAK EXPIRATORY FLOW RATE IN CHILDREN AGED 8-12 YEARS FROM WEST BENGAL, EASTERN INDIA

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Abstract

Peak expiratory flow rate (PEFR) is an essential measure in the management and evaluation of asthmatic children. The aim of this study was to determine normal PEFR of school children of West Bengal state in Eastern India and to derive prediction formula for this population. The PEFR was measured in 1201 healthy school children (781 boys and 420 girls) of Hooghly district using the mini Wright peak flow meter. All measurements were recorded in standing posture and resting condition. Best out of the three trials was recorded. Weight and height were measured. BMI and BSA were calculated using height and weight. Age was recorded from school record. Correlation between various anthropometric variables and PEFR were calculated. Simple and multiple regression analysis were used to determine the influence of anthropometric variables on PEFR. Positive correlation was seen between PEFR and age, height, weight, BMI and BSA. Highest correlation was seen with height and lowest with BMI. Simple and multiple regression equation for PEFR of boys and girls were evaluated. The boys had higher PEFR than girls in respect to height and age. Simple regression equation using height is mostly applicable for prediction of PEFR as height shows maximum correlation with PEFR and it is convenient measurement. Equations derived from this study for estimation of expected PEFR values would help the clinician in assessing the airway obstruction in this population subset.

Key words: PEFR, children, sex, age, height, weight, BSA.

1.0 Introduction

Peak expiratory flow rate (PEFR) is the largest expiratory flow rate achieved with a maximally forced effort from a position of maximal inspiration (American Thoracic Society, 1995). PEFR as a measurement of ventilatory function was introduced by Hadron in 1942, and was accepted in 1949 as an index in spirometry (Jain et al.,1983). It is a simple reliable way to following up children with bronchial asthma and other obstructive lung diseases (Pagadpally, 2013). The prevalence of pulmonary diseases especially bronchial asthma is increased world wide (Mitchell, 1985). It has been recommended that PEFR should be a part of the diagnostic evaluation and treatment of asthma (Mondal et al., 2011). The peak flow meter is a useful instrument for monitoring PEFR in children and adults. Peak flow meter is small, portable, convenient and inexpensive device.

Pulmonary function is known to vary considerably between different regional and ethnic groups, residing within the same country (Paramesh, 2003). India, being a subcontinent, changes in pulmonary function can occur from one region to another (Malik and Jindal, 1985; Chowgule et al.,1995). Therefore it is essential to have reference standard for each ethnic group of region for better evaluation of pulmonary function. Reference standards for pulmonary function that are reported for Indian children mainly from Northern, Western and Southern region of the Country (Pagadpally; 2013, Malik and Jindal, 1985; Chowgule et al., 1995; Sharma et al., 2012). There is paucity of data on PEFR of children of Eastern region of India. The reference standard of other regions of India cannot be extrapolated to Bengal children as the environment; customs, traditions and life style are all together different in this part of the country. A study was, therefore, planned to evaluate the PEFR reference value in relation to age, sex and anthropometric parameters for children in the age 8-12 year age group for eastern region of India.

2.0 Material and Method

2.1 Subject: The present study was conducted among normal healthy school children of 8-12 years studying in various schools in Hooghly district during their school hours. The prior written permission of school authority was taken. Written consent from the parents of the students experimented in the study was obtained. 1201 students (781 male and 420 female) were included in this study. The subjects of this study were chosen at random irrespective of socioeconomic status and religion so that in can reflect an overall picture of PEFR status of study region. six schools were selected for this study. All students of selected schools in this age group fulfilling the following criteria were included in the study:

i) absence of any chronic lung disease
ii) no history of acute respiratory tract infection in past two weeks
iii) no major respiratory tract disease
iv) no major systemic disease like cardiac or renal problems
v) no bone deformity of chest or spine
vi) no family history of asthma

A total of 1305 were selected first, out of which 104 children (60 boys and 44 girls) were debarred either due to exclusion criteria or due to unsatisfactory expiratory effort during the procedure.

2.2 Measurement of PEFR: The Wright's Peak Flow Meter (Air Med, UK) has been used. The dial range is 60-800 L/min. All included children were tested in a standing position. Before testing, the procedure was explained and demonstrated to each child until full familiarity was achieved. Each child was asked to take deep breath and then blow into peak flow meter as hard and fast as he/she could. Three trials were given and best of the three was chosen for analysis. The same peak flow meter was used through out this study.

2.3 Measurement of body weight: Body weight was measured using bathroom scale accurate to 0.5kg. The scale was kept on a fate surface and adjusted with '0' mark. Now the subject was requested to step on it in bare feet. Weights were taken in light cloth. Weight was recorded to the nearest 0.5kg.

2.4 Measurement of body height: Height was measured using anthropometric rod. Height of the subject was recorded without footwear and expressed to the nearest 0.1cm.

2.5 Measurement of body mass index (BMI): BMI was calculated from the height and weight using following equation: BMI (kg / m^2) = weight (kg) / height^2 (m)

2.6 Measurement of body surface area (BSA): BSA was calculated from height and weight using Mosteller formula (Mosteller, 1987). BSA=√ [Height (cm)*Weight (kg)/3600]

2.7 Statistical analysis: Data obtained from the study were given as mean ± SD. The statistical significance was determined by student's t test. Two tailed p values were used throughout and p value less than 0.01 were judged as statistically significant. Pearson correlation was used to find the significant relationship between PEFR and anthropometric parameters. Prediction equations by regression analysis were carried out.

Results

The present study was conducted among 1201 normal healthy school children (boys 781, girls 420) 8-12 years age in Hooghly, West Bengal. Table 1 shows age and gender distribution of study subject. There are 35% girls and 65% boys.

Table 1: Age and gender distribution of Children studied.

Age (yrs)	Boys		Girls		Total	
	Number	%	Number	%	Number	%
8	98	12.5	81	19.29	179	14.90
9	146	18.7	64	15.24	210	17.49
10	184	23.6	82	19.52	266	22.15
11	179	22.9	77	18.33	256	21.32
12	174	22.3	116	27.62	290	24.14
Total	781	100	420	100	1201	100

In all study age group boys show significantly higher PEFR than female (table-2). Mean PEFR of boys is also significantly higher than girls (table-3). Like age similar result is obtained for height (table-4).

Table 2: Mean PEFR of boys and girls children according to age.

Age (years)	PEFR (l/min)		P value
	Boys	Girls	
8	226 ± 39.3	199 ± 33.7	0.0001
9	255 ± 49.5	217 ± 36.3	0.0001
10	280 ± 51.9	226 ± 37.1	0.0001
11	300 ± 62.9	240 ± 44.3	0.0001
12	334 ± 78.3	262±47.8	0.0001

Table 3: Comparison of PEFR and anthropometric parameters between boys and girls.

Parameters	Boys (n=781)	Girls (n= 420)	p
Age (Years)	10.24 ± 1.32	10.20 ± 1.48	>0.5
Height (cm)	133.87 ± 9.99	133.98 ± 6.00	>0.5
Weight (kg)	28.58 ± 9.42	29.04 ± 10.28	>0.5
BMI (kg/m2)	15.75 ± 4.92	15.96 ± 6.75	>0.5
BSA (m2)	1.023 ± 0.19	1.027 ± 0.24	>0.5
PEFR (L/min)	284.89 ± 68.84	232.02 ± 46.74	<0.001

Table 4: Mean PEFR of boys and girls children on the basis of body height.

Height (cm)	PEFR (l/min)		P value
	Boys	Girls	
110.0--114.9	202.00 ± 20.97 (10)	177 ± 18.0 (11)	<0.01
115.0-- 119.9	218.84 ± 25.03 (26)	192 ± 30.0 (17)	<0.05
120.0—124.9	239.38 ± 33.21 (112)	207 ± 30.0 (32)	<0.0001
125.0—129.9	244.84 ± 39.12 (122)	210 ± 35.0 (80)	<0.0001
130.0—129.9	275.22 ± 45.09 (178)	221 ± 35.0 (90)	<0.0001
135.0—139.9	294.96 ± 48.47 (127)	236 ± 34.0 (66)	<0.0001
140.0—144.9	319.57 ± 64.76 (94)	255 ± 42.0 (59)	<0.0001
145.0—149.9	334.91 ± 61.99 (57)	279 ± 60.0 (39)	<0.0001
150.0—154.9	370.69 ± 72.65 (29)	284 ± 37 (26)	<0.0001
155.0—159.9	439.00 ± 71.25 (10)	----------	--------
160.0—164.9	461.88 ± 67.15 (16)	----------	---------

Correlation coefficient between anthropometric variables and PEFR of school children is shown in table 5. Five anthropometric variables viz age, height, weight, BMI and BSA were correlated with PEFR. Highest correlation was found with height and lowest with BMI for both boys and girls.

Table 5: Pearson correlation of PEFR and anthropometric parameters

Pair	Boys		Girls	
	r value	p value	r value	p value
PEFR vs Age	0.500	<0.001	0.484	<0.001
PEFR vs Height	0.692	<0.001	0.566	<0.001
PEFR vs Weight	0.550	<0.001	0.209	<0.001
PEFR vs BMI	0.257	<0.001	0.065	>0.05
PEFR vs BSA	0.625	<0.001	0.412	<0.001

Simple regression analysis was done for PEFR. Table 6 represents the simple regression equations for prediction of PEFR on the basis anthropometric variables those are significantly correlated with PEFR.

Table 6: Simple regression equations on the basis of anthropometric parameters for predicting PEFR

Sl no	Boys	Girls
1	PEFR(l/min) = (26.019 * age in year) + 18.465	PEFR (l/min) = (15.33 *age in year) + 75.7
2	PEFR(l/min) = (4.764 * height in cm) – 353	PEFR(l/min) = (2.72 * height in cm) – 132.5
3	PEFR(l/min) = (4.0202 * weight in kg) + 169.92	PEFR(l/min) = (0.599 * weight in kg) + 214.6
4	PEFR(l/min) = (229.218 * BSA in sq m) + 50.409	PEFR(l/min) = (94.5 * BSA in sq m) + 135

Multiple regression analysis was also done to evaluate prediction equation of PEFR. Multiple regression equation of PEFR on the basis of two variables, age and height were represented in table 7.

Table 7: Multiple regression equations on the basis of age and height for predicting PEFR.

Subject	Equation
Boys	PEFR(l/min) = (3.152 * age in year) + (4.483 * height in cm) -347.635
Girls	PEFR(l/min) = (6.426 * age in year) + (2.093 * height in cm) -113.949

Estimation of PEFR on the basis of simple regression equation in respect to height is compared with other equations (table 8). PEFR of Bengal girl children is comparatively lower than other Indian girls. The PEFR of Bengal boys is comparable North and South Indian boys.

Table 8: Comparison of PEFR (l/min) predicted from present study on the basis of height with those of other Indian studies.

Height (cm)	Swaminathan et al., 1993		Parmar et al., 1977		Taksande et al., 2008		Sharma et al., 2002		Present study	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
120	205	193	198	229	217	180	199	187	218	194
140	287	272	299	312	311	253	286	274	314	248
160	368	350	401	396	405	326	372	361	409	303

Discussion

PEFR is a simple and reliable way to monitor the severity of bronchial asthma and assessing the response to treatment. It is dependent upon various factors including airway resistance, effort of voluntary expiratory muscles. Physicians prefer a common international reference for obtaining normal values of different parameters but it has been shown that PEFR values vary with racial, environment, genetic feature, lifestyle and geographical distribution. Thus it would be more appropriate for each country for its own regional reference values. The aim of this study was to establish normal value of PEFR of healthy children of Hooghly, West Bengal, India, so that local reference standards are available when this measurement is used for the assessment of asthmatic children.

PEFR values increased in linear relation to age, height, weight, BMI and BSA. Correlation coefficient of PEFR with age, height, weight, and BSA are significant but insignificant with BMI. Highest correlation was noted for height and reported by many previous studies (Raju et al., 2003; Sharma et al., 2012; Taksande et al., 2008). Age, height, weight and BSA have all been used either alone or in combination to predict PEFR in various studies (Mittal et al., 2013; Pande et al., 1997; Nair et al., 1997). Like many other Indian studies, we used height based simple regression equation for prediction of PEFR as it is more significantly correlated with PEFR and it is a convenient measurement. .

PEFR values were predicted for three different height using simple regression based on body height.
A standardized comparison of predicted PEFR values from present study for three different height was made with the PEFR values for the same height from four previous studies. PEFR value of eastern Indian boys are comparable with the boys of northern Indian and Maharashtra but higher than boys of South India and Rajasthan. PEFR value of eastern Indian girls is comparable with the girls of Rajasthan, but lower than the northern and southern Indian girls (table 7).

Conclusion

In present study age, height, weight and BSA have been used separately for evaluation of simple regression equation and both age and height for multiple regression equations for PEFR in Eastern Indian Bengal children. We believe that these prediction equations would be useful for both physiologist and clinicians of eastern region of India.

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