ORIGINAL ARTICLE

PEAK EXPIRATORY FLOW RATES IN CHILDREN OF WESTERN RAJASTHAN 7–14 YEARS OF AGE

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Background: A lot of age-specific variations in Peak Expiratory Flow Rate (PEFR) are expected in paediatrics age group compared to adults. Therefore availability of normal values for different age group is absolutely essential for logical interpretation of PEFR. Only few studies are available on ventilator functions for children of Western Rajasthan (a desert area) 7–14 years of Age. **Method:** One hundred and eighty-eight apparently healthy school children (112 Male, 76 Female) from age group 7–14 years were included in the study. PEFR was measured in L/min with a standard Wright Peak Flow Meter. **Result:** Positive correlation was seen between age, height, weight, Body surface area, and PEFR. The regression equations for PEFR were determined for boys and girls separately. The prediction equation for PEFR based on Weight was PEFR=71.519+weight×4.202 (for boys) PEFR=115.081+weight×1.406 (for girls). Predicted formulas obtained by regression equation for Age were: PEFR=27.442+Age×17.289 (for boys), PEFR=83.88+Age×7.399 (for girls). Predicted formulas obtained by regression equation for height were: PEFR= -166.592+Height×2.653 (for boys) PEFR= -50.24+Height×1.501 (for girls). Predicted formulas for PEFR obtained by regression equation for BSA were: PEFR=42.483+BSA×159.983 (for boys), PEFR=99.714+BSA×59.505 (for girls). In both male and female children, PEFR significantly increases ($p<0.05$) with height, weight, age, and Body Surface Area (BSA). **Conclusion:** PEFR is a reliable measurement, which can be used in desert areas of Western Rajasthan for assessment of airway obstruction. Prediction formula is derived for use in this population.

Keywords: PEFR, Western Rajasthan, Children, Indian, Factors, Age, Height, BSA

INTRODUCTION

Ventilatory function tests provide a better understanding of functional changes in the lungs and their significance from the view point of diagnosis. Only few studies are available on ventilatory functions for children of Western Rajasthan (a desert area) from 7–14 years of Age.

It is well established that sex, age, height, weight and BSA are the main factors affecting Peak Expiratory Flow Rate (PEFR), Forced Expiratory Volume in the first second (FEV_1) and Forced Vital Capacity (FVC).[1] Consequently, PEFR and FEV_1 tests are used in interchange. In this study PEFR has been chosen. It is essential, therefore, to consider male and female children separately and to take into account age, height, weight and BSA when comparing individuals or groups. There is a positive correlation between PEFR and FVC or FEV_1. This correlation has been reported previously by several authors and is known to occur both in healthy persons and patients who have ventilatorydefects.[1–2]

In adults clinicians find it easy to recollect the normal values and interpret them accordingly. Since paediatric age group include babies from birth to age of 18 years lot of age specific variation in PEFR values are expected. Therefore availability of normal values for different age group is absolutely essential for logical interpretation of PEFR. The normograms available for paediatric patients in medical literature are mostly from the western countries hence cannot be applied to Indian children due to racial, ethnic and environmental factors.[3]

Ideally speaking all states and geographical regions as well as communities must have their separate norms for PFTs. Geographically Western Rajasthan is a desert area where not only environment but the customs, tradition and life style are also altogether different. Therefore the present study was done to establish norms of PEFR in healthy school children from 7–14 years of age in Western Rajasthan and to find out relationships of PEFR with Height, Weight, BSA, and Gender of children.

MATERIAL AND METHODS

One hundred and eighty-eight (188) apparently normal school children (112 male and 76 female) from age of 7–14 yrs were included in the study. A preliminary clinical evaluation was done with the help of history, general physical examination and systemic examination in all the children.

Children with major medical illness and those having acute respiratory infections within 7 days of the study were excluded. The children with asthma were excluded. The exclusion criteria for recurrent cough or chest infection; a family history of asthma or any person taking bronchodilator metered

dose inhaler (MDI) in the family; rhonchi or wheeze on auscultation. All of the children were examined thoroughly to exclude any underlying heart, lung or systemic disease.

The age of the subjects were recorded in year. Standing heights (stature) were measured in Cm with a standard stadiometer. Weights were measured in Kg. The height nearest to 0.1 Cm and weight nearest to 0.1 Kg with minimal clothing were measured using the height and weight scale. PEFR was measured in L/min with a standard Wright Peak Flow Meter (60–800 L/min).

At rest and in a standing position, each child blew three times, without nose clip, into a standard Mini-Wright peak flow meter Instructions and method of carrying out the test was demonstrated to the subjects. Each subject made 3 PEFR manoeuvres and the highest value was recorded, since this parameter requires maximum efforts. At the end of measurement subjects were grouped according to height, weight, and age and body surface area. Body surface area of the children was calculated using following formula:[4]

$$A = W^{0.425} \times H^{0.725} \times 71.84$$

Where A=Surface area in Cm^2, W=Weight in Kg, H=Height in Cm

Results were expressed as Mean PEFR±SD. For statistical analysis Pearson's correlation coefficient test was used. Linear regression equations for PEFR in relation to Age, height, weight and BSA were determined for boys and girls separately. A *p*-value of <0.05 was considered statistically significant.

RESULTS

A total of 188 healthy children of age group 7–14 years comprising 112 males and 76 females were used for determination of PEFR. 59.57% children were male and 40.42% were females. The sex ratio between male and female children was 1.47:1. Mean values of weight, height and BSA showed a gradual increase with the increment of age of children among both sexes, but anthropometric parameters were better among male children (Table-1 A, B). Majority (80.32%) subjects were having their weight well above 80% of expected weight, 12.77% subjects were having 71–80% of expected weight and 6.83% subjects were having 61–70% of expected weight.

Table-2 shows variation of PEFR in both male and female subjects according to their weight. Observations show that in both the genders PEFR were higher in males except in 46–50 Kg weight where females show higher values. In both the genders weight and PEFR shows significant correlations $p<0.001$ (M), $p<0.02$ (F). Predicted formulas obtained by regression equation for weight were following:

PEFR=71.519+weight×4.202 (boys)
PEFR=115.081+weight×1.406 (girls)

Table-3 shows variation of PEFR in Male and Female children according to their age. In all age groups Males shows higher mean PEFR then Females. In both genders age and PEFR showed significant correlation with each other, $p<0.001$ (M), $p<0.05$ (F). Predicted formulas obtained by regression equation for Age were following:

PEFR=27.442+Age×17.289 (Boys)
PEFR=83.88+Age×7.399 (Girls)

Table-4 shows variation of PEFR with height in Male and Female children. For the similar height males shows higher PEFR then Females. PEFR and Height shows significant correlation in both the genders P<0.001(M),P<0.01(F). Predicted formulas obtained by regression equation for height were following:

PEFR= -166.592+Height×2.653 (Boys)
PEFR= -50.24+ Height×1.501 (Girls)

Table-1(A): Mean Weight and Height in male and female subjects according to age

Age (year)	Male (n=112)			Female (n=76)		
	No.	Weight (Kg)	Height (Cm)	No.	Weight (Kg)	Height (Cm)
7	8	23.25±3.54	124.38±3.54	6	20.83±2.14	118.5±3.83
8	17	24.53±3.47	124.88±7.64	11	24.27±4.22	129.55±5.87
9	13	26.38±4.29	132.92±5.35	8	24.38±4.63	132.5±8.33
10	20	29.35±6.35	138.90±6.56	6	33.83±8.40	138.67±5.16
11	21	34.48±4.19	145.14±6.36	13	36.15±9.06	145.92±6.42
12	15	36.73±7.16	152.20±10.46	13	42.0±12.85	150.85±9.81
13	11	42.45±11.22	152.64±6.55	15	40.2±6.90	153.33±10.53
14	7	46.71±7.76	160.86±8.21	4	36.25±3.40	151.5±10.08

Table-1(B): Mean Body Surface Area in male and female subjects according to age

Age (year)	Male(n=112)		Female(n=76)	
	No.	Mean BSA	No.	Mean BSA
7	8	0.770±0.09	6	0.697±0.05
8	17	0.802±0.09	11	0.809±0.11
9	13	0.868±0.11	8	0.820±0.13
10	20	0.955±0.16	6	1.056±0.19
11	21	1.095±0.11	13	1.133±0.22
12	15	1.170±0.19	13	1.279±0.31
13	11	1.295±0.25	15	1.253±0.19
14	7	1.425±0.19	4	1.157±0.10

Table-2: Mean values of PEFR in subjects according to weight

Weight (Kg)	Male (n=112)		Female (n=76)	
	No.	PEFR (L/min)	No.	PEFR (L/min)
<21	3	193.67±71.86	7	143.86±58.90
21–25	29	164.03±52.55	13	137.69±35.22
26–0	25	186.76±53.24	15	156.60±45.26
31–35	27	220.33±59.65	12	158.58±51.84
36–40	10	229.10±103.29	9	204.44±70.70
41–45	8	270.75±105.20	9	182.33±68.95
46–50	5	170.00±61.01	7	181.71±59.45
51–55	4	370.25±80.91	2	115.00±57.98
>55	1	345.00±0.00	2	175.50±50.20
	r=0.48, $p<0.001$		r=0.27, $p<0.02$	

Table- 3 Mean values of PEFR in subjects according to their age

Age (yrs.)	Male(n=112)		Female(n=76)	
	No.	PEFR	No.	PEFR
7	8	148.36±44.83	6	117.67±58.07
8	17	157.29±55.83	11	147.91±35.05
9	13	209.31±71.73	8	148.38±29.74
10	20	179.25±45.14	6	170.83±50.61
11	21	227.86±66.79	13	171.15±57.99
12	15	195.20±84.27	13	165.23±72.37
13	11	261.82±88.66	15	191.67±60.90
14	7	314.57±114.91	4	147.50±45.38
	r=0.43, p<0.001		r=0.28, p<0.05	

Table-4 Mean values of PEFR in subjects according to their height

Height (cm)	Male(n=112)		Female(n=76)	
	No.	PEFR(L/min)	No.	PEFR(L/min)
111–120	6	144.17±62.47	5	129.40±65.00
121–130	22	174.18±62.04	12	142.83±37.93
131–140	30	189.30±50.96	18	142.94±39.83
141–150	30	209.37±57.40	18	174.50±58.92
151–160	14	253.71±71.13	19	191.58±67.41
161–170	10	293.70±150.62	3	152.33±29.67
>170	-	-	1	211.00±0.00
	r=0.48, p<0.001		r=0.36, p<0.01	

Table-5 shows variation of PEFR with Body surface area in Male and Female children .For the similar BSA Males shows higher PEFR then Females. PEFR and BSA shows significant correlation in both the genders p<0.001 (M), p<0.001 (F). Predicted formulas for PEFR obtained by regression equation for BSA were following:

PEFR=42.483+BSA x 159.983 (M)
PEFR=99.714+BSA x 59.505 (F)

Table-5: Mean values of PEFR in subjects according to their BSA

BSA	Male(n=112)		Female(n=76)	
	No.	PEFR(L/min)	No.	PEFR(L/min)
0.600–0.799	19	164.63±56.09	17	137.53±44.96
0.800–0.999	39	188.77±59.02	17	154.29±43.83
1.00–1.199	29	205.83±57.26	16	163.00±48.18
1.20–1.399	14	260.21±97.20	16	197.40±74.71
1.40–1.599	8	282.75±135.87	9	166.89±62.74
1.60–1.799	2	330.50±20.51	1	140.00±0.00
>1.799	1	331.10±00.08	1	211.00±0.00
	r=0.49, p<0.001		r=0.29, p<0.001	

Table-6: Comparative mean values of PEFR (L/min) observed by different workers

Age	Sharma *et al* 1996[5]		Singh *et al* 1978[6]		Despandey *et al* 1983[7]		Rahman *et al* 1990[8]	
	Male	Female	Male	Female	Male	Female	Male	Female
6	149±31.22	121.44±19.27	121.6±31.6	113.3±37.1	-	-	-	-
7	182.12±53.84	154.53±33.38	147.4±39.6	134.2±34.9	-	-	-	-
8	200.83±49.42	178.69±48.72	184.1±34.6	148.1±36.9	147.4±14.46	167.6±15.49	-	-
9	230.29±49.46	206.36±53.91	197.4±42.8	181.9±48.9	186.4±32.19	178.8±37.65	-	-
10	236.47±59.16	214.50±63.71	227.5±45.7	214±36.5	217.6±17.27	201.2±23.29	-	-
11	266.6±46.63	238.45±58.20	231.4±47.8	230±44.6	-	-	-	-
12	273.59±51.15	272.93±57.68	267.9±38.9	248.8±42.0	-	-	312±7.3	354±3.9
13	300.35±73.08	296.81±57.40	270±43.8	296±51.2	-	-	349±7.3	371±3.7
14	328.07±70.35	312.67±54.67	318.8±68.2	320.8±60.2	-	-	372±9.5	385±4.7

Table-7: Correlation coefficients worked out by various workers between PEFR and anthropometric Variables

Study	Age		Height		Weight		BSA	
	Male	Female	Male	Female	Male	Female	Male	Female
Present study	0.43	0.28	0.48	0.36	0.48	0.27	0.49	0.29
Sharma *et al* 1996[5]	---	0.73	---	0.75	---	0.65	---	---
Singh HD 1978[6]	0.87	0.89	0.90	0.89	0.88	0.87	0.91	0.90
Deshpandey *et al* 1983[7]	---	---	0.47	0.63	0.38	0.68	---	---
Rahman *et al* 1990[8]	0.76	0.50	0.76	0.75	0.75	0.69	---	---

DISCUSSION

PEFR is the maximal expiratory flow that can be achieved and sustained for a period of 0.01 second. PEFR is very useful in monitoring the long term management of asthma and determining its severity. PEFR is expressed in L/min. PEFR is a simple and reliable way of monitoring the severity of bronchial asthma and assessing the response to treatment. It is a measurement which is dependent upon several variables including airway resistance maximal voluntary muscular effort and the possible compressive effect of the manoeuvre on thoracic airways. This study aimed to establish normal values of PEFR for healthy children of Western Rajasthan so that local reference standards are available when this measurement is used for the assessment of asthmatic children.

Our data indicate that PEFR values for same age is higher in male children in comparison to their counterparts, (Table-3). Most of the other studies have recorded similar trends. However, Singh and Peri[5], and Deshpandey *et al*[6] in their studies an normal South Indian children did not show any sex variability in PEFR on the contrary Rahman *et al*[7] reported that in the same age group girls had higher PEFR than the boys.

Comparative observations by different key workers is summarised in the (Table-6). Mean values of PEFR in our study are in accordance with the studies done by above five workers mentioned in (Table-6). In contrast to our results Primhak *et al*[8] from Greece have

reported higher PEFR values in their children. This display is explainable on the basis of body built, height and ethnicity. This is well known that European children are taller and heavier than the Indian children.

Correlation coefficients of PEFR with age, height, weight and BSA were computed from our data and results were compared in summarised from in the (Table-7). Although our correlation coefficient-values are lower in comparison to all other workers yet the correlation between PEFR and age, height, weight and BSA were positive and statistically significant ($p<0.01$ for all variables) (Table-2–5). Another important fact is that correlation coefficients were better for male children in present study as well as all other studies except in the study done by Deshpandey *et al*.[6]

Overall, the study showed that in both male and female children, PEFR significantly ($p<0.05$) increases with height, weight, age and BSA.

Regression equation has been derived for age, height, and BSA with PEFR. Results shows that PEFR values for corresponding age, height, and BSA were higher among male subjects than female. Regression lines derived for age and height maintain same difference through all the ages but in BSA, the PEFR values are practically same at BSA value of 0.6 m^2 and than the difference become greater and greater to higher values of BSA.

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.

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