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Peak Expiratory Flow Rate nomogram in 6 – 12 yrs *old* healthy children of urban area in Telangana state.

Dr. Subhan Basha Bukkapatnam[1], Dr. Suresh Babu Mendu[2]
[1] Assistant Professor, [2] Associate Professor, Department of Pediatrics, Government Medical College, Siddipet, Telangana.
Corresponding Author: Dr. Suresh Babu Mendu

Abstract:
Objective: *To obtain the normal reference values of peak expiratory flow rates (PEFRs) among healthy school going children between 6 and 12 years and thereby construct a nomogram.*
Materials and Methods: *A cross sectional study was conducted among healthy children attending schools in Karimnagar city of Telangana state over a period of 12 months. PEFR values were recorded using a Mini Wright peak flow meter, and the best of three readings was documented.*
Results: *1233 students were studied. PEFR increases as the age increases. A similar trend was observed across various heights. Nomograms based on age and height were constructed separately for boys and girls.*
Conclusion: *Established baseline values of PEFR in this study can be useful in diagnosing and following asthmatic children in urban areas.*
Keywords: *PEFR, Asthma, nomogram, regional reference values*

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I. Introduction

Pulmonary function tests of various types are utilized clinically and epidemiologically to measure functional status in order to assess the disease.[1] 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. These differences influence technique, methodology and interpretation.[2]

The peak expiratory flow rate (PEFR) measurement is simple, reproducible and reliable way of judging the degree of airway obstruction in various obstructive pulmonary diseases, especially asthma. Peak expiratory flow rate is easily measured by using a mini-Wright's peak flow meter (mWPFM), which is easy to use, reliable and can be recorded even by the patients or by the parents at home. This instrument is cheap, portable, understandable and useful for physicians in managing children with respiratory diseases, particularly valuable for assessing children aged as low as 3 years, as younger children cannot perform the other pulmonary function test reproducibly.

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. Prevalence of asthma in children is increasing day by day globally supported by different studies in different countries. In south India the prevalence averages 10.3%. Prevalence of asthma in urban areas is on the rise like in Bangalore it raised from 9% in 1979 to 27.5% in 2002. 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.[3]

PEFR measurement can reveal the diurnal variability of airway of patient who has been suffering from reactive airway disease but not in normal children, that gives the early clue to have the diagnosis and management. Fall of peak expiratory flow rate in a child with asthma is impending sign of acute asthma. The response to treatment can be monitored by using serial PEFR measurement. The occurrence of diurnal variation of symptoms and airway resistance in asthmatic children are well perceived, thereby early intervention of treatment pattern and efficacy of drug can be documented by measurement of peak flow rate. PEFR can be used not only to see the airway obstruction, can be used to classify the severity of diseases of airway obstruction and its management and as a guide line of admission and discharge of asthma patients.

Nomograms and regression equation for predicting PEFR from height are available for Western children and normal value of PEFR in relation to height, age, sex and weight are present in the different states of India[4-6], but no standard value is available for cities of Telangana state.

II. Methodology

The study was carried out in the different schools in Karimnagar city of Telangana state over a period of 12 months. This was a prospective cross sectional study.

Data Collection Procedure: Considering the age (6-12 years), the students from different schools in Karimnagar city were included in the study. Permission was taken from Principals/Headmasters of the institute. From each school targeted samples were selected randomly as per roll number in the class. Students who fulfilled the inclusion criteria were separated, proper clinical examination was conducted and questionnaire was appropriately filled up. Height was measured by stadiometer and weight was recorded by bathroom scale without shoes and minimum clothes.

Six [3 low range (50-350 l/min) and 3 high range (60-800 l/min) model] well functioning miniWright Peak Flow Meter (mWPFM) were used to record PEFR (L/min). High range model was used when values >350 l/min were found. 3 serial blows for PEFR were registered in individual sheet after the child had become familiar with the technique.

Sampling: Total more or less 1233 samples with equal proportion of sex from all socioeconomic status were targeted and collection of samples was shown in table1.

Table 1: Sampling frame

1233					
607 boys			**626 girls**		
Govt. Boys Dhangar wada	Govt. upper primary school RamNagar	Primary school Mankammathota	Govt. upper primary school RamNagar	Govt. Girls school Dhangar wada	Primary school Mankammathota
286 (23.19%)	**252 (20.44%)**	**69 (5.59%)**	**268 (21.74%)**	**277 (22.47%)**	**81 (6.57%)**

Inclusion Criteria

1. Sex- boys and girls
2. Age- 6 to 12 years
3. Normal healthy school children of Karimnagar city

Exclusion Criteria

1. Children who have been suffering from asthma or having past history of asthma or wheeze.
2. Child having the thoracic deformity, or history of ARI within two weeks.
3. Child having history of atopic condition like eczema, hay fever, or atopic rhinitis.

Statistical Analysis

Statistical analysis was done using the statistical package for the social science (SPSS) program in computer. Linear and multiple regression analysis was performed by using age, weight and height as the independent variables and PEFR as the dependent variable. Independent sample test and group test statistics were also done.

III. Results

The study population included 1233 children from three different schools of Karimnagar city.

Table 2: Sex distribution

Sex	**Number**	**Percentage**	**M:F ratio**
Boys	607	49.23	1.00 : 1.03
Girls	626	50.77	
Total	1233	100	

Table 2 shows the sex distribution of study population (n=1233), among which 607 and 626 were boys and girls respectively, male female ratio being 1:1.03 (nearly equal).

Table 3: Anthropometric measurements and PEFR (l/min) of study children (n=1233)

Parameters	**Sex**	**No. of samples (n)**	**Range**	**Mean**	**Standard deviation**
Height (cms)	Boys	607	57	132.21	9.839
	Girls	626	53	129.36	10.770
	Combined	1233	58	130.76	10.417
Weight (kgs)	Boys	607	44	26.97	8.186
	Girls	626	42	25.12	8.320

	Combined	1233	44	26.03	9.303
BMI	Boys	607	17.585	15.055	2.802
	Girls	626	17.009	14.541	2.650
	Combined	1233	18.077	14.793	2.737
BSA	Boys	607	0.920	0.988	0.184
	Girls	626	0.879	0.943	0.194
	Combined	1233	0.936	0.965	0.191

Table 3 shows the anthropometric parameters and PEFR with its descriptive statistics of 1233 normal students. Their age ranged between 6 years to 12 years 11 months. Range, mean and standard deviation were shown in both sexes.

However, average PEFR was calculated from the mean of 3 blows of individual sample. Best of 3 attempt (blow) of PEFR of each sample was considered normal and in all statistical analysis. Variation between highest and average value of PEFR was only 3.0% in boys and 3.5% in girls

Fig 1: Mean PEFR of Boys and Girls Combined

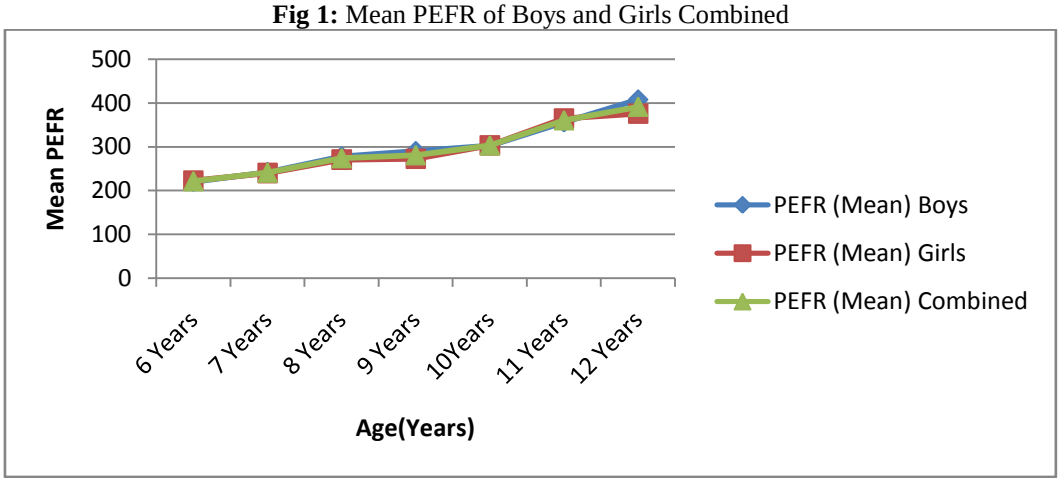
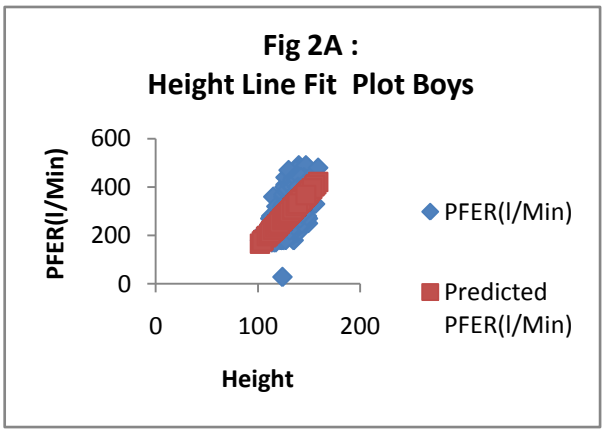


Figure 1 shows the mean PEFR (regression line) of total sample combined boys and girls and, mean PEFR (regression line) of boys and girls separately (shown in different colors). The mean PEFR of girls remained linearly similar to and just below the boys when mean line compared between the sex.



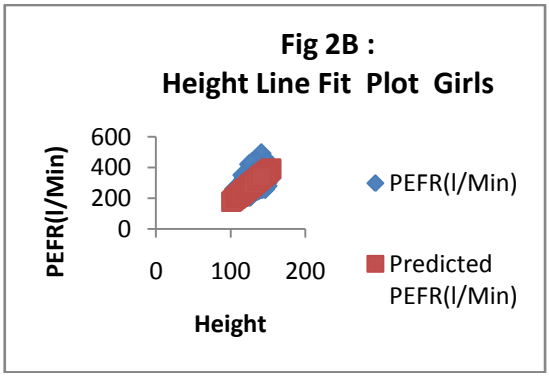


Figure 2 A and B show the PEFR (l/min) of boys and girls in relation to height with positive correlation when PEFR was considered dependent and height as an independent variable. Their coefficient of correlation was ($r=0.926$ for boys and $r=0.896$ for girls) highly significant ($p<0.001$).

Model	Sex	Variables		Regression equation	SEE*
		Dependent	Independent	PEFR (l/min)	
1	Boys	PEFR	Ht (cm)	-288.6293+4.4578(Height)	55.9292
	Girls	PEFR		-228.159+4.0283(Height)	42.7683
2	Boys	PEFR	Wt(Kg)	157.075+5.3273(weight)	56.1261
	Girls	PEFR		163.2708+5.1628(weight)	43.2001
3	Boys	PEFR	BMI	98.0231+13.4665(BMI)	60.2421
	Girls	PEFR		74.8353+14.999(BMI)	46.1740
4	Boys	PEFR	BSA	64.1042+241.5125(BSA)	55.3993
	Girls	PEFR		81.451+224.3975(BSA)	42.5612
5	Boys	PEFR	Ht(cm)	-98.0447+2.4682(HT)+2.6871(WT)	55.0662
	Girls	PEFR	& Wt (kg)	-74.7436+2.4112(HT)+2.2204(WT)	42.3550

Table 4 : Regression equation for prediction of PEFR (l/min) from different independent variables.
*Standard error of the estimate

Table 4 shows the regression equation (derived from the regression analysis and ANOVA test) where PEFR of individual person was considered dependent variable and other anthropometric parameters as independent variables. These regression equations enabled us to construct the nomogram.

Table 5: PEFR (l/min) in relation to height interval (n=1233).

Height interval(Cm)	Boys		Girls		P value
	N	PEFR Mean ± SD	n	PEFR Mean ± SD	
100-110	7	204.29± 18.13	16	221.88 ± 18.70	0.0486
110.5-120	72	239.01 ± 32.56	143	240.63 ± 25.71	0.6931
120.5-130	188	267.65 ± 57.66	179	272.07 ± 40.75	0.3993
130.5-140	206	319.51 ± 64.65	175	325.11 ± 55.97	0.3703
140.5-150	125	352.72 ± 59.07	108	351.84 ± 47.69	0.9019
150.5-160	9	403.33 ± 48.99	5	360 ± 37.42	0.1132

Table 5 Shows distribution of PEFR (l/min) according to height interval of normal children (6-12 years) in boys and girls. The values of PEFR of girls were slightly lower than that of boys.

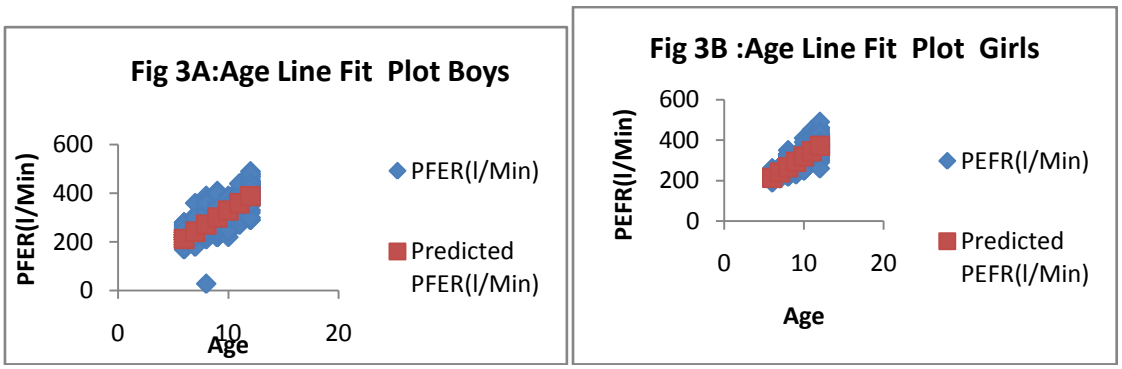
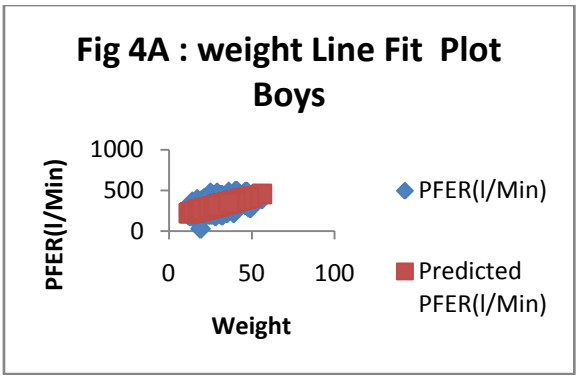


Figure 3 A & B: Scatter diagrams depict the relationship of PEFR (l/min) with age (month) and there positive correlation (r = .898 for boys & r = .878 for girls p <.001). But the relationship in case of boys was greater than that of girls.

Table 6 demonstrates the distribution of PEFR according to age interval in boys and girls. Independent sample test showed that among age categories of 6, 7, 8, 10 and 11 years, the mean difference of PEFR value between boys and girls had no significant difference but the values were lower in girls than that of boys. However in all other age categories the mean values of PEFR between boys and girls had significant difference (range of significance p< .00005).

Table 6: PEFR (l/min) of normal children in relation to age interval (n=1233)

Age Interval		Boys		Girls		
Month	Year	n	PEFR mean±SD	N	PEFR mean±SD	P value
72-83	6	85	220.35 ± 25.6	85	222.82 ± 12.87	0.42792
84-95	7	84	242.29 ± 31.36	91	239.89 ± 12.16	0.49979
96-107	8	87	277.90 ± 47.45	94	270.53 ± 26.21	0.19281
108-119	9	89	290.11 ± 40.10	95	272.31 ± 12.33	0.00005
120-131	10	87	302.99 ± 35.99	81	303.33 ± 33.47	0.95086
132-143	11	83	356.02 ± 36.89	85	364.71 ± 33.47	0.11189
144-156	12	92	407.72 ± 42.48	95	375.41 ± 40.36	<0.00001



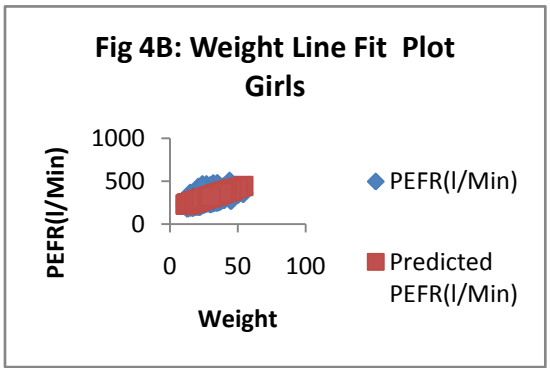
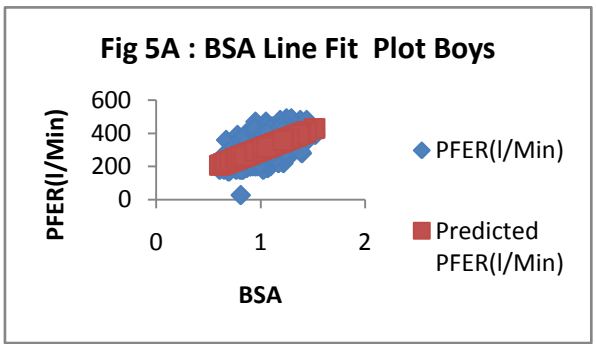


Figure 4 A & B: Show scatter diagram of PEFR (l/min) in relation to weight (kg) of boys and girls which revealed positive correlation coefficient with highly significant relationship.



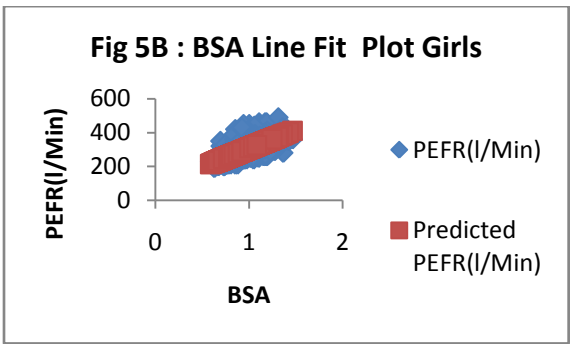
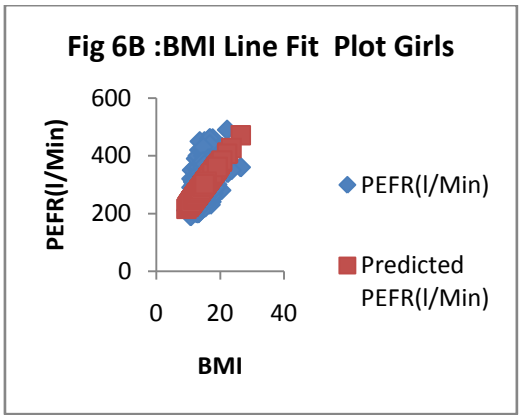


Figure 5 A & B: Scatter diagram show PEFR (l/min) in relation to body surface area (sq.m) with positive correlation with highly significant relationship.



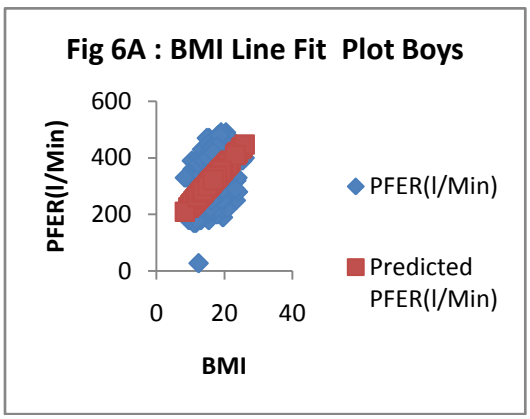


Figure 6 A & B: Scatter diagram show PEFR (l/min) in relation to body mass index (Kg/m^2) with positive correlation with highly significant relationship.

Table 7: Correlation coefficient (r) and level of significance between PEFR (l/min) and anthropometric parameters.

Parameters		**Correlation with**	**Correlation Coefficient (r)**	**P value**
Height (Cm)	Boys (n = 607)	PEFR	0.61742679	<0.0001
	Girls (n = 626)	PEFR	0.71242279	<0.0001
Weight(Kg)	Boys (n = 607)	PEFR	0.61388212	<0.0001
	Girls (n = 626)	PEFR	0.70537237	<0.0001
Age	Boys (n = 607)	PEFR	0.82522042	<0.0001
	Girls (n = 626)	PEFR	0.87070745	<0.0001
BSA	Boys (n = 607)	PEFR	0.62680528	<0.0001
	Girls (n = 626)	PEFR	0.71575360	<0.0001

Table 7 Shows the summary of correlation coefficient (r value) and the level of significance between different anthropometric parameters and PEFR in case of boys and girls. Highly significant correlation was observed in all anthropometric parameters but height correlated with PEFR (l/min) more than any other parameters.

Table 8 Comparison of normal PEFR applying different model of regression equation in different age group.

Parameters				**PEFR(l/min)**		
Age	**Height (Cm)**	**Weight (Kg)**	**sex**	**Model 1**	**Model 2**	**Model 3**
				Ht.	**Wt.**	**(Ht & Wt.)**
	120.24	18.56	Boys	220.35	220.35	220.34
6 Years	115.07	15.94	Girls	222.82	222.82	222.79
	123.37	20.25	Boys	242.29	242.29	242.29
7 Years	121.69	18.89	Girls	239.89	240.03	240.05
	128.76	23.08	Boys	277.91	278.30	278.73
8 Years	121.38	18.76	Girls	270.53	270.60	270.53
	135	29.41	Boys	293.05	289.87	289.84
9 Years	131.79	25.71	Girls	272.32	272.34	272.34
	136.78	30.13	Boys	302.99	303.97	304.00
10 Years	136.25	30.15	Girls	303.34	325.77	303.33
	138.12	31.39	Boys	347.02	356.02	356.03
11 Years	138.99	32.51	Girls	364.71	364.50	364.53
	142.23	36.34	Boys	407.72	407.59	407.70
12 Years	140.73	34.21	Girls	411.88	412.67	375.81

Table 8 Shows the PEFR values obtained by applying regression equation -on different age groups considering similar height and weight of both the sexes. It observed that values in model- 2 based on weight alone was always higher than the values calculating from any other model but difference was not significant ($p>0.1$).

Table 9A: Comparison of normal PEFR applying different parameters regression equation (Girls)

PARAMETERS	**B**	**SE**	**T STAT**	**P VALUE**
Intercept	627.9301392	854.1592607	0.735144098	0.462529272
Height	33.25320091	5.491251614	6.05566877	2.42205E-09
Age	-7.376661244	12.83671031	-0.574653558	0.565733734
Weight	-2.033084693	19.67787271	-0.103318317	0.917743694
BMI	-20.88921191	29.40371201	-0.710427714	0.477705647
BSA	721.4472241	1786.76493	0.403772881	0.68651874

Table 9B: Comparison of normal PEFR applying different parameters regression equation (Boys)

PARAMETERS	**B**	**SE**	**T STAT**	**P VALUE**
Intercept	133.597978	187.6447671	0.711972841	0.476758
Height	29.09944925	1.244761487	23.3775302	2.02E-86
Age	0.377863365	2.659597171	0.142075412	0.887068
Weight	7.961214065	4.106517901	1.93867755	0.053009
BSA	-336.578948	354.4874785	-0.9494805	0.342759
BMI	-1.84849342	6.159800356	-0.30008983	0.764213

Table 9A & B shows comparison of different parameters used in the study and its significance in predicting PEFR and in our study Height is the single most significant parameter in predicting PEFR in both girls and boys ($P < 2.42205E-09$ in girls, $P < 2.02E-86$ in boys). Other parameters are of not much significant in predicting PEFR in girls, while in boys weight is having good significance after height ($P<0.05300$.)

Table 10 : Comparison of PEFR values of the present study with other studies

Studies	**Height**					
	120 cm		**140 cm**		**160 cm**	
	Boys	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
Present study,	236	225	335	328	424	416
Durairaj et al, 2017[4]; Tamil Nadu	229	218	306	296	382	374
Taksande et al, 2008[5]; Maharashtra	217	179	311	251	405	324
Bedi et al, 2016[6]; Punjab	187	156	342	325	469	392
Reddy UN et al, 2014[7], Hyderabad	202	185	314	291	427	397
Sharma M et al, 2012[8]; Rajasthan	236	180	264	233	443	334
Nagasireesha et al,2014[9]; AP	252	182	285	290	351	310
Ashok KD et al, 2016[10]; Bihar	209	205	319	308	397	386
Mishra et al, 2015[11]; Odisha	194	214	287	292	333	329
Manjunath et al, 2013[12]; Karnataka	210	188	298	273	386	388

Table 10 Comparison of values of PEFR (l/min) Predicted from regression equation in relation to height in studies of different places of the world. It revealed that excepting a few studies PEFR value obtained in present study was more or less similar with other studies.

Table 11 : summary of age wise parameter values of the present study

Height (Mean±SD)			Weight (Mean±SD)			BMI (Mean±SD)			BSA (Mean±SD)			PEFR (Mean±SD)		
Boys	**Girls**	**Combined**	**Boys**	**Girls**	**Combined**	**Boys**	**Girls**	**Combined**	**Boys**	**Girls**	**Combined**	**Boys**	**Girls**	**Combined**
120.24 ± 6.69	115.07 ± 5.28	117.65 ± 6.54	18.56 ± 4.23	15.94 ± 2.64	17.25 ± 3.75	12.68 ± 1.78	11.98 ± 1.38	12.33 ± 1.63	0.78 ± 0.10	0.712 ± 0.070	0.74 ± 0.097	220.35± 25.60	222.82 ±12.87	221.58 ± 20.24
123.37 ±6.20	121.39 ± 5.11	122.33 ± 5.72	20.25 ± 5.05	18.71 ± 3.42	19.44 ± 4.33	13.14 ± 2.25	12.60 ± 1.45	12.85 ± 1.89	0.829 ± 0.11	0.792 ± 0.0863	0.809 ± 0.10	242.28 ± 31.36	239.890 ± 12.155	241.034 ± 23.33
128.75 ± 6.94	121.43 ± 5.12	124.95 ± 7.07	22.83 ± 5.92	18.72 ± 3.38	20.70 ± 5.19	13.58 ± 2.16	12.61 ± 1.48	13.081 ± 1.90	0.89 ± 0.13	0.792 ± 0.084	0.844 ± 0.122	277.90 ± 47.44	270.53 ± 26.20	274.077 ± 38.00
134.93 ± 6.21	131.28 ± 5.28	133.04 ± 6.02												
136.78 ± 6.42	136.24 ± 5.63	136.52 ± 6.04	29.14 ± 4.88	25.28 ± 4.84	27.15 ± 5.22	15.93 ± 1.89	14.54 ± 1.84	15.21 ± 1.99	1.04 ± 0.106	0.957 ± 0.108	0.998 ± 0.11	290.11 ± 40.099	272.31 ± 12.32	280.92 ± 30.50
138.12 ± 5.99	138.81 ± 5.53	138.47 ± 5.76	29.73 ± 6.63	30.14 ± 6.26	29.93 ± 6.44	15.75 ± 2.65	16.08 ± 2.33	15.91 ± 2.50	1.0580± 0.13	1.06 ± 0.129	1.06 ± 0.133	302.988± 35.99	303.33 ± 36.40	303.154 ± 36.082
142.228 ± 6.01	141.25 ± 5.92	141.72 ± 5.97	31.38 ± 5.77	32.30 ± 5.01	31.85 ± 5.40	16.32 ± 2.09	16.66 ± 1.63	16.49 ± 1.88	1.09 ± 0.121	1.11 ± 0.107	1.104 ± 0.114	356.024 ± 36.88	364.70 ± 33.47	360.41 ± 35.36
			36.0 ± 6.50	34.80 ± 5.60	35.38 ± 6.07	1.69 ± 2.38	17.33 ± 1.72	17.51 ± 2.079	1.18 ± 0.12	1.16 ± 0.115	1.177 ± 0.12	407.71 ± 42.48	375.40 ± 40.360	391.21± 44.36

	Age (Years)	6 years	7 Years	8 Years	9 Years	10 Years	11 Years	12 Years

IV. Discussion

Peak expiratory flow rate (PEFR) of 1233 normal children aged 6 to 12 years from different schools were measured to understand the normal value among children of Karimnagar. Male to female ratio is 1:1.03 (Table2). This study found the difference of values of PEFR (liter/minute) between boys and girls in relation to height, weight, age, body surface area. PEFR values of girls (in relation to height) were always lower than that of the boys (figure 2A&B). The difference of PEFR in boys and girls were also observed by other investigators.[4-6] But some studies observed equal values of PEFR in both the sexes.[10,11] Excepting 6, 7, 8 and 10 years age group PEFR values in relation to age were also significantly lower in girls than boys. It is possible that these lower values in girls were due to physiological reason and better performance of the boys.

The positive correlation of PEFR with height, age, weight and body surface area was observed in both the boys and girls which means that the value of PEFR increased with increase in those anthropometric parameters. The most significant correlation was observed between PEFR and height (Fig 2A&B, Table5) similar to other studies. [5,11] Thus the height had been found to provide a good basis for prediction of normal values of PEFR. Other investigators also found the superiority of height as an independent parameter which correlated well in PEFR and with other ventilatory functions.[4,6] Moreover, the superiority of the correlation coefficient for height can be confirmed by simple inspection of scatter diagram (Figure 2A and 2B). There was no disagreement regarding positive correlation of PEFR with height as an independent body parameter.

Age was the second variable which had positive correlation with peak flow rate (PEFR) in this study (Figure 3 A & B). Correlation coefficient values were less than that of the height but greater than the values observed in relation to body surface area and weight (Table 7). Our observation was also comparable to the findings of some other studies.[14]

Significant association was observed between PEFR with body surface area (Figure: 5A & B) and with body weight (Figure 6A & B). But the correlation of PEFR with body surface area was more significant than that of weight. On the other hand, the level of significance of correlation of PEFR with body surface area and with weight was less than that of height and age parameters. Such result may be due to wide variation in weight and height within same age groups. This was a possible explanation for wide scatter of PEFR values in the weight (Figure : 4A & B) and in the body surface area (Figure : 5A & B).

PEFR (l/min) values in relation to height interval in the present study were comparable to those obtained in other studies.[8,9] The PEFR was more or less similar with those studies in relation to height interval of the children. However some studies had shown the lower values PEFR than that of present study.[6,7,11] This may be due to nature of studied population, socio-economic status and sample size of the study. Our results were close to the results of studies having large sample size.[5] It is well recognized that peak expiratory flow rate may be different in normal population due to minor error in technique resulting in spuriously low value. Instrument variation may also give different values. Wright Peak Flow Meter (WPFM) will give the lower value than that of the mini Wright Peak Flow Meter (mWPFM). We have used 6 well calibrated mWPFM. Distribution of PEFR (l/min) as per age interval of normal children showed comparable values.[5] Boys and girls have significant difference in individual age category (excepting 6, 7, 8 and 10 years age groups) (Table 6) and it was observed more when age increased.

The regression equation for calculation of PEFR (l/min) in children was best when separate equation for boys and girls were calculated. The applied parameters were height, weight and height-weight combined. When combined height and weight were considered as independent variables, PEFR improved slightly than when height and weight were considered separately (Table 4 and Table 8).Studies in neighboring states of India observed that accuracy of predicted value of PEFR was more when weight was considered along with height, which is supporting the finding of the present study.[11,12] However, addition of multiple variables slightly improved the predicted result (Table 8) but the small increase in accuracy is probably offset by the increase in complexity.[15]

We found very little difference in prediction accuracy of regression equation constructed with standing height or age alone versus those using several anthropometric measurements. (Table 8). When mean PEFR (l/min) values calculated from prediction formula of different studies different height to compare (Table 11) our result, it reveal that mean predicted PEFR values of present study was a bit higher with significant difference between boys and girls values than that of studies done in other states of India (Table 11).[6,11] Difference may be due to instrumental variations and characteristics of studied population. Several studies observed significant difference of mean values of PEFR of boys and girls similar PEFR values which support our findings.[4,8] PEFR values obtained in present study were also similar with other study.[4], but a Punjab study showed the higher

values of PEFR (Table 11) than that of present study.[6] However, those findings suggest that PEFR in population of present study has difference in comparison to other states but similar to most of the states of India.

PEFR (l/min) predicted from height based regression equation was the most consistent finding in a good number of studies including ours. Our results appear to be reliable due to large sample size and high correlation coefficient with body parameters and cab be used as a normal reference value for normal children of Telangana state (6-12 years).

V. Conclusion

This study concluded that:

- There is significant difference of PEFR between boys and girls (6 – 12 years).
- Height is the best predictor of PEFR.
- Age, body weight and body surface area also correlate with PEFR but less predictive in comparison to height.
- The PEFR value of children of Telangana state is nearly similar to the other states of India.
- Result of this study can be used as a reference (PEFR value) for of Telangana state boys and girls and may need further studies with larger sample to give standard value of PEFR.

Further study is needed to understand the difference (if any) of PEFR between rural and urban normal children of Telangana state. \

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