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Peak Expiratory Flow Rate in Healthy Urban School Children (6 to 17 Years) and Its Correlation with Anthropometric Measurements

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ABSTRACT

Background: The predictive normal value of peak expiratory flow rate (PEFR), in children, is correlated with height and other anthropometric measurements, however, it shows ethnic Differences. The present study was conducted to establish the normal value of PEFR in healthy school children and to know the effect of various anthropometric factors on PEFR.

Methodology: This study was conducted among 2200 students to assess their Peak Expiratory Flow Rate (PEFR) using Mini-Wright peak flow meter. PEFR values correlated with age, gender and various anthropometric measurements.

Results: Out of total 2200 students, 1122 were boys which accounted for 51%. Mean PEFR for boys was 282.53 L/min and for girls was 270/.79 L/min. In boys and girls PEFR value increase as the age advances.

Multiple regression modeling with PEFR as dependent variable and MUAC, BMI, Age, CC, Height, Weight and BSA as independent variables shows that Height, Weight, BMI, BSA, Age and chest circumference are independently associated with PEFR value. However, MUAC is not independently associated with PEFR values.

Conclusion: From this study we conclude that in children between 6 to 17 year of age group the PEFR value in higher in boys compared to girls at any age. Height has strongest association with PEFR then the other variables.

INTRODUCTION

Peak Expiratory flow Rate (PEFR) is defined as "the maximum rate at which a child can blow exhaled air after taking maximum inspiration."[1] PEFR of any child is dependent on variables such as age, sex, height, weight etc. It depends on the voluntary effort and muscular strength of the child. [2]

Lung function tests have been increasingly used in assessing the severity of obstructive airway disease, evaluating the effect of various therapeutic regimens and providing a better understanding of disordered pulmonary physiology. [3] PEFR is an accepted index of pulmonary function and is widely used in respiratory medicine. Serial PEFR monitoring is a convenient method in investigation and diagnosis of asthma. [3]

Measurement of PEFR is simple, noninvasive, rapid and economical method to assess the strength and speed of expiration in L/min, through a forced expiration from total lung capacity. It is used to detect the reduction in pulmonary function associated with narrowing of airways, to assess the efficacy of clinical treatment. PEFR

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can detect airway obstruction in children as soon as it starts.[3]

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. [4]

The physiological principles underlying pulmonary function in health and disease were understood in surprising detail during past three hundred years. The pulmonary function tests have not only widened the knowledge about the functional capability of the lungs in normal healthy persons but also have made it possible to assess the functional abnormalities in persons with restrictive and obstructive airway disorders both qualitatively and quantitatively. The important functional abnormality in patients disabled by asthma, bronchitis, emphysema and other COPDs (Chronic Obstructive Pulmonary Disorders) is the difficulty in expiration. Hence the measurement of Peak Expiratory Flow Rate (PEFR) has gained worldwide acceptability as a method for identification, assessment, rational therapy and follow up of such patients.[4] Studies relating to PEFR and anthropometry among growing children are necessary in India as the mosaic of Indian population spreading over such a differing geography is varied and complex. [5]

Many studies have been proved the relation between the nutritional habit and respiratory functions in south Indian children. The increase in respiratory problems due to increase in Body Mass Index (BMI) in children has been a major worldwide problem. Deposition of fat over the chest wall alters the Peak Expiratory Flow Rate (PEFR) among pulmonary function test parameters. Among all the pulmonary function test parameters Peak expiratory flow rate (PEFR) directly indicate the nutritional status which is also an easy and non-invasive method for estimating the lung function in children. [6]

PEFR increases progressively with age, weight, height and more so with height in both sexes. For a given age, weight & height, boys have higher PEFR than girls. It is important to have reference standards for detecting abnormal values. Reference values are affected by regional and environmental factors. Therefore, it is necessary to have regional values for children. Since children are in dynamic process of variable growth, further studies of this nature are required. [7]

In this context, the aim of present study is to establish the normal value of PEFR in healthy school children and to correlate various anthropometric factors with PEFR.

MATERIALS AND METHODS

This study was conducted in the urban area of western India. This study was conducted in a private school considering the feasibility and cooperative attitude of the school. School children between the age group of 6 to 17 years consisted of the study population. Samples were taken from these age groups.

The data collection was done during the six-month period from August 2021 to February 2022. After collection of data, the data entry forms were checked for their completeness and missing and incomprehensible data was rechecked from the respective student. Data entry was done in MS Excel data sheet. The data cleaning and the retrieval of the missing data were done.

Study design: This was a cross sectional study. Each student was contacted once and all required data were collected. There were no follow up visits made.

Ethical Consideration: The study was initiated after taking ethical approval from the Institutional Ethical Committee. Informed written permission was taken from the school authority as well as from the class teacher of the respective student. Assent was also obtained from the student before the examination. Female students were examined only by the female investigator. All the students were examined and assessed in the presence of their respective teacher. All the students and their teachers were informed about voluntary participation, right to withdraw at any time, no compensation and confidentiality. All the data collected during the study were kept confidential and the results were presented as aggregate without disclosing the identity of any participants.

Sample Size: By taking mean PEFR among boys 201.13 L/min with SD of 44.39 and among girls 194.01 L/min with SD of 47.94 [8], the estimated sample size comes to be 1968 with 99% confidence level, 80% power of study using Open Epi software. [9] Additional 10% were added to adjust loss of sample during data collection or during data cleaning. So, the sample size become 1968+197=2165 which was rounded to 2200.

All apparently healthy children between age 6 years to 17 years were included in the study. Both boys and girls were included in the study. Any children who were known case of Asthma or having history of respiratory illness within week prior to study or having any Major systemic disease like Respiratory, Cardiac, Renal, GIT or CNS Problems was excluded from the study.

Any student absent of the day of the study was tried to contact on the next school visit day. Students not available during the entire study period or do not want to participate (as informed while taking ascent) were excluded from the study.

Sampling method: Students from all classes were taken consequently. Study was started from lowest class and covered all classes from standard one to 12. Students below 6 years were not included in the study. Sample taking continue till the sample size was completed. All required sample size was available from single school only.

Study team: The study team included one principal investigator and 2 subordinates (one male and one female) for helping the principal investigator in data collection. Before starting the study, the questionnaire was discussed among the investigator and subordinates.

Which is the information to be collected, in which way the questions to be asked to the students, what could be the possible response and how to deal with it, how to measure the anthropometric data and standardization of the scales were done between the investigator and subordinates. This was done to maintain the similarity for measurement of data among the investigators. The interview and anthropometric measurements of the participants were conducted in the same room of the school so if there was any doubt it could be rectified by consulting the principal investigator.

Study tools: A predesigned semi-structured questionnaire was prepared based on the review of literature on PEFR on school children. A piloting of 10 students was done to understand the feasibility, reliability and validity of the questionnaire. After piloting, the correction/ refinement was made in the questionnaire and methodology for anthropometric measurement based on the further review of literature and advice/suggestions of the guide of the study. Then the final questionnaire was presented in front of the guide and after minor corrections it was used for the data collection among the study participants.

The questionnaire included the information about the demographic profile of the students. Anthropometric measurements were taken to calculate height, weight, BMI, MUAC, Chest circumference and Body Surface Area. General Examination and systemic examination were conducted to exclude any acute or long-standing problem in a child.

All the questions were administered in the local language, Hindi or English, according to the understanding of the participants. Data was collected and noted at the same time. At the end of every day, all the forms were checked for their completeness of the data. Those forms which had incomplete information or information which is not comprehensible were filled again on the next day after meeting with the respective student.

Anthropometric measurements

Height (cm): The measurement of standing height was done by using appropriate scales with minimal cloths. Height was measured by using a portable, locally manufactured, stadiometer, standing upright on a flat surface without shoes. Height was recorded to the nearest 0.5 cm.

Weight (kg): The balance was placed on a hard flat surface and checked and adjusted for zero balance before each measurement. The subjects were stood in the center of the platform, look straight ahead and wearing light cloths without shoes. Weight was recorded to the nearest 0.1 kg.

Body Mass Index (BMI): Body Mass Index of the respondents to be computed using the formula, BMI = [Weight (kg) / Height (meters)^2]

Body Surface Area (BSA): Body Surface Area of the respondents to be computed using the formula:

BSA = [{Height (cm) x Weight (kg)}/3600]$^{1/2}$

Mid Upper Arm Circumference (MUAC): Mid Upper Arm Circumference was measured as follow: Bend the left arm, find and mark with a pen the olecranon process and acromium. Mark the mid-point between these two marks. With the arm hanging straight down, wrap a MUAC tape around the arm at the midpoint mark. Measure to the nearest 1 mm.

Chest Circumference (CC): Chest Circumference was measured as follow:

Ask participants to stand with feet apart and weight evenly distributed. Mark the Measurement Site. Locate the xiphoid notch which is the bony, inverted "V" at the base of the sternum. Encircle the tape measure completely around the chest at the point of the reference mark (xiphoid notch). Press the tape firmly against their bare chest. Once the tape measure is properly positioned, take measurement.

Peak Expiratory Flow Rate (**PEFR):** The procedure of Peak Expiratory Flow rate measurement using the Mini Wright peak flow meter was demonstrated to the child.

Each child was be given two trials and the next three readings were noted down. The best of three readings was taken as the PEFR of the child. If the difference between any two readings was large, the probability of a faulty procedure was considered. The procedure was demonstrated again to the child and a new set of readings will be taken. The instrument was cleaned in between the procedure.

Statistical analysis

Data management and analysis was done using Microsoft excel and SPSS software version 20. The frequency distribution and graph will be prepared for the variables. The categorical variables were presented in frequency and percentage while continuous variables were presented in mean and standard deviation. PEER was compared with other variables separately using linear regression model. Linear regression and multiple regression were calculated using SPSS software version 20. [10] Multiple regression was done using 'Enter' method.

RESULTS

This study was conducted among 2200 students to assess their Peak Expiratory Flow Rate (PEFR) and correlated them with age, gender and various anthropometric measurements.

Out of total 2200 students, 1122 were boys which accounted for 51% and 1078 were girls which accounted for 49%. Mean height for boys was 138.99 cm and for girls was 139.74 cm. Mean Weight for boys was 40.98 Kg and for girls was 36.73 Kg. Mean BMI for boys was 20.12 Kg/m2 and for girls was 17.96 Kg/m2. Mean BSA for boys was 1.09 m^2 and for girls was 1.07 m^2. Mean

MUAC for boys was 19.82 cm and for girls was 19.94 cm. Mean chest circumference for boys was 58.75 cm and for girls was 55.95 cm. Mean PEFR for boys was 282.53 L/min and for girls was 270/.79 L/min. Among the boys mean PEFR in 6-year age group was 164.82 L/min which gradually increasing with age. Mean PEFR of 17-year-old boys was 366.36 L/min. Among the girls mean PEFR in 6-year age group was 161.24 L/min which gradually increasing with age. Mean PEFR of 17-year-old girls was 339.86 L/min

Table 1: Age wise anthropometric measurement and PEFR of boys

Age (yr)	Boys	Height (cm)	Weight (Kg)	BMI (Kg/m^2)	BSA (m^2)	MUAC (cm)	CC (cm)	PEFR (L/min)
	Freq (%)	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
6	93 (8.29)	110.14 ± 5.19	21.04 ± 4.66	17.1 ± 2.25	0.63 ± 0.09	14.8 ± 1.28	48.36 ± 1.86	164.82 ± 21.18
7	95 (8.47)	117.9 ± 7.02	24.77 ± 4.9	17.59 ± 1.46	0.73 ± 0.11	15.29 ± 1.44	49.11 ± 3.1	196.48 ± 28.65
8	106 (9.45)	119.09 ± 5.35	25.81 ± 4.25	18.04 ± 1.38	0.75 ± 0.09	16.32 ± 2.89	50.02 ± 1.34	201.34 ± 21.82
9	101 (9)	129.33 ± 6.97	31.11 ± 6.87	18.32 ± 2.13	0.89 ± 0.13	17.74 ± 2.62	51.59 ± 1.91	243.1 ± 28.44
10	93 (8.29)	135.7 ± 6.66	34.76 ± 6.3	18.68 ± 1.61	0.98 ± 0.13	18.43 ± 1.82	52.94 ± 2.4	269.11 ± 27.16
11	104 (9.27)	138.66 ± 8.23	35.74 ± 7.31	18.34 ± 1.63	1.02 ± 0.16	19.35 ± 2.49	54.45 ± 7.28	281.18 ± 33.59
12	87 (7.75)	145.75 ± 10.15	41.98 ± 9.36	19.44 ± 1.71	1.16 ± 0.2	20.13 ± 3.71	58.2 ± 9.6	310.12 ± 41.41
13	78 (6.95)	150.76 ± 9.21	50.34 ± 10.37	21.84 ± 1.93	1.29 ± 0.2	21.6 ± 9.75	61.02 ± 10.31	330.54 ± 37.59
14	84 (7.49)	153.21 ± 9.63	53.25 ± 10.6	22.39 ± 1.71	1.35 ± 0.21	22.4 ± 10.05	64.94 ± 9.23	340.56 ± 39.3
15	88 (7.84)	156.3 ± 10.24	57.1 ± 10.56	23.11 ± 1.32	1.42 ± 0.22	23.31 ± 10.42	68.02 ± 7.84	353.17 ± 41.76
16	95 (8.47)	158.72 ± 9.99	60.12 ± 10.84	23.61 ± 1.4	1.47 ± 0.22	24.22 ± 10.43	72.8 ± 10.81	363.03 ± 40.77
17	98 (8.73)	159.58 ± 10.56	61.79 ± 11.29	24 ± 1.34	1.5 ± 0.23	25.46 ± 10.7	76.23 ± 11.25	366.36 ± 43.33
Total	1122 (100)	138.99 ± 18.59	40.98 ± 16.38	20.12 ± 2.99	1.09 ± 0.34	19.82 ± 7.53	58.75 ± 11.82	282.53 ± 75.82

BMI - Body Mass Index, BSA - Body Surface Area, MUAC - Mid Upper Arm Circumference, CC - Chest Circumference, PEFR – Peak Expiratory Flow Rate

Table 2: Age wise anthropometric measurement and PEFR of girls

Age (yr)	Girls	Height (cm)	Weight (Kg)	BMI (Kg/m^2)	BSA (m^2)	MUAC (cm)	CC (cm)	PEFR (L/min)
	Freq (%)	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
6	73 (6.77)	111.8 ± 5.15	20.74 ± 4.62	16.36 ± 2.19	0.64 ± 0.1	14.73 ± 1.35	44.31 ± 1.84	161.24 ± 20.17
7	87 (8.07)	118.95 ± 6.94	23.35 ± 4.81	16.28 ± 1.5	0.73 ± 0.11	15.24 ± 1.47	44.82 ± 3.06	189.28 ± 27.19
8	102 (9.46)	120.69 ± 5.45	23.98 ± 4.36	16.29 ± 1.51	0.74 ± 0.1	16.25 ± 2.82	46.02 ± 1.36	196.11 ± 21.36
9	96 (8.91)	131.2 ± 6.94	28.71 ± 6.81	16.4 ± 2.24	0.89 ± 0.15	17.9 ± 2.62	47.69 ± 1.9	237.29 ± 27.19
10	90 (8.35)	135.44 ± 6.61	30.86 ± 6.22	16.61 ± 1.77	0.95 ± 0.14	18.3 ± 1.87	48.85 ± 2.38	253.93 ± 25.91
11	100 (9.28)	138.79 ± 8.36	31.36 ± 7.4	16 ± 1.92	0.98 ± 0.17	19.27 ± 2.44	50.56 ± 7.4	267.03 ± 32.79
12	86 (7.98)	145.72 ± 10.2	36.62 ± 9.39	16.88 ± 2.05	1.11 ± 0.22	20.52 ± 3.35	54.17 ± 9.66	294.21 ± 40
13	78 (7.24)	150.76 ± 9.21	44.22 ± 10.31	19.12 ± 2.22	1.26 ± 0.22	21.51 ± 9.83	57.02 ± 10.31	313.96 ± 36.12
14	85 (7.88)	151.98 ± 9.58	46.4 ± 10.53	19.76 ± 2.06	1.3 ± 0.22	21.57 ± 10.26	60.91 ± 9.18	318.77 ± 37.55
15	87 (8.07)	154.75 ± 10.28	49.43 ± 10.54	20.33 ± 1.7	1.36 ± 0.23	24.19 ± 10.25	63.97 ± 7.87	329.61 ± 40.31
16	95 (8.81)	156.92 ± 9.99	51.7 ± 10.81	20.69 ± 1.79	1.41 ± 0.23	24.1 ± 10.44	68.8 ± 10.81	338.12 ± 39.17
17	99 (9.18)	157.37 ± 10.57	52.31 ± 11.26	20.8 ± 1.77	1.42 ± 0.24	25.01 ± 10.79	72.11 ± 11.26	339.86 ± 41.42
Total	1078 (100)	139.74 ± 17.26	36.73 ± 14.01	17.96 ± 2.69	1.07 ± 0.33	19.94 ± 7.63	55.09 ± 11.92	270.79 ± 67.67

BMI - Body Mass Index, BSA - Body Surface Area, MUAC - Mid Upper Arm Circumference, CC - Chest Circumference, PEFR – Peak Expiratory Flow Rate

Fig 1: Mean and Upper limit and lower limit (2 SD) of PEFR among Boys

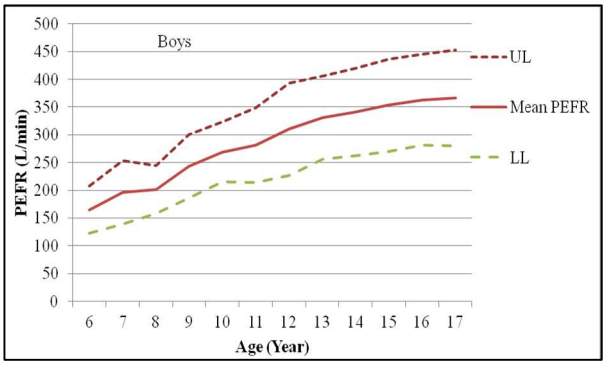

Fig 2: Mean and Upper limit and lower limit (2 SD) of PEFR among Girls

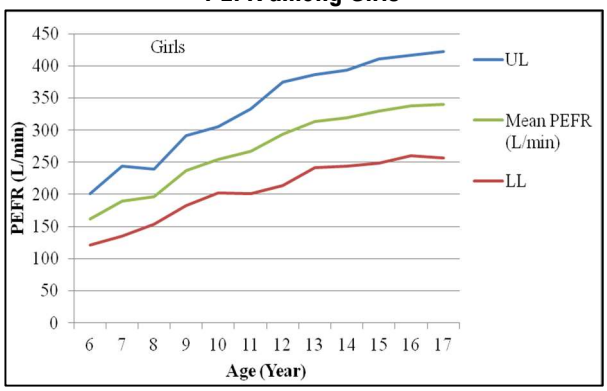

Table 3: Correlation co-efficient and Multiple regression of various variables with PEFR

Variables	Correlation coefficient	P value	Standardized Coefficients (Beta)	95.0% Confidence Interval for B		t value	P value
				Lower Bound	Upper Bound		
Age	0.859**	<0.001	-0.007	-0.225	-0.051	-3.099	.002
Height	0.995**	<0.001	1.491	5.892	6.097	114.3	.000
Weight	0.972**	<0.001	0.669	2.993	3.277	43.284	.000
BMI	0.858**	<0.001	0.057	1.159	1.558	13.354	.000
BSA	0.987**	<0.001	-1.270	-282.9	-264.5	-58.390	.000
CC	0.914**	<0.001	0.084	0.432	0.557	15.788	.000
MUAC	0.458**	<0.001	0.002	-0.001	0.043	1.853	.064

**. Correlation is significant at the 0.01 level (2-tailed).

a. Dependent Variable: PEFR

b. Predictors: (Constant/ Independent variables): MUAC (Mid Upper Arm Circumference), BMI (Body Mass Index), Age, CC (Chest Circumference), Height, Weight, BSA (Body Surface Area)

Method: Enter

In boys and girls PEFR value increase as the age advances. Regression equation shows R^2 value of 0.7687 and 0.7254 respectively for boys and girls. The value of PEFR is directly proportionate to the height of the boys and girls. Regression equation shows R^2 value of 0.9823 and 0.9587 indicates that 98.23% and 95.87% data fit the regression equation model for boys and girls respectively. The value of PEFR is directly proportionate to weight of the boys and girls. Regression equation shows R^2 value of 0.9567 and 0.9356. The value of PEFR is directly proportionate to the BMI of the boy and girl students. Regression equation shows R^2 value of 0.8395 and 0.733. The value of PEFR is directly proportionate to the BSA of the boy and girl students. Regression equation shows R^2 value of 0.9838 and 0.9719. The value of PEFR is directly proportionate to the MUAC of the boy and girl students. Regression equation shows R^2 value of 0.7047 and 0.7226. The value of PEFR is directly proportionate to the chest circumference of the boy and girl students. Regression equation shows R^2 value of 0.8253 and 0.8304.

All variable has positive relationship (positive correlation coefficient). The strongest relationship wa;s found with Height followed by BSA, weight and chest circumference respectively. MUAC has positive significant but weak relationship with PEFR.

Multiple regression modeling with PEFR as dependent variable and MUAC, BMI, Age, CC, Height, Weight and BSA as independent variables shows that Height, Weight, BMI, BSA, Age and chest circumference are independently associated with PEFR value. However, MUAC is not independently associated with PEFR values.

DICSUSSION

Peak Expiratory Flow Rate is a very simple and easy method of measuring and assessing severity of respiratory conditions like asthma. It is also useful in assessing effectiveness of the treatment. The present study was conducted to study Peak expiratory flow rate (PEFR) in healthy school children aged 6-17 yrs with mini-Wright peak flow meter in Surat, Gujarat. The study also tried to establish relationship between variables like age, sex, height, weight, body mass index with peak expiratory flow rate in children.

Age, height, weight and BSA have all been used either alone, or, in combination to predict PEFR in various studies. [11-14] In this study we used Age, height, weight, MUAC, BMI, BSA and chest circumference for constructing the regression equation for predicting PEFR.

In our study we found that the Mean PEFR of the student was 276.78 L/min with standard deviation of 72.17. Mean PEFR for boys was 282.53 L/min and for girls was 270.79 L/min. Abraham B et al [8] conducted a study among 993 were boys and 1007 were girls of the age group between 6 and 12 years which found that the mean PEFR among boys was 201.13 ± 44.39 L/min, while the same for girl was 194.01 ± 47.94 L/min. Similar findings were also observed by various studies across the country i.e. Taksande A et al [15] , Reddy UN et al [7], Veeranna *et al* [16] and Swami Nathan S et al [17].

In the present study PEFR was studied in relation to Age among Boys and Girls separately using Linear Regression model. PEFR value increase as the age advances. Sarawade et al [18] conducted a study among 642 children and found that there is a linear increase in the PEFR as the age increases. This was observed in both the gender, however, PEFR values were better in male children compared to female children of the same age. A study conducted by Durairaj P et al [1] among 1470 healthy children aged 6 to 12 years attending school in Chennai (735 boys and 735 girls) also found similar results. In Caucasian and North Indian children, Chowgule et al [19]. showed that the lung function variables have a linear positive correlation with age. As the age increase PEFR also increases.

In the present study, the value of PEFR is directly proportionate to the height of the boys and girls which indicate the PEFR value increase as the height increases. A study in Delhi city and various areas of Andhra Pradesh by Pande et al [20]. concluded that height was independently associated with PEFR which indicated that changes in the height of a child significantly changes his or her PEFR value. In Caucasian and North Indian chil-

dren, Chowgule et al [19]. showed that the lung function variables have a linear positive correlation with height.

In the present study, the value of PEFR is directly proportionate to the weight of the boy and girl students which indicates that the PEFR value increase as the weight increases. The correlation coefficient for Weight and PEFR is 0.972 (p value <0.001) indicates that PEFR value is strongly correlated with Weight. Multiple regression also shows that it is independently associated with PEFR. In his study among 2000 school students of the age group between 6 and 12 years, Abraham B et al [8] found statistically significant ($p < 0.05$) strong positive relationship between PEFR and weight of the children (correlation coefficient 0.791). In our study PEFR increased with increased in weight of both boys and girls similar to the studies done in the past by Carson JWK et al [21] and GharagozloM *et al* [22]. Sagher FA et al [23] also found that the PEFR values in children was significantly associated with weight (correlation coefficient = 0.6) $p < 0.001$.

In the present study, the value of PEFR is directly proportionate to the BMI of the boy and girl students which indicates that the PEFR value increase as the BMI increases. In a study by Shubhankar M et al [4] mean PEFR (l/min) for body mass index of up to 15 was169.0 with SD 53.65, 15.1-20.0 it was 218.0 with SD 59.28, for >20.0 it is 258.9 with SD 55. 19. However, in his study among 2000 school students of the age group between 6 and 12 years, Abraham B et al [8] did not found statistically significant ($p > 0.05$) relationship between PEFR and BMI of the children (correlation coefficient 0.87).

In the present study, the value of PEFR is directly proportionate to the BSA of the boy and girl students which indicates that the PEFR value increase as the BSA increases. In a study by Vijay Krishna K et al [24], the author found that PEFR value and BSA were positively associated. In this study Co-efficient of correlation(r) values were 0.976 in boys, 0.948 in girls and 0.967 overall. P value was less than 0.001 in all the cases. The results of the present study on relation of BSA and PEFR are also in accordance with the result of the study conducted by Parmar V et al [25] and Kashyap S et al. [26]

In the present study, the value of PEFR is directly proportionate to the MUAC of the boys and girl students which indicates that the PEFR value increase as the MUAC increases. In his study among 2000 school students of the age group between 6 and 12 years, Abraham B et al [8] found statistically significant ($p < 0.05$) positive relationship between PEFR and MUAC of the children (correlation coefficient 0.653).

In the present study, the value of PEFR is directly proportionate to the chest circumference of the boy and girl students which indicates that the PEFR value increase as the chest circumference increases. Durairaj P et al [1] demonstrated a statistically significant co-efficient of regression for chest circumference with PEFR. However, of all the anthropometric variables, chest circumference 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 boys and girl's groups respectively.

In the present study multiple regression model of PEFR as dependent variable and MUAC, BMI, Age, CC, Height, Weight and BSA as independent variables was developed. Adjusted P value indicate that Height, Weight, BMI, BSA, Age and chest circumference are independently associated with PEFR value. However, MUAC is not independently associated with PEFR values. Abraham B et al [8] among children of southern Kerala, PEFR was found to have significant correlation with age, height, weight, CC, and MUAC but no correlation with BMI. In this study PEFR values of boys were marginally higher than that of girls ($p > 005$). In this study the PEFR ranged from 124 L/min to 196 L/min and height showed the maximum variance in lung function parameters. Hence, for clinical evaluation of child's lung function, height is the most significant independent parameter in comparison to age and weight. Study by Sharma et al [27] in Indian children and another study by Primhak et al [28] in British children also showed similar findings. PEFR values of children were found to be lesser than that of other South Indian, North Indian, and Western children. This may be due to the fact that measured anthropometric parameters are less in children of Southern India compared to other parts of India. [29]

LIMITATION

The study was conducted in urban area, so the results are limited to the urban school children only. Rural children may have different values than our study results. The study didn't include out of the school children. These children may have different anthropometric measurements than the school going children. Being a school-based study, it is not possible to include out of the school children. Many observations were depended upon the instruments. Multiple instruments were used in the study. So, there is a possibility of 'Instrumental variability. To reduce instrumental variability, all the instruments were calibrated at the beginning of each day.

CONCLUSION

From this study we conclude that in children between 6 to 17 year of age group the PEFR value in higher in boys compared to girls at any age. PEFR value is increasing as the age increases. PEFR value is also increases with increase in height, weight, BMI, body surface area, mid upper arm circumference and chest circumference. Height has strongest association with PEFR then the other variables. Multiple regression shows that Height, Weight, BMI, BSA, Age and chest circumference are independently associated with PEFR value. MUAC is not independently associated with PEFR values.

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REFERENCES

1. Durairaj P, Raju S, Thirumalaikumarasamy S. Measurement of peak expiratory flow rate values in healthy school going children between 6 and 12 years attending urban schools in Chennai. Int J Contemp Pediatr 2017;4:2002-7.
2. Peak Flow Rate Measurement. Available at http://emedicine.medscape.com/article/1413347-overview. Accessed on 10 may 20
3. Bedi U, Dang BK A study of peak expiratory flow rate in normal healthy children of Punjab Int J Med and Dent Sci 2016; 5(1):1042-1047.
4. Mishra Shubhankar, Behera Asish K, Ravichandra KR, Sethy Geetanjali, Soren Narendra N. Study of Peak Expiratory Flow Rate of School Children of South Odisha. Sch. Acad. J. Biosci., 2015; 3(5):429-433
5. Kartik Ramachandra1, Santosh Srinivasaiah2, Sahana Giliyaruz Adarsh Eregowda,Study of PEFR in Urban lower and middle class high school children at Bangalore, India International Journal of Contemporary Pediatrics 2016 Feb;3(1):189-192
6. Sudha D, Chandra Selvi E, Saikumar. P. Correlation of Nutritional Status and Peak Expiratory Flow Rate in Normal South Indian Children Aged 6 to 10 Years. IOSR J Dental Medical Sci 2012; 2(3):11-16.
7. Reddy UN, Khan MU, Anjum S, Nasirmihiuddin M, Rao SP, Rao JN, Afreen S. Evaluation of mean peak expiratory flow rate (PEFR) of healthy children belonging to urban areas of Hyderabad. Asian Pac J Health Sci. 2014;1(2):113-9.
8. Abraham B, Baburaj S, Patil RB, Mohandas MK, Ruhman S, Raj S. Peak expiratory flow rate nomogram in relation to anthropometric determinants of South Indian school children. Indian J Child Health. 2014;1(2):44-8.
9. Dean AG, Sullivan KM, Soe MM. OpenEpi: Open Source Epidemiologic Statistics for Public Health, Version. www.OpenEpi.com, updated 2013/04/06, accessed 2020/09/01
10. SPSS Statistics for Windows, version x.0 (SPSS Inc., Chicago, Ill., USA)
11. Prasad R, Verma SK, Agrawal GG, Mathur N. Prediction model for peak expiratory f low in North Indian population. Indian J Chest Dis Allied Sci 2006;48:103-106.
12. Swaminathan S, Diffey B, Vaz M. Evaluating the suitability of prediction equations for lung function in Indian children: a practical approach. Indian Pediatr 2006;43:680-698.
13. Paramesh H. Normal peak expiratory f low rate in urban and rural children. Indian J Pediatr 2003;70:375-377.
14. Nku CO, Peters EJ, Eshiet AI, Bisong SA, Osim EE. Prediction formulae for lung function parameters in females of south eastern Nigeria. Niger J Physiol Sci 2006;21:43-47.
15. Amar Taksande, Manish Jain, Krishna Vilhekar, Pushpa Chaturvedi. Peak expiratory f low rate of rural school children from Wardha district, Maharashtra in India. World J Pediatr 2008; 4(3):211-214.
16. Veeranna N, Rao KR. A Study Of Peak Expiratory Flow Rates Among Tribal Children of Mysore District, J indian med Assoc; July 2004; 102(7):357-359
17. Swaminathan S, Venkatesan P, Mukunthan R. Peak expiratory flow rate in south Indian children. Indian Pediatr. 1993;30(2):207-11.
18. Sarawade S, Kumbhojkar S, Patil S. Peak Expiratory Flow Rates in Children of Western Maharashtra 10- 16 Years of Age. Int J Health Sci Res. 2017; 7(10):1-5.
19. Chowgule RV, Shetye VM, Parmar JR. Lung function tests in normal Indian children. Indian Pediatr. 1995;32(2):185-91.
20. Pande JN, Mohan A, Khilnani S, Khilnani GC. Peak expiratory flow rate in school-going children. Indian J Chest Dis Allied Sci. 1997;39(2):87-95.
21. Carson JWK, Hoey H, Taylor MRH. Growth And Other Factors affecting peak respiratory flow rate. Arch Dis Childhood 1989; 64:96-102.
22. Gharagozlo M, Khajooe V, Moin M, Rezvani M. Peak expiratory flow rate in healthy children from Tehran. Iranian Journal of Medical Sciences. 2015 Oct 25;28(1):26-8
23. Sagher FA, Roushdy MA, Hweta AM. Peak expiratory flow rate nomogram in Libyan schoolchildren. East Mediterr Health J. 1999;5(3):560-4.
24. K Vijay Krishna, S Arun Kumar, V Shivaprasad, RD Desai. Peak expiratory flow rate and its correlation with body surface area in healthy school children. Journal of Scientific and Innovative Research 2014; 3(4): 397-401
25. Parmar VR, Kumar L, Malik SK. Normal values of peakexpiratory f low rate in healthy North Indian school children,6-16 years of age. Indian Pediatr 1977;14:591-594.
26. Kashyap.S and Malik S.K.: PEFR of healthy school boys from Himachal Pradesh (North India), Indian J. Chest Dis and All. Sci. 1987; 29(4):216-218.
27. Sharma M, Sharma RB, Choudhary R. Peak expiratory flow rates in children of western Rajasthan, 7-14 years of age. Pak J Physiol. 2012;8:45-8.
28. Primhak RA, Biggins JD, Tsanakas JN, Hatzimichael A, Milner RDG, Karpouzas JG. Factors affecting the peak expiratory flow rate in children. Br J Dis Chest 1984; 78: 26-35
29. Raju PS, Prasad KV, Ramana YV, Ahmed SK, Murthy KJ. Study on lung function tests and prediction equations in Indian male children. Indian Pediatr. 2003;40(8):705-11.