Journal of Cardiovascular Disease Research

ISSN:0975-3583,0976-2833 VOL14, ISSUE 05, 2023

Normal Peak Expiratory Flow Rate Of Children Attending A Medical College Hospital In Puducherry

S S KUMARAN[1], V ANEBARACY[2*], C REKHA[3], A KARUPPIAH PANDI[4], V D RAGHAVENDRAN[5], K MAHESHWARI[6], ABHIJEET SHRIVASTAVA[7]

Dr. S S KUMARAN[1]
Associate professor,
Department of Pediatrics,
Sri Lakshmi Narayana Institute Of Medical Sciences,
Puducherry,
e-mail: drkumaran83@gmail.com
Mobile:9943540516

Dr. V ANEBARACY[2*]
Associate professor,
Department of Physiology,
Arunai Medical College And Hospital,
Tiruvannamalai.
e-mail: anbusuresh1976@gmail.com
Mobile:9787175776

Dr. C REKHA[3]
Associate professor,
Department of Pediatrics,
ACS Medical College and Hospital,
Chennai.
e-mail: chandrasekarrekha@gmail.com
Mobile:9790733257

DR. A KARUPPIAH PANDI[4]
Associate professor,
Department of Pediatrics,
Sri Lakshmi Narayana Institute Of Medical Sciences,
Puducherry.
e-mail: ikpandi85@gmail.com
Mobile: 9786288136

DR. V D RAGHAVENDRAN[5]
Professor
Department of Pediatrics,
Sri Lakshmi Narayana Institute Of Medical Sciences,
Puducherry.
e-mail: raghavendr2011@yahoo.com
Mobile: 9442038565

DR. K MAHESWARI[6]
Professor,
Department of Pediatrics,
Sri Lakshmi Narayana Institute Of Medical Sciences,
Puducherry.
e-mail: maheswarijipmer@gmail.com
Mobile: 9159746208

ISSN:0975-3583,0976-2833 VOL14, ISSUE 05, 2023

DR. ABHIJEET SHRIVASTAVA[7]
Assistant Professor,
Department of Pediatrics,
Sri Lakshmi Narayana Institute Of Medical Sciences,
Puducherry.
e-mail: drabhijeetshrivastava@yahoo.com
Mobile: 8608912340

Abstract:

Objectives: To measure the Peak expiratory flow rate (PEFR)of healthy school children and to find out the correlation between PEFR values and anthropometric parameters, to create a nomogram of PEFR for children and formulate a regression formula for PEFR.

Methods :A cross-sectional study was conducted on children between the age group of 8 years and 12years attending medical college hospital at Puducherry. After collecting baseline data, PEFR was measured using a mini Wright peak flow meter. The highest of three measurements were recorded for analysis.

Results: Of the 1500 students screened, 1000 were included in the study. Out of which 655 were boys and 345 were girls. Significant linear correlation was seen in PEFR with height, weight, BMI and BSA ($r = 0.991$, $r = 0.983$, $r = 0.775$ & $r = 0.987$ respectively, $p < 0.001$). Nomograms were plotted based on the observed values of PEFR in the study population. Prediction equations were derived for PEFR for the following variants like age, height, weight, BMI, BSA ,male and female are as follows PEFR = (AgeX25.667)-18.326, PEFR = (HtX4.104)-324.420, PEFR = (WtX6.883)+13.070, PEFR = (BMIX42.585)-496.875, PEFR = (BSAX287.029)-80.705, PEFR = (HtX4.094)-322.930 & PEFR = (HtX4.121)-326.935 respectively

Conclusions: Significant correlation was noted between PEFR and anthropometric parameters like height, weight and BMI and BSA. Hence nomograms and formulas created can be used in the study area.
Keywords: Peak expiratory flow rate, Children, Anthropometry, Nomogram

Introduction

Respiratory disorders are a major group of illnesses affecting children in India and are important causes of childhood morbidity and mortality. Obstructive airway diseases in children are in a rising trend due to environmental pollution and other causes. Global prevalence of asthma ranges from 1% to 18% of the population in different countries[1].The prevalence of asthma in India is roughly estimated to be between 10 and 15% in 5–11 y old children[2]. So assessment of pulmonary function tests in children is gaining importance day-by-day[3].

Peak expiratory flow rate (PEFR) measurement is a simple test of respiratory function, which can be easily measured and correlated well with other lung function measurements. Personal best PEFR is found to be a useful tool in asthma management plan[1]. A mini-Wright peak flow meter (mWPFM) is used to measure PEFR which is easy to use, reliable, cheap and portable. The dial range is 0–1000 L/min though the American Thoracic Society recommends a range of 100 to <850 L/Min[4,5].

Various studies carried out in different districts in India and other countries have shown that pulmonary function varies with age, sex, height, weight, race and geographic locations[5,6,7,8,9,10,11,12,13,4]. This study was done to assess correlation of anthropometry with PEFR and create a normal reference value for children in rural areas of Puducherry.

Material and Methods

This cross-sectional study was conducted on children from different villages attending the Pediatric OPD of Sri Lakshmi Narayana Institute of Medical Sciences(SLIMS), Puducherry from April 2018 through December 2018. Healthy children between the age of 8 and 12 years were included in the study. Exclusion criteria were: children below 8 years and above 12 years of age; children having acute respiratory infections within 7 days of the study; children with major medical illness, recurrent cough or chest

ISSN:0975-3583,0976-2833 VOL14, ISSUE 05, 2023

infection or chest deformity; children with family history of asthma; children with a person taking bronchodilator metered-dose inhaler (MDI) in the family; children with rhonchi or wheeze on auscultation or other findings suggestive of any chronic illness. Ethical clearance was obtained from the ethical committee of Sri Lakshmi Narayana Institute of Medical Sciences(SLIMS), Puducherry

Sample size calculation: Considering the mean & standard deviation of PEFR values for children as 192.0±21.7 L/min (for 9 years old) and 213.2±17.2 L/min (for 10 years old)[15] with alpha error as 5%, power as 80%, error of margin as 3.3, the minimum sample size required was 190 per age group using the formula below. Finally a sample of **1000** was taken considering the age groups from 8 to 12.

$$n = \frac{2Z^2_{1-\alpha/2}\sigma^2}{d^2}$$

Where zigma is the standard deviation; d is the error of margin.

.

A basic physical examination was also done to omit children based on the exclusion criteria. Data collection was done by the trained interns of the Pediatric Department of Sri Lakshmi Narayana Institute of Medical Sciences(SLIMS), Puducherry.

Anthropometric measurements for the children in inclusion criteria are taken. Weight was measured using standard weighing scale in kilograms wearing only school uniform, after removing footwear and other accessories. The weighing machine was put on an absolutely flat surface and was calibrated before taking measurements. Accuracy of the machine was ±50 g. Any fraction of weight thus measured was corrected to the nearest kilogram. Height was measured with a stadiometer without footwear and child standing erect with heel, calf, buttocks, shoulder blade and occiput touching the stadiometer. The measured height was then corrected to the nearest centimetre. Body mass index (BMI) Body surface area (BSA) were calculated from weight and height using the formula given below

$$\text{BMI} = \frac{\text{Weight in kg}}{(\text{Height in m})^2} \times 100$$

$$\text{BSA} = \frac{\sqrt{\text{Wt}} \times \sqrt{\text{Ht}}}{\sqrt{3600}}$$

Peak expiratory flow rate was measured in L/min, in standing position using mini Wright's peak flow meters (mWPFM), with a disposable mouth-piece. Accuracy of the flow meters were ±10 L/min. The flow meters were compared with the meter available in the Department of Chest Medicine in Sri Lakshmi Narayana Institute of Medical Sciences(SLIMS), Puducherry.

Training for recording the PEFR value was taken from the same department by the researcher and assistants. Students were repeatedly demonstrated and explained the procedure till they understood the correct method. They were allowed to make as many attempts as required till three values within ±20 L/min were obtained. From these three values the highest value was chosen.

Students were repeatedly demonstrated and explained the procedure till they understood the correct method. They were allowed to make as many attempts as required till three values within ±20 L/min were obtained. From these three values the highest value was chosen.

Statistical analyses were performed using SPSS version 20. Quantitative variables were described by mean and standard deviation. Qualitative variables were expressed by frequency distribution. Comparison of quantitative variables between two groups were analysed using an independent sample t test and that of more than two groups were analyzed using ANOVA. Correlations between two quantitative variables were analyzed using Pearson correlation formula. A multivariate analysis of linear regression was done for the prediction of PEFR taking height and weight as independent variables. A p value of 0.05 was taken as the level of significance.

ISSN:0975-3583,0976-2833 VOL14, ISSUE 05, 2023

Results:

Table 1 Mean and Standard deviation of Demographic data, anthropometry and PEFR values

Gender		AGE	HEIGHT	WEIGHT	BMI	BSA	PEFR VALUES
Female	N	345	345	345	345	345	345
	Range	4	27	17	2.76	.4100	110
	Minimum	8	124	24	15.61	.9000	190
	Maximum	12	151	41	18.37	1.3100	300
	Mean	9.88	136.52	32.38	17.2324	1.103159	235.70
	Std. Deviation	1.437	8.902	5.228	.65410	.1259390	37.022
Male	N	655	655	655	655	655	655
	Range	4	27	17	3.01	.4000	111
	Minimum	8	124	24	15.36	.9100	189
	Maximum	12	151	41	18.37	1.3100	300
	Mean	10.06	137.45	32.91	17.2820	1.115985	239.74
	Std. Deviation	1.400	8.819	5.237	.67405	.1261312	36.449
Total	N	1000	1000	1000	1000	1000	1000
	Range	4	27	17	3.01	.4100	111
	Minimum	8	124	24	15.36	.9000	189
	Maximum	12	151	41	18.37	1.3100	300
	Mean	10.00	137.13	32.73	17.2649	1.111560	238.34
	Std. Deviation	1.415	8.854	5.238	.66732	.1261494	36.680

Table 2: Mean and variance of PEFR with Age

Age	N	Mean	Std. Deviation	95% Confidence Interval for Mean		Minimum	Maximum
				Lower Bound	Upper Bound		
8	200	191.59	1.368	191.40	191.78	189	194
9	200	210.34	.835	210.22	210.46	208	212
10	200	234.76	.852	234.64	234.88	234	236
11	200	259.87	4.877	259.19	260.55	254	268
12	200	295.16	4.353	294.55	295.77	290	300
Total	1000	238.34	36.680	236.07	240.62	189	300

ANOVA; F value=36253.335; p value<0.001

ISSN:0975-3583,0976-2833 VOL14, ISSUE 05, 2023

Table 3: Correlation of PEFR with Age

Correlations			
		AGE	PEFR VALUES
AGE	Pearson Correlation	1	.990**
	Sig. (2-tailed)		.000
	N	1000	1000
PEFR VALUES	Pearson Correlation	.990**	1
	Sig. (2-tailed)	.000	
	N	1000	1000
**. Correlation is significant at the 0.01 level (2-tailed).			

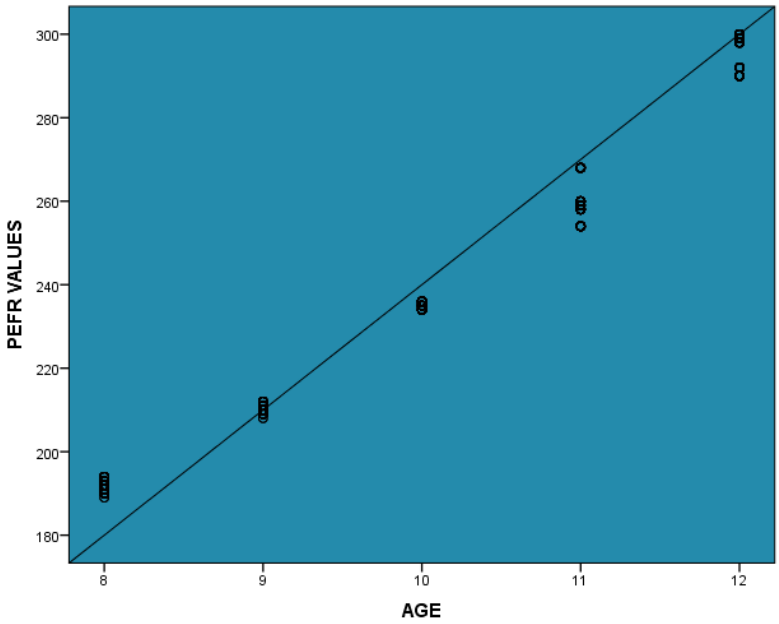

Figure 1: Peak expiratory flow rate nomogram in relation with age

Table 4:Mean and variance of PEFR with Height

Height	N	Mean	Std. Deviation	95% Confidence Interval for Mean		Minimum	Maximum
				Lower Bound	Upper Bound		
<130	390	200.72	9.450	199.78	201.66	189	212
130-140	256	237.27	9.185	236.14	238.40	208	254
140-150	273	276.42	17.402	274.34	278.49	258	300
>150	81	294.57	4.117	293.66	295.48	290	300
Total	1000	238.34	36.680	236.07	240.62	189	300

ISSN:0975-3583,0976-2833 VOL14, ISSUE 05, 2023

ANOVA; F value=2855.848; p value<0.001

Table 5: Correlation of PEFR with Height

Correlations			
		HEIGHT	PEFR VALUES
HEIGHT	Pearson Correlation	1	.991**
	Sig. (2-tailed)		.000
	N	1000	1000
PEFR VALUES	Pearson Correlation	.991**	1
	Sig. (2-tailed)	.000	
	N	1000	1000
**. Correlation is significant at the 0.01 level (2-tailed).			

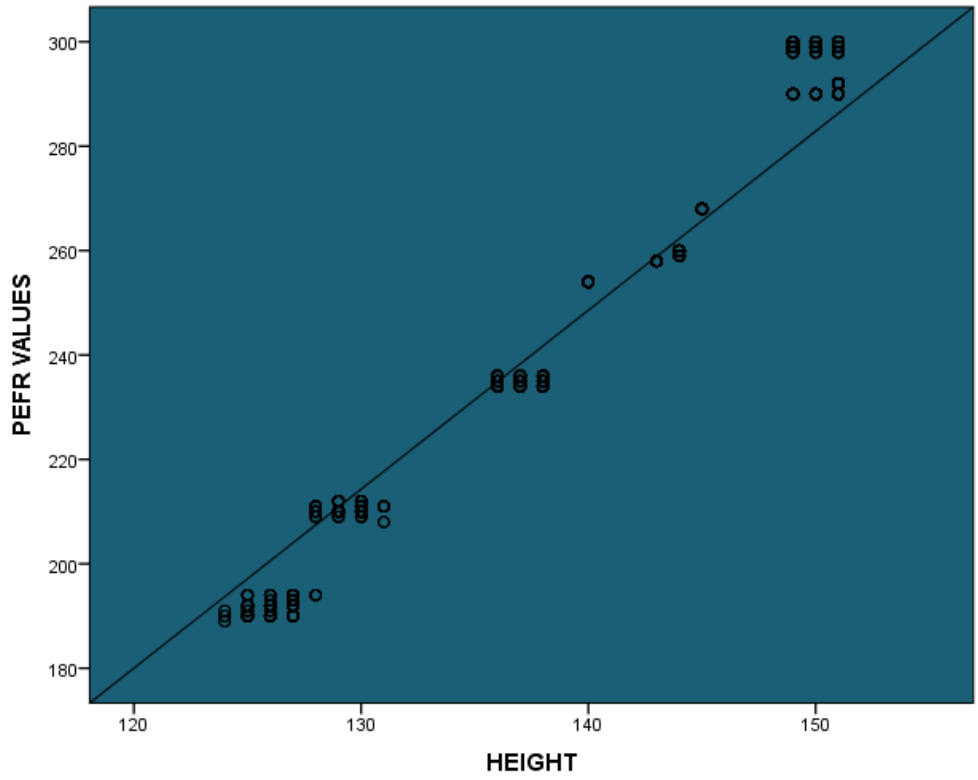

Figure 2: Peak expiratory flow rate nomogram in relation with height

ISSN:0975-3583,0976-2833 VOL14, ISSUE 05, 2023

Table 6: Mean and variance of PEFR with Height

Height	N	Mean	Std. Deviation	95% Confidence Interval for Mean		Minimum	Maximum
				Lower Bound	Upper Bound		
<30	400	200.97	9.455	200.04	201.89	189	212
30-35	200	234.76	.852	234.64	234.88	234	236
35-40	339	274.29	17.942	272.38	276.21	254	300
>40	61	295.41	4.436	294.27	296.55	290	300
Total	1000	238.34	36.680	236.07	240.62	189	300

ANOVA; F value=2728.405; p value<0.001

Table 7: Correlation of PEFR with Weight

Correlations			
		WEIGHT	PEFR VALUES
WEIGHT	Pearson Correlation	1	.983**
	Sig. (2-tailed)		.000
	N	1000	1000
PEFR VALUES	Pearson Correlation	.983**	1
	Sig. (2-tailed)	.000	
	N	1000	1000
**. Correlation is significant at the 0.01 level (2-tailed).			

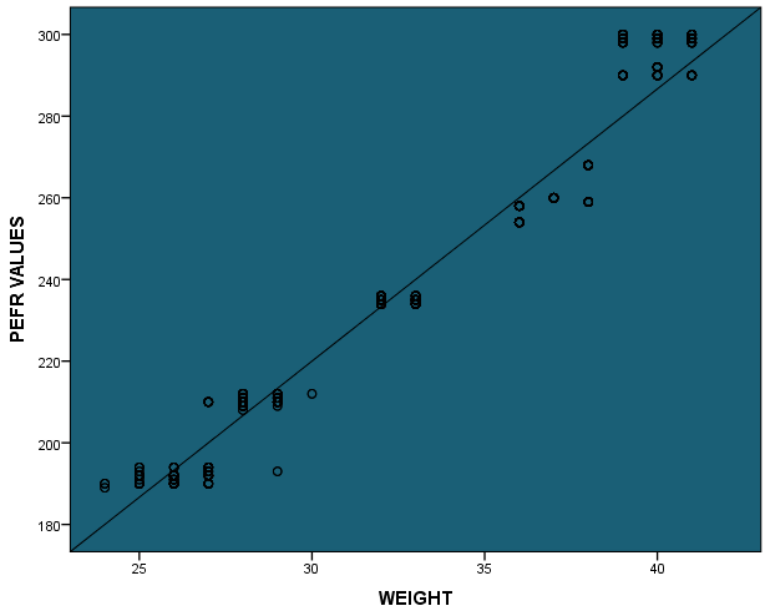

Figure 3: Peak expiratory flow rate nomogram in relation with weight

ISSN:0975-3583,0976-2833 VOL14, ISSUE 05, 2023

Table 8: Mean and variance of PEFR with BMI

Descriptive Statistics			
	Mean	Std. Deviation	N
BMI	17.2649	.66732	1000
PEFR VALUES	238.34	36.680	1000

Table 9: Correlation of PEFR with BMI

Correlations			
		BMI	PEFR VALUES
BMI	Pearson Correlation	1	.775**
	Sig. (2-tailed)		.000
	N	1000	1000
PEFR VALUES	Pearson Correlation	.775**	1
	Sig. (2-tailed)	.000	
	N	1000	1000
**. Correlation is significant at the 0.01 level (2-tailed).			

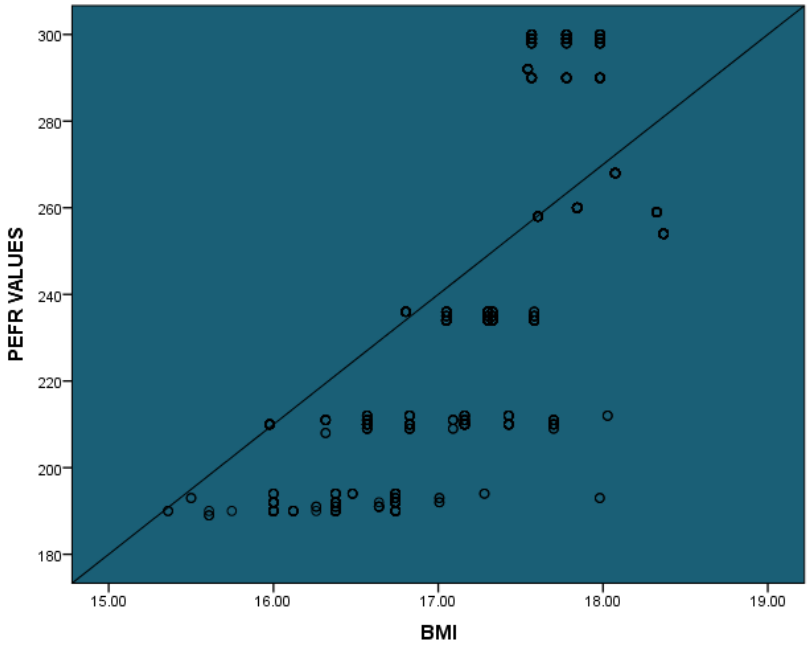

Figure 4: Peak expiratory flow rate nomogram in relation with BMI

Table 10: Mean and variance of PEFR with BSA

Descriptive Statistics

ISSN:0975-3583,0976-2833 VOL14, ISSUE 05, 2023

	Mean	Std. Deviation	N
BSA	1.111560	.1261494	1000
PEFR VALUES	238.34	36.680	1000

Table 11: Correlation of PEFR with BMI

Correlations			
		BSA	PEFR VALUES
BSA	Pearson Correlation	1	.987**
	Sig. (2-tailed)		.000
	N	1000	1000
PEFR VALUES	Pearson Correlation	.987**	1
	Sig. (2-tailed)	.000	
	N	1000	1000
**. Correlation is significant at the 0.01 level (2-tailed).			

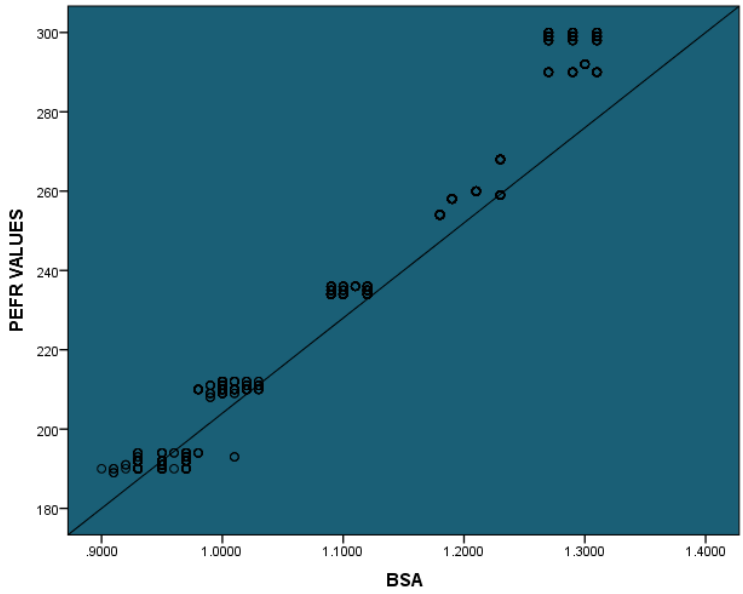

Figure 5: Peak expiratory flow rate nomogram in relation with BSA

Table 12: Predictive equations and correlation coefficient of Demographic and Anthropometric data with PEFR

Variable	Predictive equation	R Value	R^2
Age	PEFR=(AgeX25.667)-18.326	0.990	0.980

ISSN:0975-3583,0976-2833 VOL14, ISSUE 05, 2023

Height	PEFR =(HtX4.104)-324.420	0.991	0.981
Weight	PEFR =(WtX6.883)+13.070	0.983	0.966
BMI	PEFR =(BMIX42.585)-496.875	0.775	0.600
BSA	PEFR =(BSAX287.029)-80.705	0.987	0.974

Results: Of the 1500 students screened, 1000 were included in the study. Out of which 655 were boys and 345 were girls. Significant linear correlation was seen in PEFR with height, weight, BMI and BSA ($r = 0.991$, $r = 0.983$, $r = 0.775$ & $r = 0.987$ respectively, $p < 0.001$). Nomograms were plotted based on the observed values of PEFR in the study population. Prediction equations were derived for PEFR for the following variants like age, height, weight, BMI & BSA are as follows PEFR = (AgeX25.667)-18.326, PEFR = (HtX4.104)-324.420, PEFR = (WtX6.883)+13.070, PEFR = (BMIX42.585)-496.875 & PEFR = (BSAX287.029)-80.705 respectively

Discussion:

Peak expiratory flow rate measurement is a simple test of respiratory function, which is used to measure airway obstruction[8]. This can be used for monitoring PEFR, to assess the airflow as an indicator of asthma - diagnosis and management[9]. There are different studies conducted throughout India and foreign countries that showed the correlation between PEFR and age, sex, race, geographic area and anthropometric parameters.

This cross-sectional study conducted in South India on 1000 children (655-boys and 345- girls) showed a high positive correlation of PEFR with height, weight and BMI,BSA ($r = 0.991$, $r = 0.983$, $r = 0.775$ & $r = 0.987$ respectively, $p < 0.001$). This is similar to studies conducted by Mohammedzadeh et al. at Babol, Iran, and Garg et al. at Ghaziabad city, Uttar Pradesh[16,17,18] and a few other studies[19,20,21]. The PEFR value in the present study was found to be different as compared to other studies conducted in foreign countries and different regions of India. This shows a need for creating a nomogram for the children in the Urban Jabalpur District in middle India which can be used as a reference.In the present study it was found that body mass index has low positive correlation with PEFR ($r = 0.775$, $p < 0.001$) compared to that of height ($r = 0.991$, $p < 0.001$), weight ($r = 0.983$,$p < 0.001$) and BSA($r = 0.987$, $p < 0.001$). This is similar to the findings of Pramanik et al[22] , however Choudhuri et al. found a similar correlation of PEFR with height, weight and BMI[23.] In the present study the mean PEFR value of the boys and girls was found to be similar, but was not statistically significant(p 0.679). This is similar to the findings of the studies conducted by Abraham et al and Amiry et al[15,24]. Another study conducted by Budhiraja et al. on 600 normal urban and rural school children in Ludhiana district of North India in the age group 6–15 y, showed significantly higher value of PEFR in boys, as compared to that of girls($p < 0.05$)[24].Height and weight have been used either alone or in combination to create regression formula in various studies, like in the present one[19,20,22,26,27,28]. Limitation of the index study is that the details regarding family were recorded as per the knowledge of the children and parents were not interviewed regarding this. Further studies need to be conducted to identify the reasons for the difference in PEFR compared to other studies.

Conclusions

The present study showed that there is a significant correlation between anthropometric parameters like height,weight, body mass index and body surface area. Using the data obtained from the children attending the medical college hospital at puducherry the nomogram and formula is created for that population for the future.

References

1. Saharan S, Lodha R, Kabra SK. Management of status asthmaticus in children. Indian J Pediatr. 2010;77:1417–1423.
2. World Health Organization Media Centre. Bronchial asthma. Factsheet N206. Available at: http://www.who.int/mediacentre/factsheets/fs206/en/. Accessed in May 2016.
3. Dikshit MB, Raje S, Agrawal MJ. Lung functions with spirometry:an Indian perspective-I. Peak expiratory flow rates. Indian J PhysiolPharmacol. 2005;49:8–18.
4. Miller MR, Hankinson J, Brusasco V, et al. American thoracic society: standardization of spirometry. Eur Respir J. 2005;26:319–338.

ISSN:0975-3583,0976-2833 VOL14, ISSUE 05, 2023

5. Mrindha MA-A, Amin MR, Kabir ARML. Peak expiratory flow rate (PEFR): a simple ventilatory lung function test. J Shaheed Suhrawardy Med Coll. 2011;3:44–47.
6. Perks WH, Tams IP, Thompson DA, Prowse K. An evaluation of the mini Wright peak flow meter. Thorax. 1979;34:79–81.
7. Vijayasekaran D, Subramanyam L, Balachandran A, Shivbalan S. Spirometry in clinical practice. Indian Pediatr. 2003;40:626–632.
8. Kliegman RM, Stanton BF, Schor NF, St Geme JW III. In: Kennedy JF, editor. Nelson textbook of pediatrics. 20th ed. Philadelphia: Elsevier; 2016. p. 1095–1115.
9. Taylor MR. Asthma: audit of peak flow rate guidelines for admission and discharge. Arch Dis Child. 1994;70:432–434.
10. Manjunath CB, Kotinatot SC, Babu M. Peak expiratory flow rate in healthy rural school going children (5-16 years) of Bellur region for construction of nomogram. J Clin Diagn Res. 2013;7:2844–2846.
11. Doctor TH, Trivedi SS, Chudasama RK. Pulmonary function test in healthy school children of 8-14 years age in south Gujarat region, India. Lung India. 2010;27:145–148.
12. Sagher FA, Roushdy MA, Hweta AM. Peak expiratory flow rate nomogram in Libyan schoolchildren. East Mediterr Health J.1999;5:560–564.
13. Carson JW, Hoey H, Taylor MR. Growth and other factors affecting peak expiratory flow rate. Arch Dis Child. 1989;64:96–102.
14. Kashyap S, Puri DS, Bansal SK. Peak expiratory flow rates of healthy tribal children living at high altitude in the himalayas. Indian Pediatr. 1992;29:283–286.
15. 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;1:44–48
16. Mohammedzadeh I, Gharagazlou M, Fatemi SA. Normal values of peak expiratory flow rate in children from the town of Babol, Iran. Iran J Allergy Asthma Immunol. 2006;5:195–198.
17. Garg R, Anand S, Sehgal RK, Singh HP. Normative data of peak expiratory flow rate in healthy school children of Ghaziabad city - a pilot study. Natl J Physiol Pharm Pharmcol. 2015;5:309–312.
18. Kumaran K,Agrawal A. Normal Peak Expiratory Flow Rate of School Children in Jabalpur, Madhya Pradesh. Indian J Pediatr. 2017; DOI 10.1007/s12098-017-2344-y
19. Taksande A, Jain M, Vilhekar K, Chaturvedi P. Peak expiratory flow rate of rural school children from Wardha district, Maharashtra in India. World J Pediatr. 2008;4:211–214.
20. Mishra S, Behera AK, Ravichandra KR, Sethy G, Soren NN. Study of peak expiratory flow rate of school children of south Odisha. Sch Acad J Biosci. 2015;3:429–433.
21. Ray D, Rajaratnam A, Richard J. Peak expiratory flow in rural residents of Tamil Nadu, India. Thorax. 1993;48:163–166.
22. Pramanik P, Koley D, Ganguli I. Peak expiratory flow rate in respect to anthropometric parameters of adolescent boys and girlsfrom West Bengal, India. IOSR J Dental Med Sci. 2014;13:58–62.
23. Choudhuri D, Sutradhar B. Pulmonary function of adolescents from Tripura, a north-eastern state of India. Lung India. 2015;32:353–358.
24. Amiry AP, Mortazavi Z, Monadi M, Bijani A. Normal measurement of peak expiratory flow rate in the high school children in Babol, north of Iran. Casp J Intern Med. 2010;1:98–101.
25. Budhiraja S, Singh D, Pooni PA, Dhooria GS. Pulmonary functions in normal school children in the age group of 6-15 years in north India. Iran J Pediatr. 2010;20:82–90.
26. Sharma M, Sharma RB, Choudhary R. Peak expiratory flow rates in children of western Rajasthan 7–14 years of age. Pak J Physiol. 2012;8:45–48.
27. Gupta S, Mittal S, Kumar A, Singh KD. Peak expiratory flow rate of healthy school children living at high altitude. N Am J Med Sci. 2013;5:422–426.
28. Dhungel KU, Parthasarathy D, Dipali S. Peak expiratory flow rate of Nepalese children and young adults. Kathmandu University Med J. 2008;6:346–354.