A Cross Sectional Study to Assess Peak Expiratory Flow Rate in Healthy School Children for Establishment of Normative Data

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DOI: 10.3126/jnps.v40i1.27988

Submitted on:2020-03-10

Accepted on: 2020-05-13

Acknowledgements: None

Funding: Nil

Conflict of Interest: None

Permission from IRB: Yes

To cite this article: Sharma R, Kaur A, Gupta M, Kaur A, Arora H, Singh S. A cross sectional study to assess peak expiratory flow rate in healthy school children for establishment of normative data. J Nepal Paediatr Soc. 2020;40(1): 1-6.

ABSTRACT

Introduction: Peak Expiratory Flow Rate (PEFR) can be measured by cheap and portable instrument, peak flowmeter which is useful in detecting early asthmatic changes and monitoring the treatment response.

Methods: This study was conducted on 1000 normal healthy children of nine to 14 years of age of either sex from various schools of Faridkot district in South West Punjab, India. Anthropometry was done and PEFR was measured using Mini Bell Peak Flow Meter. Linear regression analysis was done and normograms were constructed.

Results: Linear regression equations were derived for PEFR with height, weight, BSA and BMI in boys and girls. The most significant correlation was seen with height (r = 0.527 in boys, r = 0.410 in girls) followed by body surface area (r = 0.506 in boys, r = 0.296 in girls). Body mass index had negative correlation (r = -0.200) with PEFR in girls. Nomograms were constructed on basis of linear regression equations of PEFR with height (-46.67 + 2.02 x height for boys, -12.64 + 1.50 x height for girls) and BSA (82.02 + 137.2 x BSA for boys, 96.61 + 88.11 x BSA for girls)

Conclusion: There is need for nomogram for each region so that personal value of PEFR can be compared to normal reference population and also with predicted value from regression equation as PEFR varies from region to region. The nomograms and regression equations derived from this study can be useful for predicting normal values of PEFR of children of South West Punjab.

Key words: normative data; peak expiratory flow rate; school children

INTRODUCTION

Peak Expiratory Flow Rate (PEFR) is the maximum expiratory flow rate generated with maximally forced effort from a position of maximal inspiration, measured by cheap and portable instrument, peak flow meter and is expressed in litres/minute.[1,2] Peak flowmeter is useful as a screening tool for detecting early asthmatic changes in children and also to see treatment response. There are various means to measure pulmonary functions like spirometry but they are cumbersome to use in out patient departments and by the parents at home. Peak flow meter is a small, easy to use instrument, which can be used and easily interpreted by parents to monitor PEFR of their children at home. To interpret the significance of PEFR measurements, comparison is made to reference (normal) values based on measurements from general population. These reference values vary from country to country and also from region to region within the same country. Nomograms and regression equations for predicting PEFR are available for many countries and different regions of India. PEFR varies by population, ethnic group, age, sex, height and weight.[3-8] Various studies have already been done in different parts of India like Maharashtra,[6] Gujrat,[5] South India[3] etc. with wide variations in values of PEFR. In Punjab also, previous literature shows PEFR values for children but these studies had smaller sample size.[8,9] Therefore, there is a need for a study with larger sample size to construct nomogram for each region so that value of PEFR can be compared to normal reference population and predicted value can be derived from regression equation. The nomograms and regression equations derived from this study can be useful for predicting normal values of PEFR for children of South West Punjab.

METHODS

This cross sectional study was conducted on 1000 normal healthy children within the age group of nine to 14 years of either sex from various schools of rural and urban areas of Faridkot district of South West Punjab, India over a period of one year from 2014 to 2015. Younger children were not able to use PEFR meter correctly even after repeated demonstrations. Institutional research and Ethics committee clearance was obtained before the commencement of study. List of schools was obtained from district school authorities. Schools were randomly selected from this list by lottery method. Subsequently, children fulfilling the inclusion criteria were recruited for the study. Children with family history of asthma or lung disease, acute respiratory tract infection in last two weeks, bony deformity of chest or spine, congenital heart disease or chronic respiratory disease like asthma were excluded from the study by exploring history including history of nebulisation or use of metered dose inhalers, proper physical examination and any previous medical record. Prior written permission of school authority was taken and written informed consent from parent/guardian was obtained. PEFR was measured using Mini Bell Peak Flow Meter.

The child was asked to take deep breath, place lips tightly on the mouth piece and blow into the peak flow meter. Exhaled breath moved the indicator on the scale of flow meter and the value was recorded. Three such readings were taken for each child and best of these three readings was considered for study. Body weight was measured by using digital weighing machine and was expressed to the nearest 0.1 kg. Body height was taken with the stadiometer affixed on the wall. Reading was expressed to the nearest 0.1 cm. BSA was calculated using Monsteller formula.[10] Statistical analysis was done using the statistical package for the social science (SPSS) program version 20. Linear regression analysis was performed by using height, weight, BSA and BMI to derive regression equations separately for boys and girls. Nomograms were constructed using PEFR and anthropometric variables separately for boys and girls.

RESULTS

A total of 1000 normal school children, aged nine to 14 years, of both sexes from rural and urban areas of South West Punjab were included in the study. There were 498 (49.8%) boys and 502 (50.2%) girls. The mean height, weight, body surface area (BSA), body mass index (BMI) and peak expiratory flow rate (PEFR) of boys and girls is depicted in table 1. PEFR was significantly higher in boys than girls.

Table 1. Comparison of peak expiratory flow rate and anthropometric parameters of boys and girls

Variable	Boys (n = 498)	Girls (n = 502)	p value
Height (cm)	141.67 ± 12.28	136.51 ± 13.58	< 0.001
Weight (kg)	34.57 ± 11.97	31.95 ± 7.32	< 0.001
BSA (m^2)	1.15 ± 0.19	1.09 ± 0.16	< 0.001
BMI (kg/m^2)	17.07 ± 6.53	17.11 ± 3.38	> 0.05
PEFR (l/min)	240.47 ± 48.47	192.98 ± 49.85	< 0.001

Table 2 shows the correlation coefficient (r value) and the level of significance (P value) 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. The most significant correlation was seen with height (r = 0.527 in boys, r = 0.410 in girls) followed by body surface area (r = 0.506 in boys, r = 0.296 in girls). Body mass index in boys was least correlated with PEFR. Body mass index had negative correlation (r = -0.200) with PEFR in girls.

Linear regression equations were derived for calculating PEFR in boys and girls separately on the basis of height, weight, BSA and BMI. These are depicted in table 3.

Table 3. Simple regression equations on the basis of different anthropometric parameters for predicting peak expiratory flow rate in boys and girls

Anthropometric parameter	Regression equation for boys	Regression equation for girls
Height (cm)	-46.67 + 2.02 x height	-12.64 + 1.50 x height
Weight (kg)	140.48 + 2.92 x weight	146.96 + 1.44 x weight
BSA (m^2)	82.02 + 137.2 x BSA	96.61 + 88.11 x BSA
BMI (kg/m^2)	145.44 + 5.65 x BMI	243.19 – 2.93 x BMI

Table 2. Pearson Correlation of peak expiratory flow rate and anthropometric parameters

Pair	Male		Female	
	r value	p value	r value	p value
PEFR vs weight	0.370	< 0.001	0.212	< 0.001
PEFR vs height	0.527	< 0.001	0.410	< 0.001
PEFR vs BMI	0.098	0.028	-0.200	< 0.001
PEFR vs BSA	0.506	< 0.001	0.296	< 0.001

These regression equations were used to construct nomograms for boys and girls separately based on height and BSA since they correlated best with PEFR. These are depicted in figure 1, 2, 3 and 4.

DISCUSSION

In order to assess peak expiratory flow rate for establishment of normative data, we took 1000 normal school going children (nine to 14 years) from five different schools (rural and urban) of South West Punjab to measure PEFR and anthropometric variables.

The mean value of PEFR in boys in our study was 240 l/min which was similar to the study in Gujarat by Doctor et al[5] (240 l/min) and in Patiala by Mittal et al.[8] (249 l/min). Mean value in case of girls was

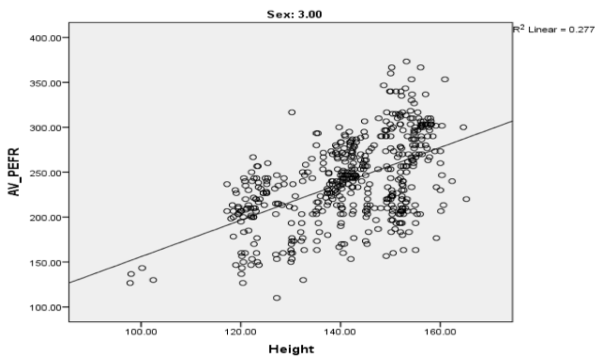

Figure 1. Peak expiratory flow rate nomogram for boys on the basis of height

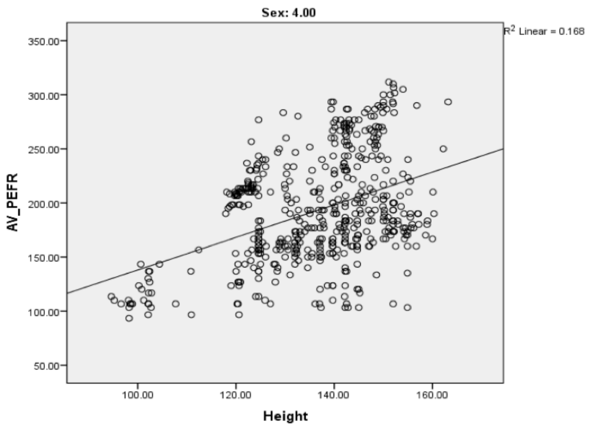

Figure 2. Peak expiratory flow rate nomogram for boys on the basis of height

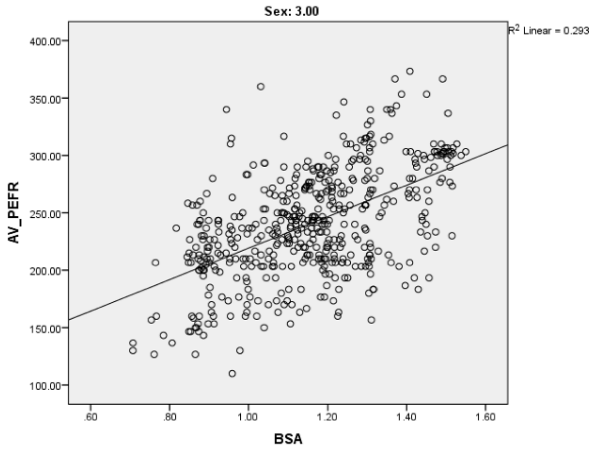

Figure 3. Peak expiratory flow rate nomogram for boys on the basis of body surface area

192 L/min which was similar to previous studies conducted in south India[11] (180 l/min) and in Punjab[9] (204 l/min). Our readings were lower than studies conducted by Mojiminiyi et al.,[12] Dhungel et al.,[13] Mishra et al.[14] and Pramanik et al.[15] So values in this region are lower than other countries like Nigeria, Nepal and even from other regions of India like Odisha and West Bengal.

Nomograms constructed on the basis of linear regression equation showed increasing trend of PEFR with height, weight and BSA in both boys and girls. The most significant correlation (r = 0.528 in boys, r = 0.408 in girls) in our study was observed between PEFR and height as compared to weight and BSA, similar to studies by Pramanik et al.,[15] Taksande et al.,[6] Doctor et al.,[5] Manjunath et al.[4] and Saxena et al.[16] But in a study at Odisha by Mishra et al., stronger association between PEFR and weight was seen as compared to PEFR and height.[14] Thus height was found to provide a good basis for prediction of normal values of PEFR. Other investigators like Chowgule et al.,[17] Godfrey et al.[18] also found the superiority of height as an independent parameter which correlated well with PEFR. Linear regression equation to calculate PEFR(l/min) had been derived in previous studies using height like Manjunath et al.[4] (-317.42 + 4.4 x height in cm), Pawar et al.[19] (-7.34 + 0.08 x height in cm) and Reddy et al.[20] (-474 + 5.63 x height in cm). With increase in BSA, PEFR increased linearly in both boys and girls (r = 0.506 in boys, r = 0.296 in girls) similar to previous studies by Krishna et al.,[21] Taksande et al.[6] and Pramanik et al.[15]

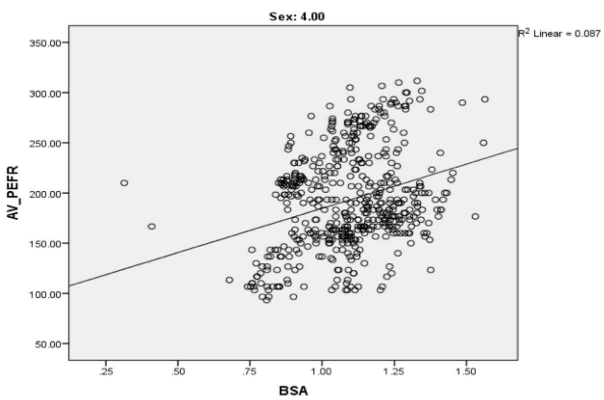

Figure 4. Peak expiratory flow rate nomogram for girls on the basis of body surface area

In our study, body mass index was higher in girls than boys but this difference was not statistically significant (P value > 0.05). In a study by Sudha et al.[22] also, BMI was higher in females as compared to males. In our study, PEFR was least correlated with body mass index (r = 0.098 in boys, r = -0.200 in girls) similar to previous studies by Mojiminiyi et al.[12] (r = 0.158 in boys, r = 0.065 in girls) and Pramanik et al.[15] (r = 0.257 in boys, r = 0.065 in girls). Our study showed that with increase in BMI, PEFR decreased in girls. Saxena et al.[16] also found negative correlation of PEFR with BMI (r = -0.207). Sudha et al.[22] also concluded that PEFR decreases with increase in body mass index.

Shekharappa et al.[23] showed statistically significant negative correlation of PEFR with BMI in obese children. Hossian et al.[24] conducted a study on 220 school children and found that PEFR was significantly lower in obese children as compared to non-obese children.

As the child grows, the physiological and anatomical growth of lungs occurs. Peak expiratory flow rate is the maximum amount of air exhaled out after maximal inspiration which depends on lung dynamics, dimensions of chest wall and power of respiratory muscles, which in turn depends on stature of child. Hence, height of child is a good parameter to predict PEFR and height can be easily measured. Asthma is a chronic disease which can lead to stunting in children if not well controlled. So, height is an important parameter to be measured in such children and their corresponding PEFR at that height rather than age. Proper adherence to treatment and monitoring of PEFR in such children can improve their height and hence their PEFR leading to healthy living and proper development. In our study, body surface area was another parameter after height which correlated significantly with PEFR in both the sexes.

PEFR can be easily measured in OPD by a paediatrician by portable and easy to use peak flow meter and observed value can be compared to normal reference values based on the height of the child. Parents can be easily trained to measure it at home and keep a diary of morning and evening values of PEFR of asthmatic children on treatment. PEFR monitoring is beneficial in detecting early asthmatic changes and in providing a quantitative measure of improvement, in response to treatment among asthmatic children, thereby improving their quality of life.

The association of higher BMI with lower PEFR indicate that increasing BMI affects lung functions. Primary prevention of obesity in childhood is utmost to prevent the diseases of adulthood. The school children and their parents must be addressed regarding healthy lifestyle. The school children must be encouraged to participate in physical activities. Awareness campaigns must be conducted from time to time in schools.

CONCLUSIONS

The most significant correlation is between PEFR and height. The derived regression equation using height as variable can be used to estimate the expected PEFR values of children between nine and 14 years in South-west Punjab. Limitation of our study is the improper distribution of subjects in the various height-wise and weight-wise categorisation.

REFERENCES

1. American Thoracic Society. Standardisation of spirometry; 1994 update. Amer J Respir & Critical Care Med. 1995; 152: 1107-36. DOI: https://doi.org/10.1164/ajrccm.152.3.7663792
2. Hall JE. Textbook of Medical Physiology.12th ed. Philadelphia: WB Saunders Company;2011. Chapter 37: Pulmonary ventilation; 465-72.
3. Swaminathan S, Venkatesam P, Mukuntham R. Peak expiratory flow rate in south-Indian children. Indian Pediatr. 1993;30:207-11. DOI: http://dx.doi.org/10.18203/2349-3291.ijcp20160157
4. 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(12):2844–6. DOI: 10.7860/JCDR/2013/7758.3773
5. Doctor TH, Trivedi SS, Chudasama RK. Pulmonary function test in healthy school children of 8 to 14 years age in south Gujarat region, India. Lung India. 2010;27(3):145-8. https://doi.org/10.4103/0970-2113.68317
6. Taksande A, Jain M, Vilhekar K, Chaturvedi P. Peak expiratory flow rate of rural school children from Wardha District, Maharashtra. World J Pediatr. 2008;4(3):211-4. https://doi.org/10.1007/s12519-008-0039-1

7. Glew RH, Kassam H, Vander Voort J, Agaba PA, Harkins M, Vander Jagt DJ. Comparison of pulmonary function between children living in rural and urban areas in northern Nigeria. J Trop Pediatr. 2004;50(4):209-16. DOI: https://doi.org/10.1093/tropej/50.4.209

8. Mittal S, Gupta S, Kumar A, Singh KD. Regression equations for peak expiratory flow in healthy children aged 7 to 14 years from Punjab, India. Lung India. 2013;30(3):183-6. https://doi.org/10.4103/0970-2113.116245

9. Budhiraja S, Singh D, Pooni PA, Dhooria GS. Pulmonary functions in normal school children in age group 6-15 years in North India. Iran J Pediatr. 2010;20(1):82-90. PMID: 23056687

10. Mosteller RD. Simplified calculation of body surface area. New Engl J Med. 1987.317-1098. DOI: https://doi.org/10.1056/NEJM198710223171717

11. Vijayan VK, Kappurao KV, Venkatesvan P, Sankaran K, Prabhakar R. Pulmonary function in healthy young adult Indian in Madras. Thorax. 1990;45:611-5. DOI: https://doi.org/10.1136/thx.45.8.611

12. Mojiminiyi FBO, Igbokwe UV, Ajagbonna OP, Jaja SI, Ettarh RR, Okolo RU, et al. Peak Expiratory Flow Rate in Normal Hausa-Fulani Children and Adolescents of Northern Nigeria. Ann Afr Med. 2006;5(1):10-5.

13. Dhungel KU, Parthasarathy D, Dipali S. Peak expiratory flow rate of Nepalese children and young adults. Kathmandu Univ Med J. 2008;6(23):346-54. https://doi.org/10.3126/kumj.v6i3.1710

14. Mishra J, Mishra S, Satpathy S, Manjareeka M, Nayak PK, Mohanty P. Variation in PEFR among males and females with respect to anthropometric parameters. IOSR-JDMS. 2013;5(1):47-50. DOI: https://doi.org/10.9790/0853-0514750

15. Pramanik P, Koley D, Ganguli I. Peak Expiratory Flow Rate in Respect to Anthropometric Parameters of Adolescent Boys and Girls from West Bengal, India. IOSR-JDMS. 2014;13: 58-62. DOI: https://doi.org/10.9790/0853-13465862

16. Saxena Y, Purwar B, Upmanyu R. Adiposity: Determinant of PEFR in Young Indian adult males. Indian J Chest Dis Allied Sci. 2011;53:29-33. PMID: 21446222

17. Chowgule RV, Shetye VM, Parmar JR. Lung function tests in normal Indian children. Indian Pediatr. 1995;32(2): 185-91. PMID: 8635780

18. Godfrey S, Kamburoff PL, Nairn JR. Spirometry, lung volumes and airway resistance in normal children aged 5 to 18 years. Br J Dis Chest. 1970;64:15-24. DOI: https://doi.org/10.1016/S0007-0971(70)80045-6

19. Pawar S, Shende V, Waghmare S, Jivtode MT. Anthropometric parameters as predictors of peak expiratory flow rate in central Indian children 5-15 years. J Diagnostics. 2014;1(1):6-12. DOI: https://doi.org/10.18488/journal.98/2014.1.1/98.1.6.12

20. Reddy UN, Khan MAU, Anjum S, Nasirmohiuddin M, Rao SP, Rao JN et al. 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. DOI: https://doi.org/10.21276/apjhs.2014.1.2.14

21. Krishna KV, Kumar SA, Shivaprasad V, Desai RD. Peak expiratory flow rate and its correlation with body surface area in healthy school children. JSIR. 2014;3(4):397-401.

22. Sudha D, Chandra SE, Saikumar P. Correlation of Nutritional Status and Peak Expiratory Flow Rate in Normal South Indian Children Aged 6 to 10 Years. IOSR. 2012;2(3):11-6. DOI:https://doi.org/10.9790/0853-0231116

23. Shekharappa KR, Smilee Johney S, Vedawathi KJ. Impact of obesity on peak expiratory flow rate in different age groups. Indian J Clin Anat Physiol. 2016;3(3):339-42. DOI: https://doi.org/10.5958/2394-2126.2016.00077.3

24. Hossain D, Khanum S, Kawser CA. Relationship of Obesity and Peak Expiratory Flow Rate (PEFR) amongst 8-15 Years Old School Children. Bangladesh J Child Health. 2015;39(2):77-81. DOI: https://doi.org/10.3329/bjch.v39i2.31537