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Assessment of Peak Expiratory Flow Rate in school-going children in selected schools of Morang district, Nepal.

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Abstract

Introduction: Childhood bronchial asthma is an important public health problem in the world. Peak Expiratory Flow Rate (PEFR) can be used as a measurement of the ventilatory function of the lung in community settings.

Objective: The objective of the study was to measure the PEFR of normal children and to study the correlation of PEFR with age, sex, Body Mass Index (BMI), and Body Surface Area (BSA) of school children from class 4-10, in selected schools of Province no.1, Nepal.

Method: A quantitative, descriptive, cross-sectional study was done over 1 year. The sample consisted of 500 school-going children from Province no. 1, Nepal (studying from class 4-10) from 5 schools. A structured questionnaire was used for data collection which was validated with the consultation of experts. Children with medical illnesses were excluded. Height and weight were measured and the technique of measuring PEFR was explained and demonstrated to the subjects. Three acceptable forced expiratory measures were recorded with mini-Wright Flowmeter and the one with the highest reading was taken as a representative value.

Result: It was found that mean age (in years) was 12.6 ± 2.1 for male, 12.4 ± 2.1 for female, mean height (in cm) was 142.5 ± 13.8 for male, 136.6 ± 12.7 for female, mean weight (in kg) was 39.6 ± 10.6 for male, 37.2 ± 10.5 for female, Mean Body mass Index was 18.1 ± 2.8 for male, 18.5 ± 3.0 for female and Mean Body surface area was 1.24 ± 0.24 for male, 1.20 ± 0.20 for female. There was significant correlation of PEFR with age (r=0.711 for male, r=0.681 for female), height (r=0.821 for male, r=0.820 for female),weight (r=0.782 for male, r=0.732 for female), body mass index (r=0.342 for male, r= 0.340 for female) and body surface area (r=0.811 for male, r=0.723 for female).

Conclusion: In this study, the PEFR value ranged from 83 to 499 L/min, and a significant correlation of PEFR was found with age, height, weight, body mass index, and body surface area.

Keywords: Asthma; Cross-Sectional Studies; Peak Expiratory Flow Rate

Introduction

The prevalence of severe bronchial asthma in children in Nepal was 7.3% as per the study done in Kathmandu.[1] In India, it's prevalence in children was 4-19%.[2,3] The diagnosis is apparent from the symptoms of variable and intermittent airways obstruction manifested by cough and wheezing and is confirmed by objective measurements of lung function. Lung function is especially useful for early diagnosis and for monitoring of the treatment.[3]Airflow limitation with reduced Peak Expiratory Flow Rate (PEFR), Forced Expiratory Volume (FEV1) and Forced Expiratory Volume/ Forced Vital Capacity (FEV1/FVC) ratio and reversibility with inhaled bronchodilator confirms the diagnosis of bronchial asthma. Measurement of PEFR twice daily may confirm diurnal variation in airflow obstruction.[3] By definition, it is "The largest expiratory flow rate achieved with a maximally forced effort from a position of maximal inspiration, expressed in liters/ min".[4]PEFR can be used as an indicator of response to treatment in asthma. Serial measurements of PEFR can be done in patients admitted to hospital with acute severe asthma and can be recorded. PEFR is the most convenient measurement for use in the diagnosis of exercise induced asthma, where a fall in PEFR of greater than 15% following exercise is considered diagnostic.[5] For making the measurement, the subject breathes out maximally into the peak flow meter after having taken a maximum inspiration. PEFR is obtained after 100–120 millisecond of starting a maximal expiratory effort. So, the expiratory effort is not needed to continue up to residual volume. For assessment of PEFR, at least 5 breathing efforts must be made, out of which 3 of the efforts should fall within 10% of each other. The best of the three efforts is recorded.[4] There are a number of factors which effect PEFR in normal subjects; anthropometry,[2] sex,[7] age,[4] ethnic background, nutritional status, socioeconomic conditions,[8,9] environmental conditions,[10,11,12] presence of respiratory diseases, etc.[6] Hence, there have also been multiple studies in different populations to measure PEFR and their association with different variables all over the world.[13-27] But studies focusing the pediatric population in Nepal are lacking. The main objectives of this study were to measure PEFR of normal children and to study the correlation of PEFR with age, sex and Body Mass Index (BMI), Body Surface Area (BSA) of school children from class 4-10 of selected schools of Province 1, Nepal.

Method

A cross sectional study was conducted from May 2016 – June 2017. The total sample consisted of 500 school going children Morang, Province no. 1, Nepal (studying from class 4-10). Formal permission was taken from the Research Center, Purbanchal University. Five schools were selected by random sampling. The sampling frame comprises all school going children of Morang, Province no. 1, Nepal who are studying from class 4-10. The names of schools selected were: a) Shree Janata Secondary School, Thalaha b) Shree Adarsha Secondary School, Biratnagar c) Shree Durga Secondary school, Majhare d) Shree Janapriya Secondary school, Katahari e) Shree Prajatantra Secondary school, Bhaudaha. Students were also selected by simple random sampling. Hundred students from each 5 schools were taken using multistage sampling of class, 20 students were taken from the list of roll no. of students, using the lottery method. Informed written consent was taken from the students prior to data collection.

Structured questionnaire comprising demographic profile of students, anthropometry, nutrition, presence of any medical condition(s), recordings of PEFR etc. were done. Validity of the questionnaire was maintained by reviewing related literature and consultation with the experts. Pretesting was done in 10% of the sample in similar settings. For all students enrolled in the study, a proforma was filled inquiring about the various symptoms to exclude asthma, cardiac or any other systemic illness. History regarding wheezing, rhinitis, eczema, allergies in present and past was enquired. Any past hospital admissions or requirement of nebulization was also enquired. The presence of a family history of asthma or allergies was also noted. Children with medical illnesses were excluded. A clinical examination was performed to find any physical abnormalities. Inquiries were made about their general health problems, appropriate history was taken, anthropometry was measured, appropriate general physical examination was done. Anthropometric measures were recorded in each individual including height and weight. Height was measured using a non-stretchable fiber optic tape pasted to a wall. Students were made to stand barefeet, their heels, buttocks and back touching the wall, eyes looking straight forward in the Frankfurt plane and the bi-auricular plane horizontal.[28] A steel ruler was kept firmly over the vertex horizontally to measure the height.[28] Weight was measured by a digital weighing machine, with a minimum precision of 10gm. The weighing scale was corrected for any zero-error before every measurement. Body mass index (BMI) was calculated by the formula: [29]

BMI = weight (kg) / height (m)^2

Body surface area (BSA) was measured by using the formula:[30]

BSA= square root [{height (cm) X weight (kg)} / 3600]

PEFR was calculated using Wright's mini peak flow meter.

The technique of measuring PEFR was explained and demonstrated to the subjects. They were taught and demonstrated to hold the peak flow meter with fingers of both hands and to properly seal the flow meter between lips. Then they were instructed to inhale deeply and blow into the mouthpiece of the peak flow meter with maximum effort as far and as fast as possible, and the reading was recorded. This was done in a standing position. Three acceptable forced expiratory measures were recorded and the one with maximum reading was recorded as representative value.

Children with major medical illness related to respiratory, cardiac, renal, nervous, endocrine system, acute respiratory illness, allergic diseases and chest deformity were excluded.

Formal permission was taken from the authority of concerned schools. Information sheet was developed and given to study participants. Informed consent was taken from all the parents of the participants. Confidentiality of the subjects was maintained. Information was used only for research purposes. Data was recorded in a systematic way in the proforma and entered into the master chart in Microsoft Excel. Data was analyzed using SPSS 16.0 statistical package software. Mean, standard deviation, and pearson's correlation coefficient were used for data analysis.

Result

Table 1: Anthropometric profile of students (n= 500)

Characteristics	Male ± SD n=285	Female ± SD n= 215
Mean Age (in years)	12.6 ± 2.1	12.4 ± 2.1
Mean Height (in cm)	142.5 ± 13.8	136.6 ± 12.7
Mean Weight (in kg)	39.6 ± 10.6	37.2 ± 10.5
Mean Body mass index	18.1 ± 2.8	18.5 ± 3.0
Mean Body surface area	1.24 ± 0.24	1.20 ± 0.20

Table 1 shows that the mean age of male students was comparatively more than that of the female students. Similarly, mean height, mean weight and mean body surface area of the male students was also comparatively more in case of male students whereas mean Body mass Index (BMI) was comparatively less in case of male students than the females.

Table 2: Correlation of PEFR with age and anthropometric parameters

Pearson correlation coefficient (r-value)	Sex	Age (years)	Weight (kg)	Height (cm)	BMI	BSA	p - value
	Male	0.711	0.782	0.821	0.342	0.811	0.001
	Female	0.681	0.732	0.820	0.340	0.723	

Table 2 presents the result of Pearson correlation analysis of PEFR, for male and female students, with age and anthropometric parameters. PEFR was significantly correlated ($p < 0.001$) with all these parameters. Out of all these parameters, PEFR had maximum correlation with height. Using the Pearson correlation analysis, the correlation coefficient, r = 0.821 and 0.820 for females and males respectively ($p< 0.001$); which means it is highly significant. The correlation is more with height than with age, weight, body mass index or body surface area.

Pearson correlation analysis showed a strong correlation of PEFR with these parameters (age, height, weight, BMI, BSA) for both male and female.

Table 3: Distribution of PEFR in different age group students (n=500)

AGE (years)	PEFR Male (n 285) Mean (L/min) ± SD	n	Female (n 215) Mean (L/min) ± SD	n
8 – 9	190.1 ± 57.2	34	158.5 ± 54.2	25
10 – 11	255.6 ± 76.5	52	218.2 ± 36.2	48
12- 13	294.2 ± 61	83	288.8 ± 48	61
14- 15	382.3 ± 76.9	87	310.9 ± 54.7	70
16- 17	423.8 ± 77.6	29	326.2 ± 28.5	11
Mean	309.2 ± 69.84		260.52 ± 44.32	

Table 3 depicts that PEFR was seen to progressively increase with age, for both male

and female. The values of PEFR were lower in girls than in boys in all age groups.
The mean of the PEFR for particular age groups is also given in table number 4. The Pearson correlation coefficient calculated between age and PEFR shows significant positive correlation, i.e. r = 0.681 ($p<0.001$) for females and r= 0.711 ($p<0.001$) for male.

Table 4: Distribution of PEFR in relation to weight

Weight (kg)	PEFR MALE		PEFR FEMALE	
	Mean (L/min)	n	Mean (L/min)	n
11-20	152.6 ± 34.6	13	142.6 ± 48	13
21-30	225.5 ± 53.8	63	208.2 ± 44.8	48
31-40	298 ± 54.7	86	272 ± 53.3	74
41-50	384.2 ± 79.7	78	312.6 ± 44	61
51-60	420.6 ± 67.9	39	336.3 ± 50.7	17
61-70	434 ± 65.6	6	370.5 ± 15	2

Table 4 shows the mean of the PEFR for particular weight intervals. The weight has been grouped into intervals of 10 kg. It was observed that the PEFR was higher for males than females in all weight groups. It was observed that there is an increase in PEFR with the increase in weight. Using the Pearson correlation analysis, it was observed that there is significant correlation between weight and PEFR; correlation coefficient (r) = 0.782 ($p<0.001$) for males and 0.732 for females ($p<0.001$).

Table 5: Distribution of PEFR in relation to height

Height (cm)	PEFR Male		PEFR Female	
	Mean ± SD (L/min)	n	Mean ± SD (L/min)	n
91-100	110 ± 0	2	96.7 ± 13	5
101-120	143.3 ± 22	5	115 ± 40.4	1
121-130	168.5 ± 32.3	14	166.7 ± 35	11
131-140	216 ± 39.5	36	198.2 ± 33	30
141-150	267.6 ± 49.5	54	253.1 ± 43.7	37
151-160	304.7 ± 47.8	68	289.5 ± 48.9	82
161-170	383.7 ± 69	66	320 ± 49.3	47
171-180	427.5 ± 45.6	40	360 ± 0	2
Mean	249.12 ± 38.21		228.43 ± 31.42	

Table no. 5 shows that PEFR was seen to progressively increase with height, for both male and female. The mean of the PEFR for different height intervals observed is given in the above table. The height has been grouped into intervals of 10 cm. The PEFR of boys was seen to be higher in all height groups.

Discussion

The PEFR has been widely recognized as a simple, easy and reliable way of assessing the bronchial asthma severity as well as the response to treatment. The Mini- Wright Peak Flow meter is cheap, can be available easily and its use extends to home-monitoring for asthmatics.[6] Baseline PEFR monitoring and recording can be made compulsory for all asthmatics while they are asymptomatic and clinically free of wheezing. The variations in PEFR daily can serve as a guide to the severity of asthma, effectiveness of the current therapy and the need for any additional treatment. The value of PEFR is decreased in respiratory illnesses with elements of obstructive airways.
Out of 500 children, 56% of the students were male and 43% were female. In our study, PEFR ranged from 83 to 499 L/min. These values were similar to other studies in healthy school children of age group 5 – 15 years where PEFR ranged from 60 – 460 L/min.[14,15,18] The Peak expiratory flow rate increased with increasing height, age, weight, BMI as well as BSA. The PEFR for females for any given age, weight and height was always less than that of male which is similar to the other studies; but is in contrary to one study done by Carson JW in which the PEFR was similar for male and female in pre-pubertal age group.[31] A study done in Nepal also showed that at preadolescence time, PEFR was almost comparable in both sexes but after puberty males obtained significantly higher values than females.[32] In our study also the difference in PEFR between male and female in the age group of 8-10 years was less than for older age groups. The higher value of PEFR in males is a known fact, which is explainable by the difference in lung volumes, lung recoil and muscle strength.[15, 26]
We have found a significant correlation of PEFR with age, height, weight, body mass index, body surface area, out of which height had the strongest correlation. This is similar to all other previous studies and is well known except in some of the Japanese studies where they have used age for interpretation of PEFR values. It is recommended to interpret the PEFR value on the basis of height of the subject as it has found to have strong correlation in comparison to other anthropometric parameters.[21,6, 33]

The most important strength of this study is its larger sample size. There are some potential limitations of our study. The gold standard for the study of lung function is spirometry and more significant volumes like FEV1, which we have not measured, as it would require more sophisticated equipment and was not possible to collect samples from the community level. Nonetheless, the PEFR is a very important marker of lung function and has been accepted worldwide. Another limitation is that we could not measure PEFR of children less than 8 years as they could not perform the forced expiratory maneuver well.

Conclusion

In our study, PEFR ranged from 83 to 499 L/min and the PEFR for females for any given age, weight and height was always less than that of male. It was observed that significant correlation of PEFR was found with age, height, weight, body mass index and body surface area, out of which height had the strongest correlation.

Recommendation

With the inference from this study; we can reliably monitor PEFR in school going children at home; who are diagnosed or suspected as having bronchial asthma or who are on treatment inorder to monitor response to treatment or acute flare up of bronchial asthma. This aids in early diagnosis and proper treatment compliance, as parents can monitor the improvement or fall in PEFR at home. Similarly at residential schools, the teachers can monitor the treatment response or can refer early if the students are suspected for bronchial asthma by monitoring the PEFR. Similar study can be done in other areas of Nepal including samples from other provinces as well so that we can have our national baseline data of PEFR in children.

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Conflict of interest

The author declares no conflict of interest.

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