Peak Expiratory Flow Rate Values of Students in Bangkok

SUWAT BENJAPONPITAK, M.D.*, CHALERAT DIREKWATTANACHAI, M.D.*,
CHITTIMA KRAISARIN, B.Sc.**, CHERAPAT SASISAKULPORN**

Abstract

Background : As there are considerable variations in normal values of peak expiratory flow rate (PEFR) shown by studies from various population, a study is required to obtain normal values of PEFR in Thai children.

Objective : To determine the values of PEFR of students in Bangkok.

Methods : In a cross sectional study of PEFR measured with standard Wright peak flow meter, 501 normal students, aged 5 to 15 years, from five public schools in Bangkok were investigated. In the selection process of subjects, strict criteria of "normality" were applied and included history of medical illnesses, physical examination and nutritional status.

Results : The relationship between PEFR and height was approximately linear in both male and female children. Prediction equations for each sex were:

Male children : PEFR (L/min) = [3.52 x Height (cm)] - 186.80

Female children : PEFR (L/min) = [3.48 x Height (cm)] - 204.11

The PEFR values of students in this study were different from the predicted values of PEFR in those of previous reports in Thai children. These discrepancies might be explained by a variety of study population and environmental factors.

Conclusions : The relationship between PEFR and height of students in Bangkok is best described by a regression equation. The prediction graphs for each sex may be used to monitor PEFR values of children with obstructive airway diseases and to compare an individual's PEFR with those of others of the same height and sex.

Key word : Peak Flow Rate, Peak Expiratory Flow Rate, Asthma, Pulmonary Function, Peak Flow Meter

* Department of Pediatrics,
** Research Center, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok 10400, Thailand.

Asthma is a disease characterized by increased responsiveness of the bronchial airways to various stimuli and is manifested by widespread narrowing of the airway lumen that changes in severity either spontaneously or as a result of therapy[1]. The measurement of pulmonary function is an important tool for the diagnosis, assessment and follow-up of patients with asthma and obstructive airway disease[1-3]. Among the pulmonary function test procedures, the peak flow meter (PFM) provides a convenient method for measuring expiratory air flow in children. In recent years, PFM has been used increasingly by clinicians in general practice. The peak flow meter has several advantages: particularly its relatively low cost, lightweight, simplicity, and reliability for measuring the maximum expiratory flow rate during a forced expiration. To serve the purpose of the evaluation of asthmatic children, the normal values of peak expiratory flow rate (PEFR) in children are needed[4]. However, there are considerable variations in PEFR among various studies[5,6]. The possible factors which may explain these variations are different races, ethnic groups or geographical distribution of population. Even among the population of the same ethnic origin such as Chinese[6], Singaporean[7] or Chinese children in Hong Kong[8], PEFR values were reported to be different. Considering these variations, this study was undertaken to determine the expected normal values of PEFR of Thai school children in Bangkok and to compare the result with those of previous reports.

SUBJECTS AND METHOD

Children were recruited from 5 public schools over a 4-month period (April-July), for a cross sectional study. Students aged 5 to 15 years were randomly selected from classes in each school year. Prior to the commencement of this study, potential subjects were interviewed and physically examined by one of the investigators to exclude those with medical illnesses and/or physical anomalies. Data obtained during the interview and examination included the date of birth, standing height (cm) without shoes, body weight (kg) with school uniform but without shoes, and PEFR. Questionnaire concerning past and present health status was also completed. Normal subjects were defined as those who fulfilled the following criteria: (1) no asthma or allergic rhinitis; (2) no any chronic respiratory diseases; (3) no chronic cough within the last 4 weeks; (4) no history of tobacco smoking; (5) no history of substance abuse; (6) normal on physical examination; (7) normal body weight and height according to the normal growth curves of Thai children of the same age and sex[9,10]. Before the PEFR testing, the purpose of the test and the method to be used were clearly explained to the students. After one or two trial attempts to perform the test, the student was encouraged to take a deep breath and to blow forcefully into a standard Wright peak flow meter (Clement Clarke International Ltd). The highest of 3 successive attempts was recorded. A total of 1,000 students were initially examined; of these, 226 students were excluded from the study because of respiratory symptoms on the day of the testing and 233 students were excluded as they did not fulfill the 7 criteria. Five hundred and one students, 242 males and 259 females, qualified as test subjects.

Statistical Methods

The correlation between PEFR and the standing height, body weight, and age was analyzed by the least square method for the male and female groups separately. The regression equations were used to determine the predicted normal values of PEFR for each sex.

RESULTS

Five hundred and one healthy students, 242 boys and 259 girls, aged 5-15 years met the enrollment requirements and provided analyzable data. In male children the mean age and height were 9 2/12 years and 136.8 cm, respectively. Among female children, the mean age and height were 9 4/12 years and 136.1 cm, respectively. From this analysis, the PEFR values of boys and girls were statistically significant different ($p < 0.05$). Therefore, data for each sex were analyzed separately. Fig. 1 and 2 were scatterplot data of PEFR against standing height for each sex. These showed a smooth, approximately linear relationship in both sexes. Therefore, linear regression analysis was carried out to determine the PEFR with respect to height, weight, and age. The data for boys showed that the correlation of PEFR was strongest with standing height ($r = 0.85$, $p < 0.001$). For girls there was also highly significant correlation ($r = 0.81$, $p < 0.001$) between PEFR and height, but was somewhat weaker than that of boys. The regression equations for both sexes were shown in Table 1. On the

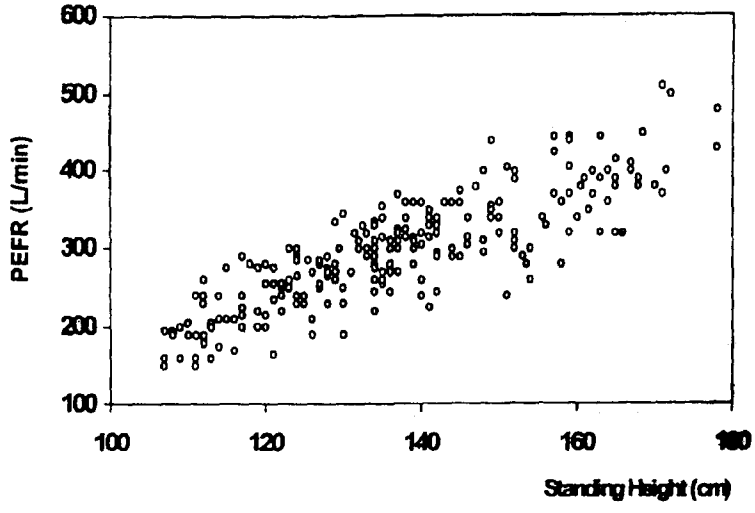

Fig. 1. PEFR against standing height in males.

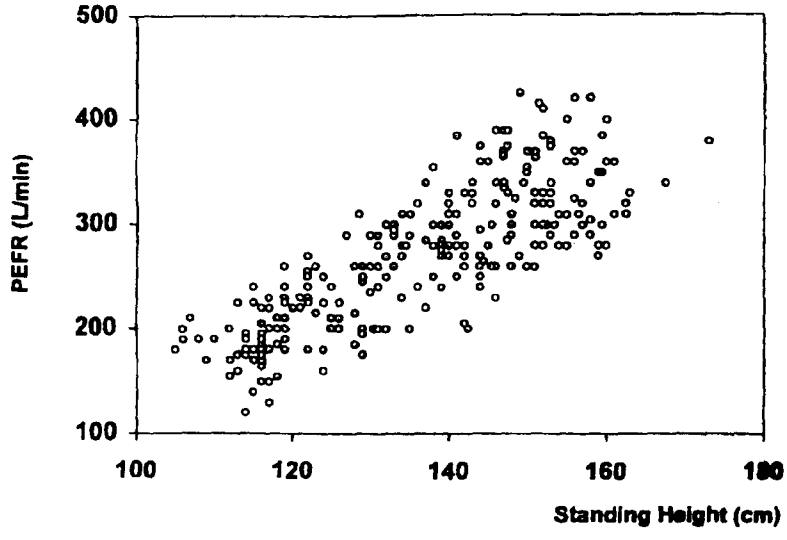

Fig. 2. PEFR against standing height in females.

basis of these results, the prediction graphs of mean PEFR ± 2SD fitted for boys and girls against standing height and age were shown in Fig. 3 and 4. These might be more easily applied in clinical use.

DISCUSSION

PEFR is a measure of the maximum flow achieved during a forced expiration (following a full inspiration to a total lung capacity) measured in litres/second or litres/minute. It provides a useful assessment of the degree of airway obstruction in evaluating an asthmatic or obstructive pulmonary disease patient[1]. The accuracy of the measurement is directly dependent on the patient's effort, the compliance of the chest wall and lungs, and the airway resistance[2]. It has been shown by others

Table 1. The equations for the linear regression with the correlation coefficient and standard deviation of the dependent variable for male and female children. PEFR, peak expiratory flow rate (L/min).

Male

Dependent variable (y)	Independent variable (x)	Correlation coefficient	Regression coefficient	R^2	Intercept value	SD
PEFR	Height (cm)	0.85	3.52	0.72	-186.80	0.14
PEFR	Age (yr)	0.81	20.74	0.66	104.83	0.95
PEFR	Weight (kg)	0.79	4.49	0.62	145.37	0.23

Regression equation : PEFR (L/min) = [3.52 x Height (cm)] - 186.80

Female

Dependent variable (y)	Independent variable (x)	Correlation coefficient	Regression coefficient	R^2	Intercept value	SD
PEFR	Height (cm)	0.81	3.48	0.66	-204.11	0.16
PEFR	Age (yr)	0.74	16.98	0.55	113.03	0.96
PEFR	Weight (kg)	0.73	4.09	0.53	133.99	0.24

Regression equation : PEFR (L/min) = [3.48 x Height (cm)] - 204.11

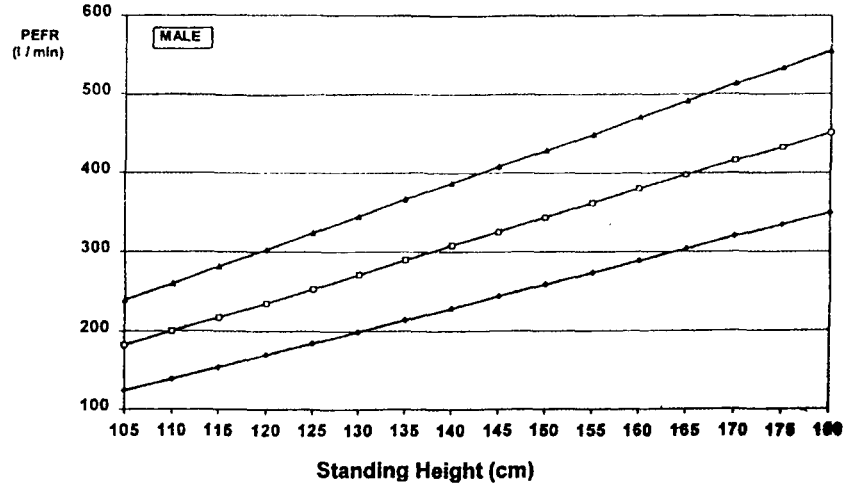

Fig. 3. PEFR prediction value with mean and 2SD lines in relation to standing height in males.

that PEFR is significantly correlated with standing height or arm span, but body weight or age did not correlate well with PEFR[7,11,12]. The present study also confirms this observation; height is the most useful physical characteristic in predicting the normal PEFR value. In this study, few students were later excluded because of their inability to perform the test as required.

This study showed that the Wright peak flow meter can be used reliably even by a young child, aged 5-6 years. The differences in PEFR among races has been demonstrated from various

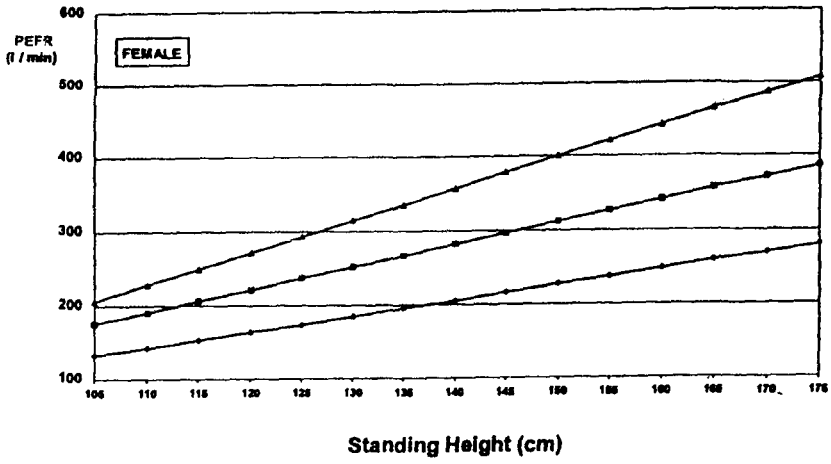

Fig. 4. PEFR prediction value with mean and 2 SD lines in relation to standing height in females.

Table 2. Comparison of mean PEFR predicted from the present study with those of previous reports.

	Sex	Mean PEFR (L/min) Standing height (cm)		
		120	140	160
Lekagul et al[14] 1980	Male	240	340	445
	Female	230	330	425
Suwanjutha et al[13] 1983	Male	232	321	423
	Female	210	295	399
Benjaponpitak et al 1995	Male	236	307	380
	Female	221	281	341

studies[5-8,11,12]. The causes of discrepancies might be explained by a variety of factors such as genetics and races of study population, their places of residence, and the inclusion criteria of each study. Residents in areas with high level of atmospheric pollution have been shown to have high incidence of impaired PEFR due to obstructive airway diseases [13]. Recently the problem of air pollution in Bangkok has gradually increased. This has been shown that the high level of small dust particles (PM10) is associated with low morning PEFR values among children in Bangkok[14]. This change might contribute to the relatively lower PEFR values reported in this study than those of previous studies in Thai children[15,16] (Table 2). However, this hypothesis needs to be conclusively proven.

Additional contributing factor is cigarette smoking by a child's family members; it has been shown that children exposed to such an environment did have a significant impairment of pulmonary function[17-19]. Although our study could not show the reliable data of smoker in the subjects' environment, the smoking effect might account for some of the low PEFR values.

Based on our findings, it is recommended that in the interpretation of PEFR in different populations it is essential to use normal predicted values based on data from similar ethnic groups and region of residence (urban or rural areas). The graphs showing the mean ± 2SD PEFR values could be used as normal values for children in Bangkok. Any value below -2SD should be considered abnormal.

However, to optimize the PEFR measurement it is essential that the peak flow meter is used correctly. The prescribing doctors or nurses should instruct the patient in the correct technique of measurement including good coordination and maximal muscular effort in the test and should re-check the technique at subsequent consultations. It is important that the interpretation of PEFR values must be applied to the clinical manifestations for grading the degree of airway obstruction.

In addition, a highly close correlation in the accuracy of the mini-peak flow meter with the standard Wright peak flow meter has been clearly shown[20,21]. For practical purpose, therefore, the mini-peak flow meter should be suitable for clinical use to detect change in PEFR in patients with asthma or other obstructive airways diseases. In conclusion, we have presented normal values of PEFR for healthy students in Bangkok. This study has shown that PEFR correlates directly with standing height. Separate regression equations of the mean and standard deviation of the mean in boys and girls were derived. Graphic presentations of mean PEFR $\pm$ 2SD from the normal children were shown. The results of this study should be of value to clinicians involved in the care of asthmatic children in Bangkok.

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ค่า Peak Expiratory Flow Rate ของเด็กนักเรียนในกรุงเทพมหานคร

สุวัฒน์ เบญจพลพิทักษ์, พ.บ., ชลีรัตน์ ดิเรกวัฒนชัย, พ.บ.*,*
*จิตติมา ไกรศรินท์, วท.ม.**, จีรพัฒน์ ศศิสกุลพร***

ค่า Peak expiratory flow rate (PEFR) มีประโยชน์อย่างมากในการตรวจวินิจฉัย และติดตามการรักษาผู้ป่วยโรคหืดและโรคหลอดลมอุดตันเรื้อรัง แต่จากการศึกษาค่าปกติของ PEFR ในเด็กพบว่ามีความแตกต่างกันมากในประชากรกลุ่มต่าง ๆ การศึกษานี้จึงมีวัตถุประสงค์เพื่อหาค่าปกติในเด็กไทย โดยได้ทำการศึกษาหาค่า PEFR ในเด็กปกติ อายุ 5-15 ปี จำนวน 501 ราย จากโรงเรียนในเขตกรุงเทพมหานคร 5 แห่ง พบว่าค่า PEFR มีความสัมพันธ์โดยตรงกับความสูงในแต่ละเพศดังนี้

เด็กชาย PEFR (L/min) = [3.52 x ความสูง (cm)] - 186.80
เด็กหญิง PEFR (L/min) = [3.48 x ความสูง (cm)] - 204.11

ค่าที่ได้จากสมการนี้ สามารถใช้เป็นค่ามาตรฐานในการติดตามการรักษาผู้ป่วยเด็กที่มีปัญหาการอุดตันของทางเดินหายใจขนาดใหญ่ ตามเพศและส่วนสูงของผู้ป่วยได้

คำสำคัญ : Peak Flow Rate, Peak Expiratory Flow Rate, โรคหืด, การตรวจสมรรถภาพปอด, Peak Flow Meter

* ภาควิชากุมารเวชศาสตร์,
** สำนักงานวิจัย, คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี, มหาวิทยาลัยมหิดล, กรุงเทพ ฯ 10400