Research Article

Prediction models for peak expiratory flow rate in Indian population aged 18–25 years

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ABSTRACT

Background: The role of peak expiratory flow rate (PEFR) has been emphasized both in diagnosis and management of patients with asthma. **Aims and Objective:** The present study was undertaken to derive the prediction formulae to determine the PEFR in normal, young, healthy, nonsmoking Indian population in the age group of 18–25 years. **Materials and Methods:** Computerized spirometry was done in 298 nonsmoking first-year medical students of both genders. All the data were statistically analyzed and prediction equations for the young Indian population were derived. **Results:** PEFR showed significant gender difference. Both height and weight showed positive correlation with PEFR in males. In females, height was positively correlated with PEFR, but age showed negative correlation. We formulated univariate and multivariate regression models for prediction of PEFR in the young Indian adults. The matched value for PEFR was found to be higher by 6%–9% in males and 2%–25% in females, in comparison to previous Indian studies. In males, the predicted PEFR was higher (26%) than Pakistani study group, but lower (1%–8%) than Iranian and Caucasian population. The value was almost similar to African-American population. In females, the matched value was found to be higher (5%–28%) than Caucasian, African-American, and Pakistani population studies, but lower by 28% compared to Iranian study. **Conclusion:** The computed regression norms may be used to predict the PEFR in young Indian population of similar age group as the study population.

KEY WORDS: Indian; Peak Expiratory Flow Rate; Respiratory Function Tests; Spirometry

INTRODUCTION

An estimated 300 million people worldwide suffer from asthma and this figure is projected to rise to 400 million by the year 2025. Asthma accounts for approximately 500,000 hospitalizations each year, with around 250,000 deaths annually attributed to the disease.[1,2] A multicenter study by the Asthma Epidemiology Study Group of the Indian Council of Medical Research found the prevalence of bronchial asthma in Indian adults to be 2.38%.[3] But despite imposing substantial burden, it still remains under-recognized, underestimated, and undertreated. Many reports have emphasized the importance of measuring peak expiratory flow rate (PEFR) in general practice to establish the diagnosis of asthma and for monitoring patients with asthma. It is the maximal flow achieved during a forced expiration following full inspiration. PEFR is particularly susceptible to dynamic compression of extra pulmonary airways. PEFR is also recommended for monitoring persons who may have occupational asthma and for detection and management of variable airflow limitation.[4] An observed PEFR must be assessed by comparing it with the subject's predicted PEFR, which is taken as the mean PEFR attainable by "normal" people of the same ethnic origin, sex, age, and body build.[5] Local reference values or those given in the text

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should be used where appropriate. However, the use of standard factors, for converting reference values, without reference to local, environmental, and cultural circumstances can mislead and should only be used where there is no locally derived alternative.[6] Moreover, reference values should be reviewed periodically and modified, where necessary, to accommodate new technical developments.[7] The present study was undertaken to determine the PEFR in normal, young, healthy, nonsmoking Indian population, to compare the same with the previously reported data[8–13] and to derive reliable prediction formulae.

Materials and Methods

This cross-sectional study included 298 first-year medical students recruited between 2007 and 2010. The research protocol was reviewed and approved by the Institutional Ethics Committee and it conforms to the provisions of the Declaration of Helsinki in 1995 (as revised in Edinburgh, 2000). Written informed consent was taken from each subject. Subjects were screened by a self-filled health questionnaire.[14] Subjects with asthma or any other past or concurrent pulmonary illness, history of smoking, any systemic diseases, doing regular exercise, or with a history of using bronchodilator drugs were excluded from the study. All the participants were informed about the study protocol before starting the test. Each participant was given the option to withdraw from the study at any moment.

Age of each subject was recorded to the nearest birthday, height to the nearest centimeter with a stadiometer, and weight to the nearest kilogram with a spring balance. All the tests were performed between 9.00 AM and 12 PM to minimize the effect of circadian rhythm.[15] Spirometry was performed in sitting position with the FLOWHANDY ZAN 100 USB computerized spirometer (nSpire Health, Oberthulba, Germany). Simultaneous recording of pulse, blood pressure, and oxygen saturation of arterial blood (SaO2) was done using the Clarity Med PMS 320 Cardiac Monitor (Clarity Medical, Mohali, India).

With the nose clip applied, the subject breathed in and out to the tightly placed mouthpiece through his/her mouth. The subject breathed slowly at least 6–8 times at a rate of about 30 breaths per minute with depth around 0.5–1.0 L. After that, the subject expired as deeply as possible and then inspired slowly to his total lung capacity and then expired as quickly and as deeply as possible; the expiration continued at least for 6 s. For each volunteer, three best results were saved. The ATS guidelines for spirometry were followed.[16] The spirometer was regularly disinfected and calibrated using a 3-L calibration pump. The results were corrected to body temperature and pressure, saturated with water vapors (BTPS). The largest value of PEFR from three stored acceptable maneuvers was reported.

All the data were statistically analyzed using SPSS version 20. Student's *t*-test was used to find any significant difference between the means of both genders. Significant relationship between the variables was found by Pearson correlation. Simple and linear regression analyses were performed. Regression diagnostics was done to know the normality of the regression equations.

Results

Anthropometric and PEFR values of the study population including 298 medical students (male = 243, female = 55) are shown in Table 1. PEFR showed significant gender difference, thus, analyzed independently, according to the gender. In the univariate analysis, both height and weight showed positive correlation with PEFR in males. In females, height was positively correlated with PEFR, but age showed negative correlation. (Table 2) Simple regression norms for prediction of PEFR were shown in Tables 3 and 4. Residual diagnostics for simple regression norms was within normal limits. Table 5 shows the multiple regression norms for prediction of PEFR in both sexes. The reliability of the models was justified by significant F value. Residual diagnostics was done to infer the normality of the models. The matched value for PEFR was found to be higher by 6%–9% in males and 2%–25% in females, in comparison to previous Indian studies. In males, the predicted PEFR was higher (26%) than that in Pakistani study group, but lower (1%–8%) than that in Iranian and Caucasian population. The value was almost similar to African-American population. In females, the matched value was found to be higher (5%–28%) than Caucasian, African-American, and Pakistani population studies, but lower by 28% compared to Iranian study. (Table 6).

Discussion

Ethnic differences in the normal range of spirometric values have been described. Geographic factors, exposure to environmental

Table 1: Anthropometric and peak expiratory flow rates of study group as per mean ± SD

Variable	Males (n = 243)	Females (n = 55)	P value (significance)
Age (years)	19.24 ± 1.14	20.38 ± 0.86	<0.001(*)
Height (cm)	167 ± 6.36	157.10 ± 3.54	0.001(*)
Weight (kg)	63.15 ± 11.07	54.98 ± 4.76	<0.001(*)
PEFR (l/m)	8.95 ± 1.12	7.01 ± 1.07	0.740 (*)

PEFR, peak expiratory flow rate.
(*), Significant (<0.05).

Table 2: Correlation coefficient between peak expiratory flow rate and physical parameters

	Height	Weight	Age
Male (n = 243)			
Pearson correlation	0.330(*)	0.382(*)	0.111
Significance (2-tailed)	0.000	0.000	0.080
Female (n = 55)			
Pearson correlation	0.535(*)	−0.057	−0.343(*)
Significance (2-tailed)	0.000	0.687	0.012

(*), Significant (<0.05).

and occupational pollution, and socioeconomic status may influence interindividual variation. Therefore, it would be more appropriate for each region to have its own value.

When prediction equation for African-Americans was used, PEFR value was almost similar to our male study population, but under-predicted by 5% in females. When we used previous Indian regression equations, PEFR was also under-predicted by 2%–25% in our study population. The differences in predicting PEFR value in different population studies may be possible due to sampling as well as environmental, nutritional, and genetic factors, which require further study. Our prediction model accounted for 20% of the explained variation in PEFR in males, and this is even higher, that is, 66% for females. Several previous Indian studies, reporting reference values of pulmonary function tests, have included smokers, asymptomatic nonsmokers, and relatives of patients attending tuberculosis research facilities. Moreover, they lacked standardized equipment and adherence to ATS guidelines. Our study addresses these issues by providing specific spirometric prediction equations for this population utilizing ATS criteria for accuracy and reproducibility. Though peak flow meter is more easy to-use by patients, physicians at primary care level, and for field surveys, the PEFR values were either similar or within 10% of PEFR value obtained by a portable spirometer in 75% of the individuals.[17] A longitudinal study would have been ideal; but again, this is difficult to accomplish. Therefore, as in most of the previous studies, our study sample represented a cross section of the population. To eliminate any confounding effects related to current or prior smoking, we have excluded all the current or ex-smokers from our study. We have recruited a sizeable number of healthy young adults from both the genders who represent the Indian population of the same age group well. Significantly lower standard error of estimate (SEE) and significant F value implied the reliability of the prediction models developed from our study. Also, the regression statistics have confirmed good correlation, lesser degree of collinearity, and absence of any unusual observations. The regression norms may be used to predict the spirometric values in Indian population of the age group similar to the study population. Our study was limited by a comparatively small number of female subjects and all the subjects belonging to a relatively narrow age group. The population studied was medical students, which may not be a representative population. We would

Table 3: Simple regression norms for the prediction of peak expiratory flow rate in males

	Regression coefficient	Standard error of coefficient	Standardized beta estimate	Adjusted R square	Standard error of estimate	F value (significance)
Constant	−0.771	1.778				
Height	5.795	1.059	0.330*	0.105	1.056	29.925*(0.000)
Constant	6.514	0.382				
Weight	0.039	0.006	0.382*	0.142	1.034	41.738*(0.000)
Constant	6.848	1.197				
Age	0.109	0.062	0.111 (NS)	0.008	1.112	3.082 (NS) (0.080)

NS, Not significant, (*), Significant (0.05).

Table 4: Simple regression norms for the prediction of peak expiratory flow rate in females

	Regression coefficient	Standard error of coefficient	Standardized beta estimate	Adjusted R square	Standard error of estimate	F value (significance)
Constant	−18.288	5.592				
Height	16.101	3.559	0.535*	0.272	0.909	20.471*(0.000)
Constant	7.705	1.726				
Weight	−0.013	0.031	−0.057(NS)	−0.016	1.075	0.164(NS) (0.687)
Constant	15.671	3.327				
Age	−0.425	0.163	−0.343*	0.100	1.011	6.791*(0.012)

NS, Not significant.

Table 5: Multiple regression norms for the prediction of peak expiratory flow rate in both sexes

	Regression coefficient	Standard error of coefficient	Standardized β estimate (significance)	Adjusted R^2	Standard error of estimate	F value (significance)
Male						
Constant	-0.510	1.683		0.199	1.000	31.495*
Height	4.423	1.034	0.252*			
Weight	0.032	0.006	0.320*			
Female						
Constant	-13.557	4.114		0.617	0.659	42.933*
Height	23.297	2.786	0.774*			
Age	-0.787	0.115	-0.635*			

*, Significant (<0.05).

Table 6: Comparison of predicted values of peak expiratory flow rate from other studies

	Males		Females	
	Predicted PEFR	% difference	Predicted PEFR	% difference
Present study	8.867		6.813	
Mohanrao[8] (Gujarat)	8.298	6.4	6.676	2.0
Saleem[9] (Kashmir)	8.088	8.8	5.327	21.8
Nikhil[10] (Puducherry)	7.992	9.9	5.110	25.0
Nadeem[11] (Pakistan)	6.566	26.0	4.857	28.7
Boskabadi[12] (Iran)	9.593	-8.2	8.728	-28.1
Hankinsons[13] (Caucasian)	8.982	-1.3	6.374	6.4
Hankinson[13] (African-American)	8.850	0.2	6.456	5.2

PEFR, peak expiratory flow rate.
Males aged 20 years, with a height-of 165 cm and weight 65 kg. Females aged 20 years, with height 155 cm and weight-55 kg.

like to conduct a multicentric study including subjects of all the age groups of both sexes, which will truly represent the prediction equations for Indian population. This study may add value to the efforts being made by the Global Lung Initiative task force to establish improved international lung function reference data representative of populations irrespective of age, ethnicity, and equipment used. These reference values and prediction equations should be revised periodically to minimize the effect of changing environment and lifestyle changes.

Conclusion

The computed regression norms may be used to predict the PEFR in young Indian population of similar age group as the study population.

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