Original Article

Estimation of peak expiratory flow rate in young Indians

Estimativa da taxa de pico de fluxo expiratório em jovens indianos

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ABSTRACT | INTRODUCTION: Peak expiratory flow rate (PEFR) is commonly used to monitor the progression of respiratory diseases as it gives good information about the status of airways. A good amount of research is going across the world to establish a local prediction equation. The joint task force of the American thoracic society and European Respiratory Society has promoted research in this regard. In India, data derived from the Caucasian population are still used for PEFR. **OBJECTIVE:** To verify the relationship between PEF levels and the variables age, sex, anthropometric and body surface area, and establish the regression equation for young Indian adults. METHODS: A cross-sectional observational study was conducted in 15-25 years aged 1000 subjects from the Metropolitan region of Mumbai. Pearson's correlation coefficient was used to understand the relation of anthropometric parameters and PEFR. Multivariate regression analysis was done for establishing a prediction equation (Alpha 5%). **RESULTS:** Age and all anthropometric parameters were correlated with PEFR. The mean PEFR of the male population was 515 ml/sec, whereas, for females, it was 399 ml/sec, for PEFR highest correlation was observed with BSA (.696) followed by weight (.667), height (.630), age (.504) whereas BMI shown lowest correlation coefficient (.445). PEFR had the best significance with age, BSA, Height, and BMI. It had less significance with weight. In females, PEFR had the best significance with Height, weight, BMI, and Age. **CONCLUSION:** Gender-wise differences exist in PEFR. Hence gender-specific equations are needed for the estimation of PEFR.

KEYWORDS: Peak expiratory flow rate. Anthropometric parameters. Prediction equation. Asthma.

RESUMO | INTRODUÇÃO: O pico de fluxo expiratório (PFE) é comumente usado para monitorar a progressão de doenças respiratórias, pois fornece boas informações sobre o estado das vias aéreas. Uma boa quantidade de pesquisas está sendo feita em todo o mundo para estabelecer uma equação de previsão local. A força-tarefa conjunta da Sociedade Torácica Americana e da Sociedade Respiratória Europeia promoveu pesquisas a esse respeito. Na Índia, os dados derivados da população caucasiana ainda são usados para o PFE. **OBJETIVO:** Estudar a relação dos parâmetros do PFE e os dados antropométricos como idade, altura, peso, índice de massa corporal (IMC), área de superfície corporal (ASC) e estabelecer uma equação de regressão para jovens adultos indianos. **MÉTODOS:** PFE foi feito em 1000 sujeitos de 15-25 anos da região metropolitana de Mumbai. O coeficiente de correlação de Pearson foi usado para entender a relação dos parâmetros antropométricos e PFE. A análise de regressão multivariada foi feita para estabelecer uma equação de predição. (Alfa 5%) **RESULTADOS:** Idade e todos os parâmetros antropométricos foram correlacionados com PFE. O pico de fluxo expiratório médio da população masculina foi de 515 ml / seg, enquanto a feminina foi de 399 ml / seg. Para o PFE, a maior correlação foi observada com a ASC seguida de altura, peso e idade, enquanto o IMC apresentou o menor coeficiente de correlação. TPFE teve a melhor significância com a idade, ASC, altura e IMC. Teve menos significado com o peso. No sexo feminino, a TPFE teve a melhor significância com altura, peso, IMC e idade. **CONCLUSÃO:** Existem diferenças de gênero na TPFE. Portanto, equações específicas de gênero são necessárias para a estimativa da TPFE.

PALAVRAS-CHAVE: Pico de fluxo expiratório. Adulto indiano. Equação de predição. Asma.

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Introduction

According to the American Thoracic Society and the European Respiratory Society, respiratory disability and death are growing concerns all over the globe. In India, acute and chronic respiratory diseases are present in substantial number.[1] Asthma and chronic obstructive pulmonary disease (COPD) are amongst the prime reasons for respiratory morbidity and mortality in the Indian context. It is estimated that 300 million people currently have asthma, which will rise to 400 million by 2025. Around 5,00,000 hospitalizations every year occurs due to asthma. The financial burden of asthma and COPD is extensive.[2,3] asthma mostly starts in early childhood which is diagnosed by its clinical presentation and history.[4] Pulmonary function test (PFT) is commonly used to confirm the diagnosis.[5]

The peak expiratory flow rate (PEFR) measures a person's highest expiratory flow, measured with a peak flow meter.[6] It is a simple method that measures the airflow from airways in L/min. Moreover, it measures flow rate directly from airways and gives good airways information in case of obstructive diseases.[6] In order to interpret the status of airways, the PEFR value of the patient is compared with reference values determined from the general population.[7-10]

The published PEFR reference values vary from population to population.[11-15] Few researchers have established that using reference data derived from other populations creates misinterpretation in the Indian population.[16] Despite this, the equations derived from the western population are still in practice in India. Many efforts are going in the world to establish reference data. In India, few attempts are also made to address this issue. India is a country that is diverse in many aspects. Variation exists in dietary nutritional habits, climate, geography, socioeconomic status, and cultural background. By observing this, it is important to have local data set for PEFR to investigate asthma and other respiratory diseases.

The study's main objective was to verify the relationship between PEF levels and the variables age, sex, anthropometric, and body surface area and establish the regression equation for young Indian adults.

Materials and methods

A cross-sectional observational study was conducted in 1000 healthy subjects aged between 15 to 25 residing in Mumbai metropolitan region, Maharashtra, India. A random sampling method was used for the selection of subjects.

Healthy 15-to-25-year aged males and females were free from congenital disorders, disease of respiratory/ cardiac/ metabolic Systems, subjects with no family histories of bronchial asthma/ COPD/ bronchiectasis/ cystic fibrosis or any other respiratory diseases willing to participate in the study were recruited in the study. Subjects diagnosed with pulmonary, cardiac, endocrine diseases; obese / malnourishment was excluded from the study.

A peak flow meter, mouthpiece, weighing scale, data recording sheet, pen and paper was used in this study. The study was carried out after obtaining permission from the institutional ethical committee. Written consent from subjects was taken after explaining the benefit, risks, and procedures of the study.

Registered medical practitioners carried out the detailed medical examination of all selected subjects to rule out any underlying heart, lung, other systemic diseases, chest/ spine deformities, and other medical abnormalities. A medical research council questionnaire for respiratory symptoms was used to screen the subjects. The subject's sheet recorded standing height, weight, age, body mass index (BMI), body surface area (BSA). The age was measured in years, height in centimetres, and weight in kilograms. The height was measured with a stadiometer. The weight was measured with the digital weighing machine. The BMI was calculated in kgm-2. The "Mosteller" formula was used to calculate BSA.[16]

The subjects had an introductory explanation of the PEFR procedure, peak flow meter, handling, and apparatus use. The training on peak flow meter was given to candidates. The final reading was taken on next morning. All subjects were tested in standing positions. The subject was instructed to take a deep breath as possible and then blow it out in the peak flow meter as forcefully as possible. Total three trials were taken, and the best of 3 values of PEFR was recorded.

The disposable mouthpiece was used for every subject, and after the test, all mouthpieces were handed over to the biomedical waste management unit.[15]

Statistical Analysis

The mean and standard deviation was derived from descriptive statistics. Microsoft Excel and SPSS software version 23 were used for data analysis. Pearson's correlation test established the relation of PEFR with age, height, weight, BMI, and BSA. The diagnostic F test and ANOVA were used for analysis, with 80% power of the study. Multi-variant regression was done for the development of a prediction equation model for PEFR separately for both genders.

Result

The study included 1000 subjects, out of which 506 were females. The mean values were used for the comparison of PEFR in both genders. The mean age of the sample was 19.94 years, mean weight was 63.64 Kg, mean height was 165.44 cm, mean BMI was 23.11 kg/m2, and mean BSA was 1.71 m2. The mean PEFR of the entire sample was 439.28 ml/min (Table 1).

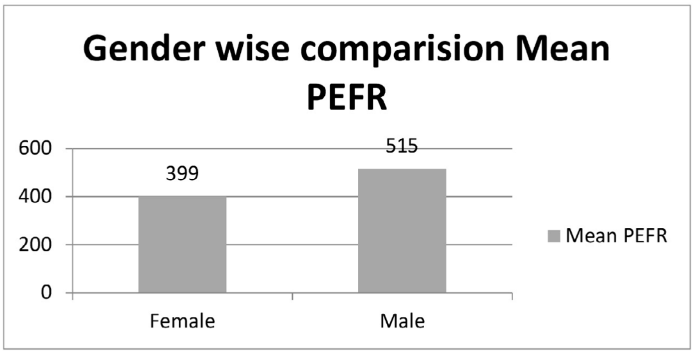
Table 1. Sociodemographic Data in young Indians 2020 (Mean)

Age	Height	Weight	BMI	BSA	PEFR
19.94	165.44	63.65	23.11	1.70	439.28

BMI: Body Mass Index; **BSA**: Body Surface Area; **PEFR**: Peak Expiratory Flow Rate

Mean PEFR of male population was 515 ml/min whereas females it was 399 ml/min with p=.000, Figure 1.

Figure 1. Comparison of PEFR by gender (Mean, p-value=0.000)



For PEFR highest correlation was observed with BSA followed by height, weight, age whereas BMI shown lowest correlation coefficient. The moderate positive correlation was observed between PEFR and age, weight, height, BSA whereas weak positive correlation was noted with BMI (Table 2).

Table 2. Anthropometric Parameters and PEFR

	Age	Weight	Height	BMI	BSA
TPFE	.504**	.667**	.630**	.445**	.696**

***. Correlation is significant at the 0.01 level (2-tailed), r=0.012, beta of the correlation=0.171*

The diagnostic F test and ANOVA were significant. Significant β coefficient was observed with age, weight, and BSA. In our study, a prediction equation was derived for males and females respectively through regression. In males, PEFR had the best significance with age, BSA, height, and BMI. It was less significant with weight (Table 3).

Table 3. Prediction Model to PFER for males

	Constant	Age	Weight	Height	BMI	BSA
B	-335.223	21.850	-0.072	1.398	-4.172	153.352
t	-1.087	15.062	-0.026	0.700	-0.631	1.275
p-Value	0.278	0.000	0.097	0.048	0.052	0.022

Final Equation: PFER (Males)=21.850(**Age**) + 1.398(**Height**) – 4.172(**BMI**) + 153.352(**BSA**) –335.223

In females, PEFR had the best significance with height, weight, BMI and age. It had less significance with BSA (Table 4).

Table 4. Prediction Model to PFER for females

	Constant	Age	Weight	Height	BMI	BSA
	1670.745	0.055	18.885	0.008	-51.707	0.225
	4.785	0.979	4.072	0.578	1.213	-6.679
	0.000	0.328	0.000	0.016	0.225	0.000

Final Equation: PFER (Females) = 18.885(**Weight**) + 0.008(**Height**) – 51.707(**BMI**) + 0.225 (**BSA**) + 1670.745

The multivariate regression model derived to predict PEFR using binary response variable at a 0.95 confidence level producing a two-sided confidence interval with a width of 0.89 was as follows.

PEFR (Males) = 21.850(Age) + 1.398(Height) – 4.172(BMI) + 153.352(BSA) –335.22.

PFER (Females) = 18.885(Weight) + 0.008(Height) – 51.707(BMI) + 0.225 (BSA) + 1670.745

Discussion

The current study attempted to estimate the reference value and prediction equation of PEFR using anthropometric indices on 1000 healthy subjects aged between 15 to 25. PEFR is used to monitor the progression of diseases like asthma. In our study, a prediction equation was derived for males and females through regression. In males, PEFR had the best significance with age, Height, BMI and BSA. It had less significance with weight. In females, PEFR had the best significance with weight, height, BMI, and BSA. It had less significance with age.

Age and PEFR: In present study studied PEFR in the 15-to-25-year age group and found that PEFR value increases with age. Most of the authors have observed PEFR increases with age and height.[17-21] The increasing age is a sign of the maturation of the respiratory system in the 15-25 years age group. Hence, we have observed a positive correlation. Age was not an important factor for females in this study, but it did for males. Age has been an important factor in determining PEFR in healthy subjects.[23]

Height and PEFR: our present study showed a positive correlation of height with PEFR. Height is an index of growth. The length of the chest is more in taller individuals as compared to shorter ones. The length of airways is also more in taller people.[21] Probably, this has resulted in a higher volume of air in taller subjects. The height influences the prediction equation in males to a great extent, whereas age and weight had greater influence in girls.[22]

Weight and PEFR: our present study showed a positive correlation of weight with PEFR. The studied population was in the age group of 15 to 25 years. This is the age group in which the increased weight represents the weight more of developing musculoskeletal system and less of fat deposition.[22]

BMI and PEFR: our present study showed a positive correlation of PEFR with BMI. BMI is calculated by a formula consisting of height and weight. PEFR has shown a positive correlation with both these components; hence the BMI shown correlation with PEFR. The findings of other studies supported our results.[23]

BSA and PEFR: In our present study, we observed linear relation of BSA with PEFR in both males and females. BSA is a higher indicator of metabolic mass than weight. As a result of it gets least affected by fat mass. Also, it considers height and weight, which gives good information about the individual's nutritional status.[24] Findings of other studies supported our results.

Gender and PEFR: Our present study included 494 healthy males and 506 healthy females. Mean PEFR in healthy males was higher than that of the female population of the study. The ability to remove air forcefully from the lung depends on muscle strength which depends on body stature. The males of this study had higher mean height, weight, BSA than females. As PEFR correlates with these parameters, higher values were observed in the male population. The linear increase has been observed with chronological age in early childhood to 13–14 years in males, and muscle strength increases till age 20 years. Whereas it linearly increases with age until 15 years, a decrease in strength is noted in females. Lung growth is attained earlier in females as compared to males. Also, the development of lung and thorax in males is seen during puberty. In opposite to males, lung development in females occurs in a short period and earlier part of puberty, and it almost completes after menarche.[25]

Therefore, the impact of this study is that it is important to have regional PEFR reference values for better comparison across diseases in terms of clinical settings. In addition, the equations designed in this study can be used in populations with similar backgrounds after statistical testing of the model in the population for which the PEFR should be tested.

Conclusion

Gender-wise differences exist in PEFR. Males have higher PEFR values than females. Hence gender-specific equations are needed for the estimation of PEFR. There is a significant positive correlation of PEFR with age, height, weight, BMI, and BSA in the studied population.

Author contribution

Kale SH structured the concepts, design, and manuscript review. Bhatt K performed PEFR tests and collected data, contributing to the manuscript preparation and review. Deo M participated in the conception, design, statistical analysis of the research data, and interpretation of results.

Competing interest

No financial, legal, or political competing interests with third parties (government, commercial, private foundation, etc.) were disclosed for any aspect of the submitted work (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis, etc.).

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