Indian J Physiol Pharmacol 2018; 62(3) : 372–379

Short Communication

Peak Expiratory Flow Rate Changes with Relevant Variables in a Population of Eastern India

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Abstract

Introduction: Peak expiratory flow rate (PEFR) is the sole screening parameter use for mass assessment of lung function in community level, although the normal value of PEFR varies with geographical, climatic and socioeconomic conditions. However available data regarding variation in PEFR in healthy eastern Indian adult population is very limited till date. This study was undertaken to analyse the changes in PEFR with various factors in a population of eastern India with normal spirometry.

Methodology: A retrospective study was conducted on 762 subjects aged 15 to 75 years with normal spirometry results. Their percent predicted values of PEFR were compared with variables like gender, height, weight, age and smoking habits. All data were obtained from database of spirometry laboratory at Physiology department, R.G. Kar Medical College and Hospital, Kolkata from August 2016 to February 2017. Appropriate administrative approval was obtained prior to the test. The spirometry was done following ATS/ERS protocol (2005) using 80% ethnic correction. The instrument used was HELIOS 702 spirometer. Statistical analysis was done by z-test, fischer's exact test and significance was assigned at $p<0.05$.

Results: Mean PEFR value of the study population was 86.017±2.042%. Mean value for male and female subjects were 89.041±23.943 and 84.706±21.667 respectively. PEFR values was lower in ever-smokers compared to never-smokers. PEFR value became higher with increase in height and weight but lower with increase in age.

Conclusion: The study evaluated PEFR of eastern Indian population in respect to various influencing factors and suggested normative values for PEFR for eastern Indian population to be used for routine respiratory evaluation.

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(Received on January 1, 2018)

Introduction

Peak expiratory flow rate (PEFR) is the largest expiratory flow rate achieved with a maximally forced effort from a position of maximal inspiration. This is effort dependent and reflects mainly the calibre of the bronchi and larger bronchioles (1). The PEFR is one of the simplest parameter for measuring lung functions in untrained individuals and therefore can be used as a screening tool in population based surveys for assessment of lung function (2-4). It is well established that variations in gender, age, anthropometric indices such as height, weight, body mass index (BMI) and also lifestyle changes like smoking habits are the main factors affecting PEFR (5). PEFR also varies considerably among population belonging to different regions and ethnic groups (6). Reference values of PEFR for Indian adult population were obtained with respect to the above mentioned variables but mainly from Northern, Western and Southern region of the country (7-9). There is paucity of data on PEFR of healthy adult population of eastern India.

Aims & Objectives:

The aim of the study was to analyse the changes in PEFR with various factors like gender, smoking habit, height, weight and age in a population of eastern India with normal spirometry.

Materials and Methods

Appropriate administrative approval was taken for the proposed study. As it was a retrospective study with the data already collected and stored in the spirometry laboratory of Physiology department, there was no scope for approval of the Ethics committee. Written informed consent from every patient was already taken prior to the test.

Experimental Protocol:

762 subjects aged between 15 and 75 years who were referred from different outpatient departments of RGKMCH, Kolkata with chief complaint of shortness of breath (SOB) between August 2016 and February 2017 were selected for the study. All study subjects were legal residence of the state of West Bengal. Therefore they could be assigned as Bengali by ethnicity. According to inclusion criteria of the study all of them were having normal spirometry values {FVC and FEV_1 ≥80% predicted, FEV1/FVC ratio ≥0.7, forced expiratory flow in the middle half of the FVC (FEF_{25-75}) of ≥50% of predicted (10) and PEFR >60% predicted (11)}.

Exclusion criteria of the study were:

1) Restrictive impairment (FEV1 and FVC each < 80% of predicted, with FEV1/FVC ratio ≥0.7 with FEV1 <80% of predicted) and obstructive impairment (FEV1/FVC ratio <0.7 with FEV1 <80% of predicted) test results (12)

2) PEFR value <60% of predicted

3) Subjects with any cardiac ailments (as written in their OPD cards)

4) Test that had been done using 100% ethnic corrections.

5) Age <15 years and >75 years.

Data regarding parameters like age, sex, height, weight and smoking habit (smoking status defined as ever/never smoker of cigarette, beeri, huqqa etc. An ever-smoker was anyone who smoked regularly for at least one year. Never-smokers were defined as those who never smoked regularly for one year or more) were already obtained prior to the test. At every time the test was performed by RMS HELIOS-702 spirometer following American Thoracic Society/ European Respiratory Society (ATS/ERS) latest guideline of 2005 (13) and using 80% ethnic correction (it had been customary to equate 80% predicted with the lower limit of normal as we had considered percent predicted values for statistical analysis (10, 14-16).

Daily calibration of the spirometer was done using a calibrated syringe according to latest ATS/ERS guidelines (13) during the tenure of the study. The author checked the syringe for leaks and damage

prior the procedure and kept the syringe next to the spirometer. The largest observed values of FEV_1 and FVC available from among at least three acceptable and reproducible tests were taken as the key parameters for interpretation.

Statistical Analysis:

The data were expressed in Mean±Standard Deviation (SD). Two-sided z-test was used to compare between two groups and fischer's exact test had done for categorical analysis. Mean, standard deviation and z values were calculated using Microsoft excel sheet whereas statistical analysis of Fischer's test and calculation of p values were done using Graph pad Quickcals software, California, USA. Differences were considered statistically significant at p value < 0.05.

Results

Table I had shown:

1) The mean age of the study population was around 40 years and female subjects were not belonging to ever-smokers group.

2) All the mean values of spirometry variables were higher than the lower limit of normal range.

Table II had shown that

The mean value of BMI was significantly higher and PEFR was significantly lower in middle aged female subjects compared to males.

Table III had shown that:

The present study had shown mean PEFR was significantly higher in never-smokers (89.041±23.943) compared to ever-smokers (84.385±19.531) among males (p value: 0.029).

Table IV had shown that:

1) The mean PEFR in the height range of 156-165 cm (84.882±20.54) was significantly lower than

TABLE I: Anthropometric and spirometric profile of the study population (n=762).

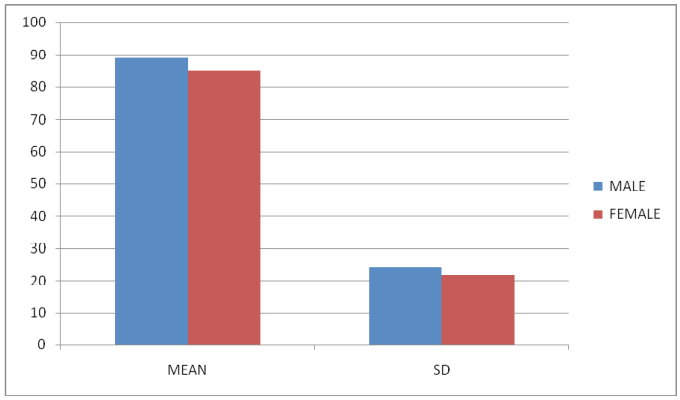
Parameters	*Analysed data*			
Age (years) (Mean±SD)	39.646±15.803			
Gender [n (%)]	*Male* 414 (54.33)		*Female* 348 (45.67)	
Height (cm) (Mean±SD)	158.182±9.089			
Weight (kg) (Mean±sd)	56.347±12.895			
Addiction [n (%)] (smoking)	*Ever-smokers* 171 (22.44)		*Never-smokers* 591 (77.56)	
	Male 100%	*Female* 0%	*Male* 28.93%	*Female* 71.07%
FVC(%) (Mean±SD)	102.821±12.057			
FEV_1(%) (Mean±SD)	104.771±12.833			
FEV_1/FVC (%) (Mean±SD)	102.622±9.647			
FEF_{25-75} (%) (Mean±SD)	77.016±16.671			
PEFR (%) (Mean±SD)	86.012±22.042			

TABLE II: Gender variance of PEFR value.

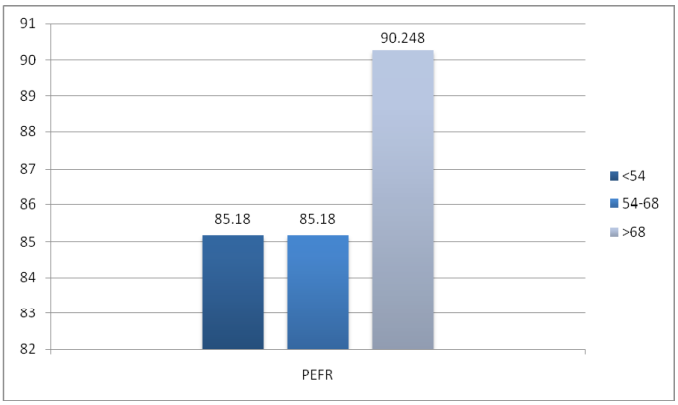
Variables	*Male (n=243)*	*Female (n=348)*	*z value*	*p value*
Age (years) (Mean±SD)	38.139±17.426	37.324±14.54	0.598	0.549
BMI (kg/m^2) (Mean±SD)	22.084±4.555	23.086±5.058	–2.513	0.011*
PEFR (%) (Mean±SD)	89.041±23.943	84.706±21.667	2.251	0.024*

TABLE III : Comparison of PEFR according to smoking status in males.

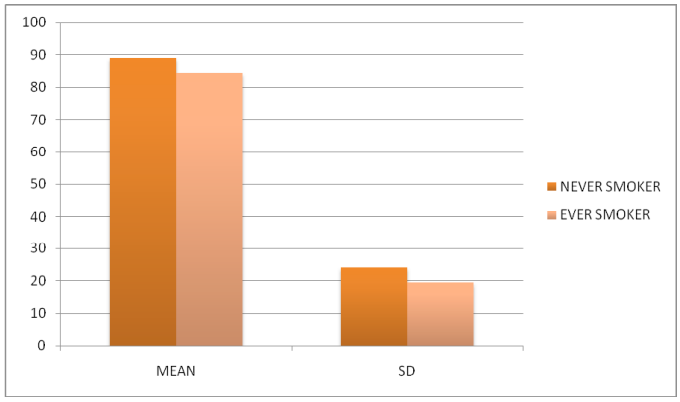
Variable	*never Smoker (n=243)*	*Ever smoker (n=171)*	*z value*	*p value*
PEFR (%) (Mean±SD)	89.041±23.943	84.385±19.531	2.173	0.029*



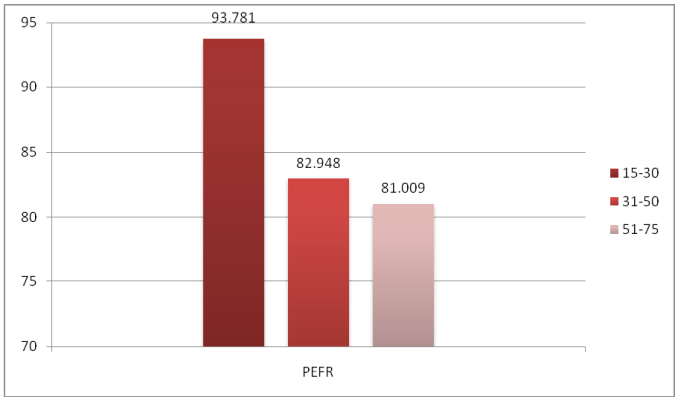
Bar diagram showing gender variance of Mean & SD of PEFR of study subjects.



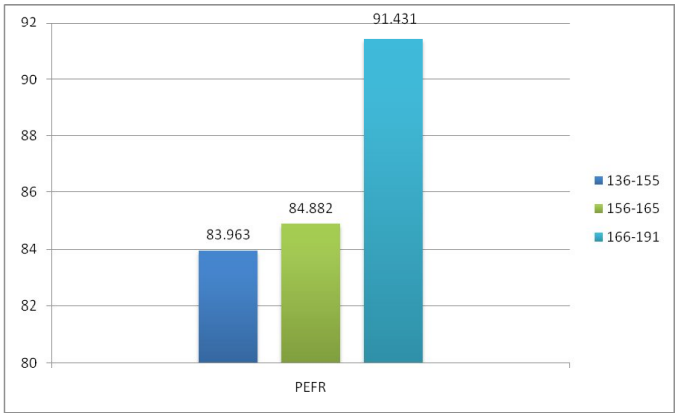
Bar diagram showing Mean PEFR in study subjects according to weight groups.



Bar diagram showing Mean & SD of PEFR according to smoking status of male subjects.



Bar diagram showing Mean PEFR in study subjects according to age groups.



Bar diagram showing Mean PEFR in study subjects according to height intervals.

TABLE IV : Comparison of Mean & SD of PEFR according to height intervals of the study subjects.

Group no.	*Height (in cm)*	*No. of subjects*	*Mean±SD of PEFR (%)*
I	136-155	299	83.963±22.71
II	156-165	289	84.882±20.54
III	166-191	174	91.431±22.53

Statistical analysis of Table IV.

Comparison	*z value*	*p value*	*Significance*
I and II	–0.515	0.606	NS
II and III	–3.13	0.001*	HS
I and III	–3.466	0.0005*	HS

that in the height range of 166-191 cm (91.431±22.53) (p value: 0.001)

2) No significant difference was observed between group I and II.

Table V had shown that:

1) The mean PEFR in the weight group of >68 kgs (90.248±22.131) was significantly higher than that in the weight group of 54-68 kgs (85.186±21.261), which was statistically significant (p value: 0.03)

2) No significant difference was observed between group I and II.

TABLE V : Comparison of Mean & SD of PEFR according to weight groups of the study subjects.

Group no.	*Weight (in Kgs)*	*No. of subjects*	*Mean±SD of PEFR (%)*
I	< 54	342	85.18±22.552
II	54-68	295	85.18±21.261
III	> 68	125	90.248±22.131

Statistical analysis of Table V.

Comparison	*z value*	*p value*	*Significance*
I and II	0.0006	0.999	NS
II and III	–2.168	0.03*	HS

Table VI had shown that:

1) The mean PEFR decreased with an increase in the age in the study subjects. The PEFR in the age group of 31-50 years (82.948±18.7) was less than that in the age group of 15-30 years (93.781±26.363), which was statistically highly significant (p value: <0.0001).

2) No significant difference was found between age 31-50 years and 51-75 years.

Discussion

This study conducted on 762 subjects from eastern India who were aged 15-75 years and had apparently normal lung health as per spirometry result was concerned. The influences of gender, smoking habits, height, weight and age on PEFR of the study population were studied. So far our knowledge and resources permit no such study had yet been conducted with eastern Indian population including young adults and middle aged as well as geriatric age group.

TABLE VI : Comparison of Mean & SD of PEFR in study subjects according to age groups.

Group no.	*Age (in years)*	*No. of subjects*	*Mean±SD of PEFR (%)*
I	15-30	252	93.781±26.363
II	31-50	308	82.948±18.7

Statistical analysis of Table VI.

Comparison	*z value*	*p value*	*Significance*
I and II	5.49	<0.0001*	HS
II and III	1.173	0.24	NS
I and III	6.121	<0.0001*	HS

The PEFR and gender:

Present study had shown that males had higher value of PEFR compared to females which was in accordance with Mishra J et al (2013) (17). Wannamethee SG et al. (2005) (18) documented that higher BMI was associated with both increased fat mass and muscle mass (i.e fat free mass) and investigators had shown that there was a decrease in the lung functions including PEFR with an increase in the BMI (5, 19, 20) which was in accordance with the present study. Lower value of PEFR in females might be due to higher BMI in this study. As a common consensus of physiology we know that females contain higher total body fat and lower total muscle mass as compare to male of same body weight, this higher BMI directly reflects presence of obesity of this study population which was an unrelated but interesting finding. Therefore obesity can be the cause of lower PEFR value in female.

The PEFR and smoking habits:

The mean PEFR in the never-smokers group was higher than that in ever-smokers group. The difference between the groups was statistically significant. Nawafleh AH et al. (2012) also found that cigarette

smokers had a lower PEFR (21). Chatterjee S, Nag SK et al. (1988) studied on 334 healthy male non-smokers and 300 healthy male smokers of the age range of 20-60 years and found that value of PEFR was significantly lower in smokers than non-smokers (22). Similar results were presented by other investigators. They documented that reduction in flow rates might be due to narrowing as well as reduction in recoil of large and small airways in smokers (23). Kim WD (1985) studied lung parenchymal changes in chronic smokers. They observed that smokers had decreased lung function than non-smokers due to destruction of the lung parenchyma (24).

The PEFR and height:

This present study showed that there was an increase in the PEFRs of the study subjects with an increase in their heights. This observation was consistent with the findings of other researchers also (25, 26). It was documented that taller subjects had the greater chest volume. The growth of the airway passages and the expiratory muscle effort also increase with an increase in the height (5).

The PEFR and weight:

This study had shown larger value of PEFR in group III compared to group II and also larger in group III compared to group I which suggested that PEFR increased with an increase in body weight and this finding was in accordance with the study result of Amin SK et al. (1978) (27). This observation could possibly be due to rapid growth of airway passages and expiratory muscle effort as weight increases (5, 28). Although no significant difference observed between group I and II. This observation was consistent with the report of other authors (29).

The PEFR and age:

The present study had shown that the PEFR decreased with the increase in age. Similar findings were observed by other investigators (30-33). Decrease in the PEFR with age is probably due to degenerative changes in the musculoskeletal system of thoraco-abdominal compartment leading to decrease in respiratory muscle strength with associated decrease in joint mobility. In addition, airway calibre decreases with age and the proportion of collapsible small airways increases as well as the airways receptors undergo functional changes with age resulting in increase resistance in airways (5, 34, 35).

The limitations of the study were-

i) Improper distribution of subjects in the various height-wise, weight-wise and age-wise categorizations. This could have been taken care of by increasing the population size and random selection of subjects from general population instead of patients.

ii) Though from the study we observed that obesity could be a cause of lower PEFR in females, we could not further analyzed the detailed parameters of obesity like waist-hip ratio, adiposity index and total body fat estimation because no data regarding these values were mentioned in the database. As a small, retrospective study performed in a single center based on database, the results may or may not vary in other settings.

Conclusion

The preliminary reference values of the PEFR for the population of eastern India have been established. The effects of various factors like gender, smoking habits, height, weight and age on the PEFR values have also been discussed in this study. Hence, the present study concludes that healthy adult males have larger PEFR value than that of female. PEFR is lower in smokers than non-smokers. We hope that reference values we have generated of PEFR for healthy adult population of eastern region will be used and that similar data can be generated for other remaining parts of the country which will be helpful to draw prediction equation of the pulmonary function in future. PEFR can be used as a risk assessment tool for the population having apparently normal lung health. Smoking causes bad impact in lung health by restricting ventilatory effort. So, aggressive tobacco control programme aimed to inform the public

about the hazards of tobacco use and to provide restriction on the use of or purchase of tobacco must be started.

Disclosure

No conflicts of interest, financial or otherwise are declared by the authors.

Acknowledgements

The authors are thankful to the Principal, all faculty members and staffs of dept. of Physiology, R. G. Kar Medical College and Hospital, Kolkata for giving such scope to do research work related to clinical respiratory physiology

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