RESEARCH ARTICLE

Peak Expiratory Flow Rate: Anthropometric Factors affecting It in Elderly Females and Reference Values

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Abstract

Background: Peak expiratory flow rate (PEFR) is an efficient measure of effort-dependent airflow. It is easier to perform and can be carried out in the field using a portable instrument. This study was done to evaluate the effect of various anthropometric parameters like age, height, weight, body mass index (BMI), and body surface area (BSA) of PEFR in healthy elderly female subjects and differences in urban and rural areas, and to establish local reference standards.

Materials and methods: The PEFR was measured in 67 urban and 50 rural female subjects in the age group of above 65 years of Amritsar district with the help of a mini Wright peak flow meter in a standing position. The best out of three trials were recorded. Its correlation with age and various anthropometric parameters was calculated.

Results: The mean PEFR was highest in the age group 65–74 years for both urban and rural females and it decreased as age increased. The correlation of PEFR with age was negative and highly significant (HS). The correlation of PEFR with age was negative and HS. Correlation with height was a positive and significant correlation with height and a non-significant correlation with weight, BMI, and BSA. The value of PEFR in urban and rural female subjects was found to be similar and the difference was non-significant.

Keywords: Age, Body mass index, Body surface area, Elderly, Height, Peak expiratory flow rate, Weight.

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Introduction

Peak expiratory flow is an important index used for screening and monitoring asthma, chronic obstructive pulmonary disease (COPD), and respiratory mortality especially in the elderly is recommended for low and middle-income countries.[1] In a country like India, which extends over a number of latitudes, cultural groups, climatic zones, and food habits, pulmonary functions among the normal residents are going to show variations.[2] The Wright peak flow meter[3] was launched in 1959 and was widely used as a simple portable instrument for assessing ventilatory function and it has proved to benefit in diagnosing and follow-up during the treatment of COPD. The mini Wright expiratory flow meter which was invented later was easier to use.[4] Researchers who carried out surveys before in the Indian subcontinent stressed upon the requirement for standardized values for pulmonary functions on the basis of ethnicity and climate.[5] Hence, standardized values for a certain population should be taken from a sample of that zone.[6] This study was done on rural and urban female inhabitants of Punjab, India to derive the local reference standards and to see the difference in PEFR values of urban and rural females. Regression equations were calculated for predicting normal PEF values.

Materials and Methods

The cross-sectional study was done in normal elderly females in the age group ranging from 65 to 94 years from rural and urban regions of the Amritsar district. The nature of the study was clarified, and from each subject, informed consent was taken. The approval of the study was given by the ethics committee of the institute. A total of 67 urban and 50 rural females were chosen for this study. The study subjects were chosen randomly from different socioeconomic strata and religious backgrounds so that a diverse picture of the PEFR status of the study region is portrayed. Subjects with a history of diabetes mellitus were not included in the study. Study subjects were mobile, without skeletal deformity, and with no history of lung pathology. The subjects, who were not able to perform had neuromuscular disease, and were smokers, were excluded from the study.

The subjects described the purpose of the study and its procedure and were convinced of its confidentiality. A thorough history was taken, and an examination was done to exclude cardiorespiratory illness. Subjects' weight and height were recorded to calculate BSA and BMI.

Age was noted in years to the nearest of 0.5 years. Height was recorded in centimeters (cm) by making the subject stand barefoot, with separated heels and hips against the wall. The weight reading was taken using a portable weighing scale in kilograms. For calculating BMI, the formula used was BMI (kg/m^2) = Weight (kg)/Height (m^2).

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Body surface area was derived using Du Bios formula,[7]
$BSA\ (m)^2 = 0.0071 \times Weight\ (kg)^{0.425} \times Height\ (m)^{0.725}$

Reading of PEFR was taken with the help of the mini Wright peak flow meter, which is a portable instrument (Clement and Clarke),[8] a device to record PEFR from 60 to 800 L/minute. Before recording, it was demonstrated to each subject, how to perform till they are fully confident of it. The subjects were instructed to inhale forcefully and then exhale in the peak flow meter with a force, and very quickly with their nose clipped. They were told to perform the test thrice and the highest of three was taken for analysis. The peak flow meter which was used in the study was the same. All the readings were taken in the erect position.

Statistical Analysis

Data collected from the study was expressed in mean ± SD. After the data were obtained, the above parameter was statistically analyzed by applying the Student's *t*-test, and $p < 0.05$ was taken as significant, while $p < 0.01$ and $p < 0.001$ were taken as HS.

Results

A total of 117 ambulatory healthy female subjects (67 urban and 50 rural) of Amritsar, Punjab, India were included. The subject's ages ranged from 65 to 94 years

Table 1 showed mean and SD values of weight, height, BMI, BSA, and PEFR values for urban females in three age groups. Mean PEFR decreases with increasing age and reaches the minimum value at 85–94 years.

Table 2 shows mean and SD values of weight, height, BMI, BSA, and PEFR for rural females in three age groups. Mean PEFR decreases with increasing age and reaches the minimum value at 85–94 years.

Table 3 shows comparative PEFR values of urban and rural females, among different age groups.

In the 65–74-year age group, the mean PEFR in urban females is 253.00 ± 39.49 L/minute and in rural females, it is 248.33 ± 47.92 L/minute. The statistical analysis revealed that the difference is found to be statistically non-significant ($p > 0.05$).

In the 75–84-year age group, the mean PEFR in urban females is 204.44 ± 29.74 L/minute and in rural females, it is 167.89 ± 32.92 L/minute. The statistical analysis revealed that the difference is found to be statistically significant ($p < 0.01$).

In the 85–94-year age group, the mean PEFR in urban females is 133.33 ± 18.02 L/minute and in rural females, it is 105.71 ± 27.60 L/minute. The statistical analysis revealed that the difference is non-significant statistically ($p > 0.05$).

Table 4 shows the correlation of PEFR with age, weight, height, BMI, and BSA among urban females. The result shows the PEFR has HS negative correlation between age ($r = -0.81$, $p < 0.001$), HS correlation between height ($r = +0.49$, $p < 0.001$), the non-significant correlation between weight ($r = +0.16$, $p > 0.05$), BMI ($r = -0.13$, $p > 0.05$), BSA ($r = +0.21$, $p > 0.05$) with maximum *r*-value for age and PEFR ($r = -0.81$).

Table 5 shows correlation of PEFR with age, weight, height, BMI, and BSA among urban females. The result shows the PEFR has HS negative correlation between age ($r = -0.87$, $p < 0.001$), HS correlation between height ($r = +0.62$, $p < 0.001$), a non-significant correlation between weight ($r = +0.17$, $p > 0.05$), BMI ($r = -0.08$) ($p > 0.05$), BSA ($r = +0.18$, $p > 0.05$) with maximum *r*-value for age and PEFR ($r = -0.87$).

Table 6 shows the feasible regression equation, multiple correlation coefficient, standard error of estimate, and *p*-value of PEFR with reference to age, weight, height, BMI, and BSA among urban females. The dependent variable, that is, PEFR has been regressed on each independent variable, that is, age, weight,

Table 1: Mean and standard deviation (SD) values of physical measurements and PEFR in urban female

Age group (year)	*Number of subjects*	*Mean weight ± SD (kg)*	*Mean height ± SD (cm)*	*Mean BMI ± SD (kg/m²)*	*Mean BSA ± SD (m²)*	*PEFR (L/min)*
65–74	40	62.10 ± 6.55	158.56 ± 4.52	24.69 ± 2.34	1.61 ± 0.09	253.00 ± 39.49
75–84	18	56.38 ± 3.75	157.36 ± 4.24	22.76 ± 2.34	1.54 ± 0.06	204.44 ± 29.74
85–94	09	50.44 ± 4.95	153.05 ± 3.48	21.48 ± 2.34	1.44 ± 0.08	133.33 ± 18.02

Table 2: Mean and standard deviation values of physical measurements and PEFR in rural female

Age group (year)	*Number of subjects*	*Mean weight ± SD (kg)*	*Mean height ± SD (cm)*	*Mean BMI ± SD (kg/m²)*	*Mean BSA ± SD (m²)*	*PEFR (L/min)*
65–74	23	63.11 ± 11.92	159.44 ± 5.91	24.86 ± 5.04	1.62 ± 0.13	248.33 ± 47.92
75–84	20	57.42 ± 7.92	155.39 ± 5.22	23.69 ± 2.29	1.53 ± 0.12	167.89 ± 2.92
85–94	07	52.71 ± 11.89	152.14 ± 3.23	22.67 ± 4.59	1.45 ± 0.15	105.71 ± 27.60

Table 3: Comparison of PEFR of urban and rural female subjects among different age groups

Age groups (year)	*Urban subjects*		*Rural subjects*				
	Number	*Mean ± SD (PEFR)*	*Number*	*Mean ± (PEFR)*	*t-value*	*p-value*	*S*
65–74	40	253.00 ± 39.49	18	248.33 ± 47.92	0.38	>0.05	NS
75–84	18	204.44 ± 29.74	19	167.89 ± 32.92	3.53	<0.01	S
85–94	09	133.33 ± 18.02	07	105.71 ± 27.60	0.66	>0.05	NS

S, significant; NS, not significant

Table 4: Correlation of PEFR with age, weight, height, BMI, and BSA among urban females (>65 years)

Parameter	*Coefficient of correlation (r)*	*p-value*	*Significance*
PEFR	–	–	–
Age (year)	–0.81	<0.001	HS
Weight (kg)	+0.16	>0.05	NS
Height (cm)	+0.49	<0.001	HS
BMI (kg/m^2)	–0.13	>0.05	NS
BSA (m^2)	+0.21	>0.05	NS

BMI, body mass index; BSA, body surface area; PEFR, peak expiratory flow rate; NS, not significant; HS, highly significant

Table 5: Correlation of PEFR with age, weight, height, BMI, and BSA among rural females (>65 years)

Parameter	*Coefficient of correlation (r)*	*p-value*	*Significance*
PEFR	–	–	–
Age (year)	–0.87	<0.001	HS
Weight (kg)	+0.17	>0.05	NS
Height (cm)	+0.62	<0.001	HS
BMI (kg/m^2)	–0.08	>0.05	NS
BSA (m^2)	+0.18	>0.05	NS

BMI, body mass index; BSA, body surface area; PEFR, peak expiratory flow rate; NS, not significant; HS, highly significant

Table 6: Regression equation of PEFR in relation to age, weight, BMI, and BSA among urban female (>65 Years)

Independent variable	*Equation (y)*	*R*	*SEE*	*p-value*
Age (year)	–6.46 (age) + 696.99	0.81	34.51	<0.05
Weight (kg)	3.47 (weight) + 17.360	0.42	54.27	>0.05
Height (cm)	6.22 (height) – 755.53	0.49	52.17	>0.05
BMI (kg/m^2)	7.01 (BMI) + 54.05	0.27	57.84	>0.05
BSA (m^2)	270.92 (BSA) – 202.03	0.49	52.22	>0.05

R, multiple correlation coefficient; SEE, standard error of estimate

height, BMI, and BSA. The results depicted that the most suitable regression equation for foretelling PEFR is with age *R* (0.81), SEE (34.51) and *p*-value < 0.05.

Table 7 shows the feasible regression equation, multiple correlation coefficients, standard error of estimate, and *p* value of PEFR with reference to age, weight, height, BMI, and BSA in rural females. The dependent variable, that is, PEFR has been regressed on each independent variable, that is, age, weight, height, BMI, and BSA. The results depicted that the most suitable regression equation for foretelling PEFR is with age *R* (0.87), SEE (32.16), and *p*-value < 0.05.

Discussion

Previously carried out studies included subjects which were taken from hospital settings like hospital attendants, nursing students,

Table 7: Regression equation of PEFR in relation to age, weight, BMI, and BSA among rural female (>65 years)

Independent variable	*Equation (y)*	*R*	*SEE*	*p-value*
Age (year)	–7.48 (age) + 763.56	0.87	32.16	<0.05
Weight (kg)	2.35 (weight) + 50.68	0.38	60.48	>0.05
Height (cm)	7.06 (height) – 921.97	0.62	51.31	>0.05
BMI (kg/m^2)	2.45 (BMI) ± 132.95	0.15	64.65	>0.05
BSA (m^2)	248.67 (BSA) – 201.16	0.52	55.60	>0.05

R, multiple correlation coefficient; SEE, standard error of estimate

and medical students. In this study, subjects were chosen randomly from the general population who were presumably normal, belonging to both urban and rural areas.

In our study, as the age increases, PEFR decreases with a negative correlation between the two factors in both urban and rural female study subjects, which were statistically significant. Ridwan et al.[9] also observed the same relation with age which states that reduced PEFR is the most common change which occurs physiologically in the elderly, and it is due to age-related decrease in muscle strength, sarcopenia – primarily geriatric syndrome characterized by loss of skeletal muscle mass and function.[1,10] As a physiological measure and a well-known index, peak expiratory flow (PEF) helps in assessing airflow obstruction, which can be of great help in the treatment of asthma and screening of COPD.[11] The PEFR in addition to related to respiratory ailment, is also an important indicator of poor patient outcomes.[12,13]

Our data suggest that height was positively related to PEFR and correlation was HS statistically in both urban and rural subjects, hence the study subjects who were taller and broader subjects had higher values of PEFR as compared to subjects who have shorter height. Other researchers also observed a similar change.[1,14] In our study, in both the rural and urban study groups, the relationship of PEFR with BMI and weight was non-significant. A similar relationship was observed by various authors[15] in the younger age group but in the elderly, they found the relationship to be significant which was contrary to what we observed.

In this study, in both the study groups relationship between PEFR and BSA was observed as to be statistically non-significant but positive, more the BSA, the more will be the PEFR. Most of the studies[16,17] done relationship between PEFR and BSA was established as positive but statistically significant which was contrary to what we have observed.

In this study when PEFR in urban and rural female subjects was compared it was found to be statistically non-significant in age groups, 65–74 and 85–94, while in the age group of 75–84, difference was found to be statistically significant and PEFR value was higher in urban subjects than in rural subjects. Almost similar observations were made by Gururaja[17] and Bhushan et al.[18]

Conclusion

Our study concluded that in study subjects, with the increase in age, PEFR decreases, and taller individuals have higher PEFR as compared to subjects who have a short height. Simple regression equations of PEFR with age and their normal ranges were derived which can be of help for clinical use and public health. The regression equations obtained from neighborhood population samples will assist in assessing the observed to expected normal values of PEFR among elderly females in Punjab. In elderly subjects, community difference does not have any effect on PEFR.

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