Central European Journal of Sport Sciences and Medicine | Vol. 39, No. 3/2022: 75–80
ISSN (print): 2300-9705 | ISSN (online): 2353-2807 | DOI: 10.18276/cej.2022.3-06

ANTHROPOMETRIC VARIABLES AND PEFR

Rashmi Chandel[A, B, C, D]

Department of Physiology, Govt. Medical college and Hospital, Sector 32 ,Chandigarh, India
ORCID: 0000-0001-5328-7453
E-mail: unique_ras@rediffmail.com

Garima Shivhare[A, B, D]

Department of Anatomy, Adesh Medical College and Hospital, Shahabad, India
ORCID: 0000-0001-9338-1073

Anumeha Bhagat[A, B, D]

Department of Physiology, Govt. Medical college and Hospital, Sector 32, Chandigarh, India
ORCID : 0000-0003-2049-3837

[A] Study Design; [B] Data Collection; [C] Statistical Analysis; [D] Manuscript Preparation

Abstract Peak expiratory flow rate (PEFR) varies with anthropometric variables like calendar age, body height, body weight, and body surface area in different regions. The present study aims at analyzing the relationship of PEFR with anthropometric variables to know a reference value in this region. We conducted the present study on healthy adult males aged eighteen to forty-five years engaged in works where they were un-exposed to pollutants in Patiala, India. Subgroups were made in each anthropometric variable category. PEFR recording was done using Mini Wright Peak Flow Meter. Results are expressed as mean PEFR ± standard deviation (mean ±S.D.), while the students' t-test was used to determine the differences between the means. We observed a linear increase in PEFR with all anthropometric variables. The correlation of PEFR with anthropometric variables was determined. PEFR is positively correlated with body height and body surface area ($r = +0.20$) and negatively correlated with calendar age ($r = -0.24$) and body weight ($r = -0.02$). We conclude that PEFR correlates best with body height ($r = +0.48$), and the result is highly significant ($p < 0.01$).

Keywords anthropometric variables, body surface area, peak expiratory flow rate (PEFR), peak flow meter, smoking

Introduction

Variation in lung functions can be seen in India as there is a variation in geographical, climatic, anthropometric, nutritional, and socioeconomic conditions (Raju, Prasad, Ramana, Murthy, 2004). Peak expiratory flow rate (PEFR) is affected by calendar age, body weight, body height and body surface area (anthropometric variables) which varies in different regions (Godfrey, Kamburoff, Nairn,1970). It is important to have a normal reference value for each region. The present paper will show the normal value of PEFR and the effect of various anthropometric variables on

PEFR of healthy adult males in the age group of eighteen to forty-five years engaged in works where they are not exposed to pollutants in the city of Patiala.

Material and Methods

Participants: Two hundred healthy, non-smoking adult males aged eighteen to forty-five years in the city of Patiala who are engaged in works where exposure to pollutants is not present were selected randomly. The institutional ethical committee approved the study. Smoking is a significant cause of respiratory symptoms and reduction in ventilatory capacity (Medabala, Rao, Mohesh, Kumar, 2013), so it is essential to take non-smokers. We excluded participants who were smokers, with a history of cardiovascular problems, wheezing and respiratory diseases, or taking any drug affecting the respiratory system from the study. Subgroups were made according to the subjects' calendar age, body height, body weight, and body surface area (BSA).

Calendar age was calculated in years to the nearest 0.5 years (yrs.). Body height was measured by making the subject stand bare-footed on the floor against the wall, with slightly separated heels and buttocks back in contact with the wall, and measured to the nearest centimeter (cm). Body weight was measured in kilograms (kgs) with the subject standing on a portable weighing machine without wearing shoes. Body surface area was calculated in square meters using Dubois formula (Dubois, Dubois, 1916) B.S.A (m^2) = 0.007184 x W0.425 x H 0.725 where W is weight in kgs and H is height in cms.

According to calendar age, they were divided into three groups, i.e., Group I: 18–27 years, Group II: 28–37 years, and Group III: ≥ 38 years. According to body height, subjects were divided into three groups, i.e., Group I: 148–157 cms, Group II: 158–167 cms, and Group III: 168–177 cms. As per body weight, they were divided into four groups, i.e., Group I: 35–44 kgs, Group II: 45–54 kgs, Group III: 55–64 kgs, and Group IV: ≥ 65 kgs. According to body surface area, they were divided into four groups, i.e., Group I: 1.2–1.40m^2, Group II: 1.41m^2–1.60m^2, Group III: 1.61m^2 –1.80m^2, and Group IV: ≥1.81m^2.

Measures: Immediately before the test, subjects completed a brief questionnaire to ensure that the subjects satisfied the criteria of healthy subjects. Informed written consent was taken from all the subjects.

Procedure: The principal investigator tested the subjects at their workplace. For PEFR, a Mini Wright Peak Flow meter (Clement Clarke International, United Kingdom) was used. Mini wright peak flow meter is very convenient to carry and use. PEFR is a simple test that makes it particularly suitable for respiratory function studies.

The test was done in the standing position. The subject was instructed to take maximal inspiration and blow into the instrument rapidly and forcefully. Three test repetitions were made, and the highest of these readings in liters/minute was taken for analysis.

Analysis: All the data were statistically analyzed. Results were expressed as mean PEFR ± standard deviation (mean ± S.D.), while the student's t-test was used to determine the differences between the means. P-values less than or equal to 0.05 ($P \leq 0.05$) were taken as statistically significant, and a P value of ≤0.001 were considered statistically highly significant.

Results

Table 1 shows the PEFR in study subjects according to three age groups. It shows that PEFR increases with calendar age till the age group of 28 years to 37 years, then declines. When the PEFR of study subjects was recorded according to four height groups, PEFR increased with the increase in body height, as shown in Table 2.

Table 3 shows the PEFR of study subjects according to four weight groups, and it shows that PEFR increases with the increase in body weight to 64 kgs and then, it declines slightly. Table 4 shows the PEFR in study subjects according to four body surface area groups; PEFR increases with the increase in body surface area. Table 5 shows the correlation of PEFR with calendar age, body weight, body height, and body surface area. The PEFR correlates best with body height.

Table 1. Mean and SD of PEFR in study subjects according to age groups

Group no.	Age (in years)	No. of subjects	Mean± SD of PEFR (Lts. /min.)
I	18–27	85	629.87 ±52.35
II	28–37	62	639.69 ±51.13
III	≥ 38	53	587.26 ±59.37

Table 2. Mean and SD of PEFR in study subjects according to height groups

Group no.	Height (cms)	No. of subjects	Mean± SD of PEFR (Lts. /min.)
I	148–157	13	584.69 ±30.83
II	158–167	89	600.71 ±63.34
III	168–177	98	645.51 ±43.62

Table 3. Mean and SD of PEFR in study subjects according to weight groups

Group no.	Weight (kg)	No. of subjects	Mean± SD of PEFR (Lts./min.)
I	35–44	–	–
II	45–54	19	597.42 ±58.76
III	55–64	87	626.79 ±55.97
IV	≥65	94	621.73 ±58.34

Table 4. Mean and SD of PEFR in study subjects according to body surface area groups

Group no.	BSA gps (m^2)	No. of subjects	Mean ± SD of PEFR (Lts. /min.)
I	1.21–1.40	–	–
II	1.41–1.60	35	587.62 ±52.93
III	1.61–1.80	128	634.28 ±50.91
IV	≥1.81	37	610.0 ±68.96

Table 5. Correlation of PEFR with age, weight, height and body surface area

Parameter	Coefficient of correlation	'p' value
PEFR	–	–
Age (in years)	–0.24	<0.01
Weight (in kgs.)	–0.02	>0.05
Height (in cms.)	+0.48	<0.01
BSA (in m^2)	+0.20	<0.01

* >0.05 is not significant, <0.01 is highly significant

Discussion

Peak Expiratory Flow Rate is an effort-dependent parameter, which measures the airflow emerging from the large airways within about 100-120 milliseconds (msec) of the start of forced expiration (Enright Linn, Edward, 2000). It remains at its peak for 10 msec (Jain, Kumar, Sharma, 1983). According to Wright and Mckerrow (1959), PEFR is the maximum expiratory flow rate sustained by a subject for at least ten milliseconds expressed in liters/minute (Wright-Mckerrow, 1959). Pulmonary function tests indicate the health status of individuals in a region (Schünemann, Dorn, Grant, Winkelstein, Trevisan,2000; Prakash, Meshram, Ramtekkar, 2007). There are various factors affecting PEFR: i) age, ii) height, iii) maximum expiratory pressure, which is a representation of respiratory muscle strength (Black, Hyatt, 1969; Smyth, Chapman, Rebuck, 1984), iv) volume and elastic properties of lungs which is a function of thoracic dimension and hence of stature, v) Volume history of the lung, that is, how the lung was stretched prior to the PEFR maneuver (Kano, Burton, Lateri, Sly, 1993; D'Angelo, Prandi, Marazzini, Milic, 1994). In the current study, PEFR was best correlated to body height even though it may correlate with other factors like calendar age, body weight, and body surface area, as in other studies (Gupta, Mishra, Mehta, Prasad, 1993; Dharamshi et al., 2015).

The present study reveals that mean PEFR in study subjects increased with the increase in calendar age till the age group of 28 years to 37 years, and then it starts declining. The correlation of coefficient is negative ($r= -0.24$), and these results are highly significant ($p < 0.01$), as shown in Table 5. Other studies report similar findings (Gregg, Nunn, 1973; Brooks, Waller, 1972; Malik, Jindal, Banga, Sharda, Gupta, 1980; Ogunlana, Oyewole, Lateef, Ayodeji,2021). PEFR is affected by the expiratory muscle's strength, the lungs' recoil pressure, and the airways' competency (Sahebjami, 1998). An increase in PEFR with age is due to an increase in muscular power with advancing age, and a decrease in PEFR after a certain age can be because this variable is dependent upon the effort of expiratory muscles, elastic recoil of lungs, and size of airways, factors which are known to reduce with advancing age. Jain et al. (1983) reported stiffness of the thoracic cage and loss of elastic recoil of lungs in older adults. So, the strength of the respiratory muscles decreases. They also report that loss of elastic recoiling prevents the closure of the respiratory bronchioles during expiration. Various factors are responsible for reducing ventilatory function in the elderly (Goyle, Venkatraman, Rastogi, Lakhera, Gautam, 1984). Regular aerobic exercise can achieve more significant cardio-respiratory benefits in older age groups for an extended time interval (Blumenthal et al., 1991).

There is a positive correlation of PEFR with body height ($r = +0.48$). The result is statistically significant ($p < 0.01$), as shown in Table 5, which shows an increase in PEFR with an increase in height. This observation is consistent with other studies (Cookson, Blake, Faranisi, 1976; Amin, Pande, 1978; Lockhart, Smith, Mair, Wilson, 1960; Ijaz, Bashir, Ikhlaq, Ijaz, Aftab, Zia, 2020; Ogunlana et al., 2021), and is probably due to more chest volume in the taller subjects. The growth of air passages and the effort of expiratory muscles also increase with an increase in height.

PEFR in study subject's increases with the increase in body weight till the weight group of 55–64 kgs, then declines. The same pattern is observed in other studies (Dharamshi et al., 2015; Ebomoyiy, Iyawe, 2005). However, the current study's relationship between body weight and PEFR is not statistically significant. The correlation of coefficient is negative ($r= -0.02$), and the results are not significant ($p > 0.05$), as shown in Table 5.

Body surface area is a function of both body height and body weight and therefore is a good outward expression of the nutritional standard of the individual (Vijay, Arun, Shivaprasad, Desai, 2014). PEFR positively correlates with body surface area (r = +0.20), and is statistically highly significant ($p < 0.01$) as shown in table 5, which shows an increase in the PEFR of study subjects with an increase in body surface area. This observation is consistent with other studies (Amin, Pande, 1978; Lockhart et al., 1960; Vijay et al., 2014).

Conclusion

We conclude that the PEFR of healthy individuals increases with calendar age and body weight till a particular age and weight, and then it declines. PEFR increases with an increase in body height and body surface area. PEFR is positively correlated with body height and surface area and negatively correlated with calendar age and body weight. The best correlation is between PEFR and body height.

Acknowledgements

We acknowledge all the subjects who took out time to participate in this study.

References

Amin, S.K., Pande, R.S. (1978). Peak expiratory flow rate in normal subjects. *The Indian Journal of Chest Diseases & Allied Sciences*, *20* (2), 81–83. PMID: 721164.

Black, L.F., Hyatt, R.E. (1969). Maximal respiratory pressures, normal values and relationship to age and sex. *American Review of Respiratory Disease*, 99, 696-702.

Blumenthal, J.A., Emery, C.F., Madden, D.J., Coleman, R.E., Riddle, M.W., Schniebolk, S., Cobb, F.R., Sullivan, M.J., Higginbotham, M.B. (1991). Effects of exercise training in cardiorespiratory function in men and women > 60 years of age. *American Journal of Cardiology*, *67* (7), 633-639. DOI: 10.1016/0002-9149(91)90904-y. PMID: 2000798.

Brooks, A.G.F., Waller, R.E. (1972). Peak flow measurements among visitors to a public health exhibition. *Thorax*, 27, 557–562.

Cookson, J.B., Blake, G.T.W., Faranisi, C. (1976). Normal values for ventilatory function in Rhodesian Africans. *British Journal of Diseases of the Chest*, *70* (2), 107–111.

D'Angelo, E., Prandi, E., Marazzini, L., Milic, E.J. (1994). Dependence of maximal flow volume curve on time course of preceding inspiration in patients with chronic obstructive pulmonary disease. *American Journal of Respiratory and Critical Care Medicine*, *150* (6), 1581–1586. DOI: 10.1164/ajrccm.150.6.7952618. PMID: 7952618.

Dharamshi, H.A., Faraz, A., Ashraf, E., Alam, S.S., Ali, A., Shakeel, O., Abidi, S.M.A., Rizvi, S.S., Fatima, Z., Wasy, H.A., Fatima, F., Mahar, M., Naqvi, T. (2015). Variation of PEFR with height, weight and waist-hip ratio in medical students. *International Archives of Medicine Section: Primary Care*, *8* (1). DOI: 10.3823/1683.

Dubois, D., Dubois, E.F. (1916). Clinical calorimetry: a formula to estimate the approximate surface area if height and weight be known. *The Archives of Internal Medicine*, *17* (6–2), 863–871. DOI: 10.1001/archinte.1916.00080130010002.

Ebomoyiy, M.Y., Iyawe, I. (2005). Variations of peak expiratory flow rate with anthropometric determinants in a population of healthy adult nigerians. *Nigerian Journal of Physiological Sciences*, *20* (12), 85–89.

Enright, P., Linn, W.S., Edward, L. (2000). Quality spirometry test performance in children and adolescents: Experience in a large field study. *Chest*, 118, 665–671.

Godfrey, S., Kamburoff, P.L., Nairn, J.R. (1970). Study of peak expiratory flow rates on a sample of 382 normal boys and girls using standard Wright peak flow meter. *British Medical Journal of Diseases of Chest*, *64*, 15.

Goyle, B.R., Venkatraman, C., Rastogi, S.K., Lakhera, S.C., Gautam, R.K. (1984). Normal standards and prediction of lung function tests in Indian Armed Forces personnel. *Medical Journal of Armed Forces India*, *40*, 151–156.

Gregg, I., Nunn, A.J. (1973). Peak expiratory flow rate in normal subjects. *British Medical Journal*, *3*, 282–284.

Gupta, C.K., Mishra, G., Mehta, S.C., Prasad, J. (1993). On the contribution of height to predict lung volumes, capacity diffusion in healthy school children of 10–17 yr. *Indian Journal of Chest Diseases and Allied Sciences*, *35*, 167–177.

Ijaz, A., Bashir, I., Ikhlaq, A., Ijaz, F., Aftab, R.K., Zia, R. (2020) Correlation Between Peak Expiratory Flow Rate, Markers of Adiposity, and Anthropometric Measures in Medical Students in Pakistan. *Cureus*, *12* (12): e12408. DOI:10.7759/cureus.12408.

Jain, S.K., Kumar, R., Sharma, D.A. (1983). Peak expiratory flow rates in healthy Indian adults: A statistical evaluation-I. *Lung India*, *3* (1), 88–91.

Kano, S., Burton, D.L., Lateri, C.J., Sly P.D. (1993). Determination of peak expiratory flow. *European Respiratory Journal*, *6* (9), 1347–1352. PMID: 8287953.

Lockhart, W., Smith, D.H., Mair, A., Wilson, W.A. (1960). Practical experience with peak flow meter. *British Medical Journal*, *1* (5165), 37–38. DOI: 10.1136/bmj.1.5165.37. PMID: 14417800; PMCID: PMC1966361.

Malik, S.K., Jindal, S.K., Banga, N., Sharda, P.K., Gupta, H.D. (1980). Peak expiratory flow rate of healthy north Indian teachers. *Indian Journal of Medical Research,* 71, 322–332.

Medabala, T., Rao, B.N., Mohesh, M.I.G., Kumar, M.P. (2013). Effect of cigarette and cigar smoking on peak expiratory flow rate. *Journal of Clinical and Diagnostic Research*, *7* (9), 1886–1889. DOI: 10.7860/JCDR/2013/6726.3342.PMID: 24179889, PMCID: PMC3809628.

Ogunlana, M.O., Oyewole, O.O., Lateef, A.I., Ayodeji, A.F. (2021). Anthropometric determinants of lung function in apparently healthy individuals. *South African Journal of Physiotherapy*, *77* (1), a1509. DOI: 10.4102/sajp.v77i1.1509.

Prakash, S., Meshram, S., Ramtekkar, U. (2007) Athelets, yogis and individual with sedentary life styles; do their lung function differ? *Indian Journal of Physiology and Pharmacology*, *51*, 76–80.

Raju, P.S., Prasad, K.V., Ramana,Y.V., Murthy, K.J. (2004). Pulmonary function tests in Indian girls- prediction equations. *Indian Journal of Paediatrics*, *71*, 893–897.

Sahebjami, H. (1998). Dyspnea in obese healthy men. *Chest*, *114*, 1373–1377.

Schünemann, H.J., Dorn, J., Grant, B.J., Winkelstein, W. Jr., Trevisan, M. (2000). Pulmonary function is the long-term predictor of mortality in the general population: 29 years' follow-up of the buffalo health study. *Chest*, *118*, 656–664.

Smyth, R.J., Chapman, K.R., Rebuck, A.S. (1984) Maximal inspiratory and expiratory pressures in adolescents, normal values. *Chest*, *4*, 569–572.

Vijay, K.K., Arun, K.S., Shivaprasad, V., Desai, R.D. (2014). Peak expiratory flow rate and its correlation with body surface area in healthy school children. *Journal of Scientific and Innovative Research*, 2014, *3* (4), 397–401.

Wright, B.M., Mckerrow, C.B. (1959). Maximum forced expiratory flow rate as a measure of ventilatory capacity with a description of a new portable instrument for measuring it. *British Medical Journal*, *21*, 1041–1046.

Cite this article as: Chandel, R., Shivhare, G., Bhagat, A. (2022). Anthropometric Variables and PEFR. *Central European Journal of Sport Sciences and Medicine*, *3* (39), 75–80. DOI: 10.18276/cej.2022.3-06.