National Journal of Physiology, Pharmacy and Pharmacology

RESEARCH ARTICLE

A cross-sectional study of assessing the effects of body mass index on peak expiratory flow rate in young people

Namita[1], Din Prakash Ranjan[2]

[1]Department of Physiology, Raichur Institute of Medical Sciences, Raichur, Karnataka, India, [2]Department of Community Medicine, Raichur Institute of Medical Sciences, Raichur, Karnataka, India

Correspondence to: Namita, E-mail: nranjan2005@yahoo.com

Received: May 07, 2019; **Accepted:** June 04, 2019

ABSTRACT

Background: Peak expiratory flow rate (PEFR) is important and a basic physiological parameter in the diagnosis, follow-up and treatment of patients with respiratory illnesses. PEFR decreases with high body mass index (BMI) in elderly age group. We have examined the association of BMI with PEFR in young people. **Aims and Objectives:** This study aims to study the effects of BMI on PEFR in young people. **Materials and Methods:** In the total of 150 students, 50 students of a school (6^{th}–10^{th} class), 50 PUC college students (11^{th} and 12^{th}), and 50 students from degree college in Raichur district were included, interviewed with predesigned questionnaire and physical examination including height, weight, and PEFR measured and BMI calculated. **Results:** The mean and standard deviation of 150 participant's age was 16.70 ± 3.14. Of 150, 59.3% were male and 40.7% were female. There was a significant negative association between BMI (21.78 ± 2.79) and PEFR (374.27 ± 61.156). There was a significant positive association between PEFR and BMI with age. There was statistically highly significant high PEFR among males compared to female. **Conclusion:** There was a significant negative association between BMI and PEFR; a significant positive association between BMI and age as well as PEFR and age; and a significant positive association between height and PEFR. In our study, there was statistically highly significant high PEFR among males compared to females.

KEY WORDS: Peak Expiratory Flow Rate; Body Mass Index; Young People

INTRODUCTION

Peak expiratory flow rate (PEFR) is an effective measure of ventilatory capacity (of effort dependent on airflow) measured by peak flow meter. It is expressed in liters per minute (lpm). Its measurement has very simple procedure and may be carried out anywhere, even outside the laboratory using portable instruments. The average PEFR of healthy young Indian males is 500 lpm and for females 350 lpm. The PEFR reaches peak at 18–20 years, maintains at this level up to 30 years in males, and about 40 years in females, and then, it declines with age.

It is taken as a basic physiological parameter in the diagnosis, follow-up and treatment of patients with respiratory illnesses such as asthma, chronic bronchitis, and emphysema.

We are paying the price for habits of highly developed society, which is a sedentary lifestyle and wrong dietary habits which result in an imbalance between energy expenditures and energy intake, which leads to obesity. Now with increasing awareness toward health, the importance of staying fit and avoiding fat is increasing day by day.

Access this article online	
Website: www.njppp.com	Quick Response code
DOI: 10.5455/njppp.2019.9.0519903062019	

Body mass index (BMI) is a known epidemiological marker of nutritional status of adolescents. Obesity not only leads to chronic diseases later in life but also during childhood.

There is a paucity of data correlating PEFR with BMI in young people. Thus, the present study was done to find out the association of PEFR with BMI in young people.

Definition of PEFR is as the maximum or peak flow rate which is attained during a forceful expiratory effort (after taking a deep inspiration). It is the measurement of airflow through the bronchial tree and gives an idea about bronchial tone. Pulmonary functions are normally determined by respiratory muscle strength, the thoracic cavity's compliance, airway resistance, and the lung's elastic recoil.[1] Pulmonary functions may usually vary according to the physical characteristics including age, height, and body weight.[2]

Obesity is now categorized as a "disease" condition by the World Health Organization (WHO). The WHO has recommended the use of BMI as the simplest form of defining obesity.[3]

Obesity is a chronic medical condition, characterized by an excessive fat accumulation in human body, and cause a general increase in body mass.[4] Obesity is usually calculated by BMI, which is weight in kg divided by height in square meter.[4]

PEFR decreases with high BMI in elderly age group. The association of high BMI with low PEFR may indicate that obesity is an important risk factor for lung function and reduced airflow.[5]

Gibson and Rubinstein *et al*. stated that obesity damages the respiratory functions through the inducing airway hyperresponsiveness in adults,[6,7] whereas Young *et al*. correlated it with the development of asthma.[8]

Individuals with obesity are more susceptible to many conditions such as obstructive sleep apnea, pulmonary, cardiovascular, hepatic, renal diseases, metabolic alterations, and neoplasm.[9]

Obesity affects the functions of respiratory system in various ways. The deposition of adipose tissue around the rib cage, abdomen, and visceral cavity affects work of breathing and decreases the pulmonary functions. Increase in pulmonary blood volume, closure of airways, atelectasis, and increased alveolar surface tension are due to obesity.[10]

According to the WHO, "adolescence" is the period between 10 and 19 years. As per United Nations, Youth is from 15 to 24 years and the term "young people" means the composite age group of 10–24 years.[11]

Many studies have been conducted in obesity and pulmonary function in the age group of 5–16 years or in the older people who are above 50 years of age.[12] But the age group of 16 to 25 years is the crucial adolescent age which is highly susceptible for obesity, very few studies have been conducted for this age group.

In one study, PEFR was negatively correlated with the BMI,[13] and it was not significant ($P > 0.05$).

By knowing the proportion of overweight and obese people in developing country like India and respiratory health problems in Indians, a cross-sectional study was conducted to understand the association of effect of BMI with PEFR, especially in young people in Raichur district.

Aims and Objectives of Study

The aims of this study were as follows:

I. Determination of PEFR, as a marker of respiratory status in health and diseases
II. To study the BMI and its pattern in young people
III. To study the association of BMI with PEFR values and effects of BMI on PEFR in young people.

MATERIALS AND METHODS

This was a descriptive cross-sectional study conducted among 150 young people in the age group of 10–24 years, from November 2018 to May 2019. This study's ethical approval was taken from the Institutional Ethics Committee, Raichur Institute of Medical Sciences.

Study Settings

Participants/subjects were selected after obtaining informed consent which includes 50 students of a school (6^{th}–10^{th} class), 50 PUC college students (11^{th} and 12^{th}), and 50 college student (degree and higher studies) in Raichur district. All the subjects were informed in detail about the procedure and an individual demonstration was given about the procedure to all the subjects.

Inclusion Criteria

The following criteria were included in the study:

1. Willing to give informed consent/assent
2. Age between 10 and 24 years.

Exclusion Criteria

The following criteria were excluded from the study:

1. History of any medication
2. History of smoking and tobacco chewing
3. History or presence of any cardiac or pulmonary conditions
4. History or evidence of any disease, affecting pulmonary functions
5. Any clinical evidence of cardiac or pulmonary diseases.

Instrument Used

Wright peak flow meter

B. M. Wright introduced the peak flow meter in 1959. In 1969, cheaper, simple, and portable instrument, the miniature Wright peak flow meter was developed, which was easy to use, its commercial production began in 1977. The mini-Wright peak flow meter is operated on a spring-loaded piston and with longitudinal slot having variable orifice, with a rider or marker as peak flow indicator. All these are fitted in a cylindrical plastic frame of dimension 5.0 cm diameter and 15 cm length. This instrument weighs 75 g [Figure 1].

Operation and use of peak flow meter

When air is blown into mouthpiece, it cannot escape until it has moved to uncovered part of the longitudinal slot. When the pressure behind the piston is just enough to balance the tension in the spring, the piston comes to rest in a position that depends on the flow rate. Then, the reading of rider will be taken.

Methods

Vital parameters such as temperature, pulse rate, and respiratory rate were recorded after clinical examination of respiratory and cardiovascular system. Blood pressure, height, and weight were also recorded.

PEFR was measured by Wright's peak flow meter of all the subject seated comfortably, keeping in mind that their readings were taken during the same time of the day. The purpose and technique of this test was described to all the subjects in groups of 10 and also the method of blowing into the instruments was demonstrated.

Each subject was instructed to seat comfortably and hold the instrument in horizontal position. Precaution was taken to avoid the obstruction of the pointer by fingers while moving in the slot. They were instructed to take a deep breath, put the mouthpiece of the peak flow meter inside mouth between the upper and lower jaw, and expel the air forcefully in one blow. Each subject then holds the instrument and was given many trial blows, until it was satisfied that he/she was using the meter properly and comfortably (this usually requires 2–5 blows).

Figure 1: Mini-Wright peak flow meter

Each subject was encouraged to make a maximal effort (as hard and as fast as possible) and was closely watched to ensure that airtight seal was maintained between lips and mouthpiece of the instrument. The value indicated by the cursor was noted and the sequence was repeated many times, thus obtaining five readings and three maximum readings were recorded.

Anthropometric measurements include height which was measured without shoes and person standing against a wall-fixed tape and weight which was measured with light clothing and without shoes on a flat platform scale with 1.0kg subtraction for correction of weight.

The BMI was calculated as weight/height^2 (kg/m^2). For adults, underweight (BMI $\leq$ 18.5 kg/m^2), normal (BMI = 18.5–24.99 kg/m^2), overweight (BMI = 25–29.99 kg/m^2), and obese (BMI = 30–34.99 kg/m^2), respectively, according to the latest WHO criteria.

The data were analyzed with appropriate statistical test wherever applicable.

RESULTS

Table 1 shows age-wise distribution of all the participants in the study. The mean and standard deviation of 150 participant's age was 16.70 ± 3.14. Minimum age was 11 and maximum age was 24 (range–13). Standard error of mean was 0.256 and variance was 9.862.

Table 1: Age-wise distribution of the study participants

Age	Frequency (%)
11	7 (4.7)
12	14 (9.3)
13	6 (4)
14	15 (10)
15	8 (5.3)
16	19 (12.7)
17	13 (8.7)
18	18 (12)
19	27 (18)
20	11 (7.3)
21	2 (1.3)
22	4 (2.7)
23	4 (2.7)
24	2 (1.3)
Total	150 (100)

Table 2 shows gender-wise distribution of all the study participants, it shows that 59.3% were male and 40.7% were female. The mean and standard deviation in male participant's age was 16.91 ± 3.483 and mean and standard deviation in female participant's age was 16.39 ± 2.558.

Table 3 shows distribution of all the study participant's BMI and PEFR. It shows that 76% had normal BMI, not a single participant was obese and 18.7% were pre-obese while 5.3% were underweight. The mean and standard deviation of BMI was 21.78 ± 2.79 and mean and standard deviation of PEFR was 374.27 ± 61.156. About 30% of participants had their PEFR between 351 and 400 lpm, while 76.6% had their PEFR between 301 and 450 lpm.

Table 4 shows correlation/association between BMI and PEFR. There was a significant negative association/correlation (−0.366) between BMI and PEFR. As BMI increases, PEFR decreases among young people. The same has been shown as scatter diagram in Figure 2.

Table 5 shows association between gender with BMI and PEFR. There was statistically significant high PEFR among males compared to female. There was no difference of BMI among males and females in young people.

Table 6 shows association/correlation between BMI and age. There was a significant positive association/correlation (0.244) between BMI and age. As age increases, BMI increases among young people.

Table 7 shows association/correlation between PEFR and age. There was a significant positive association/correlation (0.241) between PEFR and age. PEFR increases with age among young people.

Table 8 shows correlation/association between PEFR and height. There was a significant positive association between

Table 2: Gender-wise distribution of the study participants

Sex	Frequency (%)
Female	61 (40.7)
Male	89 (59.3)
Total	150 (100)

Table 3: Distribution of the study participant's BMI and PEFR

Variables	Frequency (%)
BMI (Kg/m²)	
Underweight (<18.50)	8 (5.3)
Normal (18.5–24.99)	114 (76)
Overweight (≥25)	
Pre-obese (25–29.99)	28 (18.7)
Obese Class I (30–34.99)	0 (0)
Obese Class II (35–39.99)	0 (0)
Obese Class III (≥40)	0 (0)
PEFR (lpm) category	
<250	1 (0.7)
251–300	25 (16.6)
301–350	33 (22)
351–400	45 (30)
401–450	37 (24.6)
451–500	4 (2.7)
501–550	4 (2.7)
>550	1 (0.7)

PEFR: Peak expiratory flow rate, BMI: Body mass index

Table 4: Correlation (association) between BMI and PEFR

Variables	Mean±SD	Correlation coefficient	*P* value
BMI	21.78±2.79	−0.366	<0.0001
PEFR	374.27±61.156		

PEFR: Peak expiratory flow rate, BMI: Body mass index, SD: Standard deviation

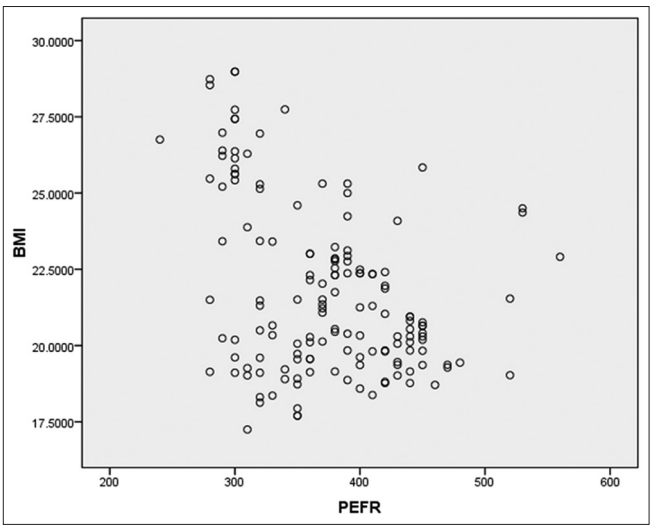

Figure 2: Scatter diagram showing association between BMI and PEFR

Table 5: Association between gender with BMI and PEFR

Variables	Sex	N	Mean±SD	*t* value	*P* value
BMI	Female	61	22.18±2.89	1.484	0.140
	Male	89	21.49±2.70		
PEFR	Female	61	352.46±41.85	3.773	<0.0001
	Male	89	389.21±67.69		

PEFR: Peak expiratory flow rate, BMI: Body mass index, SD: Standard deviation

Table 6: Correlation (association) between BMI and age

Variables	Mean±SD	Correlation coefficient	*P* value
BMI	21.77±2.79	0.244	0.003
Age	16.70±3.14		

BMI: Body mass index, SD: Standard deviation

Table 7: Correlation (association) between PEFR and age

Variables	Mean±SD	Correlation coefficient	*P* value
PEFR	374.27±61.15	0.241	0.003
Age	16.70±3.14		

PEFR: Peak expiratory flow rate, SD: Standard deviation

Table 8: Correlation (association) between PEFR and height

Variables	Mean±SD	Correlation coefficient	*P* value
PEFR	374.27±61.15	0.381	<0.0001
Height	162.33±9.30		

PEFR: Peak expiratory flow rate, SD: Standard deviation

Table 9: Correlation (association) between PEFR and weight

Variables	Mean±SD	Correlation coefficient	*P* value
PEFR	374.27±61.15	−0.059	0.471
Weight	57.65±9.70		

PEFR: Peak expiratory flow rate, SD: Standard deviation

PEFR and height. PEFR increases with height among young people.

Table 9 shows correlation/association between PEFR and weight. There was no association between PEFR and weight.

DISCUSSION

The present study was undertaken to study PEFR and BMI and the association between and BMI among in 150 young people. In our study, the mean and standard deviation of 150 participant's age was 16.70 ± 3.14. Minimum age was 11 and maximum age was 24 (range – 13). Standard error of mean was 0.256 and variance was 9.862. Gender wise 59.3% were male and 40.7% were female. Mean and standard deviation in male participant's age was 16.91 ± 3.483 and mean and standard deviation in female participant's age was 16.39 ± 2.558.

Our study shows that 76% had normal BMI, not a single participant was obese and 18.7% were pre-obese while 5.3% were underweight. Mean and standard deviation of BMI was 21.78 ± 2.79 and mean and standard deviation of PEFR was 374.27 ± 61.156. About 30% of participants had their PEFR between 351 and 400 lpm, while 76.6% had their PEFR between 301 and 450 lpm. There was a significant negative association/correlation (−0.366) between BMI and PEFR in our study. As BMI increases, PEFR decreases among young people.

In our study, there was statistically significant high PEFR among males compared to female. There was no difference of BMI among males and females in young people. There was a significant positive association/correlation (0.244) between BMI and age. As age increases, BMI increases among young people. At the same time, there was a significant positive association/correlation (0.241) between PEFR and age. PEFR increases with age among young people. There was a significant positive association between PEFR and height, but no association between PEFR and weight.

In our study, there was a significant negative association between BMI and PEFR. As BMI increases, PEFR decreases among young people. Similar finding was found in a study of Medinipur, West Bengal, where PEFR decreases with high BMI in elderly age group. The association of high BMI with low PEFR may indicate that obesity is an important risk factor for lung function and reduced airflow[5] and also in some another study, Gibson and Rubinstein *et al*. stated that obesity damages the respiratory functions through inducing airway hyperresponsiveness in adults.[6,7] One another study also shows that PEFR was negatively correlated with the BMI.[13]

Mean PEFR in male was 469 L/min and female was 365 L/min in one study[14] conducted in Orissa which is higher than our study mean PEFR in male – 389.21±67.69 L/min and female – 352.46±41.85 L/min, may be due to their study participant's age group was little higher, i.e., 18–24 years, whereas in our study, age group was 11–24 years young people. In this study also, there was a negative association between BMI and PEFR as per our study.

One study[15] showed that PEFR values are high in males than females similar to our study. One another study[16] showed decline in PEFR with high BMI similar to our study, but the same study differs from our study as it showed decline in PEFR with increasing age, while in our study, PEFR increases with increasing age. It may be due to the age group which we have taken is different from them (the PEFR reaches peak at about 18–20 years, maintains at this level up to 30 years in males, and about 40 years in females, and then, it declines with age). One study[17] conducted in 96 healthy elderly male subjects in the age group of more than 65 years from rural regions of Patiala in Punjab showed that PEFR declines with age and other findings of this study were also similar to our study.

Strengths and Limitations

Strength of the study is that it shows a significant negative association between BMI and PEFR and significant positive association between BMI and age as well as PEFR and age. We have taken sample from different school and colleges, which represent different age groups in young people. While limitation of our study is sample size, which is 150 only, and we have done study in school and college. The same study can be conducted in community with larger sample size and with more parameters.

CONCLUSION

The present study was undertaken to study the association between BMI and PEFR among young people. There was a significant negative association between BMI and PEFR; a significant positive association between BMI and age as well as PEFR and Age; and a significant positive association between height and PEFR. In our study, there was statistically highly significant high PEFR among males as compared to females.

REFERENCES

1. Cotes JE. In Lung Function: Assessment and Application in Medicine. 3rd ed. Philadelphia, Oxford: Blackwell Scientific Publications; 1975. p. 281-7.
2. Polgar G, Weng TR. The functional development of the respiratory system from the period of gestation to adulthood. Am Rev Respir Dis 1979;120:625-95.
3. Attaur-Rasool S, Shirwany TA. Body mass index and dynamic lung volumes in office workers. J Coll Physicians Surg Pak 2012;22:163-7.
4. Al Ghobain M. The effect of obesity on spirometry tests among healthy non-smoking adults. BMC Pulm Med 2012;12:10.
5. Das NK, Sarkar GN, Khan A. Correlation between body mass index and peak expiratory flow rate of an indigenous brick industry labour on bank of kangsabati river, paschim Medinipur, West Bengal. Paripex Indian J Res.2014;3:129-31.
6. Gibson GJ. Obesity, respiratory function and breathlessness. Thorax 2000;55 Suppl 1:S41-4.
7. Rubinstein I, Zamel N, DuBarry L, Hoffstein V. Airflow limitation in morbidly obese, nonsmoking men. Ann Intern Med 1990;112:828-32.
8. Young SY, Gunzenhauser JD, Malone KE, McTiernan A. Body mass index and asthma in the military population of the Northwestern United States. Arch Intern Med 2001;161:1605-11.
9. Melo LC, Silva MA, Calles AC. Obesity and lung function: A systematic review. Einstein (Sao Paulo) 2014;12:120-5.
10. Salome CM, King GG, Berend N. Physiology of obesity and effects on lung function. J Appl Physiol (1985) 2010;108:206-11.
11. World Health Organization. Programming for Adolescent Health and Development. WHO Technical Reports Series No. 886; 1999. p. 1.
12. Sahebjami H. Dyspnea in obese healthy men. Chest 1998;114:1373-7.
13. Kaur H, Singh J, Makkar M, Singh K, Garg R. Variations in the peak expiratory flow rate with various factors in a population of healthy women of the Malwa region of Punjab, India. J Clin Diagn Res 2013;7:1000-3.
14. Jena SK, Mirdha M, Meher P, Misra AK. Relation of peak expiratory flow rate to body mass index in young adults. Muller J Med Sci Res 2017;8:19-23.
15. Babu KR, Mohit M, Kolekar D. A comparative study of peak expiratory flow rate (PEFR) and BMI in male and female medical students. Int J Health Sci Res 2015;5:273-8.
16. Bhardwaj P, Poonam K, Jha K, Bano M. Effects of age and body mass index on peak-expiratory flow rate in Indian population. Indian J Physiol Pharmacol 2014;58:166-9.
17. Sandhu PK, Bajaj D, Mehta K. Correlation of peak expiratory flow rate with age and anthropometric parameters in elderly (>65 years). Natl J Physiol Pharm Pharmacol 2016;6:89-92.

How to cite this article: Namita, Ranjan DP. A cross-sectional study of assessing the effects of body mass index on peak expiratory flow rate in young people. Natl J Physiol Pharm Pharmacol 2019;9(9):828-833.

Source of Support: Nil, **Conflict of Interest:** None declared.