Correlation of body mass index with peak expiratory flow rate and vital capacity in adults in Garhwal region

Seema Gaur [1*], Neeru Garg [2], Nidhi Jain [3]
[1] Department of Physiology, Shir Guru Rai Institute of Medical and Health Science, Dehradun Uttarakhand, India
[2] Professor, Department of Physiology, Shir Guru Rai Institute of Medical and Health Science, Dehradun Uttarakhand, India
[3] Professor and Head Department of Physiology, Shir Guru Rai Institute of Medical and Health Science, Dehradun Uttarakhand, India

* Corresponding Author: **Seema Gaur**

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Abstract
Background: Spirometry and PEFR are the most fundamental pulmonary function parameters. In respiratory medicine, pulmonary function tests (PFTs) are vital. These tests are now more usually applied in the investigation of respiratory disorders because they provide reliable information the state of a person's respiratory system.
Aim & Objectives: To know the body mass index based variation in respiratory functions in healthy young adults.
Materials & Methods: The research was conducted on 140 MBBS students between the age of 18-25 years old. Physical examination including height, weight, Body Surface Area, Vital Capacity, and PEFR measured and BMI calculated.
Results: In obese people, the study showed a partial negative association between BMI and PEFR. In obese adults, PEFR was considerably the lower than in non-obese adults. In our study, there was a statistically significant difference in PEFR between males and females.
Conclusion: Obese subjects had a lower vital capacity and PEFR than normal subjects, indicating that obesity was associated with an increase in BMI.

Keywords: Body Mass Index, Pulmonary function tests, Peak expiratory flow rate

Introduction

In respiratory medicine, pulmonary function tests (PFTs) are essential. These tests are now increasingly commonly utilized in the research of respiratory disorders since they provide trustworthy information about a person's respiratory system's status [1]. They potentially help with diagnosis, severity assessment of airway congestion, monitoring lung conditions, lung growth assessment, early diagnosis of occupational lung diseases, and treatment response [2]. Tidal Volume (TV), Inspiratory Reserve Volume (IRV), Inspiratory Capacity (IC), Expiratory Reserve Volume (ERV), Forced Vital Capacity (FVC), Forced Expiratory Volume in 1st second, Peak Expiratory Flow Rate (PEFR), and Maximum Voluntary Ventilation (MVV) are all important ventilator function tests. To avoid irreversible damage, it is critical to detect and diagnose pulmonary obstruction at an advanced and reversible phase [3]. Among some of the pulmonary function indices, spirometry and PEFR are regarded as the most basic. Spirometric findings are interpreted by comparing them to reference values calculated based on age, gender, BMI, and origin [4]. Obesity is a huge global issue that leads to morbidity and mortality. Obesity rates in India have increased significantly since 1975, when they were ranked 19th for both men and women. In 2014, they were ranked 5th and 3rd, respectively, demonstrating rising obesity rates. Many obese individuals are referred for pulmonary function examinations because obesity can cause respiratory problems [5]. As shown by a linkage between a high BMI and a low PEFR, obesity may be a major risk factor for lung function and airflow. Asthma and obesity may have a causal connection since obesity precedes the onset of asthma [6]. Obesity impairs respiratory function in adulthood by causing airway hyperresponsiveness, and young *et al*. related it to the onset of asthma [7].

Excess body weight, such as that of an obese or overweight person, is usually caused by the buildup of additional body fat. In several epidemiological researches, weight and BMI (a measure of total adiposity) are utilized as predictors of lung disease [8].

Matarials and Methods

The current study was conducted in the Department of Physiology of Shri Guru Ram Rai Institute of medical and health science. The research was conducted on 140 MBBS students between the age of 18-25 years old. The subjects were firstly divided into two broad groups based on BMI and each group had 2 subgroups:

- Group 1. [Normal Weight Subjects]: Group 1 M (35 & Group 1 F (35)
- Group 2. [Overweight & Obese Subjects]: Group 2 M (35) & Group 2 F (35)

The subjects were further divided into two broad groups (A and B) based on gender.

- Group A: Group 1 M (35) & Group 2 M(35)
- Group B: Group 1 F (35) & Group 2 F (35)

Selection of Subjects

All of the participants were in good physical, mental, and socially.

Participants with bronchial asthma, COPD, tuberculosis, or any other respiratory condition were excluded from the study. Participants who smoked or drank alcohol were excluded from the study.

Measurement of Anthropometrics parameters

Age: It was computed to the nearest birthday in years.

Height: A stadiometer was used to measure it in cm. The stadiometer was calibrated using a standardized measuring rod.

Weight: A digital weighing machine was used to calculate the weight in kilogram. Subjects were told to wear in normal clothes and stand barefoot on the foot bar.

Body Mass Index (BMI)

The BMI of each subject were obtained mathematically using the formula [9]:

$$\text{BMI} = \frac{\text{Body Weight (kg)}}{\text{Height}^2(\text{m}^2)}$$

Measurements of Respiratory Parameters

Vitalometer: The vital capacity was recorded in ml using a simple spirometer by INCO, Instruments, and Chemicals Pvt. Ltd. The subject was asked to stand comfortably in front of the spirometer such that he or she could watch the bell move. The subject was instructed to inhale deeply and thoroughly to fill the lungs, then to exhale all of the air that he or she could expel with the greatest effort into the spirometer while holding the nostrils closed with their thumbs and fingers and the mouthpiece firmly between the mouth. The bell rises, and the pulley's pointer indicates the volume of exhaled air. Three further readings were taken in the standing posture at 5-minute intervals, with the highest and best readings being used.

Peak expiratory flow rate (PEFR): Using a Mini Wright Peak flow meter from Cipla Mumbai Ltd, the PEFR was measured in L/min. The individual was requested to stand up straight and take a deep breath while holding a peak flow meter horizontally in his/her mouth. He/she was also instructed to close his/her lips around the mouthpiece and ensure that no air was leaking between his/her lips and the mouthpiece. The participant was instructed to breathe as hard and quickly as possible, and the reading given by the cursor on the peak flow meter scale was recorded. The sequence was then done twice more, yielding three readings. The peak flow rate, reported in L/min, was calculated using the highest and best readings from all three measurements.

Result

In the present study on BMI-based comparison, the anthropometric parameters like weight were found statistically very highly significant in the total number of subjects (<0.001) whereas age and height were found not significant (p>0.05), (Table 1). Taking into consideration in all study subjects (n- 140) the BMI-based comparison of Respiratory parameters (VC and PEFR) showed a statistically very highly significant (p <0.001) association in both groups GR I, Gr-II (Table 2). On gender-based comparison of respiratory parameters like VC and PEFR showed statistically very highly significant (p<0.001) (Table3).

Table 1: BMI Based Comparison of Anthropometric parameters of all subjects (n=140)

Parameters	Group 1 n=70 Mean ±SEM	Group 2 n=70 Mean ±SEM	P-Value
Vital Capacity (ML)	3627.14 ± 59.84	3137.85 ± 55.82	<0.001***
PEFR (L/MIN)	438.71 ± 7.30	378.28 ±5.96	<0.001***

Table 2: BMI Based Comparison of Respiratory Parameters of all subjects (n=140)

Parameters	Group 1 n=70	Group 2 n=70	P-value
Age	20.75 ± 0.16	20.9 ± 0.21	> 0.05 #
Height (m^2)	1.64 ± 0.01	1.61 ± 0.009	< 0.001***
Weight (kg)	60.21 ±1.16	75.74 ± 1.34	<0.001***
BMI (kg/m^2)	21.99 ± 0.19	29.12 ± 0.40	< 0.001***

Table 3: Gender-based Comparison of respiratory parameters in all subjects (n=140)

Parameters	Group A (n=70) Mean ± SEM	Group B (n=70) Mean ± SEM	P -value
Vital Capacity (ML)	3744.28 ±54.89	3020.71 ± 40.32	<0.001***
PEFR(L/Min)	438 ± 7.74	378.6 ± 5.43	<0.001***

Table 4: Correlation of BMI with respiratory parameters of all subjects

Parameters	Correlation Coefficient (r)	P-value
BMI Vs Vital Capacity	-0.449	<0.001***
BMI Vs PEFR	-0441	<0.001***

The result of the present study showed that there was a partial negative correlation (r=0.449 and r=0.441) between BMI with PEFR and VC in obese adults.

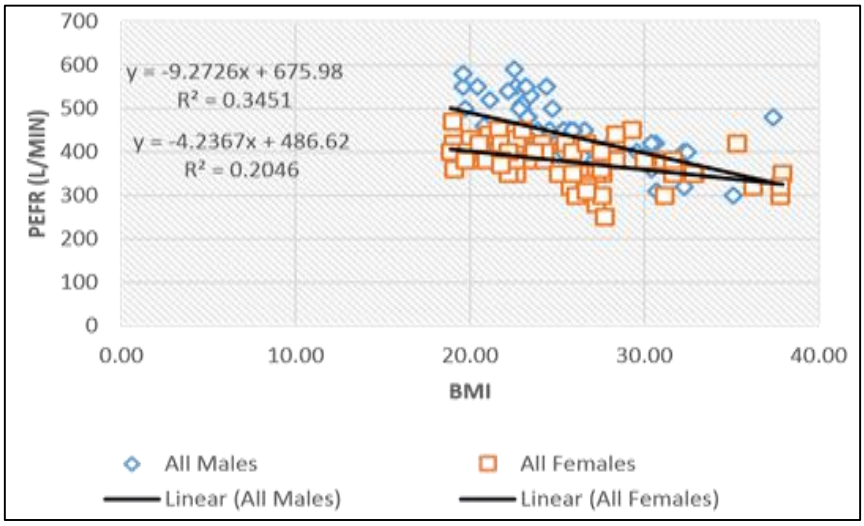

Fig 1

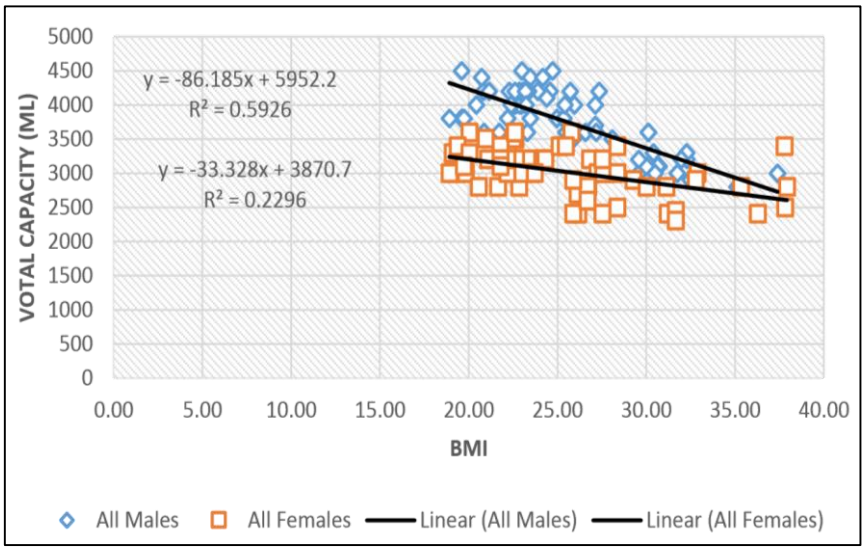

Fig 2

Discussion

Obesity is believed to be one of the most common medical and public health problems in affluent cultures although this assumption has been criticized. In this study, an attempt was made to find out whether there is an increased risk of respiratory problems in overweight and obese individuals. The results of the present study showed that there was a partial negative correlation (r=-0.449 and r=-0.441) between BMI with PEFR and VC in obese adults. Thus the study showed that on increasing BMI the PEFR and VC decreases which is consistent with past research. According to Naimark *et al*, compliance of the lung and thoracic cavity was reduced in obese subjects, most likely due to an obesity-induced increase in pulmonary blood volume and closure of dependent air passages. As a result, they suggested that a decline in vital capacity in an obese individual is associated to a reduction in total respiratory system compliance, which is largely due to reduced dispensability of extrapulmonary structures [10]. In the study of llango *et al*, Obesity determinants the decreased in PEFR indicated the pulmonary function in obese males compared to non-obese males.. They included Rochester *et al*, study which found that obesity lessens the muscular endurance of respiratory muscles, particularly the diaphragm, causing contractions ineffective. This statement was supported by the fact that the value of static maximal inspiratory pressure was % to 70% lower in obese people than in normal people [11]. In the present study, there was a partial negative correlation (r=-0.04) between Age and PEFR, as age increases PEFR decreases. At the same time, there was a positive correlation (r=0.011) between Age and VC. VC increases with age among young people. There was a significant positive correlation (r=0.35) of height with PEFR and VC. According to Garg *et al*, 100 healthy Garhwal women between the ages of 18 and 40 were chosen for the study and underwent peak flow measurement as well as other respiratory and anthropometric parameters monitoring. In total subjects, they discovered a significant negative correlation between PEFR and age, and they concluded that the alteration in PEFR values could be attributed to the effect of increasing age, differences in thoracic volumes and physique, and the fact that these women were anthropomorphically similar [3]. The present study also showed there was a partial negative correlation between BMI with PEFR and VC in males (r = -0.58 and r= -0.76) and female (r = -0.45 and r=-0.47) respectively but on the comparison, males found a more pronounced negative correlation compared to females. The pattern of fat distribution between males and females could be the reason

for this gender variation in the effect of obesity on BMI. Fat distribution is more prevalent in the extremities in females (peripheral obesity), whereas it is more prevalent in the truncal region in males (central obesity), and it is independent of total fat mass. The truncal fat presses the thoracic cavity and restricts diaphragmatic mobility, leading to a lower vertical diameter of the thoracic cavity. As a result, lungs and thoracic cavity compliance diminishes, and the strain on respiratory muscles increases, leading to a decline in PEFR [11]. According to Jayanti Mishra *et al*'s study, pulmonary function tests are one of the indications of an individual's health status and can be considered as a tool in overall health evaluation. It is altered by bodybuilding, muscle development, and nutritional state, resulting in a greater PEFR value in males than females, indicating that the female body framework is more fragile and muscle mass is replaced with more fat deposits [12].

Conclusion

The present study was undertaken to study the association between BMI and respiratory parameters (PEFR, VC), among young adults both males and females. From the present study, it can be summarized that the PEFR values are high in males when compared to females. PEFR is increased in individuals with increased stature and muscle build because of increased respiratory muscles strength and more volume of the thoracic cage. PEFR is decreased in females because of their low stature, decreased muscle building, and increased fat deposits when compared to males. The low PEFR in obese subjects in comparison to normal subjects signified that with increases in BMI, there was a decrease in PEFR which could be because of altered mechanical muscular activity due to adiposity-induced change in airway caliber. The present study is based on the premise that the height and bodyweight of students affect VC. The reduction in VC of the overweight and obese individuals could be due to a reduction in the compliance of the total respiratory system. It can be concluded from the present study conducted in this region of Uttarakhand. PFT's like VC and PEFR vary with anthropometric parameters; height, weight, and age. Further, these help determine the respiratory health status of the individual and are useful in monitoring the patients undergoing treatment for respiratory ailments like bronchial asthma and chronic bronchitis. This study will help to create awareness in the overweight and obese individuals regarding their pulmonary functionstatus.

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