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Study of the effect of Body Mass Index (BMI) on Peak Expiratory Flow Rate (PEFR) in Young Healthy Individuals

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ABSTRACT

Obesity and overweight is known to reduce the ventilatory flow rates. Peak expiratory flow rate (PEFR) is the maximum velocity with which air is forced out of the lungs. Body mass index (BMI) is commonly used to assess the overall adiposity in adults. This study was undertaken to evaluate the correlation of Body Mass Index (BMI) with Peak Expiratory Flow Rate (PEFR). It was a cross-sectional study where 150 subjects (both males and females) among the MBBS and Post –Graduate students of Silchar Medical College in the age group of 20 -29 years were recruited. BMI was calculated using Quetelet Index. Peak expiratory flow rate was measured using computerised spirometer. In the study it was found that BMI had a negative correlation with PEFR in both males (r= -0.031, p>0.01) and females (r= -0.160, p>0.01) which was not significant.

KEYWORDS : Body Mass Index, Peak Expiratory Flow Rate, Overweight, Obesity.

INTRODUCTION:

Prevalence of obesity and overweight is gradually increasing in the developing countries. WHO has defined obesity as "A condition with excessive fat accumulation in the body to the extent that the health and well-being are adversely affected" (1). Obese people show obesity-related morbidities such as cancer, cardiovascular, endocrine, rheumatologic diseases and sleep related disorders (2). Development of obesity can be linked to genetic factors, adoption of sedentary lifestyle, lack of regular physical exercise and excessive intake of junk foods (3).

Body mass index (BMI) is used as a measure of overall adiposity .Obesity is believed to influence the pulmonary function mechanically by changing lung compliance, work of breathing and the elastic recoil (4,5,6,3).

PEFR is the maximum rate of airflow achieved during a forced expiration after maximal inspiration (7). Lung functions including PEFR are affected by various factors such as sex, body surface area, physical activity, posture, environment, racial differences etc (8, 9, 10, 11). The pattern of fat distribution in the body has an effect on PEFR. Peak flow measurement is sensitive indicator to measure the strength of muscles of respiration (12).

The present study was undertaken to evaluate the correlation of Body Mass Index (BMI) with Peak Expiratory Flow Rate (PEFR) in healthy young individuals.

MATERIALS AND METHODS:

In the present study, a total of 150 subjects (both males and females) were selected. It was a cross-sectional study which was done in Silchar Medical College and Hospital, among the MBBS and Post –Graduate students. The study protocol was approved by the Institutional Ethical Committee.

INCLUSION CRITERIA

1. Healthy individuals (both males and females) in the age group of 20-29 years.

2. Individuals within the Body Mass Index of 18.5-29.99kg/m^2.

EXCLUSION CRITERIA

1. Individuals with deformities of chest wall.
2. Individuals suffering from respiratory diseases.
3. Pregnant women.
4. Smokers and individuals suffering from hypertension.

The subjects had a light breakfast on the day of the test. They were asked to report to the Department of Physiology, Silchar Medical College, before 10.00 AM and PEFR was measured before noon.

On arrival, they were asked to take rest for a few minutes. Informed written consent was taken from each subject. The procedure was explained to the subjects, a brief history was taken and a thorough clinical examination was done. A standard performa was used to record the particulars.

Standing height was measured with a stadiometer, to the nearest centimeter. Weight was measured in kilogram using a standardized weighing machine to the nearest 0.1 kg. BMI was calculated based on Quetelet index [BMI= Weight (in kg)/ Height ^{2} (in meter)] (13).

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

Group A: Consisted of 80 male subjects. It was again subdivided into two groups: Group A1 and Group A2. Each group consisted of 40 subjects. Group A1 consisted of males subjects between BMI 18.5 to 24.99 kg/m^2. Group A2 consisted of males subjects between BMI 25 to 29.99 kg/m^2.

Group B: Consisted of 70 female subjects. It was again subdivided into two groups: Group B1 and Group B2. Each group consisted of 35 subjects. Group B1 consisted of females subjects between BMI 18.5 to 24.99 kg/m^2. Group B2 consisted of females subjects between BMI 25 to 29.99 kg/m^2.

Digital Computerised Spirometer, MEDSPIROR, which can record different parameters (FVC, FEV_1, FEV_1%, PEFR etc.) was used. In this study, however, only PEFR was considered.

Spirometry was performed in a quiet room in standing position. The subjects took deep forceful inspiration followed by rapid forceful expiration through the mouth piece. Care was taken to prevent leakage of air around it. The nostrils were kept closed by a nose clip during the recording. The manoeuvre was repeated three times with a rest of 5 minutes between each. The best of the three results was taken as final reading and the parameter PEFR was taken for analysis. The data so collected were compiled.

Data was expressed as Mean ±SD and was compared using student t-test (unpaired). P-value<0.05 was considered statistically significant. Pearson's correlation coefficient test was done to see the correlation between BMI and PEFR. The non- zero values of 'r' between -1 to 0 indicate negative correlation. The non- zero values of 'r' between 0 to +1 indicate positive correlation. Microsoft Excel and SPSS statistical software was used for the analysis of the data.

RESULTS:

Table-1: Number and percentage of male and female subjects participated in the study.

Subjects	Number	Percentage
Male	80	53.33%
Female	70	46.67%

In **Table -1**, out of the 150 subjects in the study, 80 (53.33%) were male subjects and 75 (46.67%) were female subjects.

Table -2: Mean and Standard Deviation of the characteristics of normal weight males (Group A1) and overweight males (Group A2). (n is the number of subjects in each group)

Parameters	A1 (Normal weight male) n = 40	A2 (Overweight male) n = 40	p value
Age (years)	23.63 ±2.11	24.23±2.18	p>0.05
Height (cm)	169.80±6.13	169.23±7.22	p>0.05
Weight (kg)	63.20 ±6.64	77.38±8.29	p<0.05
BMI(kg/m^2)	22.11 ±1.80	27.06±1.50	p<0.05

In **Table-2**, the mean ± standard deviation for age in normal weight males and overweight males are 23.63 ±2.11 years and 24.23± 2.18years respectively (p>0.05).

The mean ± standard deviation for height of normal weight males and overweight males are 169.80 ± 6.13 cm and 169.23 ± 7.22cm respectively (p>0.05).

The mean ± standard deviation for weight in normal weight males and overweight males are 63.20 ± 6.64 kg and 77.38 ± 8.29 kg respectively. The difference is statistically significant (p<0.05).

The mean ± standard deviation for BMI of normal weight and overweight males are 22.11 ± 1.80 kg/m^2 and 27.06 ± 1.50 kg/m^2 respectively. The difference is statistically significant (p<0.05).

Table -3: Mean and Standard Deviation of PEFR in normal weight males (Group A1) and overweight males (Group A2).

PFT parameter	Normal weight males (Group A1)	Overweight-males (Group A2)	p value
PEFR(litres/sec)	7.56±1.19	7.38±1.15	p>0.05

In **Table-3**, the mean ± standard deviation of PEFR in normal weight and overweight males are 7.56 ± 1.19 litres/sec and 7.38 ±1.15 litres/sec respectively. There is decrease in PEFR in overweight males compared to normal weight males but it is statistically not significant (p > 0.05).

Table-4: Mean and Standard Deviation of the characteristics of normal weight females (Group B1) and overweight females (Group B2). (n is the number of subjects in each group)

parameters	Normal weight female (Group B1) n= 35	Overweight female (group B2) n= 35	p value
Age (years)	24.03±1.87	24.20±2.03	p>0.05
Height (cm)	156.83± 6.93	156.49±5.22	p>0.05
Weight (kg)	52.80±6.89	65.71±4.44	p<0.05
BMI (kg/m^2)	21.49±1.73	26.88±1.19	p<0.05

In **Table- 4**, the mean ± standard deviation for age in normal weight females and overweight females is 24.03±1.87 years and 24.20±2.03 years respectively (p>0.05).

The mean ± SD for height in normal weight females and overweight females is 156.83 ±6.93 cm and 156.49±5.22 cm respectively (p>0.05).

The mean ± standard deviation for weight in normal weight and overweight female is 52.80±6.89 kg and 65.71±4.44 kg respectively. The difference is statistically significant (p<0.05).

The mean ± standard deviation for BMI of normal weight and overweight females is 21.49±1.73 kg/m^2 and 26.88 ± 1.19 kg/m^2 respectively. The difference is statistically significant (p<0.05).

Table-5: Mean and Standard Deviation of PEFR in normal weight (Group B1) and overweight females (Group B2).

PFT parameters	Normal weight females (Group B1)	Overweight females (Group B2)	p value
PEFR(litres/sec)	6.07±0.72	5.84±0.66	p>0.05

In **Table-5**, the mean ± standard deviation of PEFR in normal weight females and overweight females is 6.07 ±0.72 litres/ sec and 5.84±0.66 kg litres/sec respectively. The PEFR is lower in overweight females compared to normal weight females but it is statistically not significant (p >0.05).

Table- 6: Correlation between BMI and PEFR in Males and Females.

Correlation between	' r' value	
	Males	Females
BMI and PEFR	-0.031*	-0.160*

* correlation is not significant (p>0.01).

Table 6 , shows PEFR is also negatively correlated with BMI in both males (r = -0.031) and females(r = -0.160) but it is statistically not significant (p>0.01)

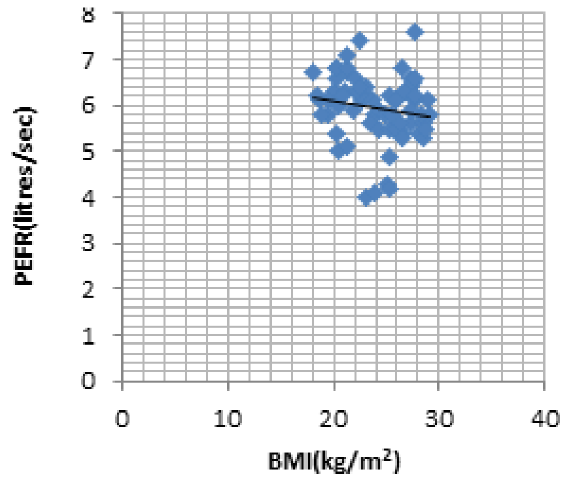

Fig-1: Scatter diagram showing the correlation between BMI and PEFR in males.

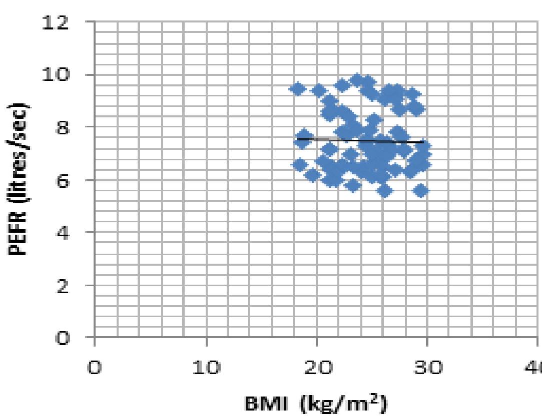

Fig-2: Scatter diagram showing the correlation between BMI and PEFR in females.

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DISCUSSION:

The present study was done with the primary objective to see the association between Body Mass Index (BMI) and Peak Expiratory Flow Rate (PEFR) in young healthy males and females. It was done on 150 subjects (both males and females) in the Department of Physiology, Silchar Medical College and Hospital, Silchar, Assam.

The study included a total 150 subjects, 80 (53.33%) were male and 70 (46.67%) were female (Table -1).

In the study , difference between the mean weight and mean BMI between normal weight and overweight males was found to be statistically significant ($p<0.05$).(Table-2)

In the female group, significant difference in mean weight and mean BMI between normal weight and overweight females ($p<0.05$) was found(Table-4).

The findings in the present study are comparable with the study done by Umesh Pralhadrao Lad et al. (14) on 180 students (90 boys and 90 girls) where they found BMI to be significantly different in overweight subjects compared to normal weight subjects.

Similar observation was also made by Sohail Attaur Rasool et al. (15) , where the weight, height and BMI of the overweight and obese group were significantly different than the normal weight subjects.

In another study done by Dayananda G. et al. (16), BMI was significantly higher in overweight compared to normal weight subjects ($p<0.05$).

In the present study, the difference in PEFR between both overweight males and females compared to normal weight males and female was found to be not significant (Table-3, Table-5). There was negative correlation between PEFR and BMI in both males and female groups (Table-6).

In healthy subjects primary factors that affect PEFR are the strength of the expiratory muscles generating the force of contraction, the elastic recoil pressure of the lungs and the airway size (17). The reduced PEFR could be due to increased adiposity which has mechanical effect on the diaphragm and fat deposition between the muscles and the ribs which can lead to increase in the metabolic demands and work-load of breathing. The pattern of fat distribution has also been suggested as a significant predictor of decreased PEFR as abdominal adiposity restricts the descent of the diaphragm and limiting lung expansion as compared to overall adiposity which may compress the chest wall (18).

Visceral adiposity influences the circulating concentrations of cytokines such as interleukin-6 and TNF-alpha(19) . A decreased level of adiponectin increases the degree of systemic inflammation, which might in turn negatively affect the pulmonary functions (20). The airway calibre of the obese persons is reduced due to remodelling of the airway by pro-inflammatory adipokines and/or by the continuous opening and closing of small airways throughout the breathing cycle (21).

Inverse correlation between BMI and PEFR was also noted by Yogesh Saxena et al. (18), Farida M. El-Baz et al.(22), Wannamethee et al.(23), Jones et al. (24) and Khwaja Nawazuddin Sarwari et al.(25)

Rochester *et al*. (26) stated that obesity reduces the strength and endurance of the respiratory muscles, especially diaphragm, making the contraction inefficient.

The present study had its limitations, for being a cross-sectional study with a modest sample size. So, a longitudinal study with a larger sample size would probably throw more light on this subject.

CONCLUSION:

This study shows that there is a inverse correlation of BMI with PEFR in both young healthy males and females. So, young individuals should be made aware about the ill effects of increase in adiposity on the body and should be encouraged to adopt a healthy life style to prevent respiratory complications.

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