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Research Paper

Effect of Body Mass Index (BMI) on Forced Vital Capacity (FVC) and Forced Expiratory Volume in first second (FEV_1) in Young Healthy Males

Medical Science

KEYWORDS : Body Mass Index(BMI), Forced Vital Capacity(FVC), Forced Expiratory Volume in first second(FEV_1)

***Dr. Kalpojit Saikia**	District Hospital, Sonapur, Kamrup (M) ,Assam. *Corresponding Author
Dr.Shrabani Barman	Dept. of Physiology, Silchar Medical College & Hospital, Silchar, Assam.
Dr.Jyotismita Deka	Dept. of Physiology, Silchar Medical College &Hospital, Silchar, Assam.

ABSTRACT

Overweight and obesity is a major health concern of today's society. Body mass index (BMI) is commonly used to assess overweight and obesity in adults. Spirometry is the most frequently performed lung function test. This study was undertaken to evaluate the correlation of Body Mass Index(BMI) with Forced Vital Capacity (FVC) and Forced Expiratory Volume in first second (FEV_1) . It was a cross-sectional study where 80 male subjects among the MBBS and Post –Graduate students of Silchar Medical College in the age group of 20 -29 years were recruited. Weight was measured using a standard weighing machine. BMI was calculated using Quetelet Index. Pulmonary function test was done using computerised spirometer, Medspiror. Inverse correlation of BMI with FVC ($r = -0.468$, $p<0.01$) and FEV_1($r = -0.388$, $p<0.01$) was found suggesting negative effect of increase BMI on respiratory functions.

INTRODUCTION:

Overweight is generally defined as having more body fat than is optimally healthy. The fundamental cause of overweight and obesity is an energy imbalance between calories consumed and calories expended.

Excess weight has reached epidemic proportions globally; with more than 1 billion adults being either overweight or obese (1). A healthy body requires a minimum amount of fat for the proper functioning of the hormonal, reproductive, and immune systems, as thermal insulation, as shock absorption for sensitive areas, and as energy for future use. But the accumulation of too much of stored fat can impair movement and flexibility.

Body mass index (BMI) is a simple index of weight-for-height, commonly used to classify overweight and obesity in adults. It is defined as a person's weight in kilograms divided by the square of his height in meters (kg/m^2). BMI provides a useful population-level measure of overweight and obesity as it is the same for both sexes and for all ages of adults.

Obesity by its adverse effects on respiratory mechanics, respiratory muscle function, lung volumes, work and energy cost of breathing and gas exchange can severely alter ventilatory functions of a person (2). It can cause obstructive sleep apnea and obesity hypoventilation syndrome, both of which are associated with substantial increased morbidity and mortality (3). People with excessive body weight tend to be chronically hypoventilated (2, 4, 5).

Fat deposition in the chest wall may diminish rib cage movement and thoracic compliance and abdominal fat deposition may directly impede the descent of the diaphragm, both leading to restrictive respiratory impairment (6). Abdominal fat deposition can also lead to a redistribution of blood to the thoracic compartment that reduces vital capacity (7). Thus obesity has a direct effect on the mechanical behaviour of the respiratory system by altering lung volumes, airway calibre and respiratory muscle strength.

Spirometry includes measurements of FVC, FEV_1, FEV_3, FEF values , PEFR, etc. helps in early detection and diagnosis of restrictive, obstructive or mixed airway diseases. The present study was undertaken to evaluate the correlation of Body Mass Index (BMI) with Forced Vital Capacity (FVC) and Forced expiratory Volume in first second (FEV_1).

MATERIALS AND METHODS:

This cross-sectional study was carried out on 80 male subjects among the MBBS and Post –Graduate students in the age group of 20 -29 years in Silchar Medical College and Hospital. The protocol of the study was approved by Institutional Ethical Committee.

The subjects had a light breakfast and avoided beverages like tea, coffee and other stimulants on the day of the test. They were asked to report to the Department of Physiology, Silchar Medical College, before 10.00 AM and Pulmonary Function Test were done 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. Smokers and subjects with respiratory diseases were excluded from the study. 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)] (8). Subjects were divided into two groups. Group A consisted of 45 subjects with BMI between 18.5 kg/m^2 to 24.99 kg/m^2.Group B consisted of 35 subjects with BMI between 25 kg/m^2 to 29.99 kg/m^2.

Spirometry was performed in a private and quiet room in standing position, after the procedure was demonstrated to the subjects. 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 were repeated three times with a rest of 5 minutes between each manoeuvre. The best of the three results was taken as final reading and the parameters FVC and FEV_1 were 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 pulmonary function parameters. 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. shows that out of the 80 male subjects, 56.25 % were within the BMI range of 18.5 -24.99 kg/m^2 and 43.75% were within the BMI range of 25 – 29.99 kg/m^2 .

Table.2. shows statistically significant decrease in FVC in Group B(3.35± 0.53 litres) compared to Group A(3.94± 0.63 litres). FEV_1 also shows statistically significant decrease in Group B(3.01± 0.52 litres) compared to Group A(3.47±0.57 litres).

Table. 3. shows that there is a statistically significant negative correlation of BMI with FVC (r = -0.468 ; p<0.01) and FEV_1(r=-0.388,p<0.01) , suggesting that as BMI increases , there is a decrease in FVC and FEV_1 values.

Fig-1: Scatter diagram showing the negative correlation between BMI and FVC .

Fig-2: Scatter diagram showing the negative correlation between BMI and FEV_1 .

DISCUSSION:

Overweight and obesity has become a major public health problem. Decrease in physical activity, changes in diet and changes in overall pattern of lifestyle of the people have promoted weight gain. Obesity is associated with adverse health effects like diabetes mellitus, hypertension, hyperlipidemia, coronary artery disease, some types of cancer and premature mortality(9). Increase in fat deposition in the body influences the mechanical properties of the respiratory system.

The present study was done with the primary objective to see the correlation of Body Mass Index (BMI) with Forced Vital Capacity (FVC) and Forced Expiratory Volume in first second (FEV_1). It was done on 80 male subjects in the Department of Physiology, Silchar Medical College and Hospital, Silchar, Assam.

In the present study there was significant inverse correlation of BMI with FVC and FEV_1 (Table.3). There is significant decrease in FVC and FEV_1 with increase in BMI (Table.2)

Healthy individuals can expire approximately 80 % of the vital capacity in 1 sec. People with obstructive lung diseases (increased airway resistance) typically have an FEV_1 that is less than 80% of the vital capacity because of the difficult to expire air rapidly through the narrowed airways (10). In restrictive disease, which is characterized by normal airway resistance but impaired respiratory movements and decrease in compliance, the FEV_1 and FVC are both reduced proportionally and the FEV_1% value may be normal or even increased (10, 11).

The decrease in pulmonary function parameters FVC and FEV_1 with increase in BMI in the present study could be due to mechanical limitation of chest expansion, as accumulation of large amount abdominal fat may impede descent of the diaphragm during inspiration. The subcutaneous fat over the chest may have led to change in the balance between the elastic recoil of the chest wall and lung-chest wall compliance.

Similar observations were made by Umesh Pralhadrao Lad *et al.* (12), where they found BMI and FVC showed a significant negative correlation in overweight males and females and correlation was stronger in males than in females. FEV_1 showed a significant negative correlation with BMI in the overweight males. Farida M. El Baz *et al.* (13), found BMI to be inversely correlated with pulmonary functions like FVC and FEV_1 when they studied 30 Egyptian children to see the impact of obesity and body fat distribution on pulmonary functions. Similarly, Wannamethee *et al.*(14), found FVC to have inverse association with BMI. The results of the present study are similar to these observations. Joshi *et al.* (15), in their study where they recruited 132 young students (68 males and 64 females) in the age group of 18 to 21 years have found significant negative correlation between BMI and FVC. Chen *et al.* (16), compared pulmonary function in normal weight, overweight and obese subjects in the age group of 18 – 79 years. They observed negative association between BMI and FVC in overweight and obese subjects when compared to normal weight subjects. Lynell C Collins *et al.* (17), did a study on the normal and mildly obese over 20 years in whom the body fat % and BMI were used as indices or predictors of obesity. They found the different measures of obesity showed a significant inverse relationship with spirometric test parameters such as FVC. In another study by K.Soundariya *et al.* (18) , recruited 100 subjects (50 males and 50 females) in the age group of 18 – 21 years and found the respiratory parameters like FVC and FEV_1 had significant negative correlation with BMI.

CONCLUSION:

This study shows that there is a significant inverse correlation of BMI with FVC and FEV_1 in young healthy males. So, awareness about the ill effects of increase in adiposity on the body and importance of adopting a healthy life style like adequate exercise, having a balanced diet, etc. must be created among the population.

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Table .1. Distribution of subjects according to BMI.

BMI (kg/m^2)	No. of Subjects	Percentage
(Group A) 18.5- 24.99	45	56.25 %
(Group B) 25- 29.99	35	43.75 %

Table. 2. Mean and Standard Deviation of pulmonary function parameters in Group A and Group B.

Parameters	Group A	Group B	P value
FVC (litres)	3.94± 0.63	3.35± 0.53	P <0.05
FEV_1(litres)	3.47± 0.57	3.01± 0.52	P<0.05

Table. 3. Correlation between BMI and Pulmonary Function Parameters. [correlation is significant at the 0.01 level (p<0.01)]

Correlation between parameters	correlation coefficient (r)	Significance
BMI and FVC	-0.468	Significant (p< 0.01)
BMI and FEV_1	-0.388	Significant (p< 0.01)

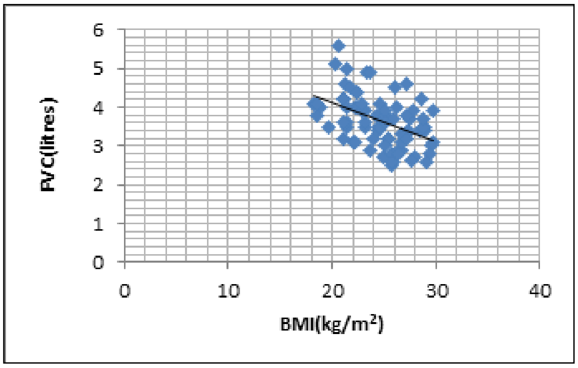

Fig-1: Scatter diagram showing the correlation between BMI and FVC .

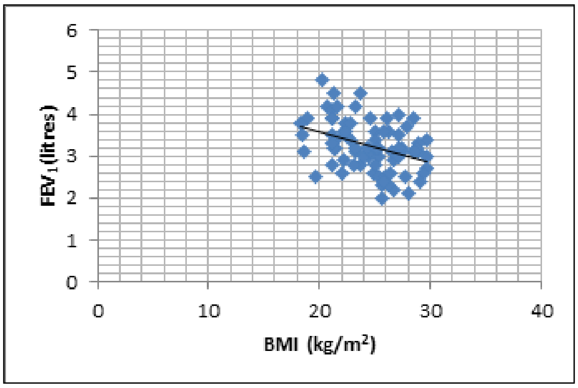

Fig -2: Scatter diagram showing the correlation between BMI and FEV$_1$.

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