Original article

A cross-sectional study showing the implication of obesity on lung function among employees of Gauhati medical college

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Abstract

Introduction: Obesity has been considered a worldwide epidemic in recent years and is associated with co-morbidities like diabetes, hypertension, atherosclerosis to name a few. It can cause deleterious effects on the body and its effect on the respiratory function can impair the health and or quality of life of the individual.

Aim: To find out the effects of obesity on lung function by comparing the pulmonary function in obese and non-obese.

Methods: We recruited 40 people between 20 and 60 years. They were divided into 2 groups obese and non-obese, depending on their body mass index (BMI) according to WHO criteria. Spirometry was performed on all the subjects. The statistical analysis was done using independent t-test and Pearson's correlation was used to show a relationship between the variables BMI, ERV, IRV and MVV. A level of significance $p< 0.05$ was considered as statistically significant.

Results: Significant differences were observed in spirometric parameters ERV, IRV and MVV between the obese and non-obese group. BMI showed a significant correlation with ERV ($r = -0.56$, $p = 0.0002$); MVV ($r = -0.3184$, $p =0.0452$) and IRV ($r =0.46$, $p =0.0023$). A positive co-relation between the ERV and the MVV ($r=0.3584$; $p=0.0232$) was also observed. No significant differences were observed in the other parameters VT, VC, FVC and FEV1.

Conclusion: Our study suggests the possible role of obesity in altering the pulmonary function by causing damage to the chest mechanics.

Keywords: obesity; body mass index; spirometric parameters.

Introduction:

Obesity today has become an epidemic. A study published in the noted medical journal Lancet says India is just behind US and China in this global hazard list of top ten countries with highest number of obese people.Obesity is a chronic disease characterized by excessive body fat that causes damage to the individual's health. (1) In addition to decreasing the quality of life, (1) it is associated with increased risk of atherosclerosis, diabetes, gall bladder disease, hypertension (2-4) and vascular dysfunction. (5, 6) Obesity in adults is defined by the World Health Organization (WHO) as having a body mass index (BMI) that is greater than or equal to 30 kg/m^2 . (1) The normal BMI range is between 18.5 and 24.99 kg/m^2. It has myriad effects on normal body physiology which renders it incapable like an old machine. Obesity impacts on many areas of clinical medicine, including pulmonary medicine, where it is debated if obesity is linked to asthma, (7, 8) or whether the obesity , due to its effect of decreasing lung volumes and increasing airway resistance, (9-13) causes symptoms that simply mimic asthma. (14-15).Since obesity is associated with alterations in lung function (9-13) it becomes necessary to assess the respiratory function of obese individuals. This may help to identify and treat these changes at an early stage in order to prevent negative effects on health and quality of life. Therefore, the objective of this study was to evaluate the impact of obesity on the pulmonary function of adult men and women with no history of pulmonary disease by comparing the changes if any between the obese and the non-obese subjects.

Materials and methods:

This cross-sectional study was carried out among the employees of Gauhati Medical College, Guwahati, Assam. A total of 40 subjects in the age group of 20-60 years were included in the study. The subjects included both male and female with sedentary lifestyle but without any underlying lung disease. Subjects with background IHD, hypertension or underlying COPD/Asthma and history of smoking as well as those unable to perform the tests adequately were excluded from the study. Written informed consent was taken from each subject and the study was approved by the Institutional Ethics Committee.

Measurement of Anthropometric Parameters:

Weight was measured to the nearest 0.1 Kg using a standardized digital weighing machine, with the subjects standing without footwear, with light clothes. The height was measured (in cm) by using a fixed tape measure while subjects stood wearing no shoes, on a hard surface. BMI was calculated using Quetlet's index (body weight in Kg/height in m^2). (16) Depending on their BMI values, the subjects were categorized into obese and non-obese groups according to BMI ranges as per WHO classification system. (17) Each group comprised of 20 subjects. The evaluation of pulmonary function was done in the department of Physiology, Gauhati Medical College, Guwahati, Assam by digital spirometer, model-RMS Helios-401 in accordance with the standards of the American Thoracic Society (ATS) and the European Respiratory Society (ERS) (2005). (18)

The subjects were asked to avoid beverages like tea, coffee and other stimulants and report to the department after a light breakfast. The test was explained and demonstrated to the subjects. The directly evaluated parameters were lung volumes, capacities and flows through the procedures of Slow Vital Capacity (SVC), Forced Vital Capacity (FVC) and Maximal Voluntary Ventilation (MVV) performed in this order in the sitting position at least three times each. The best of the three acceptable results were selected. Results were expressed as absolute values and as percentages of the reference predicted values. By means of the SVC procedure, it was possible to obtain the following variables: vital capacity (VC), tidal volume (VT), inspiratory reserve volume (IRV) and expiratory reserve volume (ERV). The FVC procedure allowed for the determination of the forced expiratory volume in one second (FEV1) and the FEV1/FVC ratio. The MVV was expressed in L/min.The data were tabulated and entered in MS Excel Worksheet and independent t-test was applied for parametric variability. The Pearson's correlation was used to show a relationship between the variables BMI, IRV, ERV and MVV. A significance level of $p \leq 0.05$ was considered as statistically significant.

Parameters	Non-Obese group (n=20)	Obese group (n=20)	P – value
1. Age (in years)	37.5 ± 6.177	38.45 ± 7.215	NS
2. BMI (in Kg/m^2)	23.088 ± 2.403	31.793 ± 2.502	< 0.0001, significant
3. FVC (in Ltrs)	2.5 ± 0.568	2.488 ± 0.597	NS
4. FEV1 (in Ltrs)	2.255 ± 0.578	2.284 ± 0.495	NS
5. FEV_1/FVC	88.236 ± 6.92	92.149 ± 6.39	NS
6. VC (in Ltrs)	3.37 ± 0.985	3.63 ± 0.984	NS
7. VT (in Ltrs)	0.681 ± 0.434	0.643 ± 0.251	NS
8. IRV (in Ltrs)	1.322 ± 0.495	1.766 ± 0.36	< 0.01 , significant.
9. ERV (in Ltrs)	0.776 ± 0.484	0.377 ± 0.311	< 0.01 , significant.
10. MVV (in Ltr/min.)	98.85 ± 30.759	81.6 ± 10.445	< 0.05 , significant.

Table 1 : Showing mean with standard deviation of different parameters in the non-obese and obese group. **BMI =** basal metabolic rate ; **FVC =** Forced vital capacity ; **FEV_1 =** Forced expiratory volume in 1 second ; **VC =** Vital Capacity ; **VT =** Tidal Volume ; **IRV =** Inspiratory Reserve Volume ; **ERV =** Expiratory Reserve Volume ; **MVV =** Maximum Voluntary Ventilation ; **NS =** Not significant.

Results:

Table 1 shows the age, body mass index (BMI) and spirometric variables of obese and non-obese groups with their p values. No significant difference was observed in the age between the two groups. The obese group showed a significantly higher BMI compared to the non-obese group. Among the spirometric variables, there were no statistical differences between the groups for the VT, VC, FVC, FEV1 and FEV1/FVC. The obese group showed a higher IRV and a lower ERV compared with the non-obese group. The MVV was lower in the obese group.

When correlating the ERV with the BMI, a negative correlation (r = - 0.5618) (p = 0.0002) was observed as shown in *figure1*. When correlating the IRV with the BMI, a positive correlation (r = 0.4684) (p = 0.0023) was observed as is evident from *figure 2*, while a negative correlation (r = - 0.3184) (p = 0.0452) was observed when correlating BMI with MVV as seen in *figure 3*. *Figure 4* shows a positive correlation between the ERV and the MVV (r = 0.3584) (p = 0.0232).

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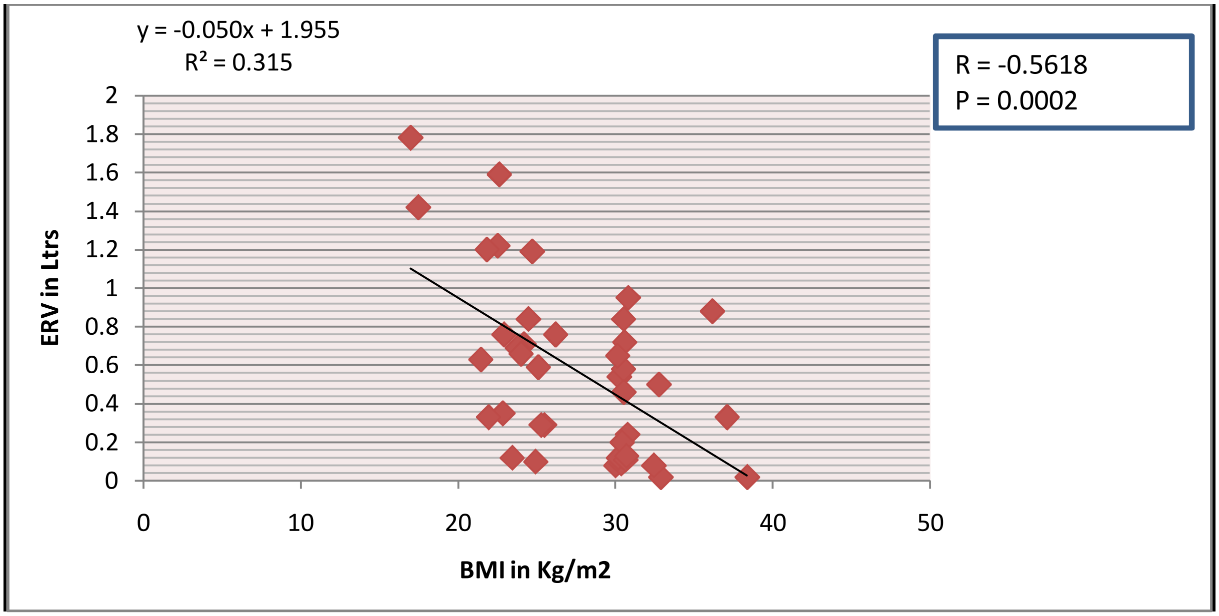

Figure 1: Correlation between BMI in Kg/m^2 and ERV in Ltrs.

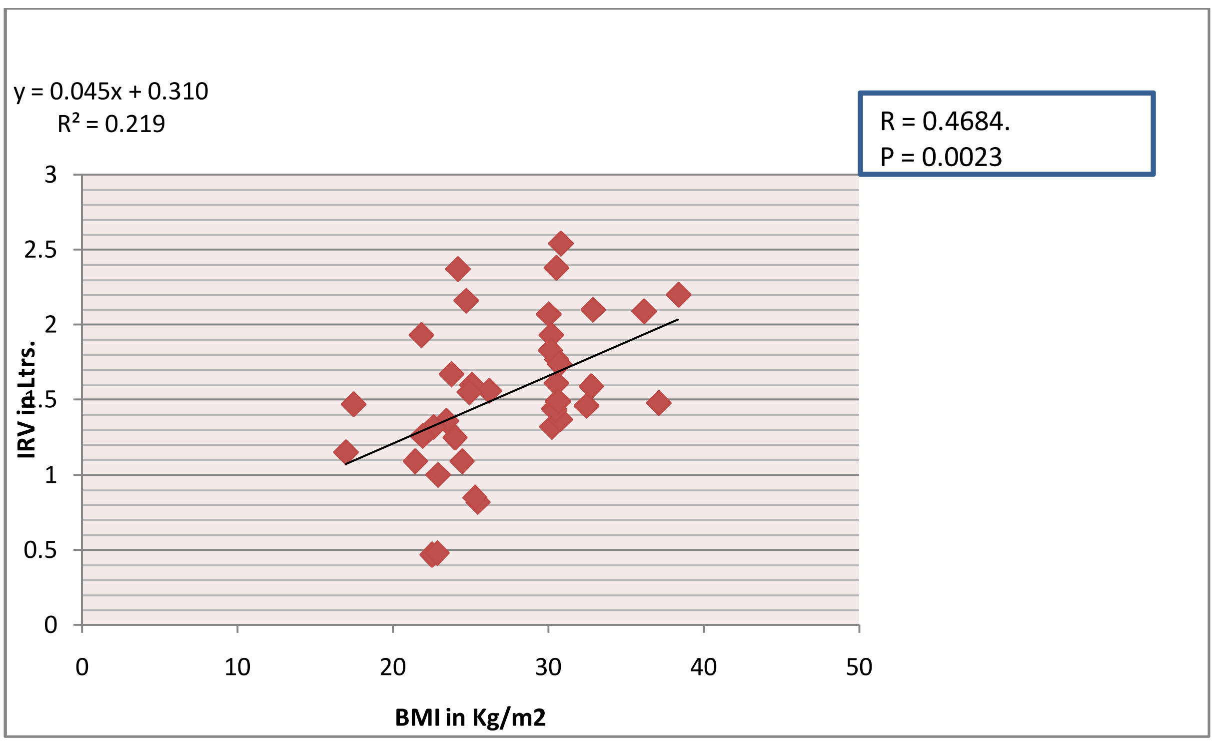

Figure 2 : Correlation between BMI in Kg/m^2 and IRV in Ltrs.

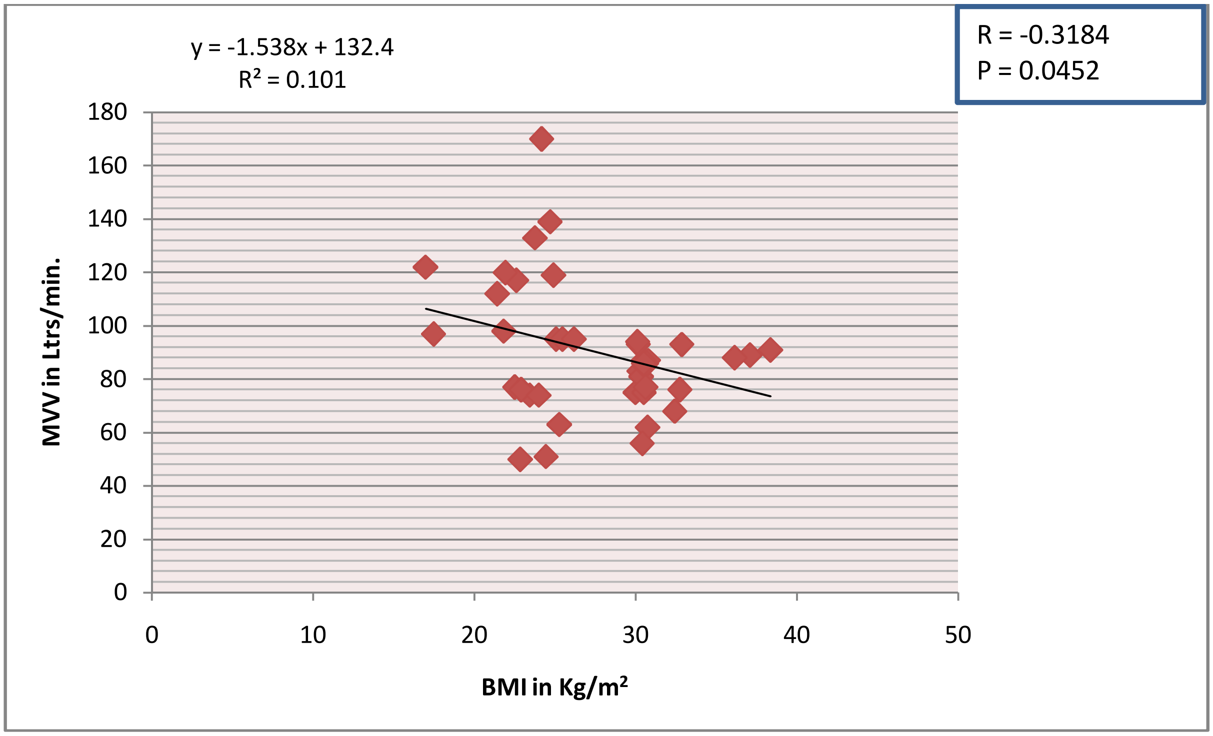

Figure 3 : Correlation between MVV in Ltrs/min. and BMI in Kg/m^{2}.

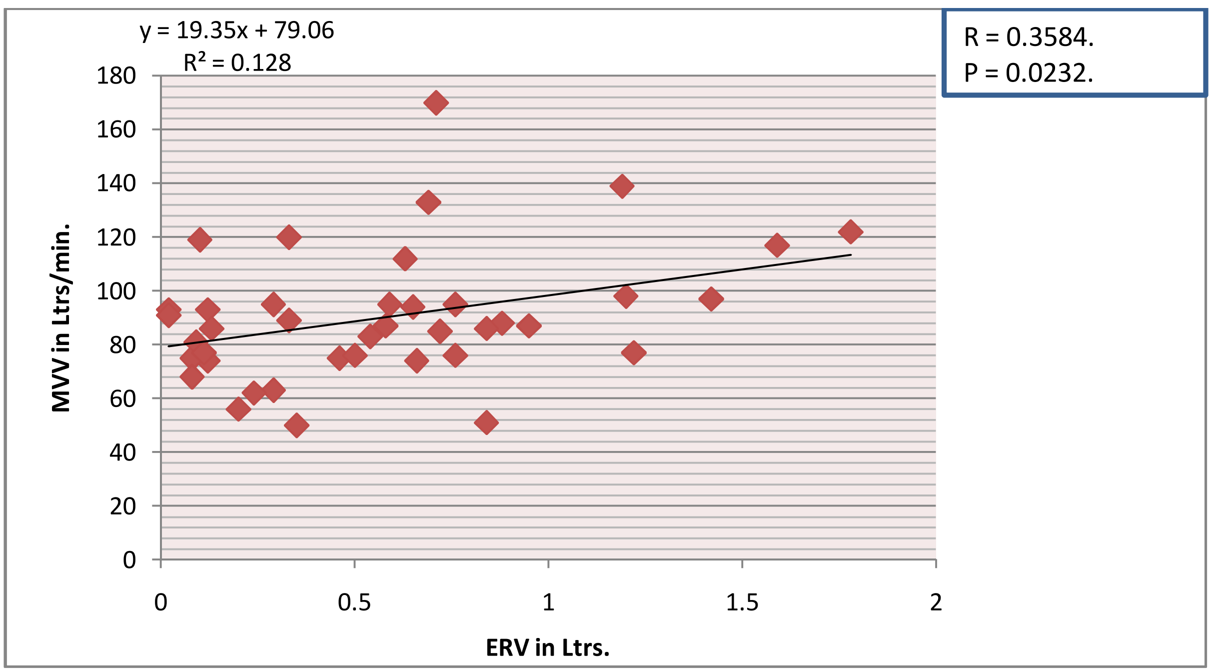

Figure 4 : Correlation between ERV in Ltrs and MVV in Ltrs/min.

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Discussion:

While assessing the implication of obesity on the pulmonary function of employees of our institute who were non-smokers and had no history of lung disease, some important and significant differences were found between obese and non-obese subjects for the ERV, IRV and MVV which can be attributed to obesity.

One of the most significant findings regarding the impact of obesity on pulmonary function was the reduction in the ERV. A strong negative correlation was observed between the BMI and the ERV. This is consistent with a similar reduction in ERV in previous studies. [19-29] Ray et al found significant decrease in the lung volumes in obese people which improved on weight loss. Jenkins and Moxham reported a reduction of FRC, ERV and arterial oxygen tension in Grade I obesity than normal weight patients with the reduction being more in Grade II obesity. In a study by Rubinstein et al, obese persons were found to have lower FRC, ERV and total lung capacity than non-obese controls. Jones & Nzekwu in 2006 reported a reduction in the functional residual capacity (FRC) and expiratory reserve volume (ERV) with increasing BMI with the greatest rates of change occurring in the overweight condition and in mild obesity. They reported that at a BMI of 30 Kg/m^2, FRC and ERV were only 75% and 47% respectively of the values for a lean person with a BMI of 20 Kg/m^2.

Koenig attributes this fact to the reduction in the mobility of the diaphragm as the diaphragm is pressed upwards by the expanded abdominal volume of obese individuals. Inselman et al [31] attributed the reduction in the ERV to the diminished lung compliance that is seen in obesity. Some authors have opined that obesity may eventually promote air trapping leading to impairment of adequate pulmonary ventilation as evidenced by a reduction in the lung volumes. [20] Ladosky et al reported a reduction of the ERV and the MVV in obese patients and suggested that the reduction of the ERV may be the result of air trapping caused by obesity and leading to a reduction in the MVV.

The MVV was also found to be significantly reduced in our study as in previous studies. [20, 26, 30] The MVV test evaluates the respiratory endurance and is influenced by the respiratory muscle strength, the lung and chest compliance, and the control of breathing and airway resistance. [20, 30] In obesity, MVV is reduced mainly by mechanical injury to the respiratory muscles, caused by the excessive weight on the thorax. [20]

The increase in the IRV evident in our result has also been reported by other authors. [19, 20] Rasslan et al [22] reported a higher IC (inspiratory capacity) in obese persons than in non-obese but the other spirometric values were within the normal range. These authors attributed the increase in IRV to be due to overload on accessory respiratory muscles caused by the obesity which serves to compensate for the reduced ERV. Thus, the reduction in the ERV in obese persons possibly leads to a compensatory increase in the IRV, keeping the VC unchanged. In our study, no significant changes were observed in the VC and VT values between the obese and non-obese groups. Some authors are of the opinion that this overload to the accessory respiratory muscles may be responsible for the dyspnoea seen in the obese group. El-Gamal (2005) [32] found an association between obesity and reduction in static lung volumes and an increased respiratory drive. These obese patients after weight loss reported a reduction in the respiratory drive and dyspnoea with improvement of the lung volumes. Thomas et al [33] studied changes in lung volumes, carbon monoxide transfer and arterial blood gas tensions in morbidly obese subjects before and after surgery-induced

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decreases in body weight, and showed that decreasing body weight had the expected positive impact on lung mechanics. The increases ranged from 14% for TLC to 54% for ERV.

Recent studies have implicated that reduction in lung volumes may also be related to the distribution of body fat. (34-36) Ochs-Balcom et al. have suggested waist circumference to be a better predictor of pulmonary function than BMI. (35) A study by Wannamethee, Shaper and Whincup have found total body fat and central adiposity to be inversely associated with lung function in elderly. (36) Our study did not take into account the body fat distribution of the subjects. Also, our sample size was small. So more studies need to be undertaken with a larger sample size taking into consideration the possible role that body fat distribution may have in diminishing the lung function.

Conclusion:

Our study showed that obesity probably caused a reduction in the pulmonary function parameters as evidenced by a reduction in the ERV with a compensatory increase in the IRV thus maintaining a constant VC. The reduction in MVV may have been due to damage to the respiratory muscles by the extra adipose tissue in the chest and the abdominal cavity. But, such changes did not cause any significant obstructive or restrictive lung disorder or dyspnoea in the obese group.

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