Original Article

Effect of Obesity on Dynamic Lung Volume and Capacity in Young Adult Males

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**ARTICLE INFO**

**ABSTRACT**

Background & objectives: Obesity is a modern epidemic. It affects various body systems which is being well documented. There is a high likelihood that obesity can also affect lung function due to various reasons. The purpose of the present study is to deduce the effect of adiposity on dynamic lung function tests. Methods: 120 volunteer participated in this study (60 normal, BMI 18.5-22.9 kg/m², 60 obese, BMI >25 kg/m²) based on their anthropometric profile. Both the groups were assessed for their parameters of obesity (BMI, waist hip ratio (WHR), and body fat % (BF) and dynamic lung volume (FEV1) and capacity (FVC) and FEV1/FVC ratio).

Results: The measured pulmonary functions were impaired in the obese group when compared to non-obese group. Statistical analysis revealed that the two groups differ significantly with obese people having lower FEV1 and FVC. The results showed a negative correlation of FEV1, FVC with BMI, WHR, and BF.

Conclusion: Obesity affects pulmonary function by both restricting and obstructing the lung parenchyma and conducting airways.

**INTRODUCTION**

Obesity can be seen as the first wave of a defined cluster of noncommunicable diseases called “New World Syndrome,” creating an enormous socioeconomic and public health burden in poorer countries. The World Health Organization has described obesity as one of today’s most neglected public health problems, affecting every region of the globe [1]. Obesity is a worldwide epidemic; there has been an increase in the prevalence of obesity and WHO has predicted that by 2015 at least 10% of the projected global adult population will be obese [2]. In 2015 approximately 1.6 billion adults (age 15+) were overweight and at least 400 million adults were obese [3]. By 2050, approximately 2.3 billion adults will be overweight and more than 700 million will be obese [3]. If these trends continue, the number of obese individuals is expected to rise to over 1 billion worldwide by 2030 [4].

In India the Prevalence of obesity ranges from 10-50%, in the 21st century, morbid obesity affecting 5% of the country’s population. The overall prevalence of obesity was 6.8% (7.8 vs 6.2%) and overweight 33.5% (35.0 vs 32.0%) among women and men, respectively [5]. The highest prevalence of obesity (7.8%) and overweight (36.9%) was found among subjects aged 35-44 years in both sexes [5]. It has now become an important health problem in developing countries particularly in India [6].

The consequences of industrialization and urbanization, which lead to decrease in physical activity, together with substantial dietary changes and overall pattern of life style, promote weight gain.

Obesity is a chronic disease characterized by excessive body fat that causes damage to the individual’s health [7,8] and is associated with co-morbidities such as diabetes [9] and hypertension [9,10] and vascular dysfunction [11,12] and cardiac disease. The association of obesity with cardiovascular disease, diabetes and other metabolic disorders has been the focus of numerous studies but effect of obesity on pulmonary function impairment that to in light of obesity as a pro-inflammatory disorder has received little attention. Indeed, obesity, through its effect on chest and diaphragm is expected to modify respiratory function [13]. As a result, pulmonary function tests (PFTs) may be abnormal in obese adults or children, particularly in those who are severely obese [13-15] Nevertheless, conflicting results have been published on the effects of obesity on lung function measures. In fact, investigators have reported either decreased, or stable, or even increased pulmonary function parameters with increasing BMI both in children and in adults [13,14,16,19].

The present research is undertaken to study the effect of body Fat % (by Durnin and Womersley Method) [20] and body fat distribution (by waist circumference and WHR) on Pulmonary Functions of selected individuals.

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The study was conducted in 120 young healthy male individuals in the age group of 30-45 years in the department of physiology people's college of medical sciences and research centre Bhanpur Bhopal. The study was approved by the review and ethics committee and due consent of the subjects was taken. Height and weight was taken and the subjects were divided into four groups depending on new BMI cut off point for Indian population by Indian government (Table 1) [21].

Underweight and Overweight individuals were excluded from the study at the beginning.

A detailed history of the selected subjects was taken and physical examination was done to rule out any systemic illness.

Exclusion Criteria

Individual suffer from nasal allergy (SAR & PAR) or Atopy.
Obstructive sleep apnea syndrome.
Inability to perform the tests adequately
Presence of any known acute or chronic respiratory and medical problems
Smoker and alcoholics

Normal weight group (n=60) and Obese group (n=60) subjected first for anthropometric measurements for the determination of body fat and its distribution followed by pulmonary function tests in forenoon to avoid diurnal variation and were instructed with light breakfast but avoid beverages like tea, coffee and other stimulants before reporting. They were briefed & familiarized with the procedure.

Anthropometry: The study groups were subjected to anthropometry by using standard procedures. The following parameters were recorded

Height: height in centimetres (to the nearest 0.1cm) was measured with a steel, anthropometric rod, with the subject, standing barefooted in erect position.

Weight: weight in kilograms (to the nearest 0.5 Kg) was recorded with the subject standing on the weighing scale, barefooted wearing minimum clothes.

Waist circumference (WC): WC was measured midway between iliac crest and lowermost margin of ribs. According to guidelines, cut-offs for waist circumferences will now be 90 cm for Indian men (as opposed to 102 cm globally) and 80 cm for Indian women (as opposed to 88 cm at the international level) [21].

Hip Circumference (HC): measured at the level of greater trochanters in centimetres (to the nearest 0.1 cm)

Measurements of skinfold thickness: it is measured in millimetres (mm) on right side of the body in standing position by using LANGE skin fold calliper (Cambridge scientific industries, Cambridge,Md) according to the technique described in anthropometric standardized references manual

Measurements

Biceps: Front of upper arm over the belly parallel to longitudinal axis of upper arm

Triceps: Midpoint of the back of the upper arm between the tip of olecranon and acromial processes, parallel to the longitudinal axis of upper arm

Subscapular: Below inferior angle of the scapula, at 45o to the vertical, along the natural cleavage lines of the skin to longitudinal axis of upper arm

Suprailiac: Superiorly on the iliac crest in mid axillary line

Then body fat % was calculated by Durnin and Womersly method and pulmonary function tests were performed. The following parameters were calculated by these data:

BMI = Weight/Height² (Kg/m²) Values used for classifying the subjects into four groups.

WHR (Waist-Hip Ratio) used to indicate the distribution of body fat.

Pulmonary Function Tests (FEV1,FVC, FEV1/FVC %) recorded in one sitting on the same day by PC based spirometry COSMED (software version 9.1 b). Three satisfactory efforts were recorded according to the norms given by American thoracic society.

Statistical Analysis: All data were analyzed by SPSS (Statistical package of social sciences version 20.) The pulmonary function tests were compared in both the normal and obese groups by the 'unpaired t' test. Data were expressed as Mean ± SD. Statistical significance was indicated by 'P' value <0.05. Simple Regression was used to determine the relation between the variables body fat % and WHR with Pulmonary Function Tests (FEV1, FVC, FEV1/FVC %). Coefficient of correlation expressed as ‘r’.

RESULTS

The anthropometric parameters of the study groups are given in Table 2. In the present study the participants were age and height matched. There was significant difference in BMI, waist to hip ratio and percentage body fat between the two groups.

On comparing specific anthropometric parameters (BMI, WHR, BF %) with dynamic lung volumes and capacities (FEV1, FVC, FEV1/FVC %), significant decline in pulmonary functions was observed in the obese group. The observed values of various lung function parameters are provided in Table 3 of both the groups.

On correlating the fore mentioned parameters, a definitive negative correlation was observed between BMI, WHR, BF % with FEV1 and FVC Table 4.

TABLE 1: showing categorization of obesity according to BMI in Indian population

<table>
<thead>
<tr>
<th>CATEGORIES</th>
<th>BMI (in kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt;18.5</td>
</tr>
<tr>
<td>Normal weight</td>
<td>18.5-22.9</td>
</tr>
<tr>
<td>Overweight</td>
<td>23-24.9</td>
</tr>
<tr>
<td>Obese</td>
<td>≥25</td>
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</tbody>
</table>
TABLE 2: Comparison of Mean ± SD of anthropometric parameters of two groups

<table>
<thead>
<tr>
<th></th>
<th>Normal Weight (n=60)</th>
<th>Obese (n=60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>36.05 ± 4.64</td>
<td>36.95 ± 4.43</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>63.5 ± 6.97</td>
<td>83.08 ± 9.74</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.71 ± 0.07</td>
<td>1.69 ± 0.07</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>21.72 ± 1.11</td>
<td>28.99 ± 2.62*</td>
</tr>
<tr>
<td>WC (cm)</td>
<td>77.40 ± 7.34</td>
<td>91.29 ± 6.02</td>
</tr>
<tr>
<td>HC (cm)</td>
<td>87.40 ± 7.91</td>
<td>96.44 ± 5.11</td>
</tr>
<tr>
<td>WHR</td>
<td>0.88 ± 0.03</td>
<td>0.95 ± 0.05*</td>
</tr>
<tr>
<td>Skinfolds thickness (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biceps</td>
<td>8.80 ± 0.88</td>
<td>14.40 ± 1.65</td>
</tr>
<tr>
<td>Triceps</td>
<td>10.65 ± 1.70</td>
<td>17.43 ± 2.29</td>
</tr>
<tr>
<td>Subscapular</td>
<td>13.05 ± 2.08</td>
<td>21.02 ± 3.02</td>
</tr>
<tr>
<td>Suprailiac</td>
<td>15.30 ± 2.47</td>
<td>25.42 ± 3.63</td>
</tr>
<tr>
<td>Body fat %</td>
<td>21.60 ± 2.08</td>
<td>27.60 ± 2.87*</td>
</tr>
</tbody>
</table>

*P<0.05 unpaired ‘t’ test; Body Fat % calculated by Durnin and Womersley method.

**TABLE 3: Comparison of Mean ± SD values of dynamic lung volumes of two groups**

<table>
<thead>
<tr>
<th>Pulmonary Function Tests</th>
<th>Normal Weight (n=60)</th>
<th>Obese (n=60)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEV1 (L)</td>
<td>2.95 ± 0.52</td>
<td>2.51 ± 0.64*</td>
</tr>
<tr>
<td>FVC (L)</td>
<td>3.58 ± 0.64</td>
<td>2.95 ± 0.71*</td>
</tr>
<tr>
<td>FEV1/FVC %</td>
<td>82.86 ± 8.36</td>
<td>83.27 ± 8.98</td>
</tr>
</tbody>
</table>

*p<0.05 independent ‘t’ test

**TABLE 4: Correlation coefficient ‘r’ between markers of obesity with dynamic lung volumes**

<table>
<thead>
<tr>
<th></th>
<th>FEV1 (L)</th>
<th>FVC (L)</th>
<th>FEV1/ FVC %</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI (kg/m²)</td>
<td>-0.408*</td>
<td>-0.514*</td>
<td>0.049</td>
</tr>
<tr>
<td>WHR</td>
<td>-0.393*</td>
<td>-0.326*</td>
<td>0.030</td>
</tr>
<tr>
<td>BF %</td>
<td>-0.478*</td>
<td>-0.421*</td>
<td>-0.005</td>
</tr>
</tbody>
</table>

*p<0.05 Pearson’s bivariate correlation (two tailed significance)

**DISCUSSION**

In the current study of males aged 30-45 years, we found that obesity is associated with deterioration in pulmonary function profiles, i.e., FEV1 and FVC are significantly reduced in obese group, that is an inverse association is seen with BMI, BF %, and central adiposity (WHR) correlated negatively with these dynamic lung function. These associations, although modest, remained significant even after adjustment for potential confounders, including age, and physical activity. Our findings complement and extend previous reports [23, 27] by simultaneously examining the effects of body composition and fat distribution on lung function measures (FEV1, FVC, and FEV1/FVC%) in study group. Higher BMI have opposite effects on lung function in this and other studies [23, 24, 27]. Previous studies of the relation of markers of obesity to lung function produced inconsistent results [23, 27]. It has been suggested that marked degrees of adiposity may be needed for adiposity to have an effect on pulmonary function [26]. However, we have shown that the effect of body fat % and body fat distribution on lung function, although modest, is not limited to obese subjects, a finding that is consistent with findings of other studies [29, 33]. With increasing obesity, fat deposition in men tends to occur centrally (both around the trunk and intraabdominally); this pattern of central fat deposition is likely to be particularly important in influencing lung function. Our findings that WHR (indicator of central adiposity) showed significant inverse relations with lung function (i.e., FEV1 and FVC) is in keeping with the importance of central adiposity and is consistent with the results of other population studies [23, 24, 273]. The stronger association of BMI with FVC than with FEV1 is consistent with a primarily restrictive pattern on lung function, which could be the result of several mechanisms.

Abdominal fat deposition may directly impede the descent of the diaphragm, whereas fat deposition in the chest wall may diminish rib cage movement and thoracic compliance, both of which lead to restrictive respiration impairment [22]. Other mechanisms have been suggested, including the possibility that abdominal fat deposition leads to a redistribution of blood to the thoracic compartment that reduces vital capacity [32]. In addition, high amounts of adiposity may be related to a greater degree of airway narrowing than would be expected on the basis of reduced lung volume alone, although the mechanisms remain uncertain [34]. The reason that WHR showed the strongest correlation with both FEV1 and FVC is uncertain. It is possible that increased WHR reflects both increased abdominal fat and reduced muscle mass, as quantified by hip circumference [35], and that both components contribute to decreased lung function.

**CONCLUSION**

The present study on 120 subjects shows a negative correlation between BMI and dynamic lung volumes FEV1 and FVC. A similar relation exists between WHR and BF% with FEV1 and FVC. Reduced FEV1 and FVC with a normal FEV1/FVC ratio suggests a restrictive pattern of impairment. The restrictive pattern seen in PFT may be due to reduced chest wall compliance due to fat deposition or hindrance of diaphragmatic descent due to abdominal fat. Obesity has effect on pulmonary mechanics.
Reference:


[21] government_in_m.h.t, India reworks obesity guidelines, BMI lowered. Published on 11/26/2008-12:40:52 PM, accessed at 9.00 p.m. on 17/11/2009.


[27] Cotes JE, Chinn DJ, Reed IW. Body mass, fat percentage, and fat free mass as reference variables for lung function: effects on terms for age and sex. Thorax 2001;56:83-944.


