EFFECT OF ABDOMINAL FAT ON DYNAMIC LUNG FUNCTION TESTS

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Abstract
Obesity is an important health problem in developing countries particularly in India. Specifically, abdominal obesity is associated with greater health risk than lower body obesity. Obesity is measured using waist circumference (WC) and body mass index (BMI). The association between body mass index, waist circumference and dynamic pulmonary function test (PFT) variables indifferent populations shows controversial results. Hence we undertook this study. 120 healthy sedentary employees were taken of 30-40 age groups, who worked in an air conditioned environment of a private motor vehicle showroom, Mangalore, for a minimum of six years. Their anthropometric measurements-height, weight, waist-hip circumference, chest expansion are measured to calculate body mass index, waist-hip ratio and total body fat%. Spirometry was performed after informed consent in all these subjects. FEV1, FVC, FEV1/FVC ratio, PEFR, FEF 25-75 was recorded. When PFT variables of low BMI and overweight BMI group is compared with that of normal BMI group, the result shows inverse relation between BMI, WC and FEV1/FVC which indicates an obstructive airway diseases would worsen the situation in genetically prone high BMI subjects. FEF25-75 varies proportionately with BMI indicates malnutrition unfavorably influences the lung functions.

Keywords: Dynamic Lung function tests, Body Mass Index, Waist circumference, abdominal fat

1. Introduction:
Obesity is a global health hazard and has been linked to numerous metabolic complications such as dyslipidemia, type II diabetes, & cardiovascular diseases and is negatively associated to the pulmonary function. Prevalence of obesity, a nutritional disorder has become an important health problem in developing countries particularly in India. Pattern of obesity is an important predictor of adverse health effects such as diabetes, hypertension, hyperlipidemia, and coronary events. Specifically, a pattern of central i.e., abdominal obesity is associated with greater health risk than lower body obesity. Obesity is measured using waist circumference (WC) and body mass index (BMI). Body weight and BMI can be easily measured and therefore are frequently used in large-scale epidemiologic studies to find out the health hazards caused by obesity. Numerous studies have examined the association between body mass index (BMI; in kg/m2) or body weight and pulmonary function testing variables. This associations vary in different subpopulations. Several studies have also evaluated the relation of waist circumference (WC) and waist-to-hip ratio (WHR) to pulmonary function testing variables with controversial results. The mechanism which influences lung function in obesity is still debated and the best marker of adiposity in relation to dynamic pulmonary function is still not clear. Industrialization and urbanization lead to decrease in physical activity and substantial dietary changes and overall pattern of lifestyle. These promote weight gain. It is well established that a sedentary lifestyle is associated with an acceleration of age-related physiological deterioration, such that the effects of aging and habitual inactivity may be additive. Some of these changes will influence the mechanical properties of the respiratory system. A physically active lifestyle is well established as a central component in the maintenance of good health and disease prevention. Previous studies have not considered the percentage of body fat, BMI, waist hip ratio influencing the pulmonary function. Thus, the purpose of this study was to evaluate the association of pulmonary functions with the abdominal obesity in sedentary workers.

2. Materials and Methods:
This study was conducted in a private motor vehicle showroom in Mangalore. A total of 120 employees (30-40 years) who worked in the
air conditioned environment showroom for a minimum of 6 years were included in the present study. The employees in the study group were not regularly doing any type of exercise and no previous history of any respiratory diseases. Institutional Ethical committee approval was obtained and written consent was obtained from all participants. Workers with any pre-existing respiratory diseases, with the history of smoking, alcohol, chest wall deformities, Neuromuscular diseases, Severe Obesity (BMI >30) and History of Pulmonary Tuberculosis were excluded from this study. The volunteers were asked to avoid beverages like tea, coffee and other stimulants and to report with light breakfast in the forenoon to avoid diurnal variations. They were briefed and familiarized with the procedure and self-demonstration of the required tests. The subjects were divided into three groups based on the Body Mass Index according to the WHO recommendations for Asian population into normal group (BMI 18.5-25), low BMI group (BMI ≤18.5) and high BMI (BMI 25-30).

2.1 Respiratory Parameters: A complete spirogram was performed with Spirolab™ portable spirometer. The test was carried out in a private and quiet room, in a standing position with the nose clip held in position on the nose. The flow, volume/timed graphs were taken out in accordance to the criteria based on the American Thoracic Society. The subject was instructed to take a deep breath until the lungs were full and then blow out through mouth as forcibly and as fast and as long as possible till his maximum capacity, sealing the lips tightly around a clean mouthpiece. Force and best of the three acceptable curves was selected as the recording. Spirometric parameters recorded for analysis were expiratory volume in 1 second (FEV1), Forced Vital Capacity (FVC), FEV1/FVC Ratio, Peak Expiratory Flow Rate (PEFR), Forced expiratory flow FEF – 25 - 75 % were recorded.

2.2 Anthropometric measurements: The subjects were enquired for any acute respiratory problem and subjected to anthropometry at the point of entry using the standard procedures and instruments. Age was recorded from birthday by calendar to the nearest of year (<6 months and >6 months).

Standing height was recorded without shoes and with light cloths on a wall mounted measuring tape to the nearest of centimeters (<5 mm and >5 mm).

Weight was recorded without shoes and with light cloths on a Krups weighing machine with a least count of 100 grams.

Body mass index was calculated by the formula of weight (in Kg) and height (in meters). BMI = Weight (Kg)/(height in m2).

Waist circumference (WC) measurement was done with minimal, adequate clothing (light cloths) with feet 25–30 cm apart and weight equally balanced with a tailor’s measuring tape in a plane perpendicular to the long body axis at the level of umbilicus without compression of the skin with nearest to 0.1 cm (WC>/=90 cm) were defined as abdominal obesity using WHO Asia Pacific prospective guidelines.

Hip circumference (HC) measurement was done with minimal, adequate clothing (light cloths) across the greater trochanter with legs and feet together by a measuring tape without compressing the skin fold.

Waist-hip ratio is the ratio of WC and HC was calculated and is the measure of central pattern of fat distribution. (>0.9 for male and >0.8 for females).

Measurement of chest expansion: Chest expansion was measured using a non-stretchable measuring tape at the level of 4th intercostal space, before and after maximum inspiration.

2.3 Body-fat percentage measurement: Body fat can be estimated from the Body mass index (BMI). There is a linear relationship between densitometrically-determined body-fat percentage (BF %) and BMI, taking age and gender into account. Based on which following prediction formula has been derived – that showed valid estimates of body fat at all ages, in males and females. The following formula was used to predict the body-fat percentage is based on current BMI, age, and gender: Adult Body Fat % = (1.20 × BMI) + (0.23 × Age) - (10.8 × gender) - 5.4 [Gender values for male = 1, female = 0].

2.4 Statistical Analysis: Statistical analysis was done by using Student’s unpaired t test. P value was taken as significant at 5 percent confidence level (p < 0.05).
Table I: Waist Hip ratio, FVC (L), FEV1 (L), FEV1/FVC (L), PEFR (L), FEF 25-75(L), BODY FAT %, Waist Circumference (cm) and Chest expansion (cm) in normal, Low BMI and high BMI subjects.

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>NORMAL</th>
<th>LOW BMI</th>
<th>HIGH BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>WAIST HIP RATIO</td>
<td>0.86± 0.04</td>
<td>0.83± 0.02***</td>
<td>0.92± 0.04***</td>
</tr>
<tr>
<td>FVC (L)</td>
<td>3.47±0.58</td>
<td>3.46±0.65NS</td>
<td>3.46±0.56NS</td>
</tr>
<tr>
<td>FEV1(L)</td>
<td>3.34±0.53</td>
<td>3.44±0.64NS</td>
<td>3.30±0.44NS</td>
</tr>
<tr>
<td>FEV1/FVC (L)</td>
<td>96.54±4.03</td>
<td>99.26±1.51***</td>
<td>93.88±4.15***</td>
</tr>
<tr>
<td>PEFR(L)</td>
<td>8.94±1.68</td>
<td>9.05±1.70NS</td>
<td>8.54±1.13NS</td>
</tr>
<tr>
<td>FEF 25-75(L)</td>
<td>5.09±1.11</td>
<td>4.73±1.53**</td>
<td>5.08±1.19 NS#</td>
</tr>
<tr>
<td>BODY FAT %</td>
<td>16.55±3.15</td>
<td>9.54±1.49***</td>
<td>22.70±2.25***</td>
</tr>
<tr>
<td>Waist Circumference(cm)</td>
<td>81.18±7.30</td>
<td>72.45±6.44***</td>
<td>92.15±5.21***</td>
</tr>
<tr>
<td>Chest expansion (cm)</td>
<td>3.78±0.16</td>
<td>4.15±0.68*</td>
<td>2.36±0.50 NS#</td>
</tr>
</tbody>
</table>

(n=40; n is the number of subjects). Values expressed as Mean ± SD.
P< 0.05*,  P< 0.001**, P< 0.0001*** -Comparison between Normal group versus Low BMI
P< 0.001**, P< 0.001***, - Comparison between Normal group versus High BMI
P< 0.05#, P< 0.001## -Comparison between Low BMI versus High BMI

3. Results:
In the present study, the waist hip ratio, waist circumference, body fat% was significantly lower (P<0.001) in the low BMI group and significantly higher (P<0.001) in the high BMI group. Chest expansion in high BMI group is significantly less (P<0.001) compared to that of low BMI group. FEV1/FVC showed a significant reduction (P<0.001) in the high BMI group and significant improvement (P<0.001) in low BMI group. FEF 25-75 is significantly reduced in low BMI group (P<0.05) when compared to high BMI group. Further FVC and FEV1 did not show any significant changes.

4. Discussion:
The health risks related to obesity, including its effects on respiratory function, are linked not only to the magnitude of obesity but also to the presence of abdominal fat14. Obesity does not cause airflow obstruction but can result in pulmonary restriction and reduction in airway15. Obesity is a pro inflammatory condition and hence could contribute to airway hyper responsiveness15.
In the developed and developing countries, due to urbanization of the population in combination with low physical activity, central obesity is increasing. Abdominal obesity is due to accumulation of fat inside the peritoneal cavity, packed between the internal organs. Visceral fat is composed of several adipose depots including mesenteric, epididymal white adipose tissue and perirenal fat. In recent years scientists have come to an important recognition that body fat, instead of body weight, is the key to evaluate obesity. Available literature shows that BMI illustrates the best estimate of the total body fat, while waist measurement gives an estimate of visceral fat and risk of obesity-related disease16,17,18.

Physical inactivity is considered a global health concern and the leading risk factor for chronic disease and death. In the present study, waist hip ratio, waist circumference and body fat percentage was less in the in the low BMI group and more in the high BMI group. Vigorous activity and total physical activity have stronger relationships with body fatness than moderate activity19. The present study showed a significant associations between low physical activity at work and both total and central obesity. These findings provide some support to the hypothesis that low levels of work-related physical activity may be contributing to obesity epidemic. A recent study suggested that it might be possible to increase physical activity at work without sacrificing productivity20: frequent micro-breaks in sedentary work, independent of the total sedentary time, was inversely associated with total and central obesity. Our findings suggest that increasing opportunities for physical activity at work as well as in leisure time and/or reducing long working hours per week should be major components of public health policy for obesity prevention. Such policies should be helpful in counteracting the current positive energy imbalance.
Pulmonary function test is a basic and essential test for diagnosis and assessment of pulmonary dysfunction, pulmonary diseases, and treatment effects. Literature shows that distribution of body fat affects pulmonary function21, 22. Larger the waist measure lesser will be the pulmonary
function. With an increasing abdominal fat deposition, thoracic volume reduces consequently. Further, not only vital capacity but power of respiratory muscles decreases deteriorating mechanical efficiency of thorax. In addition, pulmonary capacity declines and as a result of shallow and rapid respirations, respiratory dead space increases, and eventually tracheal obstruction and partial atelectasis develop. Previous studies showed an inverse relation between FVC, FEV1 and abdominal obesity\(^{23, 24}\). Our study population did not include obese subjects. The inverse relation between FEV1/FVC and overweight subjects indicates increase in waist circumference and body fat percentage would precipitate asthma. Abdominal fat is more likely to have direct effect on the downward movement of the diaphragm, thus reducing the lung volumes and capacities. Abdominal obesity has a clear potential to have a direct effect on respiratory well-being, since it increases oxygen consumption and carbon dioxide production, while at the same time it stiffens the respiratory system and increases the mechanical work needed for breathing. The association between obesity and asthma has also raised new concerns about whether the mechanical effects of obesity on the respiratory system contribute to airway dysfunction that could induce or worsen asthma\(^5\).

A PEFR or ‘peak flow’ is a measurement of the fastest air flow during forced expiration. When the airways are narrowed by bronchoconstriction during an asthma attack, the airflow is reduced, so the PEFR falls. The PEFR may start to fall before the patient is aware of symptoms, so can be useful as an early warning of an asthma attack\(^2\). In our study group, the subjects are not showing any significant change in PEFR which indicates that reduction in FEV1/FVC in these subjects is not due to they are developing asthma, but if they are genetically susceptible, an asthma attack would worsen the condition in overweight subjects. FEF 25-75 showed a marked reduction in low BMI group in our study which could be due to malnutrition. Airflow obstruction may be secondary to bronchospasm, airway inflammation, and loss of lung elastic recoil, increased secretions in the airway or any combination of this causes. A decrease in the BMI in the underweight population\(^26\). Malnutrition unfavorably influences the lung functions by decreasing the respiratory muscle mass, strength, endurance and the defense mechanisms of the lung immune system\(^27\). Muscle wasting leads to reduction in the diaphragmatic mass and a weaker respiratory muscle function diminishes the respiratory muscle strength and it changes the ventilator capacity.

Our findings suggest that there is significant impairment of the pulmonary functions is directly related to abdominal obesity due to decrease physical activity. The study is an attempt to bring awareness about variation of lung functions with increase in BMI and WC. The information may help to acknowledge the pulmonary health risks that crop up with increasing body mass index and fat accumulation. Awareness to maintain BMI and WC normal levels by lifestyle modifications and interventions might help us in moving forward for eradication of obesity and impairment of pulmonary functions. Moreover the early identification of at risk individuals, prior to the onset of disease is imperative in our developing country. Future research with larger sample size to compare the pulmonary function relation with obesity will give more insight into effect of obesity on pulmonary function.

Reference

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