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Altered pulmonary ventilatory mechanics induced by Obesity

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Abstract:

Introduction: The efficiency and functional status of lungs can be assessed by using the simple spirometric tests for effective diagnosis of various lung diseases. This study had objective of investigating alterations in respiratory function that is affected by obesity.

Methods: The respiratory function tests were done in thirty obese adults and 30 non obese adults aged between 30-50 years of both sexes.

Results: The results showed a trend in decreased response of FVC, FEV1 and FEV1%. However, FVC results were statistically not significant and FEV1 and FEV1% results are statistically significant. Trend in decrease in these variables in obese were suggestive of decreased efficiency of lungs.

Conclusion: Therefore, early detection of functional impairment of respiratory changes and its appropriate management is

the only means by which the morbidity and mortality can be reduced.

Key Words: Obesity adults, Forced Vital Capacity (FVC), Forced Expiratory Volume in 1st second (FEV1), Pulmonary function tests, Body Mass Index

Introduction: The most cardinal feature of the lung is to sustain the tension of Oxygen (Po2) and Carbon dioxide (Pco2) of arterial blood within the reference range[1]. This is executed with uptake of oxygen from the inspired air and releases carbon dioxide from expired air. Thus adequate tissue oxygenation is balanced and accumulation of carbon dioxide is prevented by the lung[2]. The basic mechanisms involved in achieving this goal are by ventilation, diffusion and perfusion. Pulmonary ventilation refers to the moment of air in and out of lungs[3]. Its sufficient ventilation is influenced by mechanism of breathing, lung volumes and capacities[4]. These different parameters lung volumes and capacities are indices of static dimensions of the lungs at various stages of inflation. The mechanics of breathing deal with static as well as dynamic mechanical properties of the respiratory apparatus[5]. Respiratory parameters indicate static element of the lungs at different stages of inhalation. The static and dynamic mechanical stuff of the lungs depends on mechanism of respiration. Assessment of maximal effort of inspiration indicates strength of muscle of respiration and functional status of respiratory system [6].

Obesity is a major intercept root of death across the world and it is one of the insidious threats to the 21st century. Obese patients tend to have higher respiratory rate and lower lung volumes[7]. In addition; total respiratory compliance is reduced, because of increase in resistance due to fat accumulation. People may be mildly hypoxemic possibly due to ventilation – perfusion mismatch where microatlectasis is likely to occur[8]. It also results in decrease in thoracic distensibility, especially of the chest wall as a consequence of the restriction imposed on the expansion of the ribcage and diaphragm[9]. Obesity has been officially accepted as a universal epidemic condition by World Health organization in 1997[10]. The prevalence of obesity is 650 million across the world as per WHO report. Obesity rises along with age up to 50 or 60 years old[11]. The traditional sign of obesity is measured by BMI. "Body Mass Index (BMI)" measured in Kg/m2.

Therefore, early detection of functional impairment respiratory changes and its appropriate management is the only means by which the morbidity and mortality can be reduced[13].This study was undertaken to evaluate the respiratory parameters in obese adults of Nellore district, Andhra Pradesh.

Methodology: Thirty cases of Obese participants and thirty non obese subjects age matched controls were recruited and estimated for Lung volumes and capacities after obtaining written and informed consent . This study was approved by institutional ethics committee. Few following criteria were followed while selecting the subjects as cases: The individuals having BMI (Body mass index) > 30Kg/m2, Age between 20-50 years and not suffering from any alternative disease or clinical manifestations. All the healthy subjects (controls) and Obese participants (cases) were subjected to general and physical examination. The pulmonary function tests were carried out morning, after familiarizing the subjects with the testing procedures.

Procedure: In every subject height in centimeters, weight in kilograms was measured. The Lung parameters were recorded in computerized spirometer (Spirowin Version 2.0 of Genesis Medical systems pvt. Ltd)[14]. Subject was asked to inspire maximally through the mouth piece, expire maximally and inspire with maximum effort again. This method was explained to the subject and a demonstration of the maneuver was given. After preliminary trials, the test was done three times and best reading was taken. The methods were performed with subjects in the standing position.

Following parameters were done to evaluate functional status of respiratory system:

1. Forced Vital Capacity (FVC): Normal value in adult male: 4600ml.
2. Forced Expiratory Volume in the first second (FEV1): Normal value: 80 –85% of FVC.
3. Forced Expiratory Volume percent FEV1%: The ratio of FEV1/FVC is approximately 0.75-0.80. This is a very sensitive predictive indicator of airway obstruction than FVC or FEV1 alone.

The above mentioned Respiratory function tests were conducted in 30 Obese (cases) and 30 Non obese (control group).

Statistical analysis: Statistical analysis was carried out using graph pad prism & data were represented as mean SD. Normality of

data was tested using Kolmogrov-Smirnov test. A p value of > 0.05 indicated normal Gaussian distribution. The data sets were skewed and Mann-Whitney test was performed.

Results: The present data reports the above tests were compared between the cases (obese) and healthy age matched controls (non obese controls). Values are expressed as mean ± SEM in the tables.

Anthropometric measurements	Obese	Non Obese	P value
Age	**36.73**	**33.2**	**<0.05**
Height	**159.53 ± 5.329**	**159.66 ± 4.671**	**0.9183**
Weight	**85.26 ± 7.728**	**59.03± 6.780**	**<0.0001*** **
BMI	**34.43 ± 3.218**	**23.01 ± 1.827**	**<0.0001**** **

Table 1: showing Demographic variations in obese and non-obese adults.

The obese and non obese groups were comparable on demographics of age and height (Table.1). Weight of the obese group significantly higher compared to non obese ($p < 0.0001$), which also reflected in significant higher BMI ($p < 0.0001$) in obese subjects.

Dynamic ventilatory measures	Non-Obese	Obese	P value
FVC	2.089 ± 0.226	2.036 ± 0.396	0.3476
FEV 1	1.652 ± 0.494	1.909 ± 0.230	0.027
FEV1%	81.67 ± 16.8	89.91 ± 8.62	

Table.2 showing forced vital capacity dynamic ventilatory measures in obese and non-obese adults.

The mean FVC for obese is 2.036 and for non-obese is 2.089 (Table.2), however this was not significantly different from non obese ($p = 0.3476$) subjects (Figure.1).

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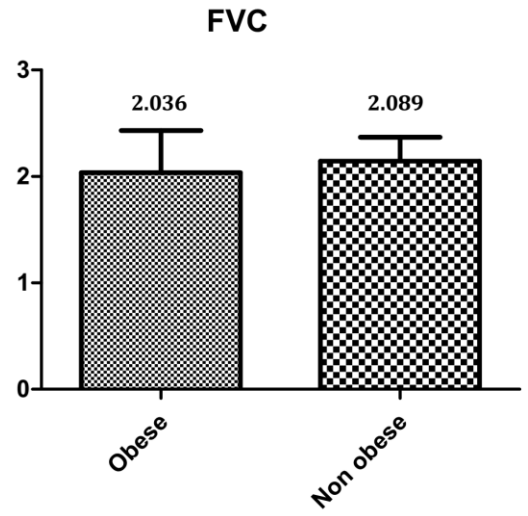

Figure 1: Forced Vital Capacity (FVC) in obese and non-obese adults

The mean FEV1 for obese is 1.652 and for non-obese is 1.909(Table.2), which was significantly different from non obese ($p > 0.05$) subjects (Figure.2).

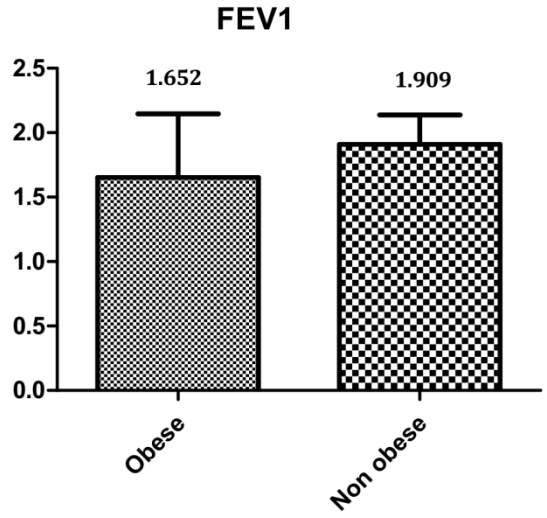

Figure 2: shows FEV1 in obese and non-obese adults.

The Mean FEV1% for obese is 81.67 and for non-obese is 89.91 (Table.2) which was significantly different from non obese ($p > 0.01$) subjects (Figure.3).

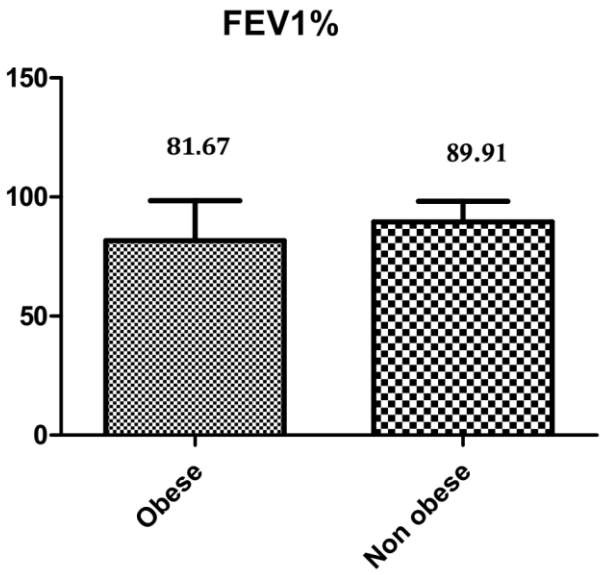

Figure 3: (FEV1%) in obese and non-obese adults.

Discussion:

Respiration is an essential function for survival of life. Any disturbance in lung function can hinder the quality and performance in activities of daily living. To maintain respiratory homeostasis, the structures that compose the respiratory system need to be in equilibrium to ensure efficient ventilation and gases diffusion. An efficient form to evaluate lung function is by determining vital capacity and its time parameter. This information is essential for

the characterization of the pathophysiological state and abnormalities in the pulmonary ventilation. The FVC is the total volume of air that exhaled forcefully after deep inspiration which is reduced in obstructive lung diseases that leads to trapping of air in the airways. The FEV_1 is the volume of air is exhaled in the first second during FVC maneuver which is used for the detection of generalized airway obstruction. FEV1% is the volume of air expired in the first and second, expressed as % of FVC. It is a potential sensitive indicator of airway obstruction, than the FVC or FEV1 alone which is reduced in central and peripheral airway obstruction[14]. In our study, we observed a decrease in FVC, FEV1 and FEV1% in obese subjects compared to non-obese controls. However FVC was not statistically significant. But FEV1 and FEV1% values were statistically significant. The reduction of FVC could be related to the alteration in ventilator mechanics in obese since the subjects did not have any respiratory disease on evaluation.

During normal respiration, the diaphragm contracts, pushing the abdominal content downwards and forwards at the same time external intercoastal muscles contracts which moves the ribs upward and forward. In obese individuals, this mechanism is restricted by excess adiposity that covers thorax and abdomen encumbers the respiratory muscles. The amount of fat accumulation in abdominal region provides more resistance to diaphragmatic movements which reduces pulmonary ventilation. Obese have increased demand for ventilation, breathing work load, respiratory insufficiency and closure of peripheral lung units[15]. Obesity adversely affects chest wall mechanics and causes a decrease in total respiratory compliance, due to deposition of subcutaneous adipose tissue. There is also a decrease in the lung compliance due to increased pulmonary blood volume. Respiratory function might also be impaired in obesity due to the mechanical disadvantage induced by changes in chest wall configuration, fat deposition and increased energy expenditure to expand the lungs. Morbid obesity may also induce restrictive disturbance of respiratory function related to reduce compliance of chest wall and pulmonary parenchyma[16].

It is important to point out that the anthropometric measurements can use to elucidate the association between obesity

and FVC. Nevertheless further research is warranted to find out precise mechanism involved for reduction in ventilatory mechanics.

The abdominal weight has a disproportionate effect on lung function that resulted in reduction in FEV1. Previous studies have reported similar findings of decrease FEV1 which was associated with increased waist circumference and waist to hip ratio. Obese individuals are far more likely to complain of dyspnea. Sleep apnea, corpulmonale, orthopnea, hypoxia and hypercapnia are the potential pulmonary consequences of obesity. Obesity can also exacerbate existing cardiovascular, pulmonary and metabolic disorders. We have reported sympathovagal imbalance in the same obese individuals. Therefore, we predict that decreased ventilatory mechanics may exacerbate existing cardiovascular imbalance in long run.[17]

The data of present study is in line with Nageswari KS et.al (2007) that the dynamic lung function tests were significantly decreased ($P < 0.04$) in obese subjects and correlated negatively with BMI. However their study population included obese children.[18]

Shiva kumar et.al (2011), Yogesh saxena et.al (2008) reported trend in decreased FEV1/FVC which were not statistically significant [19,20].

Conclusion: Obese individuals had reduced FEV1 & FEV1 % which is suggestive of altered ventilatory mechanics due to accumulation of fat in abdomen and thorax, restrictive changes & reduced work efficiency. Altered ventilation may further exacerbate existing cardiovascular abnormalities, which warrants early detection and intervention to reduce obesity induced morbidity and mortality. However, this association needs to be studied systematically & longitudinally.

Conflict of interest: None declared

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