COMPARATIVE STUDY OF DYNAMIC LUNG FUNCTION TESTS IN OBESE AND NON-OBESE INDIVIDUALS

Srinivas C.H[1], Madhavi Latha M[2], Surya Kumari N[3], Surendranath Y[4]

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ABSTRACT: BACKGROUND AND AIM: The present day global phenomenon of obesity among all age groups is causing multiple health-related issues increasing both mortality and morbidity. Functions of many organs of the body are compromised by obesity predominantly heart, liver and lungs, reducing quality of life in apparently healthy individuals. Respiratory complications form an important part of many clinical situations occurring in obese patients. Many studies have linked obstructive sleep apnoea, asthma and hypoxemia with obesity although the underlying mechanisms have not been clearly understood. **MATERIAL AND METHODS:** In this study the effect of obesity on pulmonary functions was observed in a group of adult male and female volunteers (obese and Non-Obese). Body mass index was used as index of obesity. Pulmonary function parameters used were Forced Vital capacity (FVC) (L), Forced Expiratory Volume in one second (FEV1) (L) and Peak Expiratory Flow Rate (PEFR) (L/sec). 100 adult volunteers of both the sexes, aged 25-40 yrs were randomly selected and divided into two groups based on their body mass index (BMI) - obese (BMI>30 Kg/m2) and non- obese (BMI<25 Kg/m2). Anthropometric measurements were taken and spirometric parameters were assessed following ATS protocol. **STATISTICAL ANALYSIS:** Was done using Z-test and the percentage of change in lung functions between the obese and non-obese groups in both males and females were calculated. **RESULTS:** The parameters FVC, FEV1 and PEFR were significantly lower (P=<0.001) in the obese group when compared to the non-obese group in both males and females. But the percentage of reduction in the values was more obvious in males than in the females. **CONCLUSION:** The present study showed that increase in the BMI has negative effect on the lung functions and that effect is more apparent in males when compared to females.
KEY WORDS: Lung Function Tests, BMI and Obesity.

INTRODUCTION: The prevalence of obesity is increasing at an alarming rate throughout the world, attaining epidemic proportions. The world Health Organization (WHO) has predicted that, by 2015, at least 10% of the projected world population will be obese.[1] There is wide variation in the prevalence of obesity in various regions and communities and these changes can be attributed to heredity, age, sex, dietary patterns and life style.[2] Now a common metabolic disorder, obesity has negative consequences on the human body and impairs the health and the quality of life in an individual.[3,4] Obesity has been associated with an increased risk for insulin resistance, hypertension, dyslipidemia, cardiovascular disease, non-insulin dependent diabetes mellitus, gallstones and cholecystitis, respiratory dysfunction and certain forms of cancer.[5] Obesity is also linked with a wide range of respiratory conditions like chronic obstructive pulmonary disease (COPD), obstructive sleep apnoea (OSA), and asthma,[6] even though the clear mechanism has not been presented. Without obvious respiratory illness, obese people have an increased risk of dyspnoea during exercise and this diminished exercise capacity is due to its adverse effects on respiratory

mechanics.[7, 8] Obesity alters the relationship between the lungs, chest wall and diaphragm, increasing the resistance within the system which increases the work of breathing, and affects the gas exchange.[9,10] It has been observed that fat tissue produces inflammatory mediators like C-reactive protein, interleukins etc, suggesting an immunological link between obesity and respiratory disorders, particularly asthma.[11] Some other studies indicate that the mechanisms of diminished breathing in the obese are complex and may involve central control, airway caliber and metabolic pathways.[12] The importance of associated metabolic syndrome is stressed and the strongest predictor of lung function impairment is said to be abdominal obesity rather than total body fat. [13, 14] In the present study we evaluated the effects of obesity on pulmonary function tests in the regional population without any obvious disease. Obesity is defined as a condition in which there is excess of body fat. A simple and convenient measurement of obesity is the Body Mass Index (BMI), which generally correlates highly with overall adiposity.[15] Pulmonary function tests are commonly used for evaluating the respiratory status and for managing patients with known pulmonary disease. They have become a part of the routine health examination in respiratory, occupational and sports medicine and public health screening in developed countries.[3] Pulmonary function was assessed based on the values of Forced Vital Capacity (FVC), Forced Expiratory Volume in 1st second (FEV_1) and peak expiratory flow rate (PEFR) using a computerized spirometer. Our objective was to study the relation between body mass index (BMI) and the functional lung volumes like FVC, FEV1 and PEFR in adult male and female population. We also analyzed the difference in the percentage change in volumes between males and females of obese and non-obese groups.

MATERIALS AND METHODS: The study consisted of 100 adult volunteers of both the sexes within the age group of 25-40 yrs, randomly selected over a period of six months. They were the relatives of the patients attending the Infectious diseases hospital located in the city of Guntur, Andhra Pradesh, India. The subjects included in our study were all non-smokers, aged between 25 and 40yrs, their BMI was between 20- 40Kg/m² and they all lead a relatively sedentary lifestyle. Subjects having spinal or chest deformity, cardiovascular disease, respiratory disorders or any other systemic illnesses were excluded from our study. After taking the approval from the Institutional Ethics committee, the subjects were recruited and informed written consent was obtained. The experimental procedure was carefully explained and demonstrated to the subjects. The subjects were advised to report at the laboratory of the hospital after a light breakfast without taking any stimulants like coffee or tea. They were made to rest for a few minutes and anthropometric measurements were taken. Height was measured without shoes in meters nearest to 0.1centimeter with wall mounted height measuring scale (ws708) and weight was measured nearest to 0.1kilograms on a standard weighing machine with minimal clothing. The body mass index was calculated by dividing the weight in kilograms by the square of the height in meters (kg/m²). Following the WHO classification, the study population has been divided into two groups, obese and non- obese. Obese group presented with a BMI of >30 kg/m^2 and non-obese group with BMI of <25 kg/m^2. The resting pulse rate was taken and the blood pressure was measured using sphygmomanometer.

Spirometric measurements were obtained by using a computerized spirometer (spiro-232.PK Morgan limited) and Wright's Peak flow meter (PEFR) present in the hospital. The subjects were familiarized with the equipment and they were made to sit quietly for 10 minutes. A nose clip

was applied and the mouth piece inserted taking care to prevent air leakage around it. All the measurements were done following the criteria of the American Thoracic Society[16]. Each subject performed a minimum of three acceptable respiratory maneuvers and the best of the three results was taken for analysis.

STATISTICAL ANALYSIS: The data obtained was analyzed and expressed as mean & standard deviation. The Statistical software namely SAS 9.2, SPSS 15.0 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc. For testing the significance of means, the Z -test was done between the two groups & significance was based on p value (≤ 0.05).

RESULTS: When the results were observed we found that the mean values of FVC, FEV_1 and PEFR of obese subjects (n-50) were lower than that of the non-obese subjects (n-50) with a p value of <0.001 which is statistically significant (Table -1).

Furthermore, when the obese subjects were divided into subgroups based on the gender of the subjects and compared with that of the corresponding non- obese group (graph-1, graph-2 & graph-3), we found that decrease in the mean values of FVC, FEV_1 and PEFR were more pronounced in the male obese subjects than the obese females. The percentage of decrease was FVC - 49.78%, FEV_1-44.37% and PEFR-27% in obese males, whereas in the obese female group this reduction was found to be FVC-27%, FEV_1-22.4% and PEFR-20.90%, in comparison with the non-obese female group.

DISCUSSION: Previous studies about the effect of obesity on pulmonary function showed wide variation in the study group and in the results obtained. The present study found a statistically significant reduction in the values of FVC, FEV_1 and PEFR (P-value: <0.001) in the obese individuals of both the genders. Steele et al[17] conducted a similar study and summarized that there is negative correlation between obesity and lung function in adults and these were independent of the confounding effects of physical activity and aerobic fitness. To avoid the possible confounding effect of physical activity, our study group comprised of sedentary office workers or shopkeepers who do not exercise regularly.

Reduction of FVC indicates a restrictive pattern of defect, which may be due to the mechanical limitation of chest expansion through a direct effect or by altering intercostal muscle function.[13, 17, 18] The deposition of fat around the ribcage and inside the visceral cavity creates a mechanical effect on the diaphragm, impeding its excursion and reducing the thoracic compliance.[11] Naimark at al reported that the respiratory abnormality in obesity is due to a decrease in overall compliance of the chest wall as the result of increased elastic resistance to distension. [19]

In the present study we found that both FVC, FEV_1 were reduced in the obese subjects, but the maximum percentage of reduction is seen in FVC (49.8% in males and 28% in females) than FEV_1, which is in accordance to the work by Wannamathe.[20] This can be due to redistribution of blood in the thoracic cavity reducing the vital capacity. In obese individuals a chronic low-grade systemic inflammation could predispose to airway hyper responsiveness and there may also be some intrinsic changes within the lung like cellular hyperplasia, alveolar enlargement and reductions of alveolar surface area relative to lung volume.[18, 21]

In our study we found lower level of PEFR in the obese individuals than in the control group of non-obese which is in accordance with the work of Ofuya et al done in African subjects.[22] Fat deposition reduces the movement of thoracic wall and Rubenstein et al confirmed that in obese subjects maximal expiratory flow rates were reduced at low lung volumes suggesting peripheral air flow limitation and obese people must overcome airway resistance.[23]

In our analysis we observed that the decrease in the mean values of FVC, FEV_1 & PEFR were more pronounced in the male obese subjects than in the female obese subjects. In our previous study we found that increased BMI has a significant impact on the lung function in both males and females but the effect was more pronounced in the males.[24] These results were similar to those obtained by Bottai et al[25] and can be explained by the sex- related difference in body composition and distribution of fat.

Males tend to deposit fat centrally whereas female tend to deposit peripherally and the central fat obstructs diaphragmatic movement. Abdominal fat tends to be more metabolically active and investigators like Harik khan et al[26], Canoy et al[27] and Chen et al [28] analyzed the association between the visceral obesity and the pulmonary function and reported a significant inverse relation. Chen et al [28] showed that both mean residual FVC and FEV1 were highest in the group that gained <1.0 Kg and lowest in the group that gained 4.0 KG or more reporting a significant change in lung function with changing BMI.

Limitations: The present study was a cross-sectional study; hence we could only say that increased BMI reduces pulmonary functions. We could not comment about the positive effects on the pulmonary functions that may result by reducing the BMI through proper diet and exercise, which requires a longitudinal study.

Conclusion:

The increased BMI is a significant factor in reducing pulmonary functions in both males and females and this effect is more pronounced in the males than in the females due to variation in the body fat distribution.

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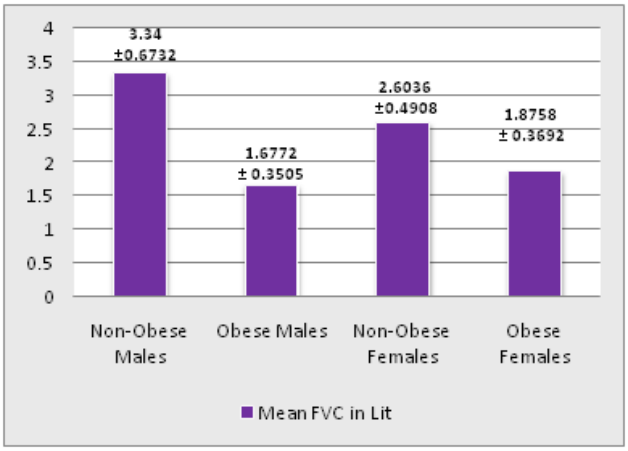
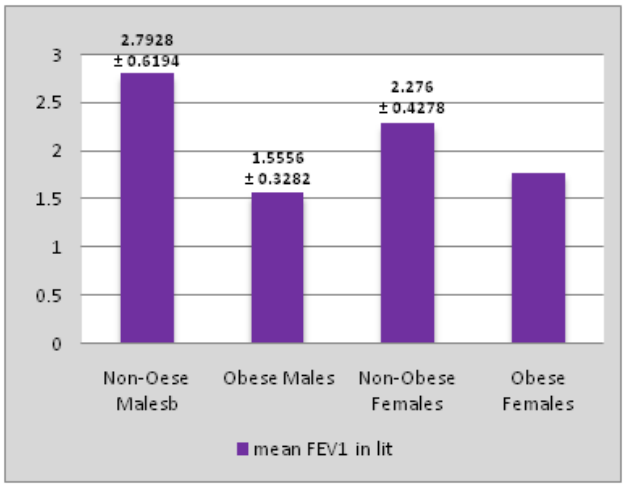
Parameter	Non-obese		Obese		Z- value	P-value
	Mean	SD	Mean	SD		
Age (yrs)	31.24	±3.65	32.28	±3.985		
BMI (Kg/m2)	22.14	±1.57	33.98	±2.307		
FVC(L)	2.9718	±0.69	1.774	±0.369	10.80484	<0.001
FEV_1(L)	2.5344	±0.58	1.66	±0.361	8.961114	<0.001
PEFR(L/sec)	5.932	±1.20	4.47	±0.859	6.982782	<0.001

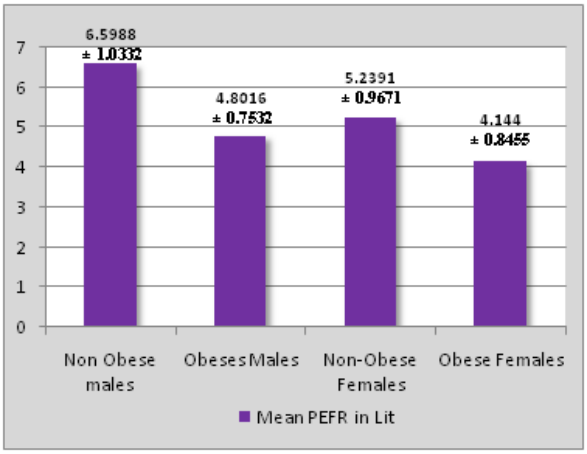
Table-1: Comparison of mean FVC, FEV1 & PEFR between obese and non-obese subjects



Graph 1:- comparison of FVC.



Graph 2:- comparison of mean FEV1.



Graph 3:- Comparison of mean PEFR in Liters/sec

AUTHORS:

1. Srinivas C.H.
2. Madhavi Latha M.
3. Surya Kumari N.
4. Surendranath. Y.

PARTICULARS OF CONTRIBUTORS:

1. Associate Professor, Department of Physiology, GSL Medical College, Rajahmundry, A.P.
2. Associate Professor, Department of Physiology, NRI Medical College, Chinakakani, A.P.
3. Assistant Professor, Department of Anatomy, GSL Medical College, Rajahmundry, A.P.
4. Tutor, Department of Anaesthesia, NRI Medical College, Chinakakani, A.P.

NAME ADRRESS EMAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Srinivas C.H,
Associate Professor,
Department of Physiology,
GSL Medical College,
Rajahmundry, A.P.
Email – chadalavadasrinivas@yahoo.com

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