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RESEARCH ARTICLE

Comparative study of body mass index and pulmonary functions between overweight and normal weight women

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ABSTRACT

Background: Obesity is a condition of abnormal or excessive fat accumulation in adipose tissue, to the extent health may be impaired. It has become one of the leading global public health problems and one of the underlying causes of non-communicable chronic diseases. It has become one of the leading causes of morbidity and mortality in both developed and developing countries. Studies have shown that overweight and obesity associated with medical disorders such as hypertension, diabetes, cardiovascular diseases, stroke, certain cancers, premature mortality, and respiratory diseases. Since morbid obesity is always associated with various other alterations, especially those of pulmonary origin, it becomes necessary to assess the respiratory functions of obese individuals. **Aims and Objectives**: To evaluate and compare the impact of obesity on pulmonary functions of obese and normal weight adult women with no history of respiratory diseases. **Materials and Methods**: A total of 70 subjects - 35 in each of the two body mass index (BMI) categories, i.e., obese, and normal weight were subjected to pulmonary function tests. **Results:** Among all the pulmonary function parameters, forced expiratory volume 1/forced vital capacity showed a significant difference between obese and normal weight subjects. **Conclusion**: The study concludes that increasing BMI has a negative effect on pulmonary functions. Therefore, awareness to maintain normal BMI by lifestyle modifications and interventions might help us in moving forward for eradication of obesity and impairment of pulmonary functions.

KEY WORDS: Pulmonary Function Test; Obese; Normal Weight; Body Mass Index

INTRODUCTION

Obesity is a condition of abnormal or excessive fat accumulation in adipose tissue, to the extent health may be impaired. It has become one of the leading global public health problems and one of the underlying causes of non-communicable chronic diseases.[1] It has become one of the leading causes of morbidity and mortality in both developed and developing countries.[2] Obesity in adult is defined as having a body mass index (BMI) that is ≥30 kg/m^2. The normal range of BMI is between 18.5 and 24.99 kg/m^2.

The prevalence of adult overweight and obesity is estimated to rapidly increase worldwide from 937 and 396 million in 2005 to 1.35 billion and 573 million in 2030.[3] India, a country with multiple ethnicities, has a varied prevalence of overweight and obesity moving across from the north to south. Furthermore, the incidence of overweight and obesity has been found to increase with age, with the middle-aged people being under higher risk compared to both their

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younger and older counterparts. The burden of overweight and obesity in India compared with rest of the world is equally worse with 36.9% and 7.8% of subjects aged between 35 and 44 years being overweight and obese, respectively.[4] This picture is expected to further worsen for the reason that in India the percentage of people in the 30–40 years range is rapidly increasing, to nearly 50% of the entire population.

Studies have shown that overweight and obesity are associated with medical disorders such as hypertension, diabetes, cardiovascular diseases, stroke, certain cancers, premature mortality, and respiratory diseases.[5,6]

Obesity can cause various deleterious effects to respiratory function such as alterations in respiratory mechanics, decrease in respiratory muscle strength and endurance, decrease in pulmonary gas exchange, lower control of breathing and limitation in pulmonary function tests (PFTs) and exercise capacity. These changes in lung function are caused by extra-adipose tissue in the chest wall and abdominal cavity, compressing the thoracic cage, diaphragm, and lungs. The consequences are decrease in diaphragm displacement, a decrease in lung and chest wall compliance, and an increase in elastic recoil, resulting in a decrease in lung volumes, and overload of inspiratory muscles. These changes are worsened with increase in BMI.

Since morbid obesity is always associated with various other alterations, especially those of pulmonary origin, it becomes necessary to assess the respiratory functions of obese individuals. Therefore, the objective of this study was to evaluate and compare the impact of obesity on pulmonary functions of obese and normal weight adult women with no history of respiratory diseases.[7]

MATERIALS AND METHODS

The present study was carried out in Tirupati, Urban areas. A total of 70 subjects - 35 in each of the two BMI categories, i.e., obese, and normal weight were selected by stratified random sampling technique after applying the inclusion and exclusion criteria. Subjects were categorized into the two groups (obese and normal weight) based on the BMI classification according to the WHO standards.

BMI (kg/m^2)	Nutritional status
Below 18.5	Underweight
18.5–24.9	Normal weight
25.0–29.9	Preobesity
30.0–34.9	Obesity

BMI: Body mass index

Ethical clearance was obtained from the institutional ethics committee before starting the study.

Inclusion Criteria

Subjects aged 25–45 years, native South Indian women, having an apparently normal general health, not practicing any form of breathing exercises or doing regular physical exercises and volunteering for the study by giving a written consent.

Exclusion Criteria

Subjects with known respiratory, cardiovascular and neuromuscular diseases, subjects with thoracic skeletal deformities, thyroid dysfunction, known diabetic subjects and pregnant ladies were excluded from the study.

The selected subjects were explained about the purpose of the study. They were also assured that the information and the results of the tests shared will be confidential and will not be passed to any agency or their employer.

- The data were collected using preformed pro forma by history taking and physical examination including measurement of height, weight, and BMI.
- BMI was calculated as weight (in kilograms) divided by height (in square meters) (Quetelet's index)

BMI Calculation

It is to test the clinical obesity. It is calculated by:

$$BMI\ (kg/m^2) = weight(kg)/height(m)^2$$

PFTs: Following explaining and demonstrating the procedure to the subject, a trial run of the procedure of spirometry was done for each one of them. Subject was asked to sit comfortably in a chair. The complete procedure was explained, all doubts if any were cleared. Subject was instructed to breathe in fully by deep inspiration with nostrils closed and seal the lips around the sterile mouthpiece of spirometer and was asked to forcefully expire as rapidly as possible.

Once the procedure was satisfactorily performed, the final recording of PFT parameters was done on each subject. Three recordings were obtained and the best of them selected for analysis. Forced expiratory volume (FEV) in 1st sec (FEV1), forced vital capacity (FVC), FEV1/FVC ratio, and FEF 25–75% were recorded ½ h after a light breakfast, using portable handheld electronic spirometer which comprises an elongated handle or body having a removable mouthpiece.

RESULTS

The present study included 70 female subjects (35 in each of normal weight and obese categories of BMI), aged 25 years and above who were apparently healthy.

Data entry and statistical analysis were performed using MS-Excel. Difference and statistical significance of mean

values and standard deviations of physical characteristics and PFT parameters between the two groups were analyzed using Student's *t*-test. Two-tailed $P < 0.05$ was considered statistically significant.

Table 1 summarizes the characteristics of the two groups with regard to various parameters recorded in this study. The means of the age showed no significant difference between the two groups. The obese significantly differed from the normal weight with their mean BMIs and also diastolic blood pressure was more in obese compared to normal weight ($P = 0.02$).

Table 2 summarizes the pulmonary function tests. Among the PFT parameters recorded, FVC and FEV1 means did not show any statistically significant difference between obese and normal weight with $P = 0.08$ and 0.73, respectively, but the values were lesser in obese group compared to normal weight. Ratio of FEV1/FVC showed a significant difference between the two groups with $P = 0.01$.

DISCUSSION

Obesity is a chronic disease characterized by excessive body fat that causes damage to individual health and is associated with comorbidities such as diabetes, hypertension, vascular dysfunction, and deleterious effects on respiratory functions.[1] Among all the harmful effects of obesity to health respiratory changes are more significant, causing decrement in the quality of life of obese individuals. In the present study, we intended to observe the pattern of change in pulmonary functions with increasing body fat as measured by BMI between obese and normal weight adult females. In our study, we observed that the abnormal pattern of pulmonary function increased with increase in BMI. FEV1 and FVC were decreased in obese compared to normal weight suggest restrictive pattern of lung function among obese. These results were similar to the studies conducted by Sudhir and Chandrashekara who observed that decrease in FEV1 was found to be significantly lower in obese compared to non-obese.[8] Decrease in FVC in obese compared to normal weight was supported by study conducted by Ray *et al*.[9] A study conducted by D canoy *et al*. also observed that both FEV1 and FVC mean values were lower among men and women with higher waist-hip ratio.[10]

Table 1: It shows the mean, SD and *P* values of age, BMI, and BP of obese and normal weight subjects

Parameters	Normal weight	Obese subjects
Age	34.03±6.01 years	35.71±6.41 years
BMI	22.51±2.12 kg/m^2	32.39±1.58 kg/m^2
SBP	124±11.2 mmHg	128±7.18 mmHg
DBP	77±4.3 mmHg	82±9.33 mmHg

BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, BP: Blood pressure, SD: Standard deviation

Table 2: It shows the values of mean, SD and *P* values of FVC, FEV1, FEV1/FVC, and FEF 25–75% of obese and normal weight subjects

PFTs	Normal weight	Obese	*P*
FVC (best)	22.15±0.85	1.86±0.39	0.08
FEV1 (best)	1.89±0.83	1.84±0.35	0.73
FEV1/FVC	95.12±8.09	98.99±2.02	0.01*
FEF 25–75%	3.22±0.33	2.74±0.37	0.82

PFTs: Pulmonary function tests, FVC: Forced vital capacity, FEV: Forced expiratory volume, SD: Standard deviation

Ratio of FEV1/FVC was more in obese than normal weight which indicates restrictive effect on lung and chest wall imparted by obesity. Accumulation of fat in obesity may mechanically affect the expansion of the diaphragm or by impeding the descent of diaphragm during inspiration. South obesity is also said to be a proinflammatory condition, induces inflammation of airways, and also increases their sensitivity, acting as a risk factor for the development of bronchial asthma.[11]

Strength of the Study

Our study concentrate on house wives who hardly find time for physical activity due to various commitments and opens the possibility of early detection of pulmonary dysfunction among them so that early intervention in the form of lifestyle modification and fitness education is provided.

Limitations

Small sample size, fewer parameters for categorizing into obese and normal weight.

CONCLUSION

The study concludes that increasing BMI has a negative effect on pulmonary functions. The study is an attempt to bring awareness about variation of lung functions with increase in BMI. The information may help to acknowledge the pulmonary health risks that crop up with increasing BMI and fat accumulation. Awareness to maintain BMI normal by lifestyle modifications and interventions might help us in moving forward for eradication of obesity and impairment of pulmonary functions. Future research with larger sample size, including other measures of obesity such as waist-hip ratio, skin-fold thickness will give more insight into effect of obesity on pulmonary functions.

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