**Scholars Journal of Applied Medical Sciences (SJAMS)** **ISSN 2320-6691 (Online)**
**Sch. J. App. Med. Sci., 2016; 4(7D):2548-2552** **ISSN 2347-954X (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublishers.com DOI: 10.36347/sjams.2016.v04i07.051

Original Research Article

# Assessment of pulmonary functions in obese individuals of selected South Indian population from Chennai

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**Abstract:** Obesity is a multi-factorial disease leading to social, psychological and medical problems. Obesity is reaching epidemic proportions in South India especially in Tamil nadu about 21.5% in males and 30.7% in females. There is paucity of large scale epidemiological studies in pulmonary function data in obese population from south India. The objective to evaluate the effects of obesity on the pulmonary function in selected obese population in Chennai. This cross sectional study included 284 subjects in which 203 were males and 81 were females belonging to Chennai Metropolitan area. After getting a relevant Medical history and clinical examination of respiratory system. Pulmonary functions were performed on all subjects using standard spirometer ((MIR SPIROBANK – Model A 23). The statistical analysis consisted of parametric or non-parametric tests, depending on the distribution of each variable, considering $p < 0.05$ to be statistically significant. Pulmonary function variables were significantly higher in normal population (FVC (4.01±0.6), FEV1 (3.26±0.4) and PEF (3.26±0.4)), when compared to obese (FVC (3.05±0.9), FEV1 (2.97±0.7) and PEF (6.66±1.6)) category in both male and female population. Males had significantly higher pulmonary functions than females. Pulmonary functions of males and females decreased as the BMI, fat mass increased, whereas increased with increase in fat free mass.
**Keywords:** obesity, BMI, fat mass, fat free mass, pulmonary functions

## INTRODUCTION:

Obesity rates have now reached epidemic proportions worldwide. WHO estimates shows that in 2014, approximately 1.9 billion adults were overweight and more than 600 million were obese. At least 42 million children under the age of 5 years were overweight globally in 2013 [1]. In developing countries like India, prevalence of obesity ranges from 30 -40% in the urban population and in South India 21.5% in males and 30.7% in females has been reported [2].

Overweight and obesity happens when there is a chronic imbalance between energy intake and actual energy requirements of the body. In many developing countries, due to urbanization, people adopt less physically active lifestyles and consume more "energy-dense, nutrient-poor" diets (WHO 2015). As a result, overweight, obesity and associated chronic health problems, such as diabetes, hypertension, cardiovascular disease, cancer, and musculoskeletal disorders, are increasing rapidly, particularly among the middle-class, urban populations [3]. It's a major contributor to the global burden of chronic disease and disability ( WHO 2015).

Obesity imposes a variety of effects on respiratory system [4]. Various studies have shown progressive loss of pulmonary function with increase in body weight and BMI [5-7]. In adults, the most frequently reported abnormalities are reductions in lung volumes and expiratory flow rates [8, 9]. Obesity has been associated with increases in the incidence and prevalence of asthma in a number of epidemiological studies of adults and children [10]. Studies have also shown that poor lung function is linked to increased mortality.

### Rationale of the study

Although epidemiologic studies have reported associations between lung function, physical activity, and disease, there is a paucity of data on pulmonary function in sedentary obese population in south India.

The purpose of this cross-sectional study was to evaluate the pulmonary functions in selected sample of sedentary population of Chennai. and also to evaluate the relationship between body composition parameters and lung functions including forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), Peak Expiratory Flow rate (PEF) in sedentary men and women.

**METHODOLOGY:**

This cross-sectional study included 284 subjects in the age group of 25 to 45 years belonging to Chennai Metropolitan area. Majority of the subjects belonged to the IT industry; others were housewives who accompanied the patients to the hospital. Subjects with history of acute illness, cardiac disorders, any surgeries in the recent past, Family history of asthma/allergies, Primary complex, wheeze, repeated respiratory infections, contact with open Tuberculosis, smoking and pregnancy were excluded. Institutional Ethics Committee clearance was obtained. Written permission was also obtained from the executive management of IT industries, after explaining to them the protocol of the study and the benefits of the study.

After getting informed consent from all the study subjects, a validated health questionnaire was used to obtain the medical history. Then respiratory examination was done. Anthropometric parameters like height and weight were measured and Body Mass Index (BMI) was calculated based on the BMI cutoff for Asian population [11]. Other anthropometric indices like Body fat, fat mass, fat free mass, muscle mass were calculated using the Standard formulas.

Pulmonary functions were measured using a standard portable data logging Spiro meter (MIR SPIROBANK – Model A23). Spirometer used performs as per the specifications of The American Thoracic Society (ATS). All the volumes were corrected to conditions of Body temperature and pressure saturable with water vapor (BTPS). The best values of Forced Vital Capacity (FVC), Forced Expiratory Volume at the end of one second (FEV1), and Peak Expiratory Flow were used for analysis provided that these values come from technically acceptable tests. ATS criteria were followed for excluding the poor invalid efforts. Most of the sources of variation in pulmonary function assessment such as motivation and effort, body position were controlled. Single investigator was involved in the recording of the pulmonary functions to control inter – investigator variability.

**RESULTS:**

. The descriptive statistics of the study population is given in table 1. This cross sectional study involved 284 subjects in which 203 were males and 81 were females. The study population were categorised into normal and obese based on their Body Mass Index. Height was not significantly different between two groups but significant difference was observed between two groups.

Normal subjects were with BMI less than 22.9 and obese subjects BMI was more than 27.5kg/$m^2$. Females had higher BMI, percent body fat and fat mass as compared to males. Males had higher fat free mass and muscle mass as compared to females.

Pulmonary function variables such as FVC, $FEV_1$ and PEF were significantly higher in normal population when compared to obese category in both male and female population. Males had significantly higher pulmonary functions than females.

**Table 1: Descriptive parameters of the study population**

| **Parameters** | **Normal (BMI less than22.9 kg/$m^2$)** | | **Obese (BMI above 27.9 kg/$m^2$))** | |
|---|---|---|---|---|
| | **Males (75)** | **Females (32)** | **Males (128)** | **Females (49)** |
| Height (cm) | 170.5±7.6 | 157.2±7.3 | 169.1±6.6 | 155±6.9 |
| Weight (kg) | 66±8.0 | 54.4±9.4 | 84.6±10.7 | 77.4±14.8 |
| Body Mass Index (Kg/$m^2$) | 22.6±2 | 21.8±2.5 | 29.6±3.5 | 32.2±6.2 |
| % Body fat | 17.3±3.6 | 26.8±2.9 | 24.4±5.4 | 43.2±9.1 |
| Fat mass | 11.6±3.3 | 14.8±3.7 | 23.5±7.3 | 32.5±14.8 |
| Fat free mass | 53.7±7.0 | 39.5±5.8 | 61.0±6.2 | 42.9±5.5 |
| Muscle mass | 26.1±4.0 | 21.7±3.7 | 33.8±4.3 | 30.9±5.9 |

Data expressed as mean ± SD.

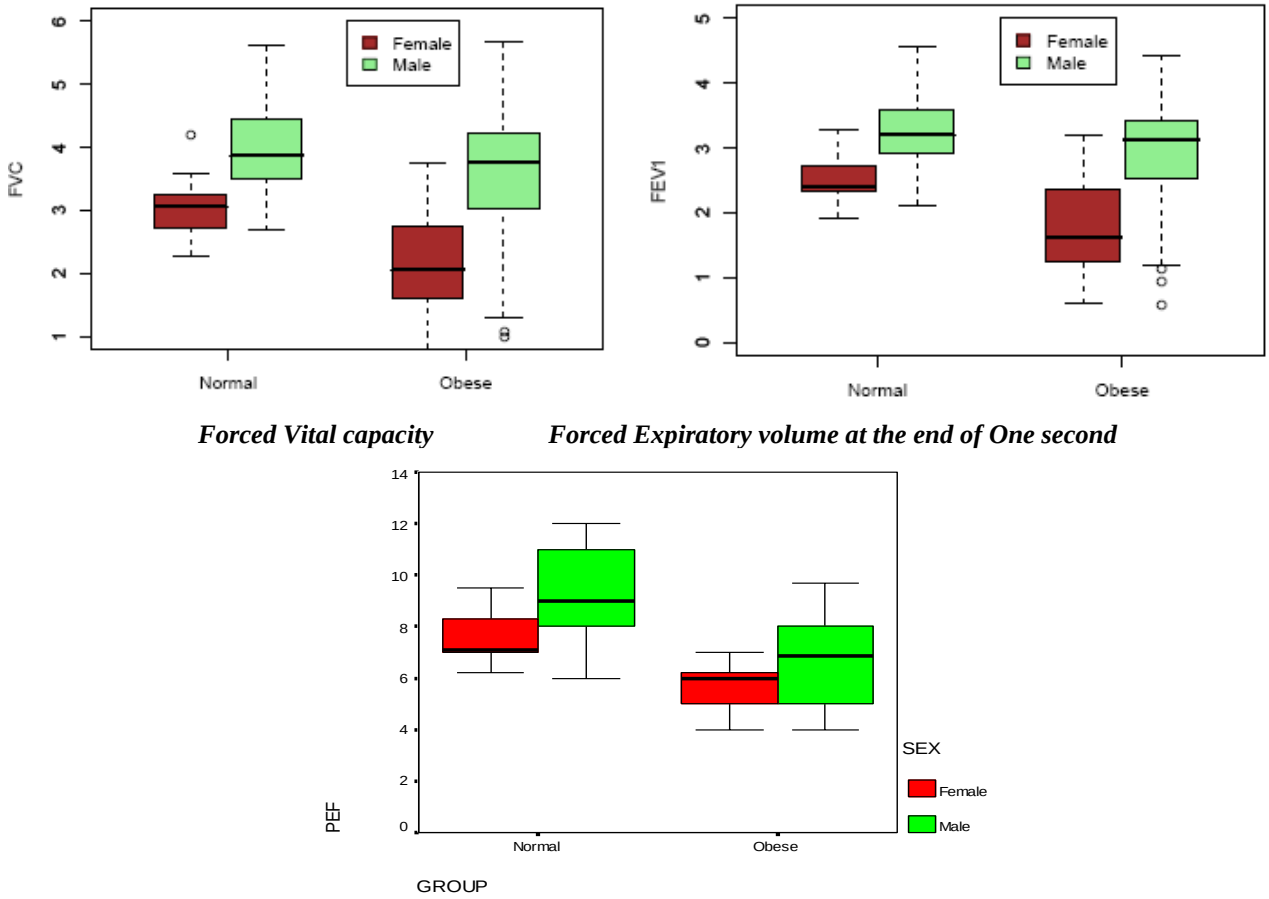
**Table 2: Comparison of the Pulmonary functions between normal and obese population**

| Parameters | Normal* | | Obese | |
|---|---|---|---|---|
| | Males† | Females | Males† | Females |
| FVC (L) | 4.01±0.6 | 3.08±0.5 | 3.05±0.9 | 2.23±0.7 |
| $FEV_1$ (L) | 3.26±0.4 | 2.48±0.4 | 2.97±0.7 | 1.84±0.6 |
| PEFR (L/Sec) | 9.28±1.6 | 7.44±1.3 | 6.66±1.6 | 5.53±1.0 |

Data expressed as mean ± SD.

FVC- Forced vital capacity; PEFR – Peak expiratory flow rate $FEV_1$-Forced expiratory volume at the end of first second

**Comparison was done using Independent t test**




***Forced Vital capacity*** ***Forced Expiratory volume at the end of One second***

***Peak Expiratory flow Rate***

**Fig 1: Comparison of the Pulmonary functions between normal and obese population**

**Analysis of Association of Pulmonary Function Parameters with Anthropometric Parameters of the Study Population**

**Table-3: Correlation of FVC and FEV1 with BMI, % Body Fat, Fat Mass and Fat Free mass**

| | *FVC (L)* | *$FEV_1$ (L)* |
|---|---|---|
| BMI (kg/m2) | - 0.55 | - 0.43 |
| %Body fat | - 0.73 | - 0.73 |
| Fat mass (kg) | - 0.53 | - 0.54 |
| Fat free mass (kg) | 0.67 | 0.65 |

FVC- Forced vital capacity; BMI – Body mass index

$FEV_1$-Forced expiratory volume at the end of first second

'r' values (correlation coefficient) are represented in the table. All the values were statistically significant ($p<0.05$).

Pulmonary function parameters were linearly correlated with the anthropometric parameters, which were statistically significant. FVC and $FEV_1$ had positive correlation with fat free mass and negative correlation with Body mass Index, percent body fat and fat mass.

**DISCUSSION:**

The present study was designed to gain an insight into the respiratory health status evidenced by pulmonary function data in sedentary individuals who represented a cross-section of urban, middle socio-economic class population in the age group of 25 to 45 years residing at Chennai metropolitan area.

The study has demonstrated that the pulmonary functions of normal whose Body mass Index was less than 22.99 was significantly higher than the obese group whose BMI was more than 27.99. This study has also evaluated the association of pulmonary function and anthropometric indices such as BMI, Fat mass and Fat Free mass.

Males of the study population had higher fat free mass and muscle mass where as females had higher percent body fat as expected which suggests that the study population was indeed a representative sample selected randomly. This also ascertains the robustness of the data of this study.

There was a positive significant relationship between the FFM versus FVC and $FEV_1$ values of study population. A negative significant relationship was demonstrated between body FM, BMI and FVC of all subjects. Studies have shown that changes in body composition and fat distribution could be major contributing factor in the lung function decline observed with aging [12]. Adiposity, especially of chest and abdomen was considered to restrict the normal movements of chest and diaphragm [13].

Respiratory function is impaired in obesity due to alterations in Physiologic and Pathophysiologic mechanisms, and the work of breathing is also increased. This is mainly due to accumulation of fat around the ribs, abdomen, and diaphragm,which leads to stiffness of the thorasic cage. According to many studies, even in healthy adults abdominal obesity is negatively associated with lung function [14, 12, 5].

Studies have reported that by using appropriate ventilatory muscle training programs, ventilatory muscle strength or endurance can be increased [15]. Further, muscle strength and lung function are closely related to lean body mass in patients with chronic obstructive airway disease [16].

Reduction in functional residual capacity (FRC) is uniformly observed in obesity, due to the effect of the abdominal contents on the position of the diaphragm [17, 18]. Normally in Obesity, tidal volume is reduced and it does not increase during times of dynamic stress such as exercise [19]. Moreover, in morbid obesity, the majority of tidal breaths are taken around the closing volume.

Many studies have come up with a notion that obesity is an inflammatory state. Studies have shown a definite associations between obese state and tumour necrosis factor alpha (TNF alpha), interleukin 6 (IL-6) and C-reactive protein [20]. Inflammatory mediators and immunomodulators could have role to play in the decline in pulmonary functions observed in obesity.

Studies have also demonstrated that pulmonary function improves after induced weight loss. Various cross-sectional and longitudinal studies done in a large population have amply confirmed the close association between physical activity and FEV1, independent of age, height, body mass index, waist-hip ratio, and smoking. On top of this, FEV1 is an important prognosticator for cardiovascular complications and all-cause mortality [21, 22]. Preventive measures such as dietary modifications and physical activity should be implemented to reduce prevalence of obesity.

**LIMITATION OF THE STUDY**:

First, the data analysis of this study is based on cross-sectional data, where prevalence of overweight and obesity is measured at the time of the survey. This cross sectional study design cannot assess the chronic or permanent functional loss resulting from obesity and potential reversibility. Second, the study collected limited information on lifestyle, physical activity, and diet.

To disentangle the effects of overweight and obesity on pulmonary functions, carefully designed prospective epidemiological studies are needed.

**FUTURE IMPLICATIONS**:

Longitudinal studies are required from developing countries to generate substantial and accurate evidence regarding the relationship between obesity and ventilatory function. Such studies can also generate the measures of risk of developing pulmonary impairment in obesity. Interventions can be planned using the results of such studies and the effectiveness of intervention can also be assessed.

Awareness program, Dietary intervention, Physical activity intervention studies will also provide the evidence of causality and reversibility. Prevention of obesity will reduce mortality and morbidity.

**SUMMARY & CONCLUSION**:

- Pulmonary functions data of sedentary obese population of metropolitan Chennai has been presented in this study.

- Pulmonary functions of both males and females decreased as the BMI, fat mass increased, whereas increased with increase in fat free mass.
- Results presented here is a part of an ongoing large scale health survey in individuals engaged in sedentary lifestyle.
- Pulmonary function results indicate a need for regular health monitoring program for individuals engaged in sedentary occupation.

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