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Original Research Article

Comparison of Peak Expiratory Flow Rate in Obese and Non-Obese Women

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ABSTRACT

Background: Obesity is a condition in which excess body fat has accumulated to the extent that it may have negative effect on health. In recent years it has reached epidemic proportion among young females in whom it has become an increasingly important medical problem. Peak expiratory flow rate (PEFR) is most commonly used method to monitor lung function. It is the largest expiratory flow rate achieved with a maximally forced effort from a position of maximal inspiration. It is measured with peak expiratory flow meter which is a small hand-held device.
Aim: The aim of the study is to Compare Peak Expiratory Flow Rate in obese and non-obese women.
Objectives: Obese women, without obvious respiratory illness, have an increased risk of dyspnoea during exercise or during sight increase in physical activity. This can lead to early and easy fatigability in the women leading to sedentary life style. Thus, there is need to find the effect of increased body mass index on peak expiratory flow rate in obese women as compared to non-obese to adequately formulate exercise prescription for improving functional capacity and weight reduction for obese women.
Methods: The study included 164 women, 82 obese (BMI $\geq$ 25 kg/m^2) and 82 non obese (BMI 18.5-22.9 kg/m^2). Women with age of 20-40 year old. Women having cardio or pulmonary condition were excluded. PEFR was measured by using Cipla™ Mini wright peak flow meter as per EU scale in standing position. Three measurements were taken and the highest was recorded.
Results: The mean and standard deviation of PEFR in obese women was 252.9 ±37.66 L/min and in non-obese women was 339.3±42.74 L/min. Comparison was done by using Mann Whitney test. P value of < 0.0001 was obtained.
Conclusion: The PEFR values were significantly lower in obese women as compared to non-obese women.

***Keywords* –** Peak expiratory flow rate, Body mass index (BMI), obese, non- obese, Mini wright peak flow meter.

INTRODUCTION

Obesity is a condition in which excess body fat has accumulated to the extent that it may have negative effect on health. [1]

In India the prevalence of obesity ranges from 10%-50% and morbid obesity affecting 5% of the country's population. In recent years it has reached epidemic proportion among young females in whom it has become an increasingly important medical problem. [2,3] More than 23% of women are either overweight or obese, which is higher than the prevalence among men (20%).[4] This is because predisposition to fat accumulation is a common occurrence in women as sex hormones strongly influence adipocyte metabolism. [2] The prevalence of obesity among Indian women has elevated by 10.6% to 12.6% from past 2 decades. [5]

Obesity is measured by calculating body mass index. Body mass index (BMI) is a simple index of weight-for-height that is commonly used to classify overweight and obesity in adults. It is defined as a person's weight in kilograms divided by the square of height in meters (kg/m^2). [6] As per Asian Indian guidelines, people are categorized as underweight (<18.5 kg/m^2), normal or lean BMI (18.5–22.9 kg/m^2), overweight (23.0 – 24.9 kg/m^2) and obese (≥25 kg/m^2). [7]

Excess body weight and fatness increases a threat to both quality and duration of one's life. The etiology of obesity is complex and multifactorial and results from the interaction of genes with the environment, lifestyle and emotional factors. The modern lifestyle is a potent risk factor for obesity. Declining physical activity levels and increased caloric intake are important environmental factors contributing to obesity. [8]

Obesity is associated with co morbidities such as diabetes, hypertension, vascular dysfunction, cardiac disease and respiratory problems. [8]

Peak expiratory flow rate (PEFR) is most commonly used method to monitor lung function. [2, 8] It is the largest expiratory flow rate achieved with a maximally forced effort from a position of maximal inspiration. It is expressed in litres/min. [9] PEFR It is effort dependent and reflects mainly the caliber of the bronchi and larger bronchioles which are subjected to reflex bronchoconstriction. [9] It is a fairly good indicator of bronchial hyper-responsiveness. [10] PEFR reaches a peak at about 18-20years of age, maintains this level up to about 40years in females and then declines with age. [11] It is an important tool to identify the degree of obstruction in the airways by measuring air flow through the bronchi. PEFR is influenced by various factors such as age, height, gender and environmental conditions. [12] It is commonly applied as a quick screening method for assessing lung function in the clinic or at the bedside. [2] It is measured with peak expiratory flow meter which is a small hand-held device. It works on the principle of a variable orifice to measure airflow indirectly. The pressure exerted by a forced expiration causes a diaphragm or vane to move and while doing so it opens a progressively larger area of the orifice. The point at which no further movement of the diaphragm occurs depends on the maximal pressure and thereby peak expiratory flow that has been generated. [13]

The primary factors that affect PEFR are the strength of the expiratory muscles generating the force of contraction, the elastic recoil pressure of the lungs and the airway size. [10] In obese women these factors can be compromised due to fat deposition and airway hyper responsiveness.

Obesity is linked with a wide range of respiratory conditions like chronic obstructive pulmonary disease (COPD), obstructive sleep apnea (OSA) and asthma. [14] Obese women, without obvious respiratory illness, have an increased risk of dyspnea during exercise or during sight increase in physical activity. This occurs due to increase in oxygen cost of breathing as the total energy required by the respiratory muscles to overcome respiratory mechanical factors, such as airway resistance, lung compliance and chest wall resistance increases due to fat deposition. [15] So even with a slight increase in ventilation from resting levels, the oxygen cost of breathing increases which can cause dyspnea. This can lead to early and easy fatigability in the women leading to sedentary life style.

Thus there is need to find the effect of increased body mass index on peak expiratory flow rate in obese women as compared to non-obese to adequately formulate exercise prescription for improving functional capacity and weight reduction for obese women.

MATERIALS AND METHODS

After obtaining Institutional Ethical clearance the present study was conducted. The sample size of the study was 164 women, out of which 82 were obese women (BMI $\geq$25kg/m^2) and 82 were non obese women (BMI 18.5 to 22.9 kg/m^2).Obese and Non-obese women coming to the Physiotherapy OPD of tertiary care hospital for prevention and treatment of obesity were recruited for the study according to the inclusion and exclusion criteria. The nature of study was explained to the subjects in the language best known to them and signed informed written consent was obtained.

Inclusion and Exclusion criteria- Age group of women between 20 to 40 years with BMI $\geq$ 25kg/m^2 i.e. obese group and BMI between 18.5 to 22.9 kg/m^2 i.e. non-obese group were included in this study. Subjects suffering from cardiac and pulmonary diseases, with chest or spinal deformity, Alcoholics, smokers and tobacco consumers were excluded from the study. Subjects undertaking regular physical exercise training were also excluded from the study.

BMI calculation: Weight was measured with participants lightly dressed and without shoes using a Digital bathroom weighing machine to the nearest 0.10 kg [16] and height was measured without shoes using a wall mounted measuring tape. BMI was calculated as weight (kg) divided by height (m) squared.

Peak Expiratory Flow Rate measurement: PEFR was measured by using Cipla™ Mini wright peak flow meter as per EU scale. [17] Subjects were asked to stand up and hold the peak flow meter without restricting the movements of the marker.Subjects were taught to blow fast and hard through the disposable mouth piece by making tight seal around it. Subject were asked to take a deep breath, put the disposable mouth piece into the mouth and breathed out as hard and fast as she can with the nose clip on. Position of the head in a neutral position, neither flexed nor extended. [18] Three measurements were taken and the highest was recorded.

STATISTICAL ANALYSIS:

Data was entered in Microsoft excel and was analysed using Graph pad prism version 6. Normality of the data was measured using Shapiro Wilk normality test and the data collected was found to be not normally distributed. Comparison of PEFR in obese and non-obese women was done using Mann Whitney test. The test was carried out at 5% significance. Confidence interval (CI) of 95% was chosen. P value <0.05 was considered to be statistically significant.

RESULTS

The mean and standard deviation of baseline categorical data (age, height, weight and BMI) in obese and non-obese women is shown in table 1.

Table 1. Mean and standard deviation of baseline categorical data in obese and non-obese women.

	Obese women (82)	Non obese women (82)
Age (years)	31.54 ± 6.40	29.66 ± 6.12
Height (cm)	152.6 ± 5.3	154.2 ± 5.59
Weight (kg)	66.69 ± 8.9	49.45 ± 5.87
BMI (kg/m^2)	28.83 ± 3.11	20.88 ±1.46

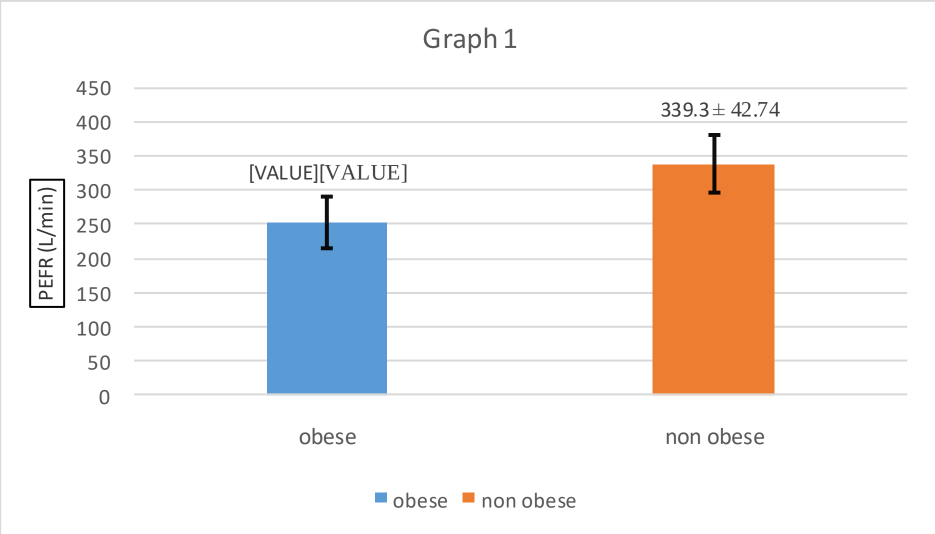
The mean and standard deviation of peak expiratory flow rate values in obese and non-obese women are shown in table 2.

Table 2 Mean and standard deviation of PEFR values observed in obese and non-obese women

	No of subjects	MeanPEFR (L/min)	Std. deviation
Obese (BMI $\geq$25kg/m^2)	82	252.9	37.66
Non obese (BMI 18.5 – 22.9kg/m^2)	82	339.3	42.74

Comparison of PEFR was done between 82 obese women (BMI $\geq$25kg/m^2) and 82 non-obese women (BMI 18.5 to 22.9 kg/m^2). The mean and standard deviation of PEFR in obese women is 252.9 ±37.66 L/min and in non-obese women is 339.3±42.74 L/min.

Comparison was done by using Mann Whitney test. P value of < 0.0001 was obtained which indicates that the difference is highly significant (p value < 0.05). Thus PEFR values were significantly lower in obese women as compared to non-obese women.



Graph 1. Comparison of PEFR in obese and non-obese women

DISCUSSION

In our study, Peak expiratory flow rate (PEFR) was compared between obese and non- obese women. The sample consists of 82 obese (BMI≥25kg/m^2) and 82 non obese (BMI 18.5 to 22.9 kg/m^2) women between age group 20 to 40 years. Peak expiratory flow rate was measured using a mini wright peak flow meter in standing position and statistical analysis was done using graph pad prism version 6.

The results of our study revealed that Peak expiratory flow rate recorded using a mini wright peak flow meter was significantly lower in obese women when compared with non-obese women.

In healthy individual primary factors that affect PEFR is the strength of the expiratory muscles generating the force of contraction, the elastic recoil pressure of the lungs and the airway size. The lower values of PEFR could be linked to obesity through several mechanisms. In obese individual, the normal respiratory biomechanics is altered. Excess body fat lines the chest and occupies the abdomen limits the action of the respiratory muscles. These structural changes in the thoracic-abdominal area restrict diaphragmatic mobility and rib movement, which promotes changes in the dynamics of the respiratory system and reduces its compliance, leading to mechanical impairment of the respiratory muscle. [8, 14]

With increase in fat deposition, static lung volumes- expiratory reserve volume (ERV), functional residual capacity (FRC) and total lung capacity (TLC) reduces. [8, 14, 19] Elevated intra-abdominal pressure due to fat deposition is transmitted to the chest which dramatically reduces the FRC and ERV. Reductions in ERV and FRC may lead to abnormalities in ventilation distribution, with closure of airway in dependent zone. This can lead to mismatch of ventilation perfusion ratio. Thus requires obese individual to breathe in a less efficient part of their pressure-volume curve, which in turn increases the work of breathing. [8]

Adipose tissue is an endocrine and energy storage organ composed of adipocytes, fibroblasts, endothelial cells, and immune cells. These cells secrete hormones and cytokines (adipokines) that exert endocrine, paracrine, and autocrine functions. [8] Under physiological and pathological conditions, adipokines induce the production of reactive oxygen species, which trigger oxidative stress. During this process, immune cells produce free oxygen radicals that promote a systemic proinflammatory state. These effects favour the development of bronchial hyper responsiveness even in non- asthmatic individuals. This hyper responsiveness of the airway due to its underlying inflammatory nature can compromises the size of the airway leading to alter lung functioning. [8, 14, 20, 21]

Hence, altered mechanical muscular activity due to adiposity, altered airway calibre and increases respiratory resistance may be responsible for the reduced lung functioning and lower PEFR in obese women.

So our study is an attempt to bring awareness about change in lung function with increase in BMI by comparing PEFR in obese and non-obese women. This will help to acknowledge the pulmonary health risks that are associated with increasing body mass index and fat accumulation.

Our findings are consistent with the findings of Kumar D, et al. [22] Aim of his study was to assess PEFR in obese and non-obese subjects in western Uttar Pradesh. PEFR was compared between 84 obese and 134 non obese subjects within the age group 20-60years and results revealed a significantly lower PEFR values among obese subjects compared to non-obese subjects.

Similar results of our study are also noted by Laxmikantborsre, et al. [23] Aim of the study was to find the effect of body weight on PEFR in 1st year medical students. 78 healthy males were included of age group 18-22 years and divided into three groups on the basis of BMI. Out of 78 students, 26 were overweight (BMI >23kg/m^2), 26 were underweight (BMI <18.5kg/m^2) and 26 were normal weight (BMI between 18.5 to 22.9kg/m^2). Results revealed that PEFR values of overweight student are significantly less than normal weight and less than underweight students.

In a study done by Jnaneshwara P Shenoy, et al [18] included 186 female medical students in age group 18-22 aimed to assess the impact of adiposity markers on PEFR. The study groups were divided into 3 groups based on BMI (normal 18.5 to 22.9 kg/m^2, overweight 23-24.9kg/m^2 and obese > 25kg/m^2). Waist circumference, waist to hip ratio and waist to height ratio were measured as measure of central obesity along with PEFR. They observed a negative correlation with adiposity markers and PEFR and it was more related to central obesity than BMI and mean value of PEFR did not show significant difference when compared between three groups.

In a study ‘correlation between peak flow and body mass index in obese and non-obese children in Kocaeli, Turkey’ by Zuhal Gundogdu [24] data was collected from 1439 children during public health screening showed that PEFR values were lower in obese children than in non-obese children and showed an inverse relation between PEFR and BMI.

In a study by Dr. Nirupama M [25] effect of BMI on PEFR was found in 20 to 30 years age group in 60 females. Results revealed a negative correlation between BMI and PEFR.

A study was performed by Chaudhari Prajakta and Jadhav Archana [6] to study effect of gradual weight reduction in groups with different weight loss targets on peak expiratory flow rate. The study group included 90 obese individuals (both males and females) BMI >25kg/m2 aged between 18-30 years enrolled for weight reduction program. They were categorized in three groups depending on target weight loss, Group1-Individuals with target weight loss >10kgs, Group2-Individuals with target weight loss between 5kg to 10 kg and Group3-Individuals with target weight loss <5 kg. PEFR was measured before and after target weight loss and compared in different groups. Results showed that there was significant gain in PEFR in all the groups with highly significant gain in PEFR in group 1 after weight loss indicating significant improvement in PEFR with weight loss.

Thus, it is evident from our study that PEFR values are lower in obese as compared to non- obese. This indicates that obesity significantly affects pulmonary functions and hence weight reduction protocol with respiratory muscle endurance and strength training should be incorporated in exercise regime of obese women to reduce the effect of obesity on pulmonary functioning.

CONCLUSION

The study aimed at comparing PEFR in obese and non-obese women and results conclude that PEFR values were lower in obese women when compared with non-obese women.

This indicates that obesity is an important risk factor for airflow limitation and lung function in obese women.

Hence regular monitoring of PEFR, a simple and easily measurable parameter, should be done in obese women as it is an important tool to assess the effect of obesity on lung functioning.

Abbreviations

BMI – Body mass index
COPD - Chronic obstructive pulmonary disease
ERV - Expiratory reserve volume
FRC- Functional residual capacity
OSA - Obstructive sleep apnea
PEFR – Peak expiratory flow rate
TLC - Total lung capacity

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