The Type of Obesity and Its Impact on Pulmonary Functions

Dr. Dipti. V. Thakker*, Dr. VirenKariya **

* Assistant Professor, Physiology Department, B J Medical College, Ahmedabad,* *Associate Professor, GMERS Medical College, Sola,Ahmedabad

Abstracts: Obesity has been associated with many health consequences, including but not limited to diabetes, hypertension, hyperlpidemia, ischemic heart diseases, obstructive sleep apnea, stroke, premature death, osteoporosis and a reduction of the overall quality of life. Obesity affects the respiratory system as well. To investigate the effect of obesity on the respiratory system, most researchers use values of pulmonary function tests (PFT). Poor respiratory function and obesity are associated with all-cause and cardiovascular disease mortality. Obese persons may also have impaired lung function, but the mechanism is unclear. Waist:hip ratio was used to assess abdominal obesity, and forced expiratory volume in 1 second (FEV_1) and forced vital capacity (FVC), obtained by spirometry, were used to assess respiratory function. Both FEV_1 and FVC were linearly and inversely related across the entire range of waist:hip ratio in both men and women. **Objectives of the study:** 1) To evaluate the effect of obesity on pulmonary functions. 2) To find out whether there is any difference in breathing pattern with the type of obesity. 3) To identify the effect of central obesity on derangement of pulmonary functions. [Thakker D NJIRM 2014; 5(6):11-15]

Key Words: The Type of Obesity and Its Impact on Pulmonary Functions

Author for correspondence: Dr.Dipti v ThakkerAssistant Professor, Physiology Department, B J Medical College, Ahmedabad **Email:** vbkvbk79@gmail.com

Introduction: Obesity is a chronic medical condition characterized by an excessive accumulation of fat on human body that causes a generalized increase in body mass. It is measured by using body mass index (BMI) which is a reflection of weight and height. Body mass index (BMI) is calculated as the weight in kilograms divided by the square of the height in meters (BMI = weight (kg)/height (m2)). The world Health Organization (WHO) classified obesity using BMI cut-off values of 25 and 30 kg/m^2. Body mass index (BMI) of 18 to 24.9 kg/m^2 is considered normal weight, a BMI of 25.0-29.9 kg/m^2 is considered overweight and a BMI of 30 kg/m2 or higher is considered obesity [1].

Obesity causes reduced strength and endurance of the respiratory muscles, altering lung compliance and chest wall impedance. It may lead to ventilation-perfusion abnormalities.

In obese people, the presence of adipose tissue around the rib cage and abdomen and in the visceral cavity loads the chest wall and reduces functional residual capacity (FRC). The reduction in FRC and in expiratory reserve volume is detectable, even at a modest increase in weight. However, obesity has little direct effect on airway calibre. Spirometric variables decrease in proportion to lung volumes, but are rarely below the normal range, even in the extremely obese, while reductions in expiratory flows and increases in airway resistance are largely normalized by adjusting for lung volumes.

Thus obesity has effects on lung function that can reduce respiratory well-being, even in the absence of specific respiratory disease, and may also exaggerate the effects of existing airway disease.[2]

In the general adult population, abdominal fat deposition may play a role in the impairment of respiratory function among the abdominally obese people.

The factors that usually affect the values of pulmonary function tests are age, gender, height, race or ethnic origin and possibly obesity. As the individual gets older age, the lung volumes and capacities become smaller and the lung volumes and capacities are larger in males than females [3]. Weight may have effects on pulmonary function tests including impairment on pulmonary function testing, small airway dysfunction and expiratory flow limitation, alterations in respiratory mechanics, decreased chest wall and lung compliance, decreased respiratory muscle strength and endurance, decreased pulmonary gas exchange, lower control of breathing, and limitations in exercise capacity [4,5].

Aims and Objectives:

- To evaluate the effect of obesity on pulmonary functions.
- To find out whether there is any difference in breathing pattern with the type of obesity.
- To identify the effect of central obesity on derangement of pulmonary functions

Material and methods: The study was conducted in 87 randomly selected subjects. The subjects were divided into overall obese, centrally obese and non obese group based on BMI (indicator of overall obesity) and WHR (indicator of central obesity). All the subjects underwent standardized pulmonary function tests. The instrument used for pulmonary function tests is "Medspiror". FVC, FEV1, FEV3, FEF 25-75%, FEV1/FVC, FEV3/FVC and MVV are the key parameters for pulmonary functions

Observation and results:

Table 1: Number of Subjects In Each Group

Group	Numbers
Non-obese	25
Overall Obese	23
Centrally obese	35
Total	87

Graph 1: Number Of Subjects In Each Group

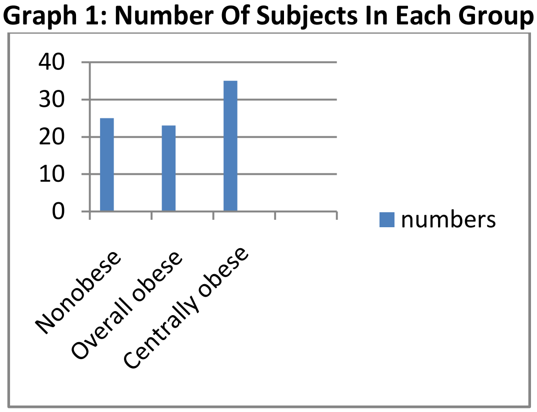


Table 2: Effect of Obesity on Pulmonary Functions

	Non obese group	Overall obese group	p value
FEV1	Normal	Reduced	>0.05
FEV3	Normal	Reduced	>0.05
FVC	Normal	Reduced	>0.05

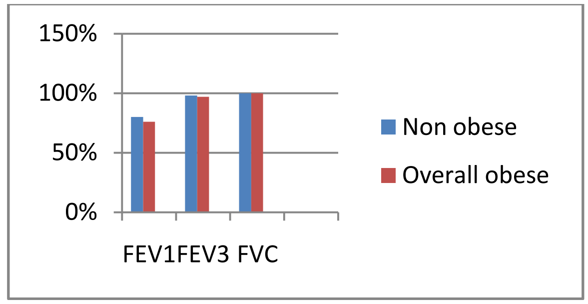
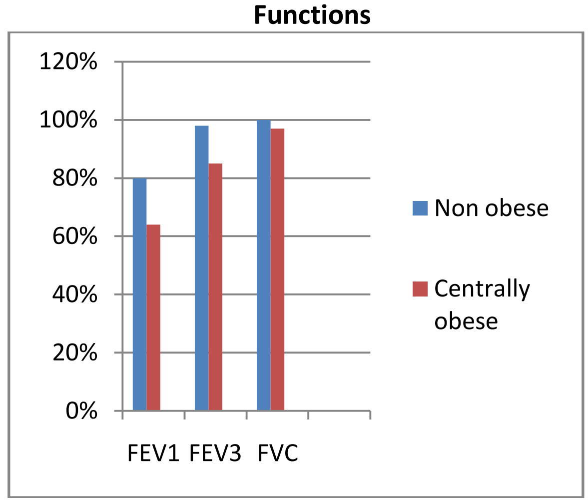


Table 3: Effect of Central Obesity on Pulmonary Functions

	Non obese group	Centrally obese group	p value
FEV1	Normal	Reduced	<0.05
FEV3	Normal	Reduced	<0.05
FVC	Normal	Reduced	<0.05

Graph 3: Effect of Central Obesity On Pulmonary Functions



Discussion: An inverse relation between respiratory function and abdominal obesity was observed in this population of men and women who had no previously known heart disease, stroke, or cancer. Both FEV_1 and FVC mean values were lower among persons in the higher quintiles of waist:hip ratio, and this relation was consistent for both men and women. This relation remained significant even after adjustment for age, height, body mass index, cigarette smoking, physical activity, prevalent bronchitis/emphysema, prevalent asthma, and social class. Even among relatively healthy nonsmoking persons without preexisting respiratory disease, the association was significant.

Persons who had prevalent serious illness (those who had heart disease, stroke, or cancer at baseline) were excluded from the analyses. We also excluded from our analyses persons who had missing data on respiratory function measures. These persons had higher waist:hip ratios than persons included in this study. Hence, it is more likely that our study could only underestimate any true association in the general population. Exclusion of obese persons (body mass index >30) from the analyses did not significantly change the results. As in other reports, age and height were important determinants of respiratory function [6,7,8], and taking these variables into account attenuated the variation of the mean FEV_1 and FVC values across waist:hip ratio quintiles.

Obesity and respiratory function could both reflect some underlying common etiology. The inverse relation with respiratory function is consistent with the findings of other studies that measured waist:hip ratio [9,10]. Of all the various indices of obesity, waist:hip ratio had the most consistent negative independent correlation with lung function in our cohort. This result differed from that of the study by Collins et al. [11], where lung function was more strongly negatively correlated with body mass index than waist:hip ratio. Although waist circumference, on its own or when adjusted for body mass index, is less related to respiratory function, adjusting further for height showed a strong inverse relation between lung function and waist circumference. The collinearity of waist circumference with body mass index makes the independent effect of waist circumference more difficult to interpret. Nevertheless, it is plausible that waist circumference, as an indicator of abdominal fat deposition, has to be understood in the context of body size to allow us to understand its full effect on respiratory function.

Obesity may directly affect respiratory function through various mechanisms. The accumulation of fat may mechanically affect the expansion of the diaphragm, probably by encroaching into the chest by the chest wall or diaphragm [12] or by impeding the descent of the diaphragm during forced inspiration [13.] Low FEV1 and FVC values suggest restrictive lung patterns among obese persons [14.] Fat deposits between the muscles and the ribs may also decrease chest wall compliance [15,] thereby increasing the metabolic demands and workload of breathing in the obese even when at rest [15].

Summary: Among the harmful effects of obesity to health, the respiratory changes represent an additional factor of functional limitation and detriment to the quality of life of obese individuals. In assessing the impact of obesity on the pulmonary function of adult who were non-smokers and presented no history of lung disease or prior changes in the pulmonary function tests, important and significant differences were found between obese and non-obese subjects for the ERV, IRV, and MVV. According to the results, such differences can be attributed to obesity.

One of the most significant findings regarding changes in ventilation caused by obesity was the reduction in the ERV[11-15,19] confirmed by our results. This fact is attributed to the reduction of the diaphragm mobility in the chest, as the diaphragm is pressed upwards due to the expanded abdominal volume of obese individuals, a mechanical disadvantage for this muscle. Another factor that may lead to the reduction in the ERV is the pulmonary compliance due to obesity.[20] Besides these detrimental mechanical aspects to the pulmonary function of obese individuals, Young et al.[21] (2003) suggested that the reduction of the ERV can lead to the increase of areas of atelectasis, harming the ventilation/perfusion mismatch and leading to arterial hypoxemia in those individuals.

Some authors have suggested that obesity may promote air trapping, which impairs adequate pulmonary ventilation through the reduction of pulmonary volumes.[12,22]Teixeira et al.[22] (2007) showed an increase in the residual volume (RV) associated with the reduction in the ERV in obese subjects who had dyspnea complaints. The authors suggested that the reduction in the ERV can be attributed to the obstruction of small airways and a consequent reduction in gas exchange. Ladosky, Botelho, and Albuquerque[12] (2001), comparing a group of obese and non-obese patients, also suggested that the reduction of the ERV may be a consequence of air trapping caused by obesity and leading to a reduction in the MVV. The MVV test evaluates the respiratory endurance and is influenced by the respiratory muscle strength, the lung and chest compliance, and the control of breathing and airway resistance.[12,23]

It has been suggested that obesity causes overload to the accessory respiratory muscles and that these muscles are primarily responsible for the dyspnea reported by the obese group.[13,24]

Ochs-Balcom et al. (2006)[25] stated that abdominal adiposity contributes to impairment of lung function and is even more important than general adiposity markers such as weight and BMI. Once body fat is more peripherally distributed in women and more centrally distributed in men, pulmonary function is also affected according to gender, as verified by some authors.[12]

Conclusions: Total respiratory system compliance is decreased; however, partitioning this into chest wall and lung components have shown conflicting results. Lungvolumes, and especially ERV, are the most consistently affected respiratory parameters. In individual patients, the distribution of fat may be more important than BMI. Based on our results, we can conclude that obesity causes significant changes in respiratory function, as is evidenced by the highlighted changes in the components of the VC (IRV and ERV). These findings suggest deleterious effects on ventilatory mechanics caused by obesity, due to probable lung compression (reduction in the ERV), leading to a compensatory increase in the IRV in an attempt to maintain a constant VC. Harming the ventilatory mechanics associated with ERV reduction may have contributed to the reduction in the MVV. However, these changes were not sufficient to cause obstructive or restrictive pulmonary disorders by spirometry or significant breathlessness complaints in obese women with a BMI between 35 and 49.99 kg/m^2.

In our study the overall pattern of pulmonary functions in both the types of obesity shows restrictive pattern but Waist hip ratio weighs greater risk compared to BMI.

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Conflict of interest: None
Funding: None