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Original Research Paper

Physiology

EFFECT OF OBESITY ON PEAK EXPIRATORY FLOW RATE IN DIFFERENT AGE GROUPS

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ABSTRACT

Background: Obesity is a state of excess adipose tissue mass. As adipose tissue accumulates in excess amounts a variety of adaptations/alterations in cardiorespiratory structure and function occur even in the absence of co-morbidities. The pulmonary disorders due to obesity results in increased mortality and morbidity. So, the study was to examine the effect of obesity on Peak Expiratory Flow Rate in different age groups.

Methods: 100 Healthy males with BMI 30 kg/m2 were classified as obese and divided into three groups depending upon their age. 100 Healthy males with BMI of 18.50–24.99 kg/m^2 were taken as controls. Anthropometric parameters were recorded and Body mass index was derived. Peak Expiratory Flow Rate (PEFR) were recorded on a computerized spirometer. ANOVA was used for multiple group comparisons and student's t-test for two group's comparison. Pearson's correlation coefficient was used to measure the relationship between the measurements.

Results: In our study PEFR showed a significant decrease in obese subjects compared to non-obese subjects. There was statistically significant decrease in PEFR in obese subjects compared to non-obese subjects in all groups. Study shows the correlation between body mass index and PEFR and BMI which showed a statistically significant negative correlation.

Conclusion: In our study BMI had an inverse relationship with PEFR in obese when compared to the normal weight subjects. Thus it is evident from the present study that obesity significantly affects the pulmonary functions which may give rise to long term complications and may lead to early morbidity and mortality.

KEYWORDS : Body mass index, Peak expiratory flow rate, Obesity, Lung function

Introduction

Obesity a state of excess adipose tissue mass is becoming a global epidemic nowadays.[1] Now a days the problem of under nutrition is coming down, indeed the overweight, obesity and obesity related diseases have risen dramatically and are expected to continue to rise.[2]

Obesity has major adverse effects on health and is responsible for cardiovascular diseases, type 2 diabetes mellitus, hypertension, certain cancers, sleep apnea/sleep disordered breathing, gall stones, reproductive, bone, joint, and cutaneous diseases.[3] As adipose tissue accumulates in excess amounts a variety of adaptations/alterations in cardiorespiratory structure and function occur even in the absence of co-morbidities.

Hence, obesity may affect the heart and lungs through its influence on known risk factors such as dyslipidemia, hypertension, glucose intolerance, obstructive sleep apnea/hypoventilation.[4] In Obese individuals due to respiratory muscle inefficiency, decreased functional reserve capacity and expiratory reserve volume the demand for ventilation and breathing work load are increased.[5] These often result in a ventilation-perfusion (V/Q) mismatch and cause of alveolar hypoventilation. Obesity also influences upper airway reflexes, lung mechanics, and may affect the central control of breathing. Historically, the obesity hypoventilation syndrome has been described as the Pickwickian Syndrome and obstructive apnea was first observed in patients with severe obesity.[5,3] In obese sleep disturbances rises dramatically and obesity is the most important modifiable risk factor for sleep disordered breathing.[6]

Symptoms of breathlessness are common complaint in overweight and obese subjects, and these may be cardiac or respiratory in origin or combination of the two.

In today's society of affluence, however, people have come to realize the morbidity and mortality associated with excess weight and the importance of maintaining normal weight.

The pulmonary disorders due to obesity results in increased mortality and morbidity So this study is undertaken to analyse the effect of obesity on Peak expiratory flow Rate since it is a single reliable way of predicting the magnitude of airway obstruction.

Materials and Methods

After obtaining Institutional Etthical clearance the present study was conducted in the department of physiology. 100 male obese subjects and also 100 male non-obese controls were selected from the general population. Healthy males with BMI 30 kg/m^2 in the age group of 30-60 years were classified as obese. Healthy males with BMI of 18.50–24.99 kg/m^2 in the age group of 30-60 years were taken as controls. Subjects with cardiorespiratory illnesses and smokers were excluded from the study. Informed consent was obtained after explaining the detailed procedure of the non-invasive technique. A brief history was taken and a clinical examination of the cardiovascular system and respiratory system was done to exclude medical problems. Anthropometric parameters were recorded. Body mass index was derived by Quetelet's index - weight (kg)/ height (m^2).

Peak Expiratory Flow Rate (PEFR) were recorded on a computerized spirometer. Subjects were explained about the whole procedure in detail and were motivated prior to the start of manuoeuvre. The test was performed over 3 times. The test with the best maneuver was selected. This spirometer has a mouth piece connected to a transducer assembly which connects an adaptor box which in turn connects to a computer. A software from Recorders & Medicare systems loaded on the computer records and generates the necessary lung function parameters (lung volumes and capacities) including the predicted values for age, sex, weight, height and body surface area.

Statistical Analysis

Descriptive data are presented as Mean, Standard Deviation and Range values. ANOVA technique was used for multiple group comparisons and student's t-test for two group's comparison. Pearson's correlation

coefficient was used to measure the relationship between the measurements.

Results

Table 1 and 2 shows the age wise distribution and the anthropometric parameters of obese and non-obese subjects.

Table 3 shows the mean PEFR (% predicted) and mean PEFR (litres/second) in non-obese subjects and in obese subjects. Both mean PEFR and Percentage predicted PEFR showed a significant decrease in obese subjects compared to non-obese subjects (P < 0.001).

Table 4 shows a Comparison of age-related changes is peak expiratory flow rate (PEFR) between non-obese and obese. In non-obese subjects with age 31-40 years, the mean PEFR (litres/second) was 7.87±60.8; between 41-50 years, the mean PEFR was 7.85±61.0; between 51–60 years, the mean PEFR was 7.43±60.6. In obese subjects with age 31-40 years, the mean PEFR was 5.40±60.1; between 41-50 years, the mean PEFR was 5.74±60.5; between 51-60 years, the mean PEFR was 5.56±60.5.There was statistically significant decrease in PEFR in obese subjects compared to non-obese subjects in all groups (P value < 0.001).

Fig. 1 shows the correlation between body mass index and PEFR and BMI which showed a statistically significant negative correlation.

Table 1: Age-Wise distribution

Age groups	Non-obese	Obese
31 – 40	11	9
41 – 50	28	56
51 – 60	61	35
Total	100	100

Table 2: Anthropometric Parameters between obese and non-obese

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Groups	Age (yrs)		Weight (kg)		Height (mt)		Body Mass Index (BMI)-kg/m^2	
	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
Non-obese 18.50-24.99	33-60	50.4±6.7	50-82	64.3±9.8	1.80-1.85	1.57±0.1	24.7-24.7	27.4±1.8
Obese ≥ 30	38-60	49.8±5.2	68-100	71.1±7.8	1.39-1.74	1.49±0.1	28.1-36.8	30.1±1.9

Table 3: Comparison of peak expiratory flow rate between non-obese and obese

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Groups	n	PEFR			
		Actual PEFR (litres/sec)		%Pred	
		Range	Mean±SD	Range	Mean±SD
Non-obese 18.50-24.99	100	6.9-10.1	7.68±0.8	85-100	93.2±4.0
Obese ≥ 30	100	4.8-6.7	5.73±0.5	61-85	72.8±6.5
Mean diff		1.95		18.4	
Significance	t	21.4		24.2	
	P	< 0.001 HS		< 0.001 HS	

Analysis for all parameters done by unpaired 't' test
HS – Highly Significant, S – Significant and NS – Not Significant.

Table 4: Comparison of age related changes in peak expiratory flow rate (litres/sec) between Non-obese and obese

Age group (yrs)	Non-Obese		Obese		Significance	
	No. of cases	Mean SD	No. of cases	Mean SD	t	p
31 – 40	11	7.87±60.8	7	5.40±60.1	9.81	< 0.001 HS
41 – 50	24	7.85±61.0	56	5.74±60.5	9.63	< 0.001 HS
51 – 60	65	7.43±60.6	37	5.56±60.5	17.14	< 0.001 HS

All values expressed as mean SD.
Analysis for all parameters done by unpaired 't' test
HS – Highly significant, S – Significant, NS – Not Significant

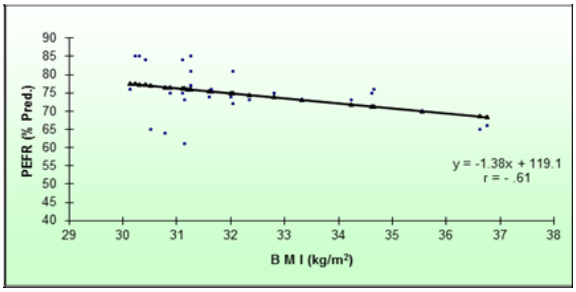

Fig. 1: Relationship between BMI & PEFR in obese individuals

Discussion

In our study, we observed a statistically significant decrease in peak expiratory flow rate in obese subjects when compared to non-obese subjects. There was a similar change observed when each age subgroup category was compared. There was also a consistent negative correlation with increasing BMI causing further decreases in PEFR.

The effects of body fat distribution on pulmonary function tests were studied by Lynell C et al in mildly obese men and revealed that lung function parameters were significantly lower in the subjects with upper body fat distribution. This suggests that upper body fat distribution may be associated with a modest impairment of lung volumes in normal and mildly obese men.[7]

Pulmonary function in obese subjects was assessed by Hamid Sahebjami and found that expiratory flow rates were significantly lower in obese subjects.[8] Y Chen and his colleagues did a 6 year follow up study on the body weight and weight gain related to lung function decline in adults, and showed that lung functions were reduced in obese individuals. They also concluded that weight gain causes lung dysfunction and the effect of weight gain on lung function is greater in men than in women.[9] Francoise Zerah and his colleagues studied the effects of obesity on respiratory resistance on healthy subjects exhibiting various degrees of obesity with BMI ≥ 30 and found that there was a change in most lung volumes as the BMI increased.[10]

Air flow limitation in morbidly obese, non-smoking men was studied by Rubinstein et al in obese men and women. They found a significant difference in pulmonary function between the obese and non-obese persons.[11] Thomas and his co-workers studied the respiratory functions in the morbidly obese before and after weight loss and showed that before weight loss Peak Expiratory Flow were not significantly below predicted values and after weight loss, there was a small but significant rise in PEF.[12]

A study on BMI on pulmonary function tests in young adults showed that the PEFR significantly reduces in overweight and obese subjects when compared to normal weight subjects and there was negative correlation of BMI with PEFR in obese subjects.[13] The probable reason for a decrease in PEFR in obese may be the fat deposition in the abdomen may resist the movement of diaphragm and in turn reduce the vertical diameter of thoracic cavity. Due to this compliance of the lungs and the thoracic cavity may decrease and increases the load on muscles of respiration, leading to reduction reduction in lung volumes and flow rates, especially PEFR.[13]

Obesity may leads to intrabdominal adipose accumulation which exert a load on cardiac and respiratory muscles especially diaphragm, which may cause dyspnea.[14] Accumulation of adipose tissue around abdomen, visceral cavity and around rib cage may produce an imbalance between inflationary and deflationary pressure on the lungs leading to reduction in PEFR. Obese subjects may also have limited lung expansion and air flow and increase adipose tissue accumulation in abdominal, restrict the downward movement of the diaphragm leading to significantly reduced PEFR.[15]

Conclusions

In our study the results showed that increase in BMI had an inverse relationship with PEFR in obese when compared to the normal weight subjects. Thus it is evident from the present study that obesity significantly affects the pulmonary functions which may give rise to long term complications and may lead to early morbidity and mortality. Weight reduction, healthy life style, exercise may prevent the morbidity due to obesity.

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