

Original Research Article

A study of pulmonary function abnormalities in obese individuals

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ABSTRACT

Background: Previous studies suggest that obese individuals are prone to pulmonary function abnormalities. The aim of this study was to evaluate pulmonary function tests in obese individuals and to relate pulmonary abnormalities if any found to lipid abnormalities and to the extent and duration of obesity.

Methods: This prospective study was done on 40 obese patients attending to Dr. D. Y. Patil Hospital, Mumbai with complaints of pulmonary functions during the period from January to December 2012. Pulmonary function test was done with the help of Jaegers pneumoscreen. The percentage of body fat was determined by using triceps skin fold thickness technique by using Vernier callipers. Fasting serum samples was collected to analyses cholesterol and triglycerides.

Results: Female preponderance was seen in the study (57.5%). Forced expiratory volume, forced vital capacity, maximum mid expiratory flow rate was significantly reduced and the ratio of forced expiratory volume in one second to forced vital capacity was significantly increased in individuals who had abnormal pulmonary function. Decrease in pulmonary function was noted with increased levels of cholesterol and triglyceride but the correlation was not significant.

Conclusions: Obese individuals although asymptomatic have significant lung function abnormality in the form of restrictive as well as obstructive pattern. Hence, reduction in the body weight may help in reversal of the pulmonary function indices.

Keywords: Abnormalities, Obesity, Pulmonary function indices

INTRODUCTION

Obesity is defined as abnormal or excessive fat accumulation that presents a risk to health.¹ Obesity is a public health crisis of mammoth proportions in the developed world.² The prevalence is also increasing rapidly in numerous developing nations worldwide. In 2008, 1.5 billion adults were overweight (BMI >25 kg/m²). Of these over 200 million men and nearly 300 million women were obese (BMI >30 kg/m²).¹ The overall prevalence rate of obesity was 27.8% in urban Indian population. Obesity was found to be more common in female subjects.³ Hypertension, coronary

heart disease, diabetes mellitus, Hypercholesterolemia and hypertriglyceridemia were found to be associated with obesity. Obesity may be associated with a number of pulmonary abnormalities namely decrease effort tolerance, physical deconditioning, and obstructive sleep apnea.

These include reduced chest wall compliance, increased work of breathing, increased minute ventilation due to increased metabolic rate, and decreased total lung capacity and functional residual capacity.⁴ The characteristic abnormality seen in obesity is a decreased expiratory reserve volume, caused a markedly decreased

functional residual capacity with a relatively well preserved residual volume. The major change in pulmonary mechanics in obesity is due to overall decrease in compliance, due to increase in weight, an increase in airway resistance and decreased respiratory muscle functions.⁵

Many studies were done to correlate the obesity with diabetes mellitus, insulin resistance, dyslipidemia and other cardiac abnormalities, but there are few Indian studies revealing the relationship between obesity and pulmonary functions.⁶⁻⁸ Hence, the current study was undertaken to study pulmonary function tests in obese individuals and to relate pulmonary abnormalities if any found to lipid abnormalities and to the extent and duration of obesity.

METHODS

This was a prospective study done on 40 obese patients during the period from January to December 2012 attending to the Dr. D. Y. Patil Hospital, Mumbai. The study was reviewed and approved by institutional ethics committee. Informed consent was taken from all the patients. Obese individuals (male or female) above 18 years were included in the study. Patients with diabetes mellitus, hypertension, ischemic heart disease, cerebrovascular diseases, history of gastroesophageal reflux disease, peptic ulcer, hiatus hernia, bronchial asthma, COPD, occupational lung diseases, history of smoking, any other addiction, other major coexisting illness and individuals with anaemia, hematological disorders were excluded.

Patient evaluation included, body fat determination, spirometry, lung volumes and fasting serum samples were collected to analyses cholesterol and triglycerides.

Baseline pulmonary function test was done with the help of Jaegers pneumoscreen (COSMED, model- Quark PFT). Physical parameters such as height and weight of the individual were entered in the machine, which then generated the predicted normal values for that particular individual. FVC (forced vital capacity) in liters, FEV1 (forced expiratory volume in first second) in liters, FEV1/FVC%, PEF (peak expiratory flow) rate in liters and PEF (25-75%) (forced expiratory flow), MMEFR (maximum mid expiratory flow rate) were the pulmonary function parameters tested.

In patients with obstructive pattern, 2 puffs of salbutamol each of 100 ug was administered and pulmonary function tested again after half hour for reversibility. The pneumoscreen calibrated for temperature, humidity and ambient environment. Body surface area was calculated as per height and weight.

The percentage of body fat was determined by using triceps skin fold thickness technique by using Vernier

calipers. Body fat calculation indices included BMI (based on weight and height kg/m²) and waist hip ratio.

Statistical analysis was performed using SPSS software (SPSS, Chicago). Pearson correlation matrix analysis was used to assess relationships between the indices of obesity and the variables of pulmonary function. p value <0.05 was considered statistically significant.

RESULTS

Demographic characteristics of the patients was shown in Table 1. Mean age of the patients was 13.320 years. Out of 40 patients, 23(57.5%) were females and 16(40.3%) were males. All the study subjects underwent pulmonary function testing. Abnormality was noted in 25 cases. Of them, obstructive lung abnormality was seen in 9 patients, restrictive abnormality in 7 patients and both abnormalities were noted in 9 patients. The incidence of lung disease was found to be statistically significant in obese patients (p<0.05) (Table 2) and females are more prone to pulmonary function abnormality.

Table 1: Demographic characteristics of study participants (n=40).

Characteristics	Findings
Age (in years) (mean±sd)	43.32±10.73
Sex (female:male)	1.5:1
Height (in cm) (mean±sd)	160.7±18.43
Weight (in kg) (mean±sd)	82±9.68
BMI (kg/m ²) (mean±sd)	31.7±2.38
Skin fold fat (in mm) (mean±sd)	22.42±3.33
Waist hip ratio (mean±sd)	1.04±0.072
Grading of cholesterolemia	
Desirable n (%)	15(37.5)
Borderline n (%)	15(37.5)
Undesirable n (%)	10(25)
Grading of triglyceridemia	
Desirable n (%)	14(35)
Borderline n (%)	9(22.5)
Undesirable n (%)	15(37.5)
Highly undesirable n (%)	2(5)

Table 2: Result of pulmonary function test in study population (n=40).

Number of subjects	Normal	Obstructive	Restrictive	Both
40	15	9	7	9

Table 3 shows the abnormal pulmonary function pattern in 25 cases. FEV1, FVC was significantly decreased in all the subjects. A decrease in PEFR and MMEFR values was observed but the difference was not significant between predicted and observed values. Significant increase in the ratio of FEV1/FVC was observed in the values. No significant response was observed in the pulmonary indices after treatment with bronchodilator.

No significant correlation was observed between the cholesterol and triglyceride levels in the patients with obstructive and restrictive pulmonary functional indices (Table 4 and 5). Cholesterol showed negative correlation with the predictive value of PEFR ($r=-0.16478$) while triglyceride levels showed negative correlation with the observed values of FEV1 ($r=-0.07718$), EVC ($r=-0.00579$), FEV1/FVC ($r=-0.08625$) and MMEFR ($r=-0.05178$) in obstructive cases. In restrictive pulmonary

abnormality cases, the level of cholesterol showed negative correlation with FVC ($r=-0.17962$) and FEV1/FVC ($r=-0.3905$) in the observed values and with PEFR ($r=-0.2479$) and MMEFR ($r=-0.1456$) in the predictive values. Triglycerides showed negative correlation with FEV1/FVC ($r=-0.4631$) and MMEFR ($r=-0.2444$) in observed values and with PEFR ($r=-0.0714$) in predictive values.

Table 3: Pulmonary function test abnormalities in the obese individuals and their bronchodilator response (n=25).

Pulmonary function test	Predicted	Observed	p value	Response	p value
FEV1	2.31±0.62	1.787±10.	0.011*	1.9±0.54	0.861
FVC	2.9±0.64	2.32±0.80	0.006**	2.24±0.67	0.756
FEV ₁ /FVC	82.62±3.75	87.33±10.69	0.047*	86.65±7.74	0.828
PEFR	345±49.8	312.6±95.78	0.061	332±105.74	0.991
MMEFR	3.49±1.03	2.27±0.94	0.064	2.27±0.98	0.548

*p<0.05, **p<0.001.

Table 4: Correlation of cholesterol and triglyceride levels with obstructive pulmonary abnormality function.

Variable	Pulmonary function test	Predicted	Observed	Response
Cholesterol	FEV1	0.379923	0.169295	0.0281
	FVC	0.282048	0.10321	0.028777
	FEV1/FVC	0.449898	0.14391	0.016642
	PEFR	-0.16478	0.021341	0.016642
	MMEFR	0.0277	0.276831	0.315787
Triglyceride	FEV1	0.645333	-0.07718	0.114375
	FVC	0.586105	-0.00579	0.209531
	FEV1/FVC	0.456934	-0.08625	-0.33989
	PEFR	-0.03198	0.221314	0.284977
	MMEFR	0.032128	-0.05178	-0.05178

Table 5: Correlation of cholesterol and triglyceride levels with restrictive pulmonary abnormality function.

Variable	Pulmonary function test	Predicted	Observed	Response
Cholesterol	FEV1	0.36511	0.478	0.52909
	FVC	0.27405	-0.17962	0.6271
	FEV1/FVC	0.6943	-0.3905	-0.31322
	PEFR	-0.2479	0.1295	0.21769
	MMEFR	-0.1456	0.0356	-0.03661
Triglyceride	FEV1	0.4822	0.0496	0.3583
	FVC	0.45344	0.0321	0.7275
	FEV1/FVC	0.477	-0.4631	-0.6827
	PEFR	-0.0714	0.34809	0.564
	MMEFR	0.0978	-0.2444	0.125

Effect of obesity indices in pulmonary function was evaluated but no significant correlation was seen between them ($p>0.05$). From the Table 6, it was evident that a negative correlation was identified between FVC ($r=-0.01$) and FEV1 ($r=-0.12$) with waist hip ratio. BMI was found to have negative correlation with FVC ($r=-0.15$).

However, Skin fold thickness showed positive correlation with both FVC ($r=0.11$) and FEV1 ($r=0.13$).

From Table 7, it was noted that no significant correlation was seen with duration of obesity with pulmonary abnormalities.

Table 6: Correlation of pulmonary function test parameters and indices of obesity in study population.

Obesity indices	FVC	FEV1
Waist hip ratio	-0.01	-0.12
Body mass index	-0.15	0.17
Skin fold thickness	0.11	0.13

Table 7: Correlation of pulmonary function parameters and duration of obesity.

	Normal PFT (N=15)	Abnormal PFT (N=25)			
		0-2 yrs	2-4 yrs	4-6 yrs	>6 yrs
Duration of obesity					
Number of subjects	15	6	6	5	8
Percentage of total	37	24	24	20	32

The response to bronchodilator was noted in 8 cases. Of them minimal improvement in pulmonary abnormalities was noted in 7 cases and good in case.

DISCUSSION

Obesity is acknowledged as a global phenomenon that increases morbidity and mortality. It is considered to be a major risk factor for cardio and cerebrovascular diseases and diabetes.⁹ Obesity shows a profound effect on the physiology of breathing.¹⁰ Obesity is found to be involved in decreasing the respiratory compliance due to involvement of mechanical factors such as increased weight on thoracic cage and abdomen. Severe obesity may lead to obesity hypoventilation syndrome and sleep apnea.

The most common pulmonary function abnormality in obese individuals is FERV. This happens because mass loading effect of obesity decreases FRC which in turn decreases ERV.¹¹ As given in literature, in mild obesity, spirometry values are normal. In obese individuals decrease in expiratory flow, FVC and FEV1 and increase in FEV1/FVC ratio was observed.^{12,13} Similar effects was also noted in this study.

In the present study, the PEF and MMEFR values are significantly decreased in individuals who had abnormal pulmonary function test. This was in accordance with the studies of Srinivas et al, and Ofuya et al.^{7,14}

Previous studies conducted on relationship between metabolic abnormality and pulmonary function, elevated serum triglycerides and cholesterol levels were considered as independent predictors of pulmonary abnormalities.^{15,16} In this study, positive correlation was observed between the cholesterol and triglyceride levels with predictive values of FVC, FEV1 and FEV1/FVC in the patients with obstructive and restrictive pulmonary

functional indices but the association was not significant. The exact mechanism of the relationship is not known yet. It was predicted that the composition of pulmonary surfactant might be a possible linkage between increased HDL cholesterol level and decreased pulmonary function.¹⁷

Body fat distribution also had an impact on the effect of obesity on lung function. Study by Collins et al, showed a significant inverse relationship between adiposity and spirometry values.¹⁸ The best measure of fat distribution was skinfold thickness. Another study by Lazarus et al, suggested that central abdominal obesity has a great impact on spirometric measures, but the relationship diminishes with age.¹⁹ In this study, no significant correlation between pulmonary function parameters and duration of obesity was observed.

The Pearson co-relation coefficient in Collin et al, study for FVC and FEV1 in relation to waist hip ratio, body mass index, triceps fold thickness was -0.18, -0.18, -0.52 and -0.11, 0.15, 0.13 respectively.¹⁸ Similar observations were also noted in this study (waist hip ratio, body mass index, and triceps fold thickness were -0.01, -0.15, 0.11 and -0.12, 0.17, 0.13 respectively) and found no significant correlation between them.

Limitations of this study was number of asymptomatic patients included in study was 40, and large number of patients with sizable subgroups, namely; symptomatic and asymptomatic, smokers and nonsmokers, would be required to express firm opinions regarding PFT abnormalities in obese individuals.

CONCLUSION

Based on the observations, authors can conclude that obesity causes change in respiratory functions. Obese individuals although asymptomatic, high BMI, body fat, cholesterol and triglyceride levels may be associated with significant lung function abnormality in the form of restrictive as well as obstructive pattern. Hence, it is not only advisable to control obesity for its well-established complications like type 2 diabetes, hypertension, IHD, osteoarthritis but also, to avoid its adverse impact on pulmonary function and complications arising thereof.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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