ORIGINAL ARTICLE

CORRELATION OF OBESITY AND PULMONARY FUNCTIONS IN PUNJABI ADULTS

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Background: Pulmonary function tests are getting increased favour not only of industrial physiologists but also of practicing physicians. Obesity is a major health concern facing today's society. This study has looked into a possible role of obesity in the aetiology of mortality, with decreased pulmonary functions resulting in cardiovascular disease. **Methods:** Pulmonary function tests (PFTs) of normal healthy non-obese males and females of Punjabi population in age group ranging 26–45 years were performed on a spirometer and compared with obese males and females of the same age group. All tests were performed at the same time of the day in all subjects. Criteria taken for obesity in our study was according to WHO criteria of BMI. **Results:** There was significant decline in FVC, FEV_1, and MVV and insignificant rise in FEV_1/FVC among obese males when compared to non-obese males of the same age group. There was significant decline in FVC, MVV and significant rise in FEV_1/FVC among obese females when compared to non-obese females of the particular age group but insignificant decline in FEV_1 was observed in the same age group. **Conclusions:** There is decline of various spirometric values in obesity.

Keywords: Obesity, pulmonary function tests, respiration, spirometry, spirometer

INTRODUCTION

Obesity may affect respiratory functions in a number of ways. 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 pulmonary functions.[1] Carbondioxide production increases as a result of increased body weight. Obese subjects consume approximately 25% more oxygen than non-obese subjects at rest.[2] Severely obese patients are often hypoxemic, especially in the supine position.[3]

The increased lung and respiratory system resistance in obesity reduces lung volume.[4–6] The cause of decline of various respiratory parameters in obesity may be due to decrease in distensibility of chest wall and is the cause for the alterations in ventilatory volume and flow[7] which may reflect extrinsic mechanical compression on the lung and thorax and/or intrinsic changes within the lung[8] in the form of deranged pulmonary function tests, modifying airway smooth muscle function by obesity related changes in lung development, chronic systemic inflammation (including increased serum levels of inflammatory cytokines and chemokines) and adipocyte derived factors including leptin, adiponectin and plasminogen activator inhibitor.[9,10]

Pulmonary function tests provide an assessment of respiratory system in terms of its functions. These are quantitative measures of various aspects of bronchopulmonary functions which help us to define the normal functions and to determine the nature and extent of bronchopulmonary dysfunctions.[11] Weight loss can reverse many of the alterations of pulmonary functions produced by obesity.[12] Pulmonary function tests in health are influenced by a number of factors like age, sex, height and weight along with various environmental pollutants and genetic, ethnic, socio-economic and technical variations.[13] Out of the above stated factors affecting pulmonary function values, increase in weight which reflects itself as obesity is considered to be commonest and worst offender which alters relationship between lungs, chest wall and diaphragm leading to profound alterations in pulmonary function values which can be assessed by spirometry.[14]

Spirometric investigation is seen as a gold standard for diagnosing airway obstruction. Therefore spirometry is increasingly seen as a quality standard in general practice.[15,16] The aim of our study was to determine the predominant pulmonary function tests in normal healthy non-obese and obese (without complications) adult population of Punjab and to assess the correlation and comparison of pulmonary functions amongst the above mentioned population.

MATERIAL AND METHODS

This study was conducted on a total of 400 men and women ranging in age from 26 to 45 years and were selected from Punjabi population by convenience sampling and arranged into 4 groups of 100 subjects in each group. Group A comprised 100 non-obese normal healthy males of 26–45 years of age. Group B comprised 100 obese males of 26–45 years. Group C comprised 100 non-obese normal healthy females of 26–45 years. Group D comprised 100 obese females of 26–45 years of age. Each group was subdivided into subgroups I and II for age group 26–35 and 36–45 years respectively.

Parameters taken as basis for obesity were according to WHO criteria of BMI. The ventilatory (pulmonary) function tests were done with the help of a computerised spirometer. The parameters recorded were FVC, FEV_1, FEV_1/FVC, and MVV. Lung functions were carried out in standing posture.

Subjects with history of smoking, chronic cough, recurrent respiratory tract infection, history of chest or spinal deformity, personal history of asthma, chronic obstructive lung diseases were excluded from the study. Before spirometry brief history was recorded and physical examination was done. Overweight and obesity was assessed from Body Mass Index. WHO criteria (1998) has published non gender specific BMI criteria for overweight and obesity, with a BMI of 25.0–29.9 indicating overweight and a BMI of ≥30.0 indicating obesity. BMI <23 is considered normal for urban Indians.[17] The anthropometric measurements were taken on each subject using standard methodology.[18]

Statistical analysis was done for all parameters, paired sample *t*-test was used to determine *p* value and $p<0.05$ were considered significant. Various statistical considerations used were Mean±SD and SEM.

RESULTS

There was statistically significant decline in FVC in group B-I when compared with group A-I (Table-1). When group A-II was compared with group B-II and C-I with D-I, and then C-II with D-II, there was statistically significant decline in FVC in group B-II, D-I and D- II respectively (Tables-2, 3, 4).

There was statistically significant decline in FEV_1 in group B-I when compared with group A-I (Table-1). Also there was a significant decline in FEV_1 in group B-II when compared to A-II (Table-2) on the other hand, C-I when compared with D-I and C-II with D-II, FEV_1 showed insignificant changes (Tables-3, 4).

FEV_1/FVC ratio showed insignificant changes when A-I was compared to B-I and A-II with B-II (Table-1, 2). On the other hand, there was significant rise in FEV_1/FVC in group D-I when compared to C-I, and in D-II when compared to C-II (Tables-3, 4).

In Maximum Voluntary Ventilation (MVV) was a significant decline in group B-I when compared to group A-I (Table-1) and highly significant decline in MVV in group B-II when compared to group A-II (Table-2). There was significant decline in MVV in group D-I when compared with group C-I and also in group D- II when compared to C-II (Tables-3, 4).

Table-1: Respiratory parameters of group A-I and group B-I (Mean±SD)

Parameters	Group A-I (n=66)	Group B-I (n=50)	*p*
FVC (L)	3.45±0.50	3.23±0.40	<0.05
FEV_1 (L)	2.80±0.53	2.60±0.40	<0.05
FEV_1/FVC (%)	81.35±13.33	81.42±8.63	>0.05
MVV (L/Min)	114.83±23.24	97.64±33.31	<0.05

Table-2: Respiratory parameters of group A-II and group B-II (Mean±SD)

Parameters	Group A-II (n=34)	Group B-II (n=50)	*p*
FVC (L)	3.38±0.54	3.18±0.31	<0.05
FEV_1 (L)	2.83±0.43	2.65±0.37	<0.05
FEV_1/FVC (%)	83.97±10.52	84.08±9.80	>0.05
MVV (L/Min)	104.12±25.83	86.44±20.06	<0.001

Table-3: Respiratory parameters of group C-I and group D-I (Mean±SD)

Parameters	Group C-I (n=72)	Group D-I (n=50)	*p*
FVC (L)	2.43±0.29	2.23±0.34	<0.05
FEV_1 (L)	2.05±0.36	2.03±0.35	>0.05
FEV_1/FVC (%)	84.65±12.50	90.75±7.86	<0.05
MVV (L/Min)	85.11±10.69	79.22±10.18	<0.05

Table-4: Respiratory parameters of group C-II and group D-II (Mean±SD)

Parameters	Group C-II (n=28)	Group D-II (n=50)	*p*
FVC (L)	2.40±0.33	2.20±0.27	<0.05
FEV_1 (L)	2.06±0.48	2.02±0.23	>0.05
FEV_1/FVC (%)	85.40±13.68	92.78±10.44	<0.05
MVV (L/Min)	85.61±11.32	78.28±15.38	<0.05

DISCUSSION

In our study, we selected the age range 26–45 years because in this region of India, this age group people are careless food habits and are fond of inappropriate intake of rich caloric junk food along with automated working profile and sedentary life style. So they are more prone to obesity.

In a study from Sydney[18] BMI was negatively associated with FVC between 40 and 69 years ($p<0.01$). Further, a change in body mass of 1 Kg was on average associated with a mean converse change in FVC of 21.1 ml.[19] FVC decreased with weight gain was observed in a six year follow up study at Canada.[20] In another study in Canada[21], significant linear relationship between BMI and vital capacity was also noted. The significant decrease in FVC may be due to elevated diaphragm, mediastinal fat deposition, interfering with the movements of the chest, decreased compliance and marked thoracic kyphosis. A 10 Kg weight increase induced an additional fall of FEV_1 of 51 ml in women.[22] A study showed the similar type of effects of obesity on FEV_1/FVC at all ages where BMI was positively associated with this ratio ($p<0.01$).[23]

Some results have been shown by other researchers, where there was a highly significant decline in MVV in the obese group when compared to the normal group ($p<0.001$), i.e., it declined from 79.20 to 66.50 L/Min which was 16.03% decline.[24] In our study decline has also been significant or highly significant. In males it is 7.6%. Another study on pulmonary physiologic changes of morbid obesity showed a significant decline in MVV.[25]

Although spirometric values are usually normal in patients who are obese, there may be a mild reduction in vital capacity and a proportionate reduction in FEV_1, depending upon the age, type of body fat distribution (with central fat distribution having a relatively greater effect), and severity of obesity.[26] Another possible change in severe obesity is a decrease in MVV that may be explained by respiratory muscle inefficiency, increased upper airway resistance, and inspiratory flow resistance.[27] The decline in MVV in obesity may be due to increased tissue resistance, increased intra abdominal pressure in obese persons, exaggeration of the normal spinal curvature due to forward displacement of the centre of gravity of the body thus causing profound thoracic kyphosis. It leads to elevation of lower sternum and relative fixation of the chest in a position of moderate inspiration and consequently reduced ERV.[28]

According to a study by Joshi *et al*[28], in males percentage of body fat showed negative correlation with forced vital capacity (FVC), maximum ventilatory volume (MVV) and forced expiratory volume at the end of first second (FEV_1). It was observed that in females percentage of body fat had negative correlation with FVC and MVV. These results indicate that increase in percentage of body fat and central pattern of fat distribution may affect the pulmonary function tests.[28] According to Singh *et al*[29] overweight and obese children showed 13% to 44% reduction in FVC and 20% to 46% reduction in FEV_1 depending upon their degree of obesity. Spirometric variables, such as FEV_1 and FVC, tend to decrease with increasing BMI. However, the effect is small, and both FEV_1 and FVC are usually within the normal range in healthy adults. The FEV_1/FVC ratio is usually well preserved or increased even in morbid obesity indicating that both FEV_1 and FVC are affected to the same extent. This finding implies that the major effect of obesity is on lung volumes, with no direct effect on airway obstruction.[30]

The decrease in various lung function parameters in obesity have been described by various scientists through different mechanisms. The accumulation of fat may mechanically affect the expansion of the diaphragm.[23] Low FEV_1 and FVC values suggest restrictive lung pattern among obese persons.[31] Fat deposits between the muscles and the ribs may also decrease chest wall compliance thereby increasing the metabolic demands and workload of breathing in the obese individuals even at rest.[32]

CONCLUSION

Obesity significantly affects the pulmonary functions in both males and females. The cause of decline of various respiratory functions in obesity may be due to limited expansion of thoracic cavity which causes reduced ventilatory volume and total lung capacity. But these hazardous effects of obesity might be reversible and weight loss could improve lung functions.

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