RESEARCH ARTICLE

Obesity and Spirometric Ventilatory Status Correlation in Adult Male Population of Amritsar

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ABSTRACT

Aims & Objective: To study the effects of obesity on the lung functions in adult male population of Amritsar

Materials and methods: Pulmonary function tests (PFTs) of normal, healthy, non-obese males and healthy but obese males of Amritsar were determined and were compared and correlated. Criteria for obesity in our study taken were according to WHO criteria of BMI. The PFTs were carried out with a computerized spirometer "Med-Spiror". The data was collected; compiled, statistically analysed and valid conclusions were drawn. Higher lung volumes and flow rates were achieved.

Results: There was statistically highly significant decline in FVC in obese when compared with nonobese groups. The values of FEV1 in both groups when were compared showed significant changes. The ratio of FEV1/FVC, the values of PEFR and FEF25-75% showed insignificant changes but MVV when were compared showed highly significant changes.

Conclusion: There is decline of various respiratory functions in obesity. The cause of decline of various respiratory functions in obesity may be due to decrease in distensibility of chest wall or limited expansion of thoracic cavity and is the cause for reduced ventilatory volumes and total lung capacity.

KEY WORDS: Pulmonary; Expiration; Obesity; Pulmonary Function Test

INTRODUCTION

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.[1,2] Out of the above stated factors affecting pulmonary function values, 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.[3] Obesity may affect respiratory function in a number of ways. Carbon dioxide production increases as a function of body weight. Obese subjects consume approximately 25% more oxygen than nonobese subjects at rest.[4] The increased lung and respiratory system resistance in obesity is due to the reduction of lung volume.[5-7] It can profoundly alter pulmonary function and diminish exercise capacity by its adverse effects on respiratory mechanics, resistance with in the respiratory system, respiratory muscle function, lung volumes and energy cost of breathing, control of breathing and gas exchange.[8]Obesity is not a single disease in itself. It places patient at the risk of many diseases including hypertension, dyslipidemia, type II diabetes mellitus, coronary heart disease, cerebral stroke, gall bladder disease, osteoarthritis, some cancers, aspiration pneumonia, pulmonary thromboemblism, obstructive sleep apnoea, obesity hypoventilation syndrome and respiratory failure which are associated with substantial morbidity and increased mortality. Weight loss can reverse many of the alterations of pulmonary function produced by obesity.[9] No thorough study has been undertaken on the effect of obesity on pulmonary function status by computerised spirometer in this part of the country, where the prevalence of obesity is maximum. So, in the present study an attempt will be made to examine the effect of obesity in relation to body mass index on the selected parameters of pulmonary function tests. But these hazardous effects of gaining weight might be reversible and weight loss can improve lung function in obesity as it was observed that most of those who reduced their BMI values also increased their lung function. The extent of lung function loss tends to be higher among those who, at baseline report greater BMI values. This study can encourage losing weight to improve their lung function.[10]

MATERIALS AND METHODS

In the present study, total 200 subjects were studied including 100 non obese males and 100 obese males (according to WHO criteria of BMI)selected from the general population of Amritsar. Overweight and obesity was assessed from Body Mass Index because BMI can be considered to provide the most useful albeit crude, population level measure of obesity. Considering BMI as the most dependable indicator of obesity, as other measures of obesity provide additional information rather than primary information,[11] the subjects were in the age group of 26-35 years and 36-45 years.

The ventilatory (pulmonary) function tests were done with the help of PC based computerised spirometer **(Computerized Spirometer-MEDSPIROR RMS CHANDIGARH, INDIA. PLATFORM WIN 98 VERSION 1)** and the following parameters were recorded FVC, FEV_1, PEFR, $FEF_{25-75\%}$, FEV_1/FVC, and MVV. The mean values with standard deviation of age, parameter of obesity i.e. BMI, spirometric parameters in the different groups i.e. Group A (non obese control males, n=100) and group B (obese males, n=100) have been tabulated.

Statistical analysis (mean, standard deviation, standard error of mean) was done for all the parameters when group A (control males) compared with group B (males), 'p' and 't' values were determined, $p>0.05$ were considered as nonsignificant. Data obtained was fed to a computer and analysed and valid conclusions were drawn.

Lung functions were carried out in standing posture. Subjects with any 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 doing the test brief history was recorded and examination was done. Theanthropometric measurements taken on each subjects using standard methodology given by Weiner and Lourie were, Height and weight.[12]Body mass index**=** Weight (kg)/Height^2 (m). To assess overweight and obesity WHO (1998) criteria of BMI has been most accepted criteria all over the world.[11]Subsequently one more criteria labeled as WHO (2000) criteria of BMI in asians was introduced in which cut off for overweight (≥23.0 Kg/m^2) and obesity (≥25.0 Kg/m^2) are lower than WHO criteria (1998). In the present study an attempt was made to select the subjects according to WHO (2000) criteria of BMI. [13]

RESULTS

Division of Sample Size: 100 non obese males in group A (controls) were divided into in group A-I and group A-II. Group A-I non obese males in the age group of 26-35 years the sample size came out randomly to be 66. In group A-II, there were 34 non obese males in the age group of 36-45 years. 100 obese males in group B (obese) were divided into group B-I and group B-II. Group B-I was having 50 obese males in the age group of 26-35 years. In group B-II, there were also 50 obese males but in the age group of 36-45 years (Table 1A& B).

Table-1 A & B: Division of Sample Size

Groups	Classification	Number of subjects	Control/obese
Group A	Non obese males	100	Control
Group B	Obese males	100	Obese

Group	Obese/ non obese	Sex	N	Age group (years)
Group A-I (Control)	Non obese	M	66	26-35
GroupA-II (Control)	Non obese	M	34	36-45
Group B-I (Obese)	Obese	M	50	26-35
Group B-II (Obese)	Obese	M	50	36-45

Forced vital capacity(FVC): There was statistically highly significant decline in FVC in group B when compared with group A. (Table 2) When group A-I was compared with group B-I, there was statistically significant decline in FVC in group B I compared to group A-I. When FVC in group A-II was compared with that of group B-II, there was statistically significant decline in FVC in group B-II obese males. (Table 3, 4)

Forced Expiratory volume in 1 second(FEV_1): The values of FEV_1 in group A and group B when were compared showed significant changes (Table 2).Similarlywhen group A-I was compared with group B-I and A- II with B II, FEV_1showed significant changes statistically. (Table 3, 4)

FEV1/FVC: The ratio of **FEV1/FVC**in group A and group B when were compared showed insignificant changes (Table 2). Similarlywhen group A-I was compared with group B-I and A- II with B II, FEV_1/ FVC showed insignificant changes statistically. (Table 3, 4)

Table-2: Respiratory Parameters with Mean Values (±SD) of Group ANon-Obese Males (Controls) and Group B Obese Males (26-45 years)

Parameters	Group A (Mean±SD)	Group B (Mean ±SD)	't' value
FVC	3.43± 0.51	3.20±0.36	3.68 ** HS
FEV_1	2.81±0.50	2.63±0.38	2.87 S
PEFR	7.25±1.66	7.20±1.14	0.25 NS
$FEF_{25-75\%}$	3.63±0.87	3.55±1.03	0.59 NS
FEV_1/FVC	82.25±12.46	82.33±9.14	0.21 ** NS
MVV	111.19±24.55	92.04±27.93	5.15 **HS

****HS= highly significant p<0.001, *S= significant p<0.05 NS=Nonsignificant p>0.05**

Table-3: Respiratory Parameters with Mean Values (±SD) of Group A-I Non Obese (Controls) Males and Group B-I Obese Males (26-35 years)

Parameters	Group A-I (Mean±SD)	Group B-I (Mean ±SD)	't' value
FVC	3.45±0.50	3.23±0.40	2.55 * S
FEV_1	2.80±0.53	2.60±0.40	2.23 * S
PEFR	7.26±1.64	7.20±1.12	0.22 NS
$FEF_{25-75\%}$	3.65±0.86	3.55±1.13	0.54 NS
FEV_1/FVC	81.35±13.33	81.42±8.63	0.33 NS
MVV	114.83±23.24	97.64±33.31	3.27 * S

***S= significant p<0.05 NS=Nonsignificant p>0.05**

Table-4: Respiratory Parameters with Mean Values (±SD) of Group A-II Non Obese Males (Controls) and Group B-II Obese Males (36-45 years)

Parameters	Group A (Mean±SD)	Group B (Mean ±SD)	't' value
FVC	3.38±0.54	3.18±0.31	2.26 * S
FEV_1	2.83±0.43	2.65±0.37	2.05 * S
PEFR	7.23±1.74	7.20±1.18	0.09 NS
$FEF_{25-75\%}$	3.60±0.88	3.55±0.93	0.25 NS
FEV_1/FVC	83.97±10.52	84.08±9.80	0.31 NS
MVV	104.12±25.83	86.44±20.06	3.53 ** HS

****HS= highly significant p<0.001, *S= significant p<0.05 NS=Nonsignificant p>0.05**

Mean forced expiratory flow during middle half of the FVC ($FEF_{25-75\%}$): The values of **($FEF_{25-75\%}$)** in group A and group B when were compared showed insignificant changes (Table

2). Similarlywhen group A-I was compared with group B-I and A- II with B II, **($FEF_{25-75\%}$)** showed insignificant changes statistically. (Table 3, 4)

Peak expiratory flow rate(PEFR): The values of **(PEFR)** in group A and group B when were compared showed insignificant changes (Table 2). Similarlywhen group A-I was compared with group B-I and A- II with B II, **(PEFR)** showed insignificant changes statistically. (Table 3, 4)

Maximum voluntary ventilation(MVV): The values of **MVV** in group A and group B when were compared showed highly significant changes (Table 2).When group A-I was compared with group B-I it showed significant changes and on comparing groups A- II with B II, MVV showed highly significant changes statistically. (Table 3, 4)

DISCUSSION

In our research, we selected the above mentioned range of age (26- 45 years) and this particular sex (males) because in this region of Punjab (Amritsar), the males of this age group have careless and inappropriate intake of caloric rich easily available junk food and automated working profile with sedentary life style so are more prone to obesity. In the present study, there was statistically highly significant decline in FVC in group B when compared with group A (Table 2). With our previous knowledge, as we know FVC is affected by age, sex, bodies build, occupation etc. Moreover, BMI was negatively associated with FVC between 40 and 69 years ($P<0.01$), also observed in a normative aging study at Sydney.[14]Further a change in body mass of 1 Kg was on average associated with a mean converse change in FVC of 21.1 ml.[15] Also FVC decreased with weight gain was observed in a six year follow up study at Canada. [16]In another study at Canada, significant linear relationship between BMI and vital capacity was also shown.[16] In the present study, the values of FEV_1 in group A and group B when were compared showed significant changes (Table 2). A 10 kg weight increase induced an additional fall of FEV_1 of 51 ml in women.[17]Similar to our study, many corroborative studies have also been reported where FVC decreased significantly with obesity.[18] In the present study, the ratio of **FEV1/FVC**in group A and group B when were compared showed insignificant changes (Table 2).A study showed the positive association of obesity on FEV1/FVC at all ages which was not in accordance with our study.[19] Contrary to our study, in the other study on longitudinal changes of body mass index, spirometry and diffusion in a general population, this ratio increased as BMI increased in males. The values of **($FEF_{25-75\%}$)** in group A and group B when were compared showed insignificant changes in the present study (Table 2).Contrary to our study, another study showed that FEF25-75% (forced expiratory flow during mid expiratory phase) decreased significantly in extreme obesity.[20] In the present study, the values of **(PEFR)** in group A and group B when were compared showed insignificant changes (Table 2)but no other study has shown the similar result to our study. The values of MVVin group A and group B when were compared showed highly significant changes in the present study (Table 2).Some results have been shown by other researchers, where there was a highly significant decline in MVV in obese group when compared to normal group ($P<0.001$) i.e. it declined from 79.20 liters/min to 66.50 liters/min which is 16.03% decline.[21] In our study decline has also been significant or highly significant. In males it is 7.6% decline. Further another study on pulmonary physiologic changes of morbid obesity, showed a significant decline in MVV in obesity.[22] The decrease in various lung function parameters in obesity have been described by various scientists through different mechanisms. Low FEV1 and FVC values suggest restrictive lung pattern among obese persons.[23] Fat deposits between the muscles and the ribs may also decrease chest wall compliancethereby increasing the metabolic demands and workload of breathing in the obese individual even when at rest.[24]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.[25]

CONCLUSION

Obesity influences the respiratory function enhancing dyspnea and increasing both cardiac load and respiratory muscle fatigue of the thoracic wall and the diaphragm due to the higher pressure exerted by intrabdominal adipose accumulation (visceral adiposity). After analysis of observations, conclusions were drawn on comparison of various respiratory parameters in non obese controls versus obese cases in males. Thus it is evident from the present study that obesity significantly affects the pulmonary functions. The cause of decline of various respiratory functions in obesity may be due to decrease in distensibility of chest wall or limited expansion of thoracic cavity and is the cause for reduced ventilatory volumes and total lung capacity. Because of increase in elastic recoil pressure, the ratio FEV1/FVC may be greater than normal. There may be increased elastic work of breathing, and decreased compliance. But these hazardous effects of gaining weight might be reversible and weight loss can improve lung function in obesity. So, obese patients benefit from weight loss by improved pulmonary mechanics.

REFERENCES

1. Sharma VK, Garg VK, Parihar HL, Jain NK, Rathor RS. Respiratory morbidity and pulmonary function impairment in ‘soldiers’. An occupational Hazard in Modern Electronics. Lung India. 1993; 11(4): 143-46.
2. Singh SK, Nishith DS, Tandon GS, Shukla N, Sexena SK. Some observations of pulmonary function tests in rice mill workers. Ind J Physiol Pharmacol. 1988; 32(2): 152-57.
3. Ray CS, Sue DY, Bray G, Hansen JE, Wasserman K. Effects of obesity on respiratory complication. Am Rev Respir Dis. 1983; 128: 501-06.
4. Darrat I, Yaremchuk K. Early mortality rate of morbidly obese patients after tracheostomy. Laryngoscope. 2008. 118:2125-2128.
5. Sin DD, Jones RL, Man SF. Obesity is a risk factor for dyspnea but not for airflow obstruction. Arch Intern Med. 2002; 162:1477-1481.
6. Jones RL, Nzekwu MU. The effects of body mass index on lung volumes. Chest 2006; 130:827-833.
7. Collins LC, Hobert PD, Walker JF, et. al. The effect of body fat distribution on pulmonary function tests. Chest 1995; 107:1298-1302.
8. Koenig SM. Pulmonary complications of obesity: A review, Am J Med Sci. 2001; 321: 249-79.
9. Chen Y, Rennie D, Cormier YF, Dosman J. Waist circumference is associated with pulmonary function in normal weight, overweight and obese subjects. Am J ClinNutr. 2007; 85 (1): 35-39.
10. Bottai M, Postello F, PedeFdi, Corrozzi L, Baldacci S, Matteelli G et al. Longitudinal changes of body mass index, spirometry and diffusion in a general population. EurRespir J. 2002; 20: 665-673.
11. WHO (1998). Techn. Rep. Ser., 894. Obesity preventing and managing the global epidemic. http://www.who.int/nutrition/publications/obesity/WHO_TRS_894/en/index.html. Accessed on 12 Dec 2011.
12. Weiner JS, Lourie JA. Practical human biology. New York, Academic Press Inc. 1981; 34-49.
13. WHO (2000). The Asia Pacific perspective: redefining obesity and its treatment. WHO regional office Western Pacific region. Accessed on 12 Dec 2011.
14. Lazarus R, Sparrow D, Weiss ST. Effects of obesity and fat distribution on ventilation function: The normative aging study. Chest 1997;111: 891-898.
15. Chinn DJ, Cotes JE, Reed JW. Longidutinal effects of change in body mass on measurements of ventilatory capacity. Thorax 1996; 51: 699-704.
16. Chen Y. Pulmonary complications of obesity: A review, Am J Med Sci. 2001; 321: 249-79.
17. Jones RL, Nzekwu MM. The effects of body mass index on lung volumes. Chest 2006; 130 (3): 827-833.
18. Lazarus R, Gore CJ, Booth M. Effects of body composition and fat distribution on ventilatory function in adults. Am J Clin Nutr. 1998; 68: 35-41.
19. Carey IM, Cook DC, Strachan DP. The effects of adiposity and weight change on forced expiratory volume decline in a longitudinal study of adults. Int J Obst Relat Metab Disord. 1999; 23: 979-985.
20. Biring MS, Lewis MI, Liv JT. Pulmonary physiological changes of morbid obesity. Am J Med Sci. 1999; 318: 293-297.
21. Oriel EJ, Vasavada JP, Khanijo SK, Agarwal RC, Bisarya BN, Agarwal RL. Observations on pulmonary functions in obesity. Ind J Chest and Allied Sciences 1979; 21 (2): 73-79.
22. Zerah F, Harf A, Perlemuter L. Effects of obesity on respiratory resistance. Chest 1993; 103: 1470-1476
23. Pankow W, Podszus T, Gutheil T. Expiratory flow limitation and intrinsic positive end expiratory

pressure in obesity. J Appl Physiol. 1998; 85: 1236-1243.
24. Bossino E, Sergi M, Natale B. Ventilatory volumes, flow rates, transfer factor and its components in obese adults and children. Respiration. 1984; 45:321-326.
25. Inselman LS, Milanese A, Deurloo A. Effect of obesity on pulmonary function in children. Pediatr Pulmonol. 1993; 16: 130-137.

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