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Effect of Central Adiposity on Lung Function Tests in Young Adults

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Abstract: *Obesity is a major health issue all over world. Many studies indicated the association between obesity and a wide range of health problems including respiratory diseases. It is one of the most important factors contributing to increase mortality and morbidity. The purpose of this study was to assess the impact of waist circumference (WC) on lung function in young population. A cross sectional study was conducted among healthy male and female students aged 18-25 yrs having no lung disease, who were grouped into control and obese according to their WC. Spirometry was performed on all subjects .Results were analyzed by using Graph pad Prism5,comparison was done using Student's unpaired t tests and correlation was determined by Pearson's correlation coefficient. The results showed a significant decrease in expiratory reserve volume (ERV) and maximum voluntary ventilation (MVV) along with a significant correlation between WC and MVV and ERV in obese population of both sexes suggesting a lower pulmonary reserve which in the future may lead to respiratory diseases if weight reduction is not undertaken.*

Keywords*: Central adiposity, ERV, MVV, WC.*

I. Introduction

Obesity is a chronic disease which is prevalent in both the developed and the developing countries, affecting children as well as adults [1]. As the standards of living are continuing to rise, weight gain and obesity are posing a growing threat to health. Obesity can cause various deleterious effects to respiratory function, such as alterations in respiratory mechanics, decrease in respiratory muscle strength and endurance, decrease in pulmonary gas exchange, and limitations in pulmonary function tests and exercise capacity [2,3,4].These changes in lung function are caused by extra adipose tissue in the chest wall and abdominal cavity, compressing the thoracic cage, diaphragm, and lungs [2]. The consequences are a decrease in diaphragm displacement, a decrease in lung and chest wall compliance, and an increase in elastic recoil, resulting in a decrease in lung volumes and an overload of inspiratory muscles [5].

Body fat that accumulates around waist, known as "abdominal fat", poses a greater risk than fat carried in the hip and thigh. Men are genetically predisposed to gain weight around waist, while females tend to be more pear-shaped. The abdominal fat is measured by waist circumference.

The wide use of Body Mass Index (BMI) as an obesity marker is explained by its simplicity, but it does not provide information on body fat distribution [6,7]. Most of the studies regarding the effect of obesity on Pulmonary function Tests (PFTs) have been conducted considering BMI; adequate study has not been done in the Indian adult population considering WC which correlates to intra abdominal and subcutaneous fat.

A review study on physiology of obesity and its effect on pulmonary function showed that central obesity is more likely to affect lung volume, without direct effects on pulmonary obstruction [6]. So, the aim of this study was to compare the lung function tests between obese and non obese young adults in both sexes using WC as the obesity marker. We also wanted to explore the correlation between the different PFTs and WC in both sexes.

II. Materials And Methods

2.1 Study Population: Healthy young adults both obese and normal in either sex, aged between 18 -25 years were chosen randomly from students of M.G.M. Medical College, Kishanganj Bihar, after getting an approval from the Institutional Ethics Committee (IEC).

2.2 Exclusion Criteria:

Non smokers, non-alcoholics, non-diabetics, not suffering from any respiratory or cardio-vascular disease.

2.3. Study Population:

Cut off values for WC is 80cm in female and in male it is 90cm [8, 9]. Out of 60 girls, 34 females were taken as controls with WC ≤ 80cm while 26 females having WC >80 cm were taken as obese.70 males were taken of which 42 had WC ≤90 cm who were taken as control and 28 having WC >90 cm were considered as obese.

2.4. Method:

All subjects were informed about the test and a written consent was obtained. WC measurement was done with feet 25-30 cm apart with a tailor's measuring tape in a plane perpendicular to the long body axis at the level of umbilicus in supine posture without compression of the skin with nearest to 0.1cm (according to WHO guideline) [10].

PFTs were done with the help of a Computerized Spirometer (Helios 401), observing the guidelines laid down by the ATS [11]. The volunteers were asked to take a rest for 5–10 minutes and then they were asked to take a deep inspiration and breathe out as rapidly as and as long as possible into the mouth piece of the spirometer. Flow volume curve was plotted and best of the three acceptable curves was selected as recording. MVV was recorded by asking the subject to breathe as rapidly and as deeply as possible for 12 sec.

2.5. Spirometric parameters recorded:

FVC: Forced Vital Capacity in Litres
FEV_1: Forced Expiratory Volume in one second in Litres
FEV_1/FVC: Ratio of Forced Expiratory Volume and Forced vital Capacity in %
MVV: Maximum Voluntary Ventilation in Litres
ERV: Expiratory Reserve Volume in Litres
PEFR: Peak Expiratory Flow Rate in Litres/min.

2.6. Statistical Analysis: Statistical analyses were done with Graph Pad Prism5.Values were expressed as mean ± SD. Data were analyzed by unpaired t test. Pearson's correlation coefficient was calculated to determine the relationship between WC and pulmonary function parameters.

III. Result And Analysis

Table 1: Mean (SD) age, height, weight, and waist circumference of men and women

Parameters	Male (N=70)	Female (N=60)
Age (Years)	19.55 ± 1.09	18.96 ± 0.87
Height (cm)	170.03 ± 7.04	155.28 ± 5.76
Weight (kg)	72.64 ± 15.66	57.65 ± 10.19
Waist circumference (cm)	85.47 ± 12.43	78.46 ± 7.16

Table 1 shows a comparison of baseline characteristics between the males and females showing that the age group was same in both sexes.

Table 2: Distribution of PFTs in relation to Waist circumference in Males

PFTs	Control (N=48) Mean ± SD	Obese (N=22) Mean ± SD	p value
FVC (L /s)	4.35 ± 0.503	3.98 ± 0.412	0.003**
FEV_1 (L /s)	3.58 ± 0.451	3.28 ± 0.348	0.007**
FEV_1/FVC(%)	84.72 ± 11.65	82.23 ± 1.13	0.324
PEFR (L/min)	7.86 ± 1.18	7.33 ± 1.25	0.09
MVV (L)	109.04 ± 14.17	93.31 ± 15.30	0.0001**
ERV (L)	1.07 ± 0.207	0.759 ± 0.30	0.0001**

$p < 0.05$ significant, $p < 0.0001$ highly significant

Table 2 shows that there is a significant reduction in FVC, FEV_1, MVV and ERV in obese males compared to non obese.

Table 3: Distribution of PFTs in relation to Waist Circumference in Females

PFTs	Control (N=34) Mean ± SD	Obese (N=26) Mean ± SD	p value
FVC	2.47 ± 0.5	2.195 ± 0.41	0.021*
FEV_1	2.07 ± 0.45	1.85 ± 0.34	0.043
FEV_1/FVC	83.5 ± 3.08	83.9 ± 2.21	0.57
PEFR	4.88 ± 1.22	4.33 ± 0.93	0.059
MVV	75 ± 2.15	63 ± 13.30	0.014*
ERV	0.83 ± 0.36	0.38 ± 0.15	0.0001**

P <0.05 significant, p <0.001 highly significant

Table 3 depicts a significant reduction in FVC, MVV and ERV in obese females compared to non obese.

Table 4: Pearson's correlation coefficient of Waist circumference with PFTs in both sexes

Parameters	Male Pearson's r value (N=70)	Female Pearson's r value (N=60)
FVC (L/s)	r = - 0.336* p = 0.004**	r = - 0.119 p = 0.362
FEV_1 (L/s)	r = - 0.3183* p = 0.007**	r = - 0.094 p = 0.470
FEV_1/FVC (%)	r = - 0.3282* p = 0.005**	r = -0.1607 p = 0.220
PEFR (L/min)	r = 0.003 p = 0.979	r = 0.1120 p = 0.394
MVV(L)	r = - 0.472** p < 0.0001**	r = - 0.309* p = 0.016**
ERV(L)	r = - 0.555** p < 0.0001**	r = - 0.509** p < 0.0001**

Table 4 shows that WC is strongly negatively correlated with ERV (r value ≥0.5) in both sexes (**) while in males a significant negative correlation is also found with FEV_1, FVC/FEV_1 % and MVV (*). In females a significant negative correlation is found with MVV.

IV. Discussion

Obesity is a rapidly escalating global hazard in all age groups. Recent National Health and Family Welfare Survey III (2005-2006) have observed an increase in the prevalence of overweight and obesity in the age group of 18-45 years from total average of 10.6% (1998-1999) to 14.4% (2005-2006) [12]. Impairment of pulmonary function is associated with both adolescent and adult obesity.

BMI does not give any indication of fat distribution [13], while WC is more directly proportional to total body fat and the amount of metabolically active visceral fat [14] .Moreover simplicity of measurement is a major advantage of WC and so it was taken as an obesity marker.

The present study showed that there was a decrease in all the parameters in obese subjects in both the sexes but a significant decrease in FVC, ERV and MVV was prominent. In male obese there was also a significant reduction in FEV_1.

S Goya Wannamethee et al in 2005 found a significant lowered FVC and FEV_1 in both sexes in obese in relation to WC [15] and we too found it in males only. Yue Chen et al in 2007, in his cross-sectional survey of men and women aged 25-64 years also found a significant decrease in FVC and FEV_1 in both sexes [6]. Similar to our study, Yogesh Saxena et al, in 2009 [16], observed a significant decrease in FVC in obese females with respect to WC and in contrast, Lazarus R et al in 1998[17] found no significant change in FVC in obese women. Paralikar [18] in 2013 observed a significant decrease in FEV_1 and FVC ratio in obese adolescents in both sexes which is more or less consistent with our study.

Abdominal fat deposition may directly impede the descent of diaphragm and increase thoracic pressure during the FVC maneuver while fat deposition in the chest wall may diminish rib cage movement and thoracic compliance. This explains the reduced MVV in obese in both sexes. High amounts of adiposity may be related to a greater degree of airway narrowing though the mechanism remains uncertain [19]. This could account for the lowered FEV_1 and FVC ratio in males in our study. Also the reduction of ERV in both sexes can be explained by the fact that abdominal adiposity compresses the lungs and diaphragm [20].

Correlation study shows a strong negative correlation between WC and MVV and ERV in both sexes and there is also a negative correlation with FEV_1 and FEV_1/FVC % in males only.

S. Goya Wannamethee et al in 2005[15] in his study in elderly men showed that WC was inversely correlated with FVC and FEV_1.

Y. Saxena et al in 2009 [16] showed significant inverse relation with FVC, FEV_1 with respect to WC in both sexes. Yue Chen et al in 2007 [6] showed an inverse association of WC with FVC which are contrary to our studies. Lazarus R et al [17] in 1998 did not find any association of WC with FVC in females which is in accordance with our study.

In obese males the FVC and FEV_1 were decreased significantly while in obese females, there was a significant decrease in FVC. All the dynamic functions of the lung depend on the compliance of the thorax-lung system, airway resistance and muscular strength of the respiratory muscles which may be reduced with obesity.

The primary factors that affect PEFR are strength of expiratory muscles and as it is an effort dependent process, it did not show any significant change as the subjects were young and could be motivated. Moreover decrease in FVC and PEFR may not be the most suitable variable to detect early deterioration of the ventilatory function.

MVV provides an overall assessment of the effort, coordination and flow-resistive properties of the respiratory system. It is hypothesized that some obese subjects manifest peripheral airway abnormalities, suggested by reduced expiratory flow rates at low lung volumes and air trapping.

As a result, inspiratory muscles are at a mechanical disadvantage leading to lower inspiratory pressure and flow, and reduced respiratory muscle strength causing a low MVV. This could also explain the cause of reduced ERV. As a strong negative correlation between WC and MVV and ERV was found in both sexes, it can be said that WC can be a predictor for decreased MVV and ERV.

Our study was a random sample of individuals from only a segment of the population. Moreover our study population comprised of young students coming from an affluent background and many of them undertook regular exercise programs.

But this study definitely unravels another health hazard associated with obesity i.e respiratory dysfunction and it highlights the need to reduce the body weight aggressively. A larger sample size involving volunteers from a mixed socioeconomic status and a longitudinal study will definitely be of a greater value in predicting the relationship between PFTs and the different obesity markers.

V. Conclusion

This study suggests that obesity has effects on the lung function that can reduce respiratory wellbeing even in the absence of specific respiratory diseases and may exaggerate effects of existing airway disease due to lower respiratory reserve and more importantly weight loss can reverse these problems. The isolated effects of obesity in adolescents, unassociated with other diseases must be identified and obesity related respiratory dysfunction must be evaluated in detail. This study is an attempt to bring awareness about variation of lung function with increase in WC and this can be a step forward to eradicate obesity and impaired lung function. It suggests that obesity has effects on the lung function that can reduce respiratory wellbeing and WC can be used in health promotion programmes to identify obese individuals prone to develop respiratory problems in later life. Future research with larger sample size to compare the pulmonary function relation with obesity will give more insight into effect of obesity on pulmonary function.

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References

[1]. Obesity: Preventing and managing the global epidemic. Report of a WHO consultation. World Health Organ Tech Resp Ser, 894, 2004,1-253.

[2]. J Faintuch, SAF Souza ,Valexi AC, Sant´ana AF, Gama-Rodrigues JJ, Pulmonary function and aerobic capacity in asymptomatic bariatric candidates with very severe morbid obesity. Rev Hosp Clin Fac Med S Paulo. 59,2004,181-86.

[3]. S M Koeing, Pulmonary complications of obesity, Am J Med Science, 321, 2001, 249-79.

[4]. W Ladosky, MAM Botelho, et al, Chest mechanics in morbidly obese non hypoventilated patients, Respiratory Medicine, 95, 2001, 281-286.

[5]. D Canoy,R Luben, AWelch et al. Abdominal obesity and respiratory function in men and women in the EPIC-Norfolk study, United Kingdom,.Am J Epidemiology 159,2004,1140-1149 .

[6]. Y Chen,Rennie, et al,WC is associated with Pulmonary function in normal weight, overweight, and obese subjects. Am J Clinic Nutr, 85(1), 2007, 35-39.

[7]. CM Salome et al, Physiology of Obesity and effects on lung function, J Appl Physiology, 108, 2010,206 -211.

[8]. C Dobblesteyn, M Joffres, D MacLean, G Flowerdew, and the Canadian Heart Health Surveys Research Group, A comparative evaluation of waist circumference, waist to hip ratio and body mass index as indicators of cardiovascular risk factors. The Canadian Heart Health Surveys. Int J Obes Relat Metab Disord, 25, 2001, 652-661.

[9]. A Misra, N K Vikram, R Gupta,RM Pandey,J S Wasir, and V P Gupta.Waist circumference cut-off points and action levels for Asian-Indians for identification of abdominal obesity. Int J Obesity 30, 2006, 106-111.

[10]. S Bhave, A Bavedkar, M Oliv, IAP National Task Force for prevention of adult disease: Childhood obesity. Indian Pediatr 41, 2004, 559-575.

[11]. American Thoracic Society. Standardization of spirometry. Am J Respir Crit Care Med, 152, 1995, 1107-1136.

[12]. S C Lakhera, Lazar, Sengupta J et al, Pulmonary functions of Indian athelets and sportsmen, A comparison with American athlets . Ind J physiol Pharmacol 1984; 28:187-94.
[13]. Park K. Park's Textbook of Preventive and Social Medicine. 18th ed. Jabalpur: Banarasidas Bhanot 2005, 290-296, 313, 317.
[14]. Haslm D et al.ABC of obesity time to wake up.BMJ, 2006, 333:640-2.
[15]. S Goya Wannnamethee, A Gerald Shaper and Peter H Whincup et al. Body fat distribution, body composition, and respiratory function in elderly men. Amc J Clin Nutr 82(5), 2005, 996-1003.
[16]. Saxena Yogesh, Sidhwani Girish and Upmanyu Rashi. Abdominal obesity and pulmonary functions in young Indian adults: a prospective study. Indian J Physiol Pharmacol, 53(4), 2009, 318–326.
[17]. R Lazarus, C J Gore, M Booth et al. Effects of body composition & fat distribution on ventilatory function in adults. American J Clin Nutr 68,1998, 35-41.
[18]. Swapnil J Paralikar et al. Assessment of Pulmonary functions in obese adolescent boys. http:/www.lungindia.com June 2013.
[19]. G G King, N J Brown, C Diba et al.The effects of body weight on airway caliber. Euro Resp J 25, 2005, 896-901.
[20]. M Heather, Ochs Balcom, et al.Pulmonary function and abd adiposity in the general population. Chest, 129(4), 2006, 853-862.