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OBESITY AND LUNG FUNCTION AMONG HEALTHY EMPLOYEES OF A REGIONAL URBAN MEDICAL COLLEGE IN ODISHA, INDIA

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ABSTRACT

Obesity associated restrictive lung capacity is poorly understood, notably in an otherwise healthy population. To evaluate this relationship, we recruited non-smokers without any pulmonary disorders & examined their body mass index (BMI) and standard pulmonary tests. Following consent and eligibility determination, 81 healthy non-smokers from 354 employees at a regional medical college were considered. Overall, BMI was inversely correlated with MVV15 ($r=-0.24$, $p=0.03$). Analysis of mean Maximum Voluntary Ventilation (MVV15) stratified by BMI categories showed an inverse gradient MVV15 by ascending obesity categories (normal-overweight-obesity). In one multiple regression analyses, after adjusting for age, gender, FEV1/FVC ratio, overall BMI contributed to a quarter of a point lowering of MVV15 (beta=-0.248, t=2.36, p=0.02), with the model explaining 26% of variance (R^2=25.5). In a separate equation with same covariates, obese participants (BMI>=30) contributed almost a 4-point reduction in MVV15 (beta=3.91, t=2.73, p=0.007) with the latter model explaining 28% of variance (R^2=27.6%) in MVV15. Obesity in healthy individuals may produce restrictive pulmonary function due to differential distribution of adipose tissue in the chest and abdomen, which needs further investigation.

KEYWORDS: ***Body mass index, obesity, pulmonary function test***

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INTRODUCTION

Globally obesity is accepted as a health hazard because of its strong association with complications like diabetes mellitus, hypertension, atherosclerosis, coronary artery diseases, diabetes mellitus, thyroid disorders, rheumatologic diseases, obstructive sleep apnoea, premature death thereby impacting the overall quality of life.[1-2] Obesity also affects the respiratory system, as measured by pulmonary function tests (PFT). Other factors that may affect pulmonary function are gender, age, race/ethnicity & stature. With increasing age, there is an increasing in weight but also there is reduction in lung volume & capacity.[3, 4]Weight can affect pulmonary functions, mostly due to small airway dysfunction, expiratory flow limitation, alterations in respiratory mechanics, decreased chest wall and lung compliance, decreased respiratory muscle strength & endurance, decreased pulmonary gas exchange, lower control of breathing & limitations in exercise capacity[5.] Variations in PFT & their relationship with obesity have been found in many ethnic groups specifically Asians, Latin Americans, Indians & South Africans[6-8]Little is known about the relationship between obesity & lung function among people living in coastal areas, particularly in Odisha, a south-eastern coastal state in India. The primary objectives of this investigation were to – i) evaluate pulmonary function anomalies in our local, healthy population. ii) Examine the relationship between the degree of obesity & lung function impairment among a healthy population –employees of a regional, urban medical institution.

MATERIAL & METHOD

The present study was conducted in the Department of Physiology, of the S.C.B. Medical College (SCBMC), Cuttack, Odisha, a regional urban medical college centre. The SCBMC is the oldest of the 7 public & private medical institutions in the state, serving primary, secondary & tertiary level of medical care to the entire population of the state. The study was conducted among the employees of the SCBMC during a three month period.

Inclusion criteria

Obese and normal weight males and females between 16-60 years old were invited to participate in the study.

Exclusion criteria

- Smokers – current and those who quit in the past 24 months
- Subjects with history of asthma, bronchitis, COPD, emphysema, diabetes mellitus, hyper tension, other cardiovascular diseases, endocrine disease or surgery
- Subjects on chronic medication, alcoholics
- Subjects with noticeable weight gain or weight loss over the preceding 3 months
- Subjects having any neuro-muscular disorder
- A total of 354 employees were approached to participate in the study during a 3 month period. After excluding as per exclusion criteria we enrolled a convenient sample of 81 healthy non-smokers. Following consent of the subjects, the subjects were thoroughly examined. Detailed personal & family histories were taken. First anthropometric measurements were done as per the protocol described in Helsinki declaration.
- First age was recorded
- Standing height was recorded without shoes with a stadiometer in centimetres
- Weight was recorded without shoes and with light clothes on a weighing machine
- Body mass index (BMI) was recorded as weight in kilogram divided by height in sq meter as per Quetelet's index.[9]

The participants of this study sample classified on the basis of BMI. According to World Health Organization (WHO) persons having BMI 18.5kg/m² to 24.9kg/m² considered as normal, BMI 25-29.9 kg/m² considered as overweight & BMI ≥30kg/m² considered as obese.[10] Pulmonary function tests were performed using RMS medspiror. This spirometer has a mouth piece attached to a transducer assembly which is connected to an adapter box and this is connected to the computer by a serial cable. Software from Recorders & Medicare system is loaded onto the computer. This software allows the calculation of the predicted values for age, sex, weight and height and it also gives the recorded values of all the parameters. Institutional Ethical clearance was obtained prior to conducting the study as a part of post graduate thesis. Subjects were motivated prior to the start of manoeuvre. After obtaining written consent from the participants the pulmonary function tests were recorded at noon before lunch, as expiratory flow rates are highest at noon.[11] the subjects were made to sit on a stool. The tests were carried out in a private and quite room. For each volunteer three satisfactory efforts were recorded according to the norms given by American thoracic society & the result of the best effort was taken[12]. The tests were first self demonstrated by the examiner for better understanding of the subjects. Recording of the pulmonary function tests were done in one sitting. First FVC manoeuvre was done. The subject was asked to place the mouth piece firmly in the mouth and to take a maximum inspiration, then nostrils were closed using a nose clip and subject was asked to execute a maximum forced expiration with full effort and this is followed by a maximum forced inspiration through mouthpiece. Second the procedure of SVC was done that is after putting the nose clip first 3 to 4 normal breathing was done. This is followed by maximum inhalation followed by maximum exhalation & again there was normal breathing for sometimes. Lastly MVV was recorded by taking deep inspiration followed by forceful expiration as quickly as possible for 15 seconds. Test measures included for the study were Forced Vital Capacity (FVC), Forced Expiratory Volume (FEV1), Maximum Voluntary Ventilation 15 secs (MVV15), Expiratory Reserve Volume (ERV)

RESULTS

Table 1
Sample Characteristics

Measure		Frequency				Min-Max
		No	%	Mean	S.D	
Gender	Female	41	50.6			
	Male	40	49.4			
Age in years				29.8	10.6	17-50
Height in meters				1.61	0.07	1.5-1.8
Weight in kilograms				68.0	13.9	44-110
BMI (Quetlet's index)				26.3	5.4	18.6-46.4
<25		41	50.6			
25-29.9		21	25.9			
≥30		18	23.5			

This table shows that 50.6% of our sample was female & 49.4% was male. The mean age of the sample was 29.8±10.6 years, mean height was 1.61±0.7 meters. The mean weight was 68.0±13.9 kg & the mean BMI was 26.3±5.4 kg/m². Among the BMI grouping 50.6% people were having BMI<25kg/m², 25.9% were overweight with BMI 25-29.9kg/m² and 23.5% of sample were obese having BMI≥30kg/m².

Table 2
Lung Function test results

Measure			Min-Max
	Mean	S.D	
FEV-1	2.2	0.5	1.1 – 3.6
FVC	2.3	0.5	1.4 – 3.6
FEV1-FVC Ratio	93.2	9.2	52 – 100
MVV-15	22.0	5.7	8 – 38
ERV	0.8	0.4	0.7 – 2.8

Table 3
Pearson Correlation Coefficients between BMI and Lung Function Tests

	MVV15	FEV1	FVC	FEV1-FVC ratio	ERV
BMI	-0.239*	-0.295**	-0.337**	0.059	-0.133

****P<0.05; ** p<0.01***

This table shows correlation between BMI & lung function. After doing Pearson Correlation Coefficient FEV1, FVC were shown to have inverse correlation with BMI. MVV was found to be more significantly decreased in obese group as Pvalue<0.01.

Table 4
Lung Function Tests by BMI Categories (Mean±S.D.)

BMI Categories	MVV15	FEV1	FVC	FEV1-FVC Ratio	ERV
Normal (<25)	22.9±5.7	2.3±0.5	2.5±0.5	92.8±9.0	0.8±0.3
Overweight	22.2±5.1	2.1±0.3	2.3±0.5	93.7±11.5	0.7±0.5
Obese(≥30)	19.8±5.9	2.0±0.5	2.1±0.4	93.7±6.7	0.8±0.4
p value	0.136	0.146	0.051	0.913	0.787

Table 5
Regression Models for Lung Function Test (MVV15) Predicted by BMI

Models	Beta	S.E.	R^2
BMI (Unadjusted)	-0.239*	0.116	5.7%
BMI (Adj. Age,sex)	-0.245**	0.105	22.1%
BMI (Adj. #2 + FEV1,FVC	-0.240**	0.105	25.5%

**** P <0.05 ** p <0.01***

This table shows Regression model analysis for lung function test. After adjusting for gender, age, FEV1 & FVC, BMI was inversely associated with MVV15.

Table 6
Multivariable Regression Analysis for Lung Function Test (MVV15) Predicted by BMI Categories

Variables		Beta	S.E.	t-statistics	p value	R^2
BMI Categories	Normal	(Ref)	---	---	---	
Overweight (BMI 25-29)		-1.979	1.392	1.422	0.159	
Obese	(BMI >=30)	-3.915	1.404	2.789	0.007	
Co-variables						26.7
Female Gender		-4.551	1.12	4.049	0.000	
Age in years		-0.165	0.062	2.674	0.009	
FEV1-FVC Ratio		-0.061	.070	0.879	0.382	

This table shows that obese (BMI>=30) participants had a 4 point lower MVV15 (beta=-3.915, p<0.01) than participants with normal BMI, after controlling for age, gender and FEV1-FVC ratios.

DISCUSSION

In this healthy sample, lung function appears to be influenced by BMI. It was found that Lung function tests were inversely correlated with BMI. Although not significant, individuals identified with the obese category showed poorer lung function test results than those with normal BMI. Our study is consistent with the study by Collins et al where lung function was more strongly negatively associated with BMI[13]. Obesity related decrease in lung function may be due to various mechanisms. The accumulation of fat may mechanically affect the expansion of the diaphragm, probably by encroaching into the chest by the chest wall or diaphragm[14] or by impeding the descent of the diaphragm during forced inspiration[15]. Fat deposits between the muscles and the ribs may also decrease chest wall compliance[14,16-17] thereby increasing the metabolic demands & workload of breathing in the obese individuals [17-19]. Chronically obese persons have peripheral airway obstruction independent of smoking[19]. It has been found that hypoxia due to chronic obstruction may trigger the sympathetic nervous system activity leading to pulmonary vascular resistance[20-21].This leads to decrease in capacity of the lungs. Recent findings shows that obesity may be associated with markers of systemic & vascular inflammation such as the hormone leptin[22]. Inflammatory factors may exert local effects on lung tissue, leading to subtle reduction in airway diameter which leads to decrease in lung function. Our study population consisted of subjects without any underlying condition, which could affect MVV. In our study we found decreased value of MVV in obese individuals. This is consistent with the previous findings [23-27] that MVV can be low in obese individuals. Sharp[28] and associates reported increased total respiratory work, decreased respiratory compliance & low MVV in obese individuals. Naimark and Cherniack [24] showed that reduced compliance of the total respiratory system in obese individuals was almost entirely related to the reduced chest wall compliance. In 6 of 11 obese subjects, MVV was less than 80% predicted. In obese individuals, diaphragmatic muscle weakness due to various causes may lead to decrease in MVV[29]. In our study population FEV1, FVC were also shown to have inverse correlation with BMI.

CONCLUSION

In our study only subjects who were healthy, non-smokers & without co-morbidity were eligible to participate in the study. As a first study in the region, our results will shed light for similar future studies such as gender base pulmonary function. Self reported data for determining eligibility and rigid exclusionary criteria may have provided under or over estimates of the relationship.

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CONFLICT OF INTEREST

Conflict of interest declared: none.

REFERENCES

1. Haslam DW, James WPT. Obesity. *The Lancet*. 2005; 366(9492):1197–09.
2. Guilleminault C, Simmons FB, Motta J, Cummiskey J, Rosekind M, Schroeder JS, Dement WC. Obstructive sleep apnea syndrome and tracheostomy: long-term follow-up experience. Arch Intern Med. 1981 Jul 1; 141(8):985-8.
3. World Health Organization: Obesity: Preventing and managing the Global Epidemic. Geneva: WHO;2004.
4. Jones RL, Nzekwu MM. The effects of body mass index on lung volumes. Chest journal. 2006 Sep 1;130(3):827-33.
5. Costa D, Barbalho MC, Miguel GP, Forti EM, Azevedo JL. The impact of obesity on pulmonary function in adult women. Clinics (Sao Paulo). 2008;63(6):719-24.
6. Yap WS, Chan CC, Chan SP, Wang YT. Ethnic differences in anthropometry among adult Singaporean Chinese, Malays and Indians and their effects on lung volumes. Respir Med.2001; 95:297-04.
7. Fulambarker A, Copur AS, Javeri A et al. Reference Values for Pulmonary Function in Asian Indians Living in the United States. Chest.2004;126:1225-33
8. Sarwari K, Ali I, Jaleeli K, Shanmukhappa N. Assessment of pulmonary functions in young obese males and females in the age group 18-25 years. IJABMR.2012; 2(3):185-9.
9. Garrow JS, Webster J. Quetelet's index (W/H2) as a measure of fatness. Int J Obes . 1984 Dec;9(2):147-53.
10. Barba C, Cavalli-Sforza T, Cutter J, Darnton-Hill I. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. The lancet. 2004 Jan 10;363(9403):157.
11. Hetzel MR. The pulmonary clock. Thorax.1981;36:481-6
12. American Thoracic Society. Standardization of spirometry: 1994 update. Am J Respir Crit Care Med 1995; 152: 1107–36.
13. Collins LC, Hoberty PD, Walker JF, et al. The effect of body fat distribution on pulmonary function tests. Chest. 1995;107:1298-302

14. Ray CS, Sue DY, Bray G, Hansen JE, Wasserman K. Effects of Obesity on Respiratory Function 1–3. Am Rev Respir Dis. 1983 Sep;128(3):501-6.
15. Lazarus R, Gore CJ, Booth M, et al. Effects of body composition and fat distribution on ventilator function in adults. Am J Clin Nutr.1998;68:35-41
16. Kannel WB, Hubert H, Lew EA. Vital capacity as a predictor of cardiovascular disease: Am Heart J 1983; 105:311-15.
17. Pankow W, Podszus T, Gutheil T, Penzel T, Peter JH, Von Wichert P. Expiratory flow limitation and intrinsic positive end-expiratory pressure in obesity. J Appl Physiol. 1998 Oct 1;85(4):1236-43.
18. Luce JM. Respiratory complications of obesity. Chest Journal. 1980 Oct 1;78(4):626-31.
19. Rubinstein I, Zamel N, DuBarry L, Hoffstein V. Airflow limitation in morbidly obese, nonsmoking men. Ann Intern Med. 1990 Jun 1;112(11):828-32.
20. Henriksen JH, Christensen NJ, Kok-Jensen A, Christiansen IB. Increased plasma noradrenaline concentration in patients with chronic obstructive lung disease: relation to haemodynamics and blood gases. Scand J Clin Lab Invest. 1980 Jan 1;40(5):419-27.
21. Reisin E, Frohlich LD. Obesity: cardiovascular and respiratory pathophysiological alterations. Arch Intern Med 1981;141:431-4.
22. Pan H, Guo J, Su Z. Advances in understanding the interrelations between leptin resistance and obesity.PhysiolBehav. 2014 May 10;130:157-69.
23. Bedell GN, Wilson WR, Seebohm PM. Pulmonary function in obese persons. J Clin Invest. 1958 Jul;37(7):1049.
24. Naimark A, Cherniack RM. Compliance of the respiratory system and its components in health and obesity. J Appl Physiol. 1960 May 1;15(3):377-82.
25. Cullen JH, Formel PF. The respiratory defects in extreme obesity. The American Journal of Medicine. 1962 Apr 1;32(4):525-31.
26. Barrera F, Reidenberg MM, Winters WL. Pulmonary function in the obese patient. The Am J Med Sci. 1967 Dec 1;254(6):785-96.
27. Rochester DF, Enson Y. Current concepts in the pathogenesis of the obesity-hypoventilation syndrome: mechanical and circulatory factors. Am J Med. 1974 Sep 1;57(3):402-20.
28. Sharp JT, Henry JP, Sweany SK, Meadows WR, Pietras RJ. Effects of mass loading the respiratory system in man. J Appl Physiol. 1964 Sep 1; 19(5):959-66.
29. Sahebjami H, Gartside PS. Pulmonary function in obese subjects with a normal FEV 1/FVC ratio. Chest. 1996 Dec 31; 110 (6):1425-9.

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