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Respiratory Medicine

BODY MASS INDEX ON LUNG FUNCTION IN HEALTHY MALE AND FEMALE ADULTS

T.V.Gopinath	Associate professor, Dept of Respiratory Medicine, Sri Lakshmi Narayana Institute of Medical Science, Pondicherry.
Rohith Reddy*	Assistant professor, Dept of Respiratory Medicine, Sri Lakshmi Narayana Institute of Medical Science, Pondicherry.*Corresponding Author
C. Aravindh	Professor of General Medicine, Sri Lakshmi Narayana Institute of Medical Science, Pondicherry.
Y. Sai Reddy	Associate professor, Dept of Respiratory Medicine, Sri Lakshmi Narayana Institute of Medical Science, Pondicherry.
Vignesh.K	Senior Resident, Dept of Respiratory Medicine, Sri Lakshmi Narayana Institute of Medical Science, Pondicherry.
E. Prabhakar Reddy	Professor Of Biochemistry, Sri Lakshmi Naryana Institute Of Medical Sciences, Puducherry, Affiliated To BIHER, India.

ABSTRACT Obesity is becoming one of the serious public health problems of modern world with rapidly changing lifestyles involving consumption of high calorie foods with decreased physical activities. Spirometery is the initial screening tool for pulmonary diseases. The aim of this study was to evaluate the prevalence of deranged BMI, pulmonary function tests and correlation between BMI and pulmonary function test. Our aim is to find association and correlation between BMI and pulmonary functions parameters. Increasing BMI is associated with decrease in lung functions in healthy population of either gender. Regular pulmonary function monitoring may assess adverse effects of obesity on pulmonary functions. Hence, proper and timely advice regarding lifestyle modification to obese subjects will prevent unwanted complications of obesity.

KEYWORDS : Body Mass Index (BMI), Pulmonary Function Test (PFT), Forced Vital Capacity (FVC), Spirometery.

INTRODUCTION:

Lung function is a significant predictor of future morbidity and mortality in the general population.[1] Maintaining good lung function across adult life is important to prevent chronic respiratory diseases,which nowadays represent a serious public health problem around the world.[2] There is consistent evidence showing that overweight, obesity and weight gain in adulthood are detrimental to lung function, as described by the forced vital capacity (FVC) and/or forced expiratory volume in 1 s (FEV1). Previous population-based and occupational cohort studies have shown that excessive weight gain in adulthood is associated with lower lung function levels and with an increased rate of lung function decline independently of age and smoking status.[3–8]. This precludes a more comprehensive understanding of the role of weight change on lung function during adulthood and older life and supports the need for further studies with longer follow-up periods extending into late adult life. Understanding the effects of weight changes on lung function during adult life is of utmost importance given the epidemic levels of overweight and obesity globally.[9] BMI has also shown its importance in the prediction of various disease conditions, the most important being the predictor of cardiovascular risks.[10] However, the link between BMI and lung function test is yet to be explored in detail.[11] Previous studies have well established the association of age, sex, and anthropometric indices with pulmonary functions.[12-16]

Spirometry is now widely acceptable test to assess pulmonary functions. They are considered as the initial screening tool for pulmonary diseases and are easy to conduct by using equipment that is available in all pulmonary functions laboratories. Therefore, our study aimed to assess the effects of BMI on spirometric test parameters among young healthy adults. Our aim is to find association and correlation between BMI and pulmonary functions parameters

Materials and methods:

This is a cross sectional study conducted in Department of Pulmonary Medicine of SLIMS, Pondicherry. After approval from institutional ethics committee, total 70 adult subjects in the age group of 18 to 75 years were selected. Both males and females were included. The subjects selected were healthy volunteers, hospital staff and relatives of patients. Informed written consent was taken from all the participants. Each individual underwent a thorough medical evaluation including medical history and complete physical examinations. Current smokers, ex-smokers and tobacco users in any form like chewing, snuffing or water pipe were excluded from this study. Subjects with pre-existing pulmonary diseases like tuberculosis, bronchial asthma, COPD etc or having systemic conditions like diabetes mellitus, hypertension, ascites etc were also excluded. Patients having history of recent cardiac or thoracic surgery or having chest deformities or serious medical conditions were also not considered.

Measurement of anthropometric parameters:

Standing height of subject was recorded to the nearest one centimetre using Bio–plus stadiometer, without footwear, with heels together and heels, calf, buttocks and preferably back touching the stadiometer. The weight was measured by eagle's weighing machine to the nearest 0.1 kg, in standing position; subjects were wearing light clothes and were bare footed. Body mass index (BMI) was calculated by using Quetelet's index. (BMI = Weight in kg/ Height in m^2).[17] Depending on the BMI values, the subjects were divided into obese, overweight and non obese groups as per WHO classification system. The first group consisted of non-obese (normal body weight) subjects with BMI of 18 to 24.9 kg/m^2, second group consisted of BMI of 25 to 29.9 kg/m2 and obese subjects with BMI of 30 kg/m^2 and above.

Measurement of Pulmonary Function Tests:

The pulmonary function parameters were measured by using computerized body plethysmograph (Medgraphics – Platinum Elite SepiesTM Plethysmograph) machine in the Department of Pulmonary Medicine. The tests were conducted according to the American Thoracic Society/ European Respiratory Society (ATS/ERS) task force guidelines.[18] The instrument was calibrated daily. All the subjects were instructed to avoid tea, coffee and other stimulants and to report after a light breakfast. The test was explained and demonstrated to the subjects. After a rest for 5–10 minutes, the test was carried out in the sitting position, wearing a nose clip. The best of the three acceptable results were selected. Parameters recorded were; Forced vital capacity (FVC) in litres, Force expiratory volume in one second (FEV) in litres, FEV /FVC, Peak expiratory flow rate (PEFR) in litre per second, Forced expiratory flow rate 25-75%. All spirometric parameters were considered as a percentage of predicted on reported height and age.[19]

Statistical Analysis:

The detailed data was entered into the Microsoft excel sheet and subsequently analyzed statistically spss-11.5. Obtained Values were reported as Mean ± S.D. Comparison of lung functions in males and females was done using student's 't' test. Comparison of lung functions in normal, overweight and obese subjects was done using ANOVA test. Pearson's correlation coefficient was applied to determine the correlation between pulmonary functions parameters and BMI. Significance level was set at $p<0.05$ and considered as significant.

RESULTS:

Table 1: Baseline characteristics of study population according to gender

Variables	Male	Female	p- value
Age (Years)	47.12 ± 15.16	45.44 ± 15.68	0.51
Height (cm)	153.08 ± 06.08	164.45 ± 09.84	<0.0001*
Weight (Kg)	64.34 ± 16.78	71.55 ± 17. 78	0.015*
BMI (Kg/m2)	27.67 ± 06.98	26.84 ± 09.08	0.52
FVC (%)	88.50 ± 11.72	88.81 ± 12.89	0.86
FEV1 (%)	76.59 ± 12.30	76.30 ± 11.63	0.87
FEV1 / FVC	86.15 ± 10.66	85.87 ± 10.87	0.21
EFF 25-75%	87.43 ± 7.41	86.58 ± 4.64	0.82
PEFR (%)	249.58 ± 46.09	352.9 ± 53.75	<0.0001*

Table 2: Comparison of characteristics of various BMI categories in males

Variables	BMI category (kg/m2)			p value
	Normal (n=34)	Overweight (n=26)	Obese (n=10)	
Age (Years)	49.14 ± 16.65	46.42 ± 14.47	42.60 ± 11.63	0.42
Height (cm)	164.09 ± 7.25	165.06 ± 4.66	159.23 ± 20.36	0.11
Weight (Kg)	59.55 ± 6.65	74.54 ± 5.40	101.69±21.07	<0.0001*
BMI (Kg/m2)	21.79 ± 1.49	27.01 ± 1.39	41.94 ± 15.17	<0.0001*
FVC (%)	80.87 ± 12.45	79.23 ± 11.37	82.21 ± 12.38	0.10
FEV1 (%)	77.70 ± 11.32	72.50 ± 9.25	65.42 ± 12.53	0.06*
FEV1 / FVC	96.21 ±11.08	88.48 ± 8.37	83.42 ±12.38	0.04*
EFF 25-75%	91.19 ± 26.08	84.34 ± 23.73	76.42 ± 21.35	0.21
PEFR (%)	360.59 ± 102.55	302.67 ± 86.18	252.58 ±105.37	0.020*

Table 3: Comparison of characteristics of various BMI categories in females

Variables	BMI category (kg/m2)			p value
	Normal (n=28)	Overweight (n=18)	Obese (n=24)	
Age (Years)	44.53 ± 17.09	42.09 ± 13.82	48.46 ± 15.79	0.42
Height (cm)	153.88 ± 06.20	152.83 ± 06.44	152.29 ± 5.83	0.62
Weight (Kg)	51.14 ± 07.09	63.90 ± 06.93	80.04 ± 16.18	<0.0001*
BMI (Kg/m2)	21.46 ± 01.75	27.24 ± 01.00	35.20 ± 05.67	<0.0001*
FVC (%)	87.57 ± 12.18	88.09 ± 12.88	89.21 ± 11.38	0.91
FEV1 (%)	76.25 ± 12.75	75.47 ± 11.88	73.42 ± 12.53	0.42
FEV1 / FVC	87.32 ± 10.32	85.21 ± 08.37	82.83 ± 12.38	0.04
EFF 25-75%	91.10 ± 14.49	94.34 ± 23.73	78.54 ± 31.40	0.013*
PEFR (%)	248.48 ± 67.74	208.67 ± 86.18	161.49 ± 75.51	0.015*

Table 4: Correlation between BMI and lung function parameters in different BMI categories in both genders

BMI Category	Parameter	Male		Female	
		r2	p value	r2	p value
Normal	FVC (%)	0.01	0.46	0.0096	0.91
	FEV1 (%)	0.044	0.13	0.007	0.78
	FEV1 / FVC	0.008	0.49	0.036	0.26
	EFF 25%-75%	0.001	0.69	0.007	0.77
	PEFR (%)	0.013	0.39	0.009	0.92
Overweight	FVC (%)	0.119	0.02	0.046	0.37
	FEV1 (%)	0.929	< 0.0001*	0.17	0.10
	FEV1 / FVC	0.003	0.65	0.19	0.09
	EFF 25%-75%	0.039	0.22	0.21	0.07
	PEFR (%)	0.003	0.67	0.03	0.42
Obese	FVC (%)	0.249	0.0145	0.5812	< 0.0001*
	FEV1 (%)	0.179	0.0881	0.5953	< 0.0001*
	FEV1 / FVC	0.419	0.0302*	0.9631	< 0.0001*
	EFF 25%-75%	0.009	0.6277	0.03543	0.30
	PEFR (%)	0.059	0.377	0.02624	0.35

DISCUSSION:

Obesity is one of the major health hazards across the world. It can lead to various clinical complications such as diabetes, vascular diseases, osteoarthritis, etc. But less emphasis has been given on the effect of obesity on respiratory system.[20] In this study an attempt was made to find out whether there is an increased risk of respiratory problems in overweight and obese individuals. Pulmonary function tests are generally related to body size and age, where height is a proxy for chest size, and age reflects maturity.[21] Because of this reason every individual has different range of normal values.

In present study it was observed that in overweight and obese male subjects FEV1, FEV /FVC and PEFR values were significantly lower. This can be explained on the basis of fact that with increase in obesity, respiratory and airway resistance increases.[22] Some investigators also observed similar findings in their studies.[23,24] But Costa et al reported no significant difference of lung functions among obese and non-obese females.[25]. In overweight and obese female subjects FEF25-75% and PEFR values were observed to be significantly lower. This shows obstructive pattern of smaller airways. Due to increased fat deposition on the chest wall, expansion of thoracic cavity is affected.[26] Also fat deposition in abdominal cavity shifts diaphragm upwards decreasing lung functions further and increasing work of breathing.

We observed significant negative correlation between BMI and FEV $_1$ in overweight males. Obese females showed significant negative correlation between BMI and FEV , FVC, FEV /FVC; while males showed significant negative correlation between BMI and FEV /FVC$_1$. Similar results were also observed by many other studies.[27-29] It may be because of fat accumulation around ribs, abdomen and diaphragm which causes restricted movements of ribs, reducing lung volume and decreasing respiratory compliance.[30].

All the parameters of pulmonary function tests were negatively correlated with Body mass index (BMI) in rural population. The present findings were not supported by the study done by Piyali et al. [31]The possible cause of the difference between two studies may be age factor and mild COPD for both sexes in their study. Therefore, it can be said that obesity has significant impact on respiratory problems. Excess of abdominal fat may restrict the diaphragmatic movement which leads to a decrease in pulmonary function. This study suggested significant impairment of pulmonary functions in overweight and obese population due to limited expansion of thoracic cavity which leads to possibility of small airway diseases. The lung functions might be improved by weight loss. According to WHO, BMI is the gold standard to classify obesity at present time. But BMI does not take an account of body fat distribution. Thoracic and abdominal fat have direct effects on movement of diaphragm rather than fat in hips and thighs. Hence, along with BMI, other indicators of fat distribution should also be considered.

CONCLUSION:

Moderate and high weight gain over 20 years was associated with accelerated lung function decline, while weight loss was related to its attenuation. Control of weight gain is important for maintaining good lung function in adult life. No significant difference was detected in spirometry parameters between obese/overweight and normal weight school children in our study. Increasing BMI is associated with decrease in lung functions in healthy population of either gender. Regular pulmonary function monitoring may assess adverse effects of obesity on pulmonary functions. Hence, proper and timely advice regarding lifestyle modification to obese subjects will prevent unwanted complications of obesity.

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