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Physiology

EFFECT OF BODY MASS INDEX ON LUNG FUNCTION PARAMETERS IN YOUNG HEALTHY ADULTS

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ABSTRACT **Introduction:** Obesity has been linked with impairment in multiple body functions. Increasing weight may affect pulmonary functions. Body mass index (BMI) is the most widely used and simplest index of adiposity. Our study aimed to assess the effects of BMI on spirometric test parameters among young healthy adults.

Methods: Spirometric tests were carried out in 139 young healthy adults of either gender after recording history and anthropologic parameters. Subjects were divided as per BMI into normal, overweight and obese groups.

Results: FEV_1, FEV_1/FVC and PEFR were significantly lower in overweight and obese males. EFF 25-75% and PEFR were significantly lower in overweight and obese females. In obese BMI group, females showed significant negative correlation between BMI and FEV_1, FVC, FEV1/FVC; while males showed significant negative correlation between BMI and FEV_1/FVC

Conclusion: BMI has significant effect on lung functions.

KEYWORDS : Body Mass Index, Lung Functions

INTRODUCTION:

Epidemic of Obesity is increasing rapidly all over the world.[1] Obesity has been linked with impairment in multiple body functions. Many studies have been done and are still going on to find out the effects of obesity on different body functions. Increasing weight may affect pulmonary functions including expiratory flow alteration, small airway dysfunction, decreased respiratory muscle strength, decreased chest wall and lung compliance, limitations in exercise capacity.[2,3]

Body mass index is the most widely used and simplest index of adiposity. According to WHO, obesity is defined as BMI greater than or equal to 30kg/m^2. Normal BMI ranges 18.5 to 24.99 kg/m^2.[4] In different racial groups, age and gender; the validity of BMI in prediction of body fatness is well-established.

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.

AIM:

To find association and correlation between BMI and pulmonary functions parameters

MATERIALAND METHODS:

Study Design:

This is a cross sectional study conducted in Department of Physiology in collaboration with Department of Pulmonary Medicine of a tertiary care hospital. After approval from institutional ethics committee, total 139 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.

Methods:

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).[5] 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/m^2 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 Sepies™ 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.[6] 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_1) in litres, FEV_1/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.[7]

Statistical Analysis:

The detailed data was entered into the Microsoft excel sheet and subsequently analyzed statistically by using graph pad prism 5 software. 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:

The baseline characteristics of the study subjects are shown in Table 1. Total study population was 139 subjects. There were 71 male subjects (51.08%) and 68 female subjects (48.92%) included in the study. Mean age of males was 47.16±15.19 and mean age of females was 45.48±15.71. We found no statistically significant difference in age (p value=0.52) or BMI (p value=0.54) between the male and female subjects. But difference in height and weight was statistically significant in males and females ($p<0.05$). With respect to spirometric tests, we found significant difference in PEFR ($p<0.001$) between males (249.62±46.12) and females (353.3±53.78).

Table 1: Baseline characteristics of study population according to gender:

Variables	Male	Female	p- value
Age (Years)	47.16 ± 15.19	45.48 ± 15.71	0.52
Height (cm)	153.12 ± 6.11	164.49 ± 9.87	<0.0001*
Weight (Kg)	64.38 ± 16.81	71.59 ± 17. 81	0.015*
BMI (Kg/m^2)	27.71 ± 7.01	26.88 ± 9.11	0.54
FVC (%)	88.54 ± 11.75	88.85 ± 12.92	0.88
FEV_1 (%)	76.63 ± 12.33	76.34 ± 11.66	0.89
FEV_1 / FVC	86.19 ± 10.69	85.92 ± 10.90	0.22
EFF 25-75%	87.47 ± 7.44	86.62 ± 4.67	0.85
PEFR (%)	249.62 ± 46.12	353.3 ± 53.78	<0.0001*

On comparing lung functions in different BMI categories of males, FEV_1 (%) and FEV_1/FVC showed significant difference in normal, overweight and obese males (p<0.05). Similarly, PEFR showed significant difference (p<0.0001) in normal (360.63±102.57), overweight (302.71±86.21) and obese (252.62±105.40) males. No difference was observed in means of FVC and FEF 25-75% of three categories. (Table 2)

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

Variables	BMI category (kg/m^2)			p value
	Normal (n=34)	Overweight (n=26)	Obese (n=11)	
Age (Years)	49.18 ± 16.67	46.46 ± 14.50	42.64 ± 11.66	0.45
Height (cm)	165.03 ± 7.28	166.00 ± 4.69	159.27 ± 20.39	0.15
Weight (Kg)	59.59 ± 6.69	74.58 ± 5.43	101.73 ±21.10	<0.0001*
BMI (Kg/m^2)	21.83 ± 1.52	27.05 ± 1.42	41.98 ± 15.20	<0.0001*
FVC (%)	80.91 ± 12.48	79.27 ± 11.40	82.25 ± 12.41	0.11
FEV_1 (%)	77.74 ± 11.35	72.54 ± 9.28	65.46 ± 12.56	0.07*
FEV_1 / FVC	96.25 ±12.01	88.52 ± 8.40	83.46 ±12.41	0.04*
EFF 25-75%	91.23 ± 26.11	84.38 ± 23.76	76.46 ± 21.37	0.25
PEFR (%)	360.63 ± 102.57	302.71 ± 86.21	252.62 ± 105.40	0.021*

On comparing lung functions in different BMI categories of females, statistically significant difference was observed in EFF 25-75% (p=0.013) and PEFR (p=0.015). FVC (%), FEV_1 (%) and FEV_1/FVC didn't showed significant difference in normal, overweight and obese females. (Table 3)

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

Variables	BMI category (kg/m^2)			p value
	Normal (n=28)	Overweight (n=16)	Obese (n=24)	
Age (Years)	44.57 ± 17.12	42.13 ± 13.85	48.50 ± 15.82	0.44
Height (cm)	153.92 ± 6.23	152.87 ± 6.47	152.33 ± 5.86	0.64
Weight (Kg)	51.18 ± 7.12	63.94 ± 6.96	80.08 ± 16.21	<0.0001*
BMI (Kg/m^2)	21.50 ± 1.78	27.28 ± 1.01	35.24 ± 5.70	<0.0001*
FVC (%)	87.61 ± 12.21	88.13 ± 12.91	89.25 ± 11.41	0.93
FEV_1 (%)	76.29 ± 12.78	75.50 ± 11.91	73.46 ± 12.56	0.45
FEV_1 / FVC	87.36 ± 10.35	85.25 ± 8.40	82.87 ± 12.41	0.06
EFF 25-75%	91.14 ± 14.52	94.38 ± 23.76	78.58 ± 31.43	0.013*
PEFR (%)	248.51 ± 67.77	208.71 ± 86.21	161.53 ± 75.54	0.015*

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

BMI Category	Parameter	Male		Female	
		r^2	p value	r^2	p value
Normal	FVC (%)	0.011	0.56	0.0004	0.91
	FEV_1 (%)	0.045	0.23	0.003	0.78
	FEV_1 / FVC	0.009	0.59	0.047	0.27
	EFF 25%-75%	0.002	0.79	0.003	0.78
	PEFR (%)	0. 015	0.49	0.001	0.95
Overweight	FVC (%)	0.12	0.08	0.056	0.38
	FEV_1 (%)	0.93	< 0.0001*	0.18	0.10
	FEV_1 / FVC	0.004	0.75	0.20	0.09
	EFF 25%-75%	0.04	0.32	0.22	0.07
	PEFR (%)	0.004	0.77	0.04	0.44
Obese	FVC (%)	0.25	0.1145	0.5912	< 0.0001*
	FEV_1 (%)	0.18	0.1881	0.6053	< 0.0001*
	FEV_1 / FVC	0.42	0.0309*	0.9731	< 0.0001*
	EFF 25%-75%	0.01	0.7277	0.04543	0.32
	PEFR (%)	0.06	0.4770	0.03624	0.37

We applied Pearson's correlation coefficient to find out correlation between BMI and lung function parameters in all three BMI categories in both genders. We observed that in normal BMI subjects there was no correlation between BMI and lung function parameters. In overweight males we observed significant negative correlation between BMI and FEV_1 (p<0.001). Overweight females didn't show any correlation between BMI and lung function parameters. In obese BMI group, females showed significant negative correlation between BMI and FEV_1, FVC, FEV1/FVC; while males showed significant negative correlation between BMI and FEV_1/FVC.

DISCUSSION:

Present study reports the findings of association between obesity and pulmonary functions in normal healthy adult population. It was observed that gender had no effect on mean values of FVC%, FEV1% and FEF 25-75%. But mean values of PEFR were varying significantly in males (249.62±46.12) and females (353.3±53.78), being higher in males. (Table 1) Ali Baig M et al and Harik-Khan RI et al have reported that baseline values of FVC%, FEV_1% and PEFR were higher in males.[8,9] This gender difference in pulmonary function can be attributed to bigger lung size and more muscularity in males.[10] The reason why we did not get gender difference in FEV_1, FVC and FEF 25-75%; might be attributed to use of percentage predicted values for analysis. According to some researchers measured volumes in liters tend to be higher in males than females.[11]

In present study it was observed that in overweight and obese male subjects FEV1, FEV_1/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.[12] Some investigators also observed similar findings in their studies.[13,14] But Costa et al reported no significant difference of lung functions among obese and non-obese females.[15]. 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.[16] Also fat deposition in abdominal cavity shifts diaphragm upwards decreasing lung functions further and increasing work of breathing.[13]

We observed significant negative correlation between BMI and FEV_1 in overweight males. Obese females showed significant negative correlation between BMI and FEV_1, FVC, FEV_1/FVC; while males showed significant negative correlation between BMI and FEV_1/FVC. Similar results were also observed by many other studies.[17,18,19] But Banerjee J et al[20] observed significant negative correlation between BMI and FEV_1/FVC in female subjects. Discrepancy in PFT values between studies could be because of wide variations in ethnicity of different population groups or may be because of use of different methodologies for study purposes.

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. Another limitation is we did not considered the status of physical activity and physical fitness; which were the confounders of the relationships between BMI and the lung function measures which also have to be considered in pulmonary function studies.

CONCLUSION:

Thus, to conclude, 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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