Original Article

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Physiology Section

Association of Body Mass Index (BMI) with Lung Function Parameters in Non-asthmatics Identified by Spirometric Protocols

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ABSTRACT

Introduction: Many studies have been published about the correlation between asthma and obesity in males and females. Various epidemiological data showed that obesity precedes development of asthma and increases the prevalence and incidence of asthma, indicates the possibility of a causal association.

Aim: To find out the correlation between body mass index and lung functions parameters in non-asthmatics, diagnosed by spirometric values in males and females.

Methods: A retrospective study was conducted from October, 2012 to March, 2013 in Physiology department, R.G.Kar Medical College, Kolkata, India on the spirometric data stored in our laboratory. About 590 test results were reviewed, among them only 424 test results of non asthmatics were analysed for our study.

Results: Comparison of lung function parameters between male and female showed a significant difference. Lung function parameters like Forced Expiratory Volume (FEV), Forced Expiratory Flow (FEF) rates, were significantly correlated with BMI among the obese subjects [FEV1(r=-0.531, p=0.009); FEF25-75% (r=-0.653, p=0.001); FEV1/FVC (r=-0.603, p=0.002)]. Significant association was found between BMI and lung function parameters in obese female but not in obese male.

Conclusion: Association was found between indices of spirometry and BMI in non-asthmatic obese group along with a gender disparity.

Keywords: Asthma, Obesity, Spirometric parameters, Pulmonary function test

INTRODUCTION

It has been observed that obesity is a global problem due to its significant contribution to mortality and morbidity [1]. Studies have been reported the association between BMI and asthma [2]. Asthma prevalence is increasing with obesity [1,3]. A previous study showed that incidence of asthma was higher in subjects with a BMI ≥ 25 kg/m^2 than the subjects with normal BMI <24.9 kg/m^2 [2]. Many studies also reported the similar findings about increasing prevalence of asthma with obesity [4-6]. Other studies reported no association between asthma and obesity [7-9]. There may be a causal association between asthma and obesity as obesity precedes the development of asthma. It has been seen that surgical and diet-induced weight-loss interventions improves lung function and symptoms of asthma. Previous studies showed that the association between asthma and obesity was stronger in females than males [4,6,10-13]. Aim of the study was to find out the association between body mass index and lung functions in non-asthmatics identified by spirometric protocols including gender differences.

METHODS

In this retrospective study 590 test results were taken from study database. Out of those 424 test results of non-asthmatic subjects were included considering inclusion and exclusion criteria. Written informed consent from every patient was already taken. Ethical approval was granted by the Ethical committee of R.G.Kar Medical College, Kolkata.

Experimental protocol: The spirometric data were collected for six months from October, 2012 to March, 2013 in the Physiology Department, R.G.Kar Medical College, Kolkata and these results were subjected to retrospective analysis. We obtained study subjects from General Medicine, General Surgery, Chest Medicine, Gynaecology, Paediatrics etc. The treatment sheets of every patient were also considered.

The cases under review were selected on the basis of: a) FEV1 ≥ 80% of predicted, b) FEV1/FVC ≥ 70% of predicted c) Bronchodilator Response (BDR) test with< 12% improvement in FEV1 d) FEV1 < 80% of predicted but with >12% improvement in FEV1 in BDR test. The exclusion criteria were subjects with any cardiac ailments, and severely ill patients.

Measurement of anthropometric parameters: Weight was measured nearest to 0.1 kg using a standardized electronic weighing machine, with the subjects standing without footwear and wearing light clothes. The height of the subjects was measured with the stadiometer, to the nearest centimetre. Body mass index (BMI) was calculated by using Quetlet's index (body weight in kg/height in m^2) [14]. Depending on their BMI values, the subjects were classified into obese and non obese groups according to BMI ranges as per WHO classification system [1].

Measurement of the pulmonary functions: Pulmonary functions were measured by the electronic spirometer, model-RMS Helios-702 following the guideline given by the American Thoracic Society (ATS) [15]. The subjects were asked to avoid tea, coffee and other stimulants and to report after a light breakfast. The test was explained and demonsrated to the subjects. After a rest for 5–10 minutes, the test was carried out. The best of the three acceptable results were selected. Bronchodilator was given and after 10 minutes of administration of the drug spirometry was performed again for reversibility test. Patient's age, height, weight, gender and smoking status were recorded. Spirometric parameters included Forced Vital Capacity (FVC), forced expiratory volume in one second (FEV1), FEV1/FVC, and Forced Expiratory Flow rates (FEF25%, FEF50%, FEF75%, FEF25%-75%). All spirometric parameters were considered as a percentage of predicted on reported height and age [16].

STATISTICAL ANALYSIS

The data were expressed in mean±SD and they were analyzed by SPSS (Statistical Package for Social Sciences) statistical software version 17.0 using proper statistical test. Differences were considered statistically significant when $p<0.05$.

RESULTS

[Table/Fig-1] shows the basic characteristics of the study subjects. Two hundred thirty-two out of 424 subjects were male among them 111 were smoker and 14 females out of 192 females were smokers. Significant differences between genders were found in pulmonary function variables (FEV1, FEV1/FVC, FEF25-75%, FEF75%) (all $p<0.05$), but not for FVC, FEF25%, and FEF50% [Table/Fig-2].

[Table/Fig-3] shows that BMI is not significantly associated with FVC, FEV1, FEV1/FVC and FEF25-75% in non obese subjects. But in obese subjects there is significant negative correlation between BMI and FEV1, FEF25-75% but FEV1/FVC have significant positive correlation with BMI. There is lack of association between FEF25%, FEF50%, FEF75% and BMI.

In obese female subjects there is significant negative correlation between BMI and FEV1, FEF25-75% but FEV1/FVC have significant positive correlation with BMI [Table/Fig-4].There is lack of association between BMI and FEF25%, FEF50%, FEF75% in obese female subjects [Table/Fig-4]. It also shows that there is no significant association between BMI and lung function parameters (FVC, FEV1, FEV1/FVC, FEF25-75%) in obese male subjects. FEF25%, FEF50% and FEF75% have lack of association with BMI in obese male subjects like obese female [Table/Fig-4].

Parameters		Mean(±SD) / percentage
Age		42.29 (±17.7) years
Gender	Male	54.72% [232]
	Female	45.28% [192]
BMI		21.72(±4.5)
Height		157.5(±9.83)
Weight		53.72 (±12.4)
Smoking history	Smoker	29.48% [125]
	Non smoker	70.52% [299]

[Table/Fig-1]: Basic characteristics of the subjects.

Variables (% of predicted)	Male Mean(±SD)	Female Mean(±SD)	p-value
FVC	111.87(±23.41)	115.54(±23.43)	>0.05
FEV1	109.88(±24.1)	118.10(±26)	0.001
FEV1/FVC	98.85(±12.24)	102.56(±11.54)	0.002
FEF 25%	69.22(±30.35)	69.49(±27.22)	>0.05
FEF50%,	64.53(±31.71)	64.11(±26.79)	>0.05
FEF75%	61.00(±37.23)	52.70(±26.03)	0.007
FEF25%-75%	75.73(±31.7)	92.09(±35.39)	0.001

[Table/Fig-2]: Comparison of lung function test between male and female.
p<0.05 is significance

Correlation of BMI with		Pearson correlation coefficient (r)	p-value
Non-Obese	FVC	-0.019	0.710
	FEV1	-0.010	0.849
	FEV1/FVC	0.039	0.438
	FEF25%-75%	0.007	0.895
Obese	FVC	-0.245	0.260
	FEV1	-0.531*	0.009
	FEV1/FVC	0.603**	0.002
	FEF25%-75%	-0.653**	0.001

[Table/Fig-3]: Correlation of spirometric parameters with BMI in non-obese and obese subjects.
*Significant, ** Highly significant

Correlation of BMI with		Pearson correlation coefficient (r)	p-value
Male	FVC	-0.326	0.302
	FEV1	-0.385	0.216
	FEV1/FVC	0.173	0.591
	FEF25%-75%	-0.400	0.198
Female	FVC	0.113	0.741
	FEV1	-0.506	0.013
	FEV1/FVC	0.958**	0.000
	FEF25%-75%	-0.797**	0.003

[Table/Fig-4]: Correlation of spirometric parameters with BMI in obese male and female subjects.
**Highly significant

DISCUSSION

The effects of obesity on spirometric values are not consistent in most of the studies, some studies showing no effects [17-20] and some other studies showing significant effects [21-24]. This discrepancy between studies could be explained by the wide variations in ethnicity of different population in PFT values or this may be a result of methodological differences in these studies. A study reported increase in FEV1/FVC with increasing BMI among the subjects including asthmatics, which suggested the restrictive effects of BMI [25]. In present study, we found that there is a significant positive correlation of BMI with FEV1/FVC ($r=0.603^{**}$, $p=0.002$) in non-asthmatics obese. One study reported no significant association of BMI with FEV1 [26], but in our study BMI showed significant negative correlation with FEV1($r=-0.531^{*}$, $p=0.009$) in obese subjects. Few studies showed similar findings [25,27,28].

The pattern of respiratory function may also be given by the study of expiratory flow rates of subjects. One study reported about negative correlation of BMI with FEF25% and FEF50% among the subjects who have obstructive type of lung function [29].

Our study showed that there is no significant association between BMI and FEF25%, FEF50%, FEF75% though previous studies [29] reported about significant association of BMI with and FEF25%, FEF50%, FEF75%. So these findings of our study suggest that the pattern of lung function of study subjects were non obstructive type which is most likely due to the exclusion of asthmatic subjects from our study. The strength of our study is the recruitment of subjects who were healthy without co-morbidity and the selection of subjects for the study who had been seen by a physician prior to being tested, and there were no indications that they had any co-morbidity including asthma.

In our study FVC, FEV1/FVC were affected with increasing BMI whereas expiratory flow rates were uncompromised effects of increasing BMI. These findings may be due to movement limitation of diaphragm and chest wall of non-asthmatic subjects with increasing BMI. Our study analysed the respiratory function in male and female separately and it showed that mean of FEV1, FEV1/FVC, FEF25-75%, were significantly more in female than male whereas mean of FEF75% was significantly more in male subjects. Other studies did not report the similar differences in male and female [28-31]. Our study also demonstrate that in obese female subjects BMI has a negative correlation with FEV1($r=-0.506$, $p=0.013$), FEF25-75%($r=-0.797$, $p= 0.003$), and significant positive correlation with FEV1/FVC($r=0.958$, $p=0.0001$) but there is no association with FEF25%, FEF50%, FEF75%. Whereas there is lack of association between lung function parameters and BMI in obese male subjects. So our study showed an unique observation of compromised airflow in obese female non-asthmatic subjects. Others have reported the significant increase in FEV1/FVC with increasing BMI [27,28, 30,32] but these studies have not consider gender. One study considering males and females separately showed no association between BMI and FEV1, but showed negative correlation of BMI with FEV1/FVC ratio in female subjects only [33].

CONCLUSION

In our study there was a significant association was found between BMI and lung function parameters in non-asthmatic obese group and it was more pronounced in females. The spirometric parameters of females were generally higher than those of males.

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