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

JOYASHREE BANERJEE1, ANINDYA ROY2, ANILBARAN SINGHAMAHAPATRA3, PRANAB KUMAR DEY4, ACHYUT GHOSAL5, ANUBRATA DAS6

ABSTRACT

Introduction: Association between obesity and asthma has been reported widely, with disparity between males and females. Epidemiological data which indicate that obesity precedes development of asthma and increases the prevalence and incidence of asthma, raises the possibility of a causal association.

Aim: To find out the association, including gender differences, between Body Mass Index (BMI) and lung functions in non-asthmatics identified by spirometric protocols.

Methods: A retrospective analysis was conducted of the spirometry results obtained between October 2012 and March 2013 for six months. Participants were referred by a variety of medical specialties to the pulmonary function laboratory in the Physiology department, R.G. Kar Medical College, Kolkata, India of the 590 test results recorded in the study database 424 non-asthmatic subjects were reviewed.

Results: Significant differences in the spirometric parameters, measured as a percentage of predicted were evident between male and female. Among obese subjects significant correlation is found between BMI and pulmonary function values, 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 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: Spirometric parameters, Pulmonary function test

INTRODUCTION

Obesity is a global problem and it is a significant contributor to morbidity and mortality [1]. An association between obesity and asthma has been reported widely, with disparity between males and females. The magnitude of increase in obesity has been paralleled by an increase in the prevalence of asthma in many global locales [1,2]. A meta-analytical study of the effect of elevated BMI on asthma incidence [3] determined that the likelihood of asthma was 1.51 times higher in subjects with a BMI ≥ 25 kg/m² compared to those of a normal weight (18.5-24.9 kg/m²) [Odds Ratio (OR) 1.51, 95% CI, 1.17-1.62]. Numerous other studies are also suggestive of an increased prevalence of obesity amongst adults with asthma [4-6], but do not adequately describe any cause and effect relationship between the two. The association between asthma and obesity, however, was not found by studies that investigated the association of obesity and airway responsiveness [7-9]. Epidemiological data indicate that obesity precedes the development of asthma raises the possibility of a causal association. Furthermore, surgical and diet-induced weight-loss interventions have been reported to result in improvements in lung function and symptoms in patients with asthma. In the studies for association between asthma and obesity, stronger correlation has been reported in females compared to males [4,6,10-13]. Aim of the study was to find out the association, including gender differences, between BMI and lung functions in non-asthmatics identified by spirometric protocols.

METHODS

In this 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 Ethics committee of R.G. Kar Medical College, Kolkata, India.

Experimental Protocol: A retrospective analysis of the spirometry data obtained between October 2012 and March 2013 was conducted in the Physiology Department, R.G. Kar Medical College, Kolkata for six months. Patients were selected from those participants, referred to the pulmonary function laboratory in Physiology Department by a variety of medical specialties including General Medicine, Chest Medicine, General Surgery, Pediatrics, Gynecology, Oncology, etc. The treatment sheets of every patient referred by physicians were consulted for their relevant history so also the pulmonary functions test results. The cases under review were selected on the basis of: (a) < 12% improvement in FEV1 after reversibility test, (b) FEV1 ≥ 80% of predicted without reversibility test and c) FEV1 < 80% of predicted but with FEV1/FVC ≥ 70% of predicted without reversibility test. The exclusion criteria were a) ≥ 12% improvement in FEV1 after reversibility test (b) FEV1 < 80% of predicted without reversibility test and (c) FEV1 < 80% of predicted and FEV1/FVC < 70% of predicted without reversibility test, (d) subjects with any cardiac ailments.

Measurement of Anthropometric Parameters: Weight was measured nearest to 0.1 kg using a standardized electronic weighing machine, with the subjects standing without footwear, with light clothes. The height of the subjects were measured with the stadiometer, to the nearest centimetre. BMI was calculated by using Quetlet's index (body weight in kg/height in m²) [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 in accordance with the standards of lung function testing of the American Thoracic Society/European Respiratory Society (ATS/ERS) [15]. The subjects were asked to avoid beverages like tea, coffee...
and other stimulants and to report on a light breakfast. The test was explained and demonstrated to the subjects. After a rest for 5–10 minutes, the test was carried out. The best of the three acceptable results was selected. Post bronchodilator (reversibility test) testing was performed 10 minutes after administration of the bronchodilator. Pulmonary function report included patient’s gender, height, weight, age and smoking status. Standard spirometric measures included, forced vital capacity (FVC), forced expiratory volume in one second FEV1, the ratio of forced expiratory volume in one second to forced vital capacity (FEV1/FVC), Forced Expiratory Flow in 25% (FEF25%), Forced Expiratory Flow in 50% (FEF50%), Forced Expiratory Flow in 75% (FEF75%), and Forced Expiratory Flow in 25-75% (FEF25%-75%). Pulmonary function variables were recorded as a percentage of the normal value 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 using proper statistical test. Differences were considered statistically different 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 125 were smoker. Significant differences between genders were found in pulmonary function variables (FEV1, FEV1/FVC, FEF25%-75%, FEF75%) (all p < 0.05), but not for 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].

**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. The significant increase in FEV1/FVC demonstrated throughout increasing BMI ranges is suggestive of the restrictive effects of the increased BMI. This phenomenon has also been reported in studies where asthma was not objectively excluded [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. Further suggestion of the predominance of a restrictive pulmonary function profile is offered by the lack of any significant effect of BMI on FEV1 in another study [26]. But in our study BMI showed significant negative correlation with FEV1(r=-0.531*, p=0.009 ) in obese subjects. This finding corroborates with the findings of several previous workers [25,27,28].

Further evidence for classification of the unique respiratory function pattern of non-asthmatic obese and non obese subjects is offered by the patterns of their expiratory flow rates. Previous studies have identified a clearly obstructive pattern and they have shown a negative correlation between increasing body weight with FEF25% and FEF50% [29] when evaluating these expiratory flow rates [27-29]. These studies however, did not exclude asthma through objective tests from the subject pool; hence the remaining obstructive indices may be indicative of the presence of asthmatics. 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. The results of our analyses are quite distinct from those previously described. No significant association was found between FEF25%, FEF50%, FEF75%, and BMI. These findings not only reinforce the suggestion that airway obstruction is not an obvious effect in these subjects but also clearly demonstrate that it is different from previously published results. We postulate that this is most likely secondary to the distinctive and unique profile of the study’s subject pool due to its unique exclusion criteria.
The compromised FVC, FEV1/FVC, and uncompromised expiratory flow rates together suggest the dominant effects of increasing BMI on chest wall restriction and/or diaphragmatic limitation. We have also allowed for the isolation of this effect by inclusion of only non-asthmatic participants. If asthma were present in this subject pool, then we anticipate that airway obstruction would be exaggerated by the reduced lung volumes. Our findings demonstrate a marginal increase in airflow secondary to chest wall impedance. The results of our data analysis also examined the differences in the respiratory function pattern of each gender. Unlike several investigations that did not report differences in the pulmonary function profiles of the genders [28-31], we observed significant differences between their mean predicted values for FEV1, FEV1/FVC, FEF25-75%, FEV75% (all p < 0.05). 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 lack of association with FEF25%, FEF50%, FEF75%. Whereas there is lack of association between lung function parameters and BMI in obese male subjects. So our study offers an important demonstration of the clear difference in pattern of airflow compromise between genders in non-asthmatic subjects. Several investigations have found either no effect or a positive association between FEV1/ FVC with increasing adiposity [27,28,30,32] without considering gender. One recent study, however, analyzed males and females separately [33]. In this study no association was found between adiposity and FEV1, but FEV1/FVC ratio was negatively associated with adiposity (p < 0.046) in females and males were not affected when smoking was adjusted.

CONCLUSION
Our study showed that clear association was found between indices of spirometry and increasing BMI in non-asthmatic obese group. While the spirometric values of females were generally higher than those of males, the effect of BMI on the female group was more pronounced. The unique features of these profiles indicate a compromise in respiratory function at increasing BMI in females than in males. However the results offer a rationale for underlying mechanisms that may be responsible for gender disparity in lung function of non asthmatics.

REFERENCES