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A Comparative Study of Pulmonary Function Tests Between Obese and Non-Obese Asthmatic Patients

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Abstract

***Background:** Bronchial asthma and obesity are both chronic diseases constituting important health problems worldwide. Obesity and bronchial asthma are common conditions characterised by the presence of inflammation. This systemic pro-inflammatory state leads to worsening of the airway inflammation seen in asthmatic patients.*

***Materials and methods:** This is a cross-sectional observational study with the aim of assessing the effect of obesity on pulmonary function in asthmatic patients. Study was conducted in the Department of Medicine, PGIMER, Dr. Ram Manohar Lohia Hospital, New Delhi from November 2014 to March 2016. Asthmatic patients attending the Medicine Department who satisfied the inclusion and exclusion criteria were included in the study. We compared pulmonary function tests between obese and non-obese asthmatic patients and compared the severity of asthma between obese and non-obese asthmatic patients. Spirometry of the patients was done to evaluate the pulmonary function. They were assessed for asthma severity according to GINA (Global initiative for asthma) 2014 guidelines. Significance of difference in means (quantitative variables) was calculated using student t test. Significance of difference in proportions (qualitative variables) was calculated using chi square test.*

***Results:** The mean age of non-obese asthmatic patients was 38.76 years (SD±13.44). The mean age of obese asthmatic patients was 39.23 years (SD ± 9.03). The mean FEV1 (% predicted) of non obese asthmatic patients was higher than the mean FEV1 (% predicted) of obese asthmatic patients and it was statistically significant (p value 0.002). The mean FEV1/FVC ratio of non-obese asthmatic patients was higher than the mean FEV1/FVC ratio of obese asthmatic patients and it was statistically significant (p value < 0.001). There was statistically significant (p value < 0.001, df-3) difference in severity of asthma in non obese and obese asthmatic patients.*

***Conclusion:** There is a strong association between BMI and pulmonary function in asthmatic patients. Pulmonary function tests are more deranged in obese asthmatics patients in comparison to non-obese asthmatic patients. Also the pulmonary functions had a negative correlation with BMI, i.e., the pulmonary functions deteriorated with increasing BMI among asthmatic patients. In conclusion, overweight and obesity is associated with significantly more airflow obstruction and poor disease control.*

***Key words:** Asthma, obesity, pulmonary function test.*

Introduction

Bronchial asthma and obesity are both chronic diseases constituting important health problems worldwide. Bronchial asthma is a chronic inflammatory disease characterised by lower airway hyper responsiveness and by variable airflow limitation that can resolve spontaneously or through treatment[1].

The mechanisms linking obesity and asthma remain poorly understood and multiple hypotheses have been proposed. Some studies propose that bronchial asthma in obese subjects may have a particular phenotype[2]. Obesity may be associated with respiratory symptoms via cardio-respiratory de-conditioning, physiological restriction of the chest wall by excess mass, or comorbidities, including gastro-oesophageal reflux and sleep-disordered breathing[3].

Obesity and bronchial asthma are common conditions characterised by the presence of inflammation[4]. Numerous cytokines, and soluble fractions of their receptors and chemokines have all been found to be increased in obesity[5]. This systemic pro-inflammatory state leads to worsening of the airway inflammation seen in asthmatic patients[6].

Therefore, this study aims to find the probable association between obesity and asthma. It also aims to research the

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impact of obesity on the clinical manifestations and severity of bronchial asthma which will be classified according to the GINA (Global Initiative for Asthma) guidelines[7].

Materials and methods

The aim of the study was to assess the effect of obesity on pulmonary function in asthmatic patients.The study was conducted with the objectives to compare pulmonary function tests and the severity of asthma between obese and non-obese asthmatic patients.

It was a cross-sectional observational study conducted from November 2014 to March 2016. Asthmatic patients attending the Medicine Department who satisfied the inclusion and exclusion criteria were included in the study. The diagnosis of asthma was based on history of characteristic symptom patterns (wheeze, dyspnoea, coughing) which are variable, both spontaneously and with treatment. Evidence of variable airflow limitation was demonstrated from bronchodilator reversibility testing (In adults: increase in FEV1 > 12% and > 200 mL). A patient with an FEV1 < 80% was given inhaled short acting beta-2 agonist bronchodilator and the spirometry was repeated after 15 min. If the FEV1 increases by more than 12%, it is indicative of reversible airway disease[8].

Inclusion criteria were subjects aged 18 years or older and who were asthmatic for more than one year. Exclusion criteria were subjects who were pregnant, had any additional respiratory disease (like COPD, ILD), smokers, with cardiac illnesses and patients who will not be able to perform pulmonary function tests by spirometry. Any cardiac illness was excluded by ECG and 2D-ECHO among all the patients included in the study.

A total of 30 obese asthmatics and 30 non-obese asthmatic patients were enrolled for the study. BMI of these patients was calculated and they were classified as obese and non-obese accordingly.

Spirometry of the patients was done to evaluate the pulmonary function. They were assessed for asthma severity according to GINA[7] (Global initiative for asthma) 2014 guidelines (Table I).

A patient was classified as underweight, overweight, and obese according to Body Mass Index (BMI) which is a simple index of weight-for-height used in adults (Table II). It is defined as the weight in kilograms divided by the square of the height in metres (kg/m^2)[9].

Table I: GINA classification of bronchial asthma severity[7].

	Symptoms/Day	Symptoms/Night	PEF or FEV_1
Intermittent	< 1 time a week Asymptomatic and normal PEF between attacks	</= 2 times a month	>/= 80%
Mild Persistent	> 1 time a week but < 1 time a day Attacks may affect activity	> 2 times a month	>/=80%
Moderate Persistent	Daily Attacks affect activity	> 1 time a week	60% - 80%
Severe Persistent	Continuous Limited physical activity	Frequent	</= 60%

PEF: Peak Expiratory Flow; FEV_1: Forced Expiratory Volume in the first second.

Table II: Classification of patients according to BMI[9].

Classification	BMI (kg/m^2)
	Principal cut-off points
Underweight	< 18.50
Normal range	18.50 - 24.99
Overweight	≥ 25.00 - 29.99
Obese	≥ 30.00

Statistical analysis

The data were checked for normal distribution. The qualitative variables were described in the form of proportions and quantitative variables were described in the terms of mean scores, range and standard deviation. Significance of difference in means (quantitative variables) was calculated using student t test. Significance of difference in proportions (qualitative variables) was calculated using chi square test. Fischer exact test was applied in some of the statistical analysis. Correlation was also evaluated in some cases. A p value of less than 0.05 was considered significant.

Results

The study included 30 non-obese and 30 obese asthmatic patients. Among non obese asthmatic; 7 (23.33%) patients were between the age of 18 - 30 years; 9 (30%) were in age group of 31 - 40 years; 7 (23.33%) were in the age group of 41 - 50 years; 5 (16.6%) were between 51 - 60 years of age and only 2 (6.66%) were above the age of 60 years. Among non-obese asthmatic patients, 14 (46.66%) were women and 16 (53.33%) were men.

Among obese asthmatic patients, 5 (16.66%) were in the

age group of 18 - 30 years; 13 (43.33%) were of age between 31 - 40 years; 8 (26.66%) were in age group of 41 - 50 years; and 4 (13.33%) between the age of 51 - 60 years. No obese asthmatic was above the age of 60 years. Among obese asthmatic patients, 11 (36.66%) were women and 19 (63.33%) were men.

The number of patients in various age groups of non-obese and obese asthmatic patients was comparable with a p value of 0.51 (df = 4), which was not statistically significant. Fig. 1 show the distribution of non-obese and obese asthmatic patients according to age.

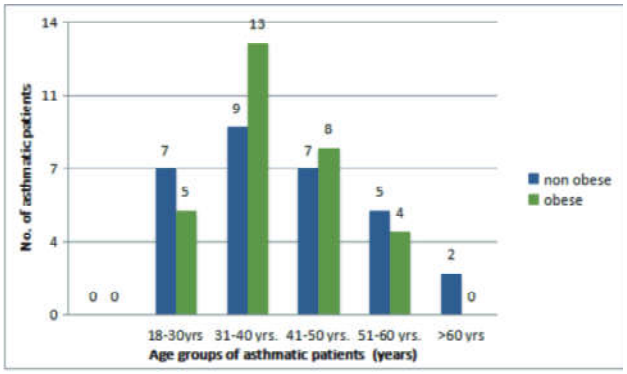

Fig. 1: *Distribution of non-obese and obese asthmatic patients according to age.*

The mean age of non-obese asthmatic patients was 38.76 years (SD ± 13.44). The mean age of obese asthmatic patients was 39.23 years (SD ± 9.03). The difference in the mean age of non-obese and obese asthmatic patients was not statistically significant (p value 0.87).

The mean BMI of non-obese asthmatic patients was 23.47 kg/m^2 (SD ± 3.35). The mean BMI of obese asthmatic patients was 30.96 (SD ± 0.51). There was a statistically significant difference in mean BMI of non-obese and obese asthmatic patients (p value < 0.001). Fig. 2 show the distribution of asthmatic patients according to Body Mass Index (BMI) (kg/m^2).

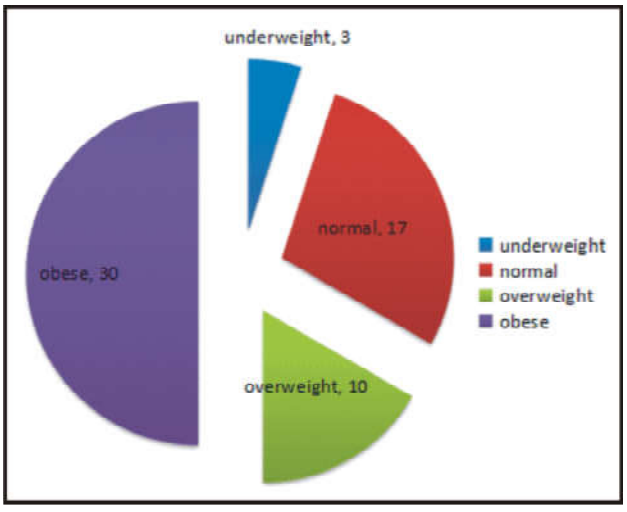

Fig. 2: *Distribution of asthmatic patients according to BMI.*

The mean FEV1 (% predicted) of non-obese asthmatic patients was 65.56 (SD ± 5.37). The mean FEV1 (% predicted) of obese asthmatic patients was 61.56 (SD ± 3.85). The mean FEV1 (% predicted) of non-obese asthmatic patients was higher than the mean FEV1 (% predicted) of obese asthmatic patients and it was statistically significant. (p value 0.002). Fig. 3 shows the mean FEV1 (% predicted) of non-obese and obese asthmatic patients.

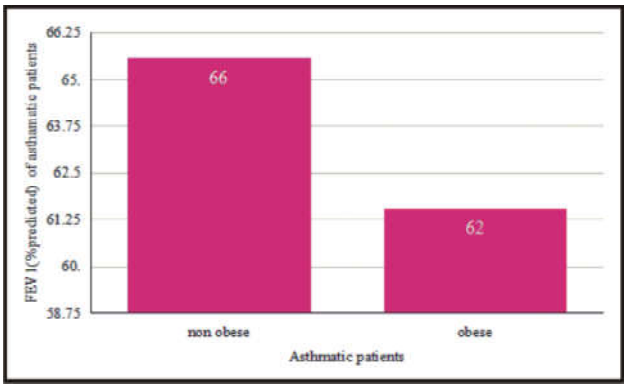

Fig. 3: *Mean FEV1 (% predicted) of non-obese and obese asthmatic patients.*

The mean FVC (% predicted) of non-obese asthmatic patients was 70.66 (SD ± 5.95). The mean FVC (% predicted) of obese asthmatic patients was 65.70 (SD -4.40). Thus, mean FVC (% predicted) of non-obese asthmatic patients was higher than that of obese asthmatic patients and it was statistically significant (p value < 0.001). Fig. 4 shows the distribution of asthmatic patients according FVC (% predicted).

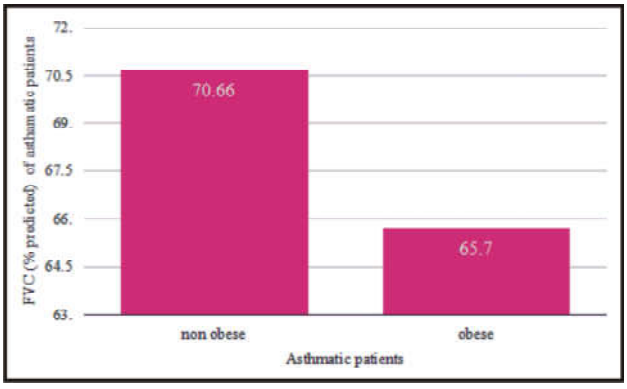

Fig. 4: *Mean FVC (% predicted) of non-obese and obese asthmatic patients.*

The mean FEV1/ FVC ratio of non-obese asthmatic patients was 66.26 (SD ± 4.55). The mean FEV1/FVC ratio of obese patients was 61.66 (SD ± 4.38). The mean FEV1/FVC ratio of non-obese asthmatic patients was higher than the mean FEV1/FVC ratio of obese asthmatic patients and it was statistically significant (p value < 0.001). Fig. 5 displays mean FEV1/FVC ratio of non-obese and obese asthmatic patients.

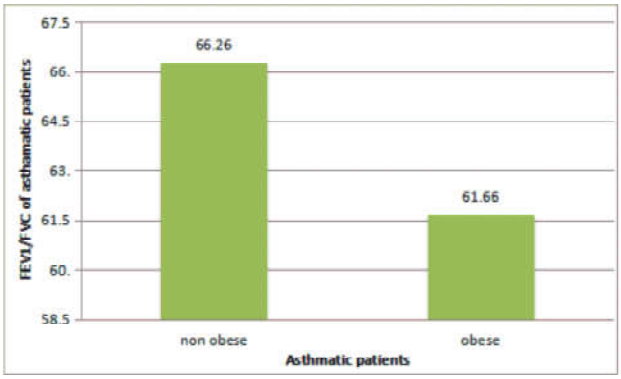

Fig. 5: *Mean FEV1/FVC ratio of non-obese and obese asthmatic patients.*

The Fig. 6 depicts the correlation of BMI (kg/m^2) with FEV1 (% predicted) of asthmatic patients. There was statistically significant correlation between BMI (kg/m^2) and FEV1 (% predicted) of asthmatic patients [Pearson correlation co-efficient = (-0.45); p value < 0.001; df-1]. As the BMI of asthmatic patients increased, the FEV1 (% predicted) decreased, i.e., a negative correlation was observed.

There was statistically significant correlation between BMI (kg/m^2) and FVC (% predicted) of asthmatic patients [Pearson correlation co-efficient (-0.41); p value 0.001; df-1]. As the BMI of asthmatic patients increased, the FVC (% predicted) decreased, i.e., a negative correlation was observed. The Fig. 7 depicts the correlation of BMI (kg/m^2) with FVC (% predicted) of asthmatic patients.

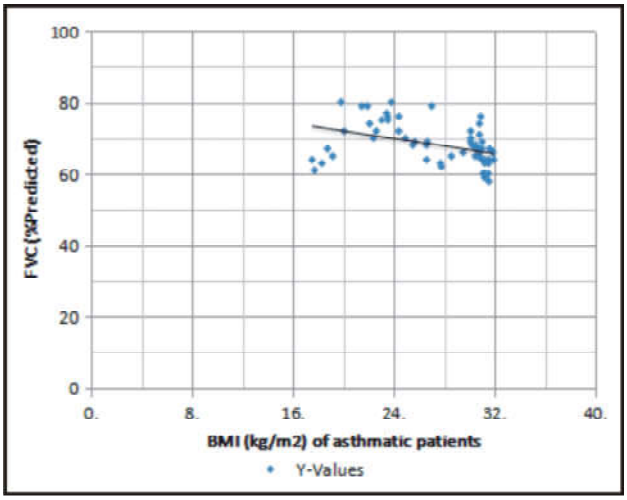

Fig. 7: *Correlation of BMI (kg/m^2) of asthmatic patients with FVC (% predicted).*

There was statistically significant correlation between BMI (kg/m^2) and FEV1/FVC (% predicted) of asthmatic patients [Pearson correlation co-efficient (-0.55; p value < 0.001, df-1]. As the BMI of asthmatic patients increased, the FEV1/ FVC decreased, i.e., a negative correlation was observed. The Fig. 8 depicts the correlation of BMI (kg/m^2) with FEV1/ FVC of asthmatic patients.

Fig. 9 depicts the severity of asthma in non-obese and obese asthmatic patients. There was statistically significant (p value

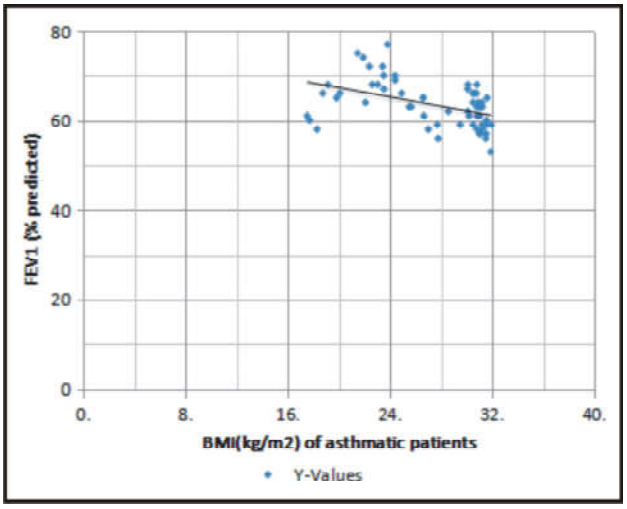

Fig. 6: *Correlation of body mass index with FEV1 (% predicted) in asthmatic patients.*

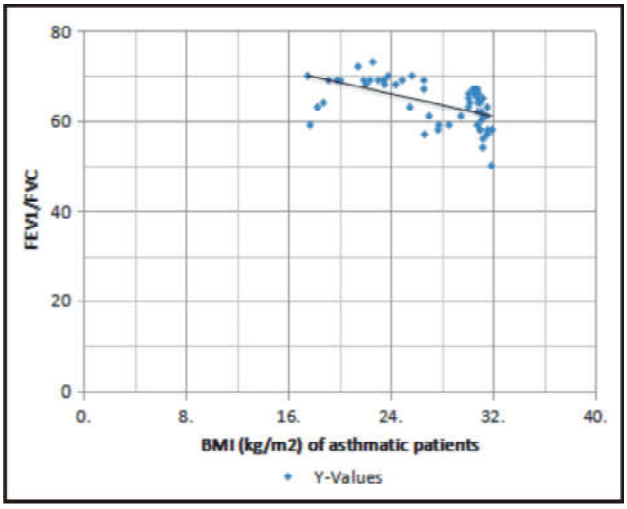

Fig. 8: *Correlation of BMI (kg/m^2) of asthmatic patients with FEV1/FVC ratio.*

< 0.001, df-3) difference in severity of asthma in non-obese and obese asthmatic patients. Among non-obese asthmatic patients, 23 (76.66%) patients had grade 3 severity of asthma, whereas 7 (23.33%) had grade 4 severity of asthma. Among obese asthmatic patients, 16 (5.33%) had grade 3 severity of asthma, while 14 (46.66%) had grade 4 asthma. Proportion of patients with grade 4 severity of asthma was significantly higher in obese asthmatic patients in comparison to non-obese asthmatic patients.

Table III: Severity of asthma in obese and non-obese asthmatic patients

S. No.	Asthmatic patients	Severity of asthma		p value (df)
		Grade* 3	Grade* 4	
1.	Non obese (n=30)	23 (76.66%)	7 (23.33%)	< 0.001 (3)
2.	Obese (n=30)	16 (53.33%)	14 (46.66%)	

**Grade: GINA classification, *chi square test*

Fig. 9 shows the association of BMI (kg/m^2) with Peak expiratory flow rate (% predicted) in asthmatic patients. There was statistically significant difference in the PEF (% predicted) of obese and non-obese asthmatic patients. It was significantly higher in non-obese (68.26 ± 3.26) asthmatic patients in comparison to obese (68.26 ± 3.76) asthmatic patients (p value < 0.001).

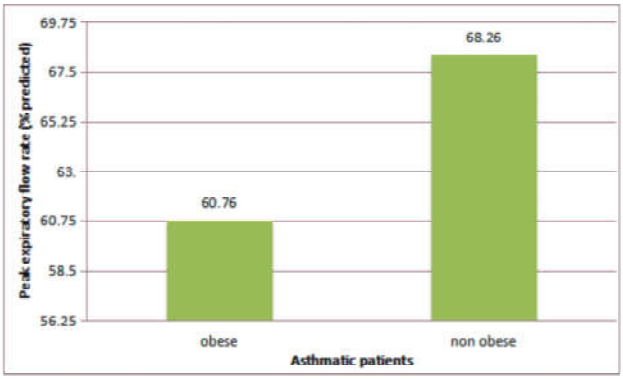

***Fig. 9:** Association of BMI (kg/m^2) with Peak expiratory flow rate (% predicted) in asthmatic patients.*

Discussion

Bronchial asthma and obesity are both chronic inflammatory diseases and each one is associated with systemic inflammatory state. Both of them affect respiratory mechanics and pulmonary function to variable extent.

Taking this into consideration, the present study was conducted in 30 obese asthmatic patients and 30 non-obese asthmatic patients. Pulmonary functions were assessed and compared in the two groups.

The mean age of non-obese asthmatic patients was 38.76 years (SD ± 13.44). The mean age of obese asthmatic patients was 39.23 years (SD ± 9.03). Thus the mean age of both age groups was comparable.

In the current study, the mean FEV1 (% predicted) of non-obese asthmatic patients was higher than the mean FEV1 (% predicted) of obese asthmatic patients. This was found to be statistically significant in current study. Similar results were found in a cross-sectional study conducted between 2009 and 2010 in a Respiratory Hospital in Tunisia by Maalej *et al*[10] (2012) in which it was observed that mean FEV1 was significantly lower in the obese group.

A statistically significant difference in the mean FVC (% predicted) of non-obese and obese asthmatic patients was observed in the current study. The mean FVC (% predicted) was significantly lower in obese asthmatic patients in comparison to non-obese asthmatic patients. Spathopoulos *et al*[11] (2009) conducted a study aimed to investigate primarily the effect of obesity on the lung function tests and secondary the possible link of obesity with atopy and asthma in a large cohort of children in Greece. The % expected FVC was significantly reduced in overweight or obese children compared to children with normal weight (p value < 0.001) as observed in our study.

The current study also revealed statistically significant difference in the mean FEV1/FVC ratio (% predicted) of non-obese and obese asthmatic patients. It was found to be higher in non-obese asthmatic patients in comparison to obese asthmatic patients. Similarly, in a study conducted by Lang[12] (2013) in obese and non-obese males, it was observed that obese males had significantly reduced FEV1/FVC. Similar results were obtained in a study carried-out by Chu *et al*[13] (2009) to find the relationship between body mass index (BMI) and lung function. This study showed that high BMI in both sexes was associated with low FEV1/FVC.

It was also observed in the current study, that not only there was statistically significant difference in mean FEV1 (% predicted) and mean FVC (% predicted) between non-obese and obese patients, but also a significant decrease in FEV1 (% predicted) and FVC (% predicted) as the BMI of patients increased. There was statistically significant correlation between FEV1 (% predicted) and FVC (% predicted) with BMI of asthmatic patients. Similar results were observed in a study conducted by Raviv S, Dixon EA, Kalhan R, Shade D and Smith JL[14] (2011) in America to

determine effect of obesity on asthma severity. The study revealed decreasing FEV1 and FVC with increasing BMI.

Also, a statistically significant negative correlation was observed between BMI (kg/m^2) and FEV1/FVC (% predicted) among asthmatic patients.

A statistically significant (p value < 0.001, df-3) difference in severity of asthma was observed between non-obese and obese asthmatic patients in the present study. The proportion of patients with grade 4 asthma severity was more in obese asthmatic group in comparison to non-obese asthmatic group. A study was conducted by Fitzpatrick S, Joks R and Silverberg JI[14] among inner city adults at a bronchial asthma clinic in New York between 1997 and 2010 to determine whether or not obesity is associated with increased bronchial asthma prevalence, severity and exacerbations. The study revealed that class I and II/III obesity was associated with worsened asthma severity (ordinal logistic regression; I: OR: 4.23, 95% CI: 1.61 - 11.06, P = 0.003; II/III: OR: 2.76, 95% CI: 1.08 - 7.09, P = 0.03), as observed in the current study.

In the current study, there was statistically significant difference in the PEF (% predicted) of obese and non-obese asthmatic patients. It was significantly higher in non-obese (68.26 ± 3.26) asthmatic patients in comparison to obese (68.26 ± 3.76) asthmatic patients (p value < 0.001). Borse JL, Modak KH, Bansode GD, Yadav DR[16] (2014) carried-out a study among first year medical college student to find the effect of body weight on PEFR (Peak Expiratory Flow Rate). Findings of the study suggested that PEFR values of overweight student were significantly less compared to normal weight, as observed in the current study.

This study shows that there is a strong association between BMI and pulmonary function in asthmatic patients. Pulmonary function tests are more deranged in obese asthmatics patients in comparison to non-obese asthmatic patients. Also, the pulmonary functions had a negative correlation with BMI, i.e., the pulmonary functions deteriorated with increasing BMI among asthmatic patients. Thus, in conclusion, overweight and obesity is associated with significantly more airflow obstruction and poor disease control.

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