ORIGINAL RESEARCH

To evaluate the influence of inhaled bronchodilator therapy on spirometric test variables in obese and non-obese asthmatics

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Abstract

In India, the prevalence of overweight individuals is reported to be between 20-40% in various studies, with over 5-10% being obese. Obesity acts as a risk factor for asthma through various mechanisms and it also reduces the spirometric variables as well as total lung capacity and functional residual capacity. Forced expiratory volume in one second (FEV_1) was done on 100 patients in tertiary care hospital using RMS Helios 401 electronic spirometer, by Recorders and Medicare Systems Pvt. Ltd. All the statistical analysis was done using SPSS, Ver. 17.0, (IBM, Chicago, Illinois and student unpaired T-test and analysis of variance (ANOVA) test was used for estimating results. 59 were males and 41were females, of the 59 males, 29 were obese and 30 were non-obese and of the 41 females 20 were obese and 21 were non-obese. There was highly significant difference found in the spirometric variables in obese and non-obese asthmatics. There is significant amount of reversibility (% change) after inhalation of short acting beta-2 agonist in non-obese group as compared with obese group with mean percentage change in non-obese group being 16.20% and obese group 13.58%. p value 0.002($p<0.05$). The amount of reversibility (mean % change) was found to be more for controlled asthmatic groups (16.88%) as compared with partly controlled asthmatics (14.84%) and uncontrolled asthmatic groups(12.78%) p value 0.001($p<0.05$). To conclude, it can be said that age does not have any significant influence on the levels of asthma control in both obese and non-obese asthmatics. Obesity has a significant influence on various spirometric variables.

Keywords: asthma; obese; non-obese; spirometry values; reversibility; cross sectional study

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Introduction

In the present era of health consciousness and better educational standards, health, lifestyle and behaviour of an individual play a key role. Asthma is a chronic disorder affecting millions of people worldwide. The prevalence of asthma is around 300 million and is expected to increase another 100 million by 2025 (WHO: Global surveillance, prevention and control of chronic respiratory diseases; 2007) [1]. In India, the prevalence of overweight individuals is reported to be between 20-40% in various studies, with over 5-10% being obese [2, 3].

There is epidemiological data indicating a causal relationship between obesity and asthma. Several

studies suggest that weight loss and weight gain may have an effect on the clinical course of asthma [2, 4-9]. Prospective studies show that obesity is a risk factor for asthma, though the mechanisms linking the two are not fully understood. Obesity is a disorder associated with systemic inflammation, and an increase in inflammatory mediators, which may also result in airway hyper reactivity, which is observed in obese individuals [4].

Adipose tissue is an important source of cytokines and contributes to the inflammatory milieu. Apart from general obesity, visceral adipose tissue is the key factor in the formation of low grade chronic inflammation in obese individuals [10] and plays a role in remodelling, which is characteristic of asthma. High levels of interleukin-6 (IL-6) and tumour necrosis factor-alpha (TNF-α) are observed in individuals with visceral obesity. IL-6 is the primary mediator in acute phase response and leads to the synthesis of C-reactive protein(CRP), which exacerbates the inflammatory response [11].

Asthma is a chronic inflammatory disease of the airways [12]. Obesity acts as a risk factor for asthma through various mechanisms. TNF-α is expressed in the airways and TNF-α may increase contractility against airway constrictor agents; in other words they may increase airway hyper reactivity [2].

Asthma significantly lowers specific conductance and the spirometric variables, while increasing airway reactivity and residual volume. Obesity also reduces the spirometric variables as well as total lung capacity and functional residual capacity. Residual volume, specific conductance, and airway responsivity are unaltered [13]. Besides, it may reduce respiratory muscle strength, decrease thoracic cage compliance and impede diaphragmatic excursion, especially when it is massive and central. Thus, there is over diagnosing asthma in the obese. Asthma has been reported to be more difficult to control in obese patients compared to individuals with normal weight [14-17].

Therefore, in the light of this new information, further studies are required to explore the relation between asthma and obesity in India.

Materials and methods

A cross-sectional study was conducted at tertiary care centre Krishna Institute of Medical Sciences, Ltd. Secunderabad. Over 6 months period on 100 bronchial asthma patients were distributed into two groups, 50 obese and 50 non-obese. Patients who were diagnosed with asthma and fall in the age group of 18-65 years were included in this study.

To limit the study to the effects of asthma and obesity, subjects with history of lung disease other than asthma, like coronary artery disease, congestive heart failure or cor pulmonale and smoking were excluded.

Selected patients were explained the purpose of the study and the need of co-operation were emphasized. All subjects participated in the study voluntarily. Written informed consent was obtained from all patients. Ethical and scientific clearance for the study was obtained from the institutional Ethical Committee.

Spirometry was done on all the subjects using RMS Helios 401 electronic spirometer (Figure 1), by Recorders and Medicare Systems Pvt. Ltd., which is a precaliberated and computerized spirometer. After instruction, each subject performed a minimum of three forced expiratory manoeuvres and following spirometric parameter was recorded for analysis: 1) forced vital capacity (FVC); 2) forced expiratory volume in one second (FEV_1); 3) FEV_1/FVC.

Figure 1: Showing the technique of performing pulmonary function test (PFT) using Helios spirometer.

Body mass index (BMI): Body mass index is an index of weight for height, which is commonly used in classifying overweight and obesity in adult population (Table 1).

BMI= weight in kg/square of height in meters [Quetelet's index].

Table 1: BMI classification.

Classification	*BMI*
Underweight	< 18.5
Normal range	18.5-22.9
Overweight at risk	23-24.9
Obesity I	25-29.9
Obesity II	≥ 30.

Spirometry is the recommended method to establish a diagnosis of asthma, while PEF measurement is more useful for monitoring of asthma (Table 2). Spirometry is reproducible but effort dependent.

Reversibility: The term is applied to rapid improvement in FEV_1 or PEF, measured within minutes after inhalation of a rapid acting β2 bronchodilator, salbutamol 200 mcg inhaler 2 puffs through spacer. The degree of reversibility in FEV_1 which indicates a diagnosis of asthma which is 12% or 200 ml from pre-bronchodilator value was taken into consideration.

Table 2: The level of asthma control is evaluated by monitoring symptoms and PFT: (Global initiative for asthma (GINA) updated 2012).

Characteristic	*Controlled (all of the following)*	*Partially controlled (any measure present)*	*Uncontrolled*
Daytime symptoms	None (twice/ <per week)	More than twice per week	Three or more features of partly controlled asthma present in any week.
Limitation of activities (Including exercise)	None	Any	
Nocturnal awakenings/ symptoms	None	Any	
Need for rescue treatment	None (twice/ <per week)	More than twice/ week	
Lung function (PEF or FEV_1)	Normal	<80% predicted or personal best if known	

Statistics: All the statistical analysis was done using SPSS, Ver. 17.0, (IBM, Chicago, Illinois). Master sheet of data was made with microsoft excel, graphs and charts were made with MS excel and word. Student unpaired 'T' test was used for comparing the spirometric variables in obese and non-obese asthmatic groups. Each individual quantitative data such as BMI, weight, and duration of asthma are compared considering the levels of asthma using analysis of variance (ANOVA) test.

Results

Out of 100 asthmatics that were enrolled in the study, 59 were males and 41were females. Of the 59 males, 29 were obese and 30 were non-obese. Of the 41 females 20 were obese and 21 were non- obese. The mean age of obese group is 45.92 years; and non-obese group is 40.78 years. Details are given in figure 2.

The number of patients with uncontrolled asthma was 27 and the mean age was around 43 in the three groups of asthma control as seen in table 3.

Table 3: Age and levels of asthma control.

Levels of asthma control	*N*	*Mean age (Years)*
Controlled	30	41.6
Partly controlled	43	43.83
Uncontrolled	27	44.51

As p value is 0.000 (p <0.001) this shows BMI increased from 22.34 to 29.84 the level of asthma control deteriorated from controlled state to uncontrolled state. Detailed data is given in table 4.

Table 4: BMI and levels of asthma control.

Level of asthma control	*N*	*Mean BMI (Kg/m^2)*
Controlled	30	22.34
Partly controlled	43	24.27
Uncontrolled	27	29.85

The mean percentage change in reversibility of spirometric values in non-obese population was 16.2% whereas in obese population it was 13.58% (Figure 3).

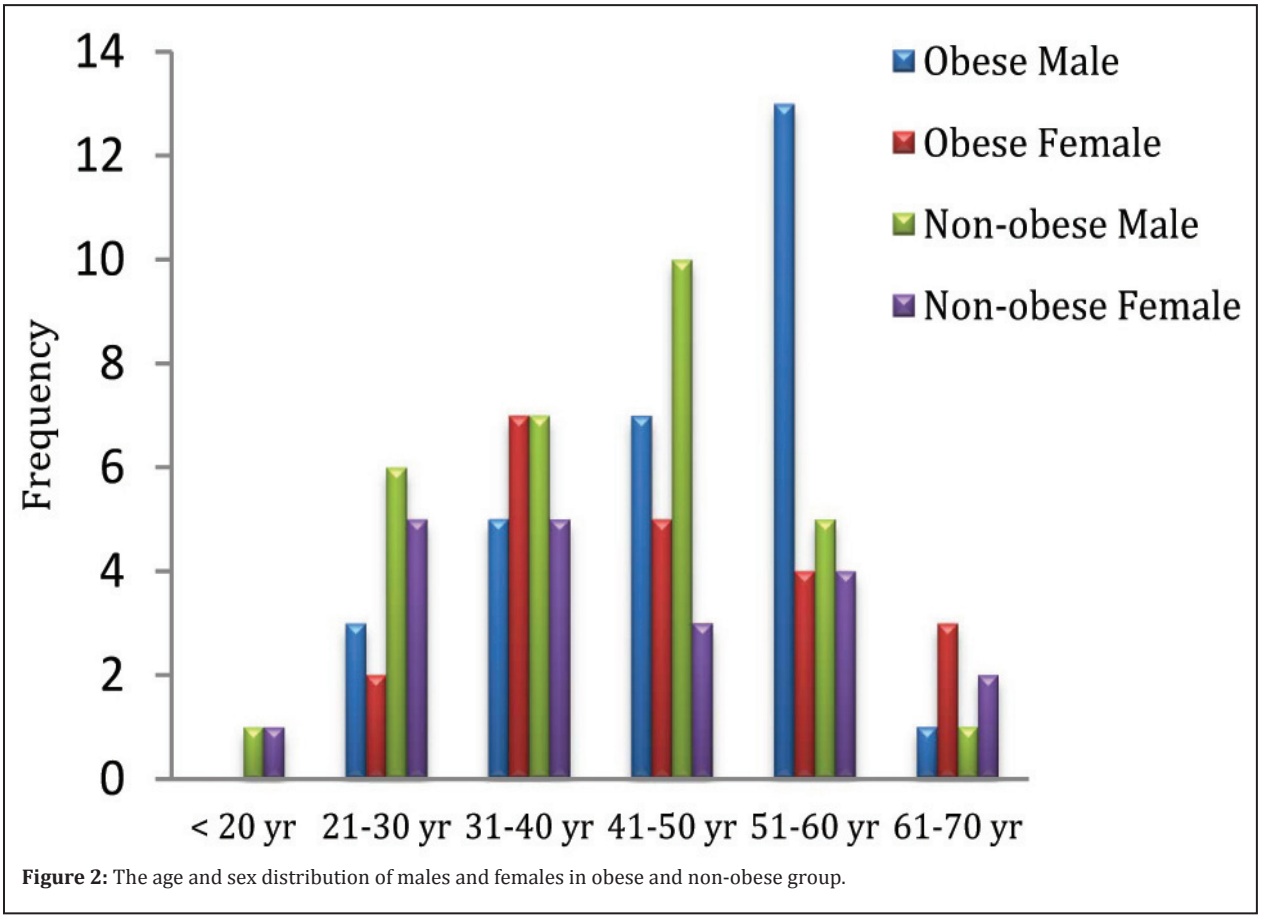

Figure 2: The age and sex distribution of males and females in obese and non-obese group.

Table 5: Comparing the spirometric test results in obese and non-obese asthmatics.

	Class	*N*	*Mean*	*Std. Deviation on*	*t value*	*p value*
Pre FEV_1	Non-obese	50	2.73	0.674	5.203	0.000*
	Obese	50	2.07	0.588		
Pre FVC	Non-obese	50	4.08	0.863	4.126	0.000*
	Obese	50	3.44	0.698		
Pre FEV_1/FVC	Non-obese	50	65.96	3.833	5.485	0.000*
	Obese	50	58.64	8.623		
Post FEV_1	Non-obese	50	3.17	0.818	5.423	0.000*
	Obese	50	2.35	0.687		
Post FVC	Non-obese	50	3.90	0.845	5.047	0.000*
	Obese	50	3.09	0.753		
Post FEV_1/FVC	Non-obese	50	80.80	6.302	3.663	0.000*
	Obese	50	75.42	8.256		

Abbreviations: * = indicates high significance.

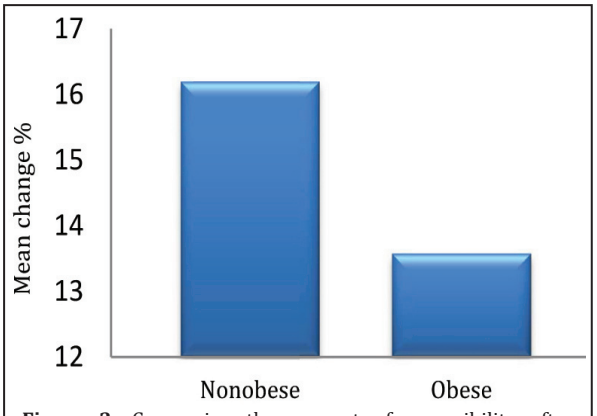

Figure 3: Comparing the amount of reversibility after inhalation of inhaled bronchodilator in obese and non-obese asthmatics.

As the p value is 0.000 ($p<0.001$) there was highly significant difference found in the spirometric variables in Obese and non-obese asthmatics. The details are given in table 5. The amount of reversibility was the highest in well controlled asthmatics with 16.88% and least in uncontrolled asthmatics with 12.78%. The details are given in table 6.

Discussion

In our study, the comparison of various spirometric variables (FEV_1, FVC, and FEV_1/FVC) in 100 asthmatics patients randomly divided into 50 obese and 50 non-obese groups, and the influence of inhaled bronchodilator therapy on spirometric test values (i.e. the amount of reversibility) in obese and non-obese asthmatics was analysed.

In our study, the mean age in years for controlled group is 41.6 years, for partly controlled is 43.83 years and for uncontrolled group is 44.51 years, and no statistical significant found between three groups of levels of asthma control considering age, as p value is 0.615 ($p > 0.05$) i.e. variation observed in three groups is by chance and not due to variation in age of subjects. So age does not have any effect on levels of asthma control. So no adjustment of age was done for comparing levels of asthma control. In a study by Lang JE, et al. [18], age is a significant effect modifier on the relationship between obesity and asthma phenotype.

In our study as the mean BMI (kg/m^2) increased from 22.34 to 29.84 the levels of asthma control deteriorated from controlled state to uncontrolled state (p- 0.000, highly significant as $p<0.001$). Studies supporting our study, Mosen D.M. et al. [19] showed obese adults were more likely than those with normal BMIs (<25 kg/m^2) to report poor asthma-specific quality of life (odds ratio [OR], 2.8; 95% CI, 1.6-4.9), poor asthma control (OR, 2.7; 95% CI, 1.7-4.3), and a history of asthma-related hospitalizations (OR, 4.6; 95% CI, 1.4-14.4). In a case series, by Hernandez LV, et al. [20]. The relation between body mass index and asthma severity is evident; patients with BMI greater than 25 kg/m^2 are more susceptible to suffer asthma from moderate to severe degree, mainly woman. Obesity seems to be more prevalent among asthmatics with poor control [21].

In our study spirometric variables (FEV_1, FVC, and FEV_1/FVC) are significantly lower in obese asthmatics as compared with non-obese asthmatics. (p value 0.000, highly significant as $p<0.001$) indicating obesity having a significant correlation on various spirometric parameters and lung function.

Several studies have different results on the effects of obesity and lung function. There was an effect of BMI on the FEV_1/FVC ratio, indicative of airway obstruction. Particularly, in boys, FEV_1/FVC declined with increasing quintiles of BMI, indicating that obesity promotes airways obstruction. A decline in FEV_1/ FVC with BMI in children was also reported by Gold, et al. There is significant amount of reversibility (% change) after inhalation of short acting beta-2 agonist in non-obese group as compared with obese group with mean percentage change in non-obese group being 16.20% and obese group 13.58%. p value 0.002 ($p<0.05$).

The amount of reversibility (mean % change) was found to be more for controlled groups (16.88%) as compared with partly controlled (14.84%) and uncontrolled groups (12.78%). p value 0.001($p<0.05$). Tantisira, et al. [22] noted an inverse relationship between BMI and bronchodilator response: children with higher BMIs had smaller bronchodilator responses.

Conclusion

Measured spirometric variables are significantly lower in obese asthmatics as compared to non-obese asthmatics. Age does not have any significant influence on the levels of asthma control in both obese and non-obese asthmatics. Levels of asthma control deteriorated from controlled state to uncontrolled state as mean BMI (Kg/m^2) increased. The amount

of reversibility (mean percentage change) after inhalation of short acting β2 agonist is more for non-obese asthmatic group (16.2%) as compared to obese asthmatic group (13.58%). Obesity has a significant influence on various spirometric variables (FEV_1, FVC, FEV_1/FVC).

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Conflict of interest

There was no conflict of interest and all the authors were in tone with the work.

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