Original Article

Body Mass Index Association with Airflow Obstruction in Asian Population: A Retrospective Study

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This article is available on www.vpci.org.in

ARTICLE INFO

Received: January 19, 2021

Accepted: February 2, 2021

Indian J Chest Dis Allied Sci 2021;63:125-129

KEY WORDS

Body mass index, Chronic obstructive pulmonary disease, Obesity.

ABBRIVATIONS USED IN THIS ARTICLE

COPD = Chronic obstructive pulmonary disease
BMI = Body mass index
FVC = Forced vital capacity
FEV_1 =Forced expiratory volume in one second
GOLD = Global Initiative for Chronic Obstructive Lung Disease
WHO = World Health Organization
OSAS = Obstructive sleep apnoea syndrome
ANOVA = Analysis of variance

Abstract

Background. The prevalence of chronic obstructive pulmonary disease (COPD) is high in India. Various studies predict better survival in obese COPD patients in comparison to malnourished. The association between the body mass index (BMI) and progression of COPD is still ambiguous and less evaluated. Thus, we aim to determine the impact of different grades of BMI with pulmonary functions.

Methods. We studied 294 patients with COPD diagnosed on spirometry on out-patient basis from January 2015 to August 2019. As per BMI the patients were categorised into underweight, normal, overweight and obese. Association between BMI and lung volumes was studied.

Results. The number of cases and mean BMI as per BMI grades were: underweight (34 cases, BMI 16.5 Kg/m^2), normal weight (76 cases, BMI 21.1 Kg/m^2), overweight (27 cases, BMI 24.1 Kg/m^2) and obesity (157 cases, BMI 28.2 Kg/m^2). With increasing BMI, the value of forced vital capacity (FVC), forced expiratory volume in one second (FEV_1) and FEV_1/FVC ratio were significantly increased. Also, majority of the cases in the obesity group were of low severity as per Global Initiative for Chronic Obstructive Pulmonary Disease (GOLD) classification.

Conclusion. Our observations suggest that as the BMI increases, lung volumes improve; thus, it may be used as a prognostic indicator for COPD.

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Introduction

Chronic obstructive pulmonary disease (COPD) is a disorder with persistent airflow limitation. The disease is progressive with pathophysiology of chronic hyper-inflammatory responses to noxious gases or particles in the inhaled air, especially in chronic smokers and overt pollution levels. Small airways in lungs are the most affected.[1,2] According to World Health Organization (WHO) around 65 million people are suffering from moderate to severe COPD. Due to increasing number of COPD patients, it will be definitely among the top leading cause of death worldwide by 2030.[3-5] India, a country with the population of more than 130 million, surely contributes a significant percentage in COPD associated mortality.[6-8] Extra-pulmonary complication, such as malnutrition associated with COPD leads to high risk of exacerbations and has emerged as a significant risk for morbidity and mortality.[9] On the other hand, obesity has also been proven to be protective against mortality with the greatest effect in severe COPD.[10] It is well proven that high body mass index (BMI) has detrimental effect on patients suffering from asthma and obstructive sleep apnoea syndrome (OSAS). However the role of BMI in COPD patients is still ambiguous.[10-13] Recently, the concept of "obesity paradox" is being explored in patients with COPD, where higher BMI is correlated with a better prognosis. Thus, the study was done to determine the impact of different grades of BMI on pulmonary function parameters in COPD patients.

Material and Methods

We retrospectively reviewed the case records of 1000 patients who were referred from the medicine outpatient department for spirometry in the Department of Medicine, All India Institute of Medical Sciences, New Delhi between January 2015 and August 2019. All the patients with age above 18 years were enrolled in the study.

The hospital records databases, including basic information (gender, age, weight, height and BMI), spirometry (forced expiratory volume in 1 second [FEV_1]) (post bronchodilator FEV_1), forced expiratory vital capacity (FVC), ratio of FEV_1/FVC and the patients were classified according the pulmonary function tests results into restrictive, obstructive and mixed lung diseases as per standard spirometry guidelines.[14,15]

Body mass index was used as an independent variable and according to the Asian-Pacific cut-off points, patients were categorised into four groups: underweight (BMI <18.5 Kg/m^2), normal weight (18.5–22.9 Kg/m^2), overweight (23–24.9 Kg/m^2), and obese (≥25 Kg/m^2).[16]

Spirometric variables, such as post-bronchodilator FEV_1, FVC were used for the evaluation of spirometry results. The main criteria used for the diagnosis of COPD was FEV_1/FVC ratio <70%. Further sub-classification on the basis of FEV_1 into four classes was done according to Global Initiative for Chronic Obstructive Lung Disease (GOLD 2020)[14]: GOLD 1 (FEV_1 ≥80 % pred), GOLD 2 (50 % pred ≥ FEV_1 <80 % pred), GOLD 3 (30 % pred ≥ FEV_1 <50%pred), and GOLD 4 (FEV_1<30 % pred) for assessing the severity of COPD.

Statistical Analysis

Descriptive analysis was carried out first to summarise the study population. Data distribution was checked by normal probability plot and Shapiro-Wilk normality test. Outliers were detected using standard techniques (Leverage statistics, Cook's distance and Jackknife residuals) and were treated accordingly. Exclusion of any outlier from study was carried out only when it was found to be biologically implausible and was mentioned in the results. Quantitative variables not following normal distribution were treated with appropriate transformation techniques before parametric analysis. Student's 't' test and analysis of variance (ANOVA) were carried out for parametric data, otherwise Mann-Whitney U test and Kruskal-Wallis followed by Dunnett's multiple comparison test was used for non-parametric data. Qualitative variables were compared between the two groups using Chi-square test. For testing of hypothesis, test was two-tailed and a P value of <0.05 was considered statistically significant. All statistical analysis was carried out using STATA V14 Stata Corp LLC, TX, USA.

Results

Out of 1000 patients, 294 patients were finalised for the study after considering the inclusion and exclusion criteria. In 294 cases, 166 were males with a mean age of 47 years and 128 were females with a mean age of 46 years. Mean BMI in males and females were 24.0 and 25.5, respectively. The mean FEV_1 actual in males and females was 1.90±0.81 and 1.34±0.58, respectively which is moderately low (Table 1).

As per the BMI, all the participants were divided into four classes: underweight (34 cases, BMI 16.5 Kg/m^2), normal weight (76 cases, BMI 21.1 Kg/m^2), overweight (27 cases, BMI 24.1 Kg/m^2) and obesity (157 cases, BMI 28.2 Kg/m^2) (Table 2). Table 2 also shows that obese patients had higher flow rates in comparison to other classes. The FVC, FEV_1 and FEV_1/FVC (%) were higher in participants with high BMI and the results were highly significant statistically.

To determine the association between BMI and expiratory flow rate, correlation coefficient was

Table 1. Gender-based demographic profile and lung function parameters

Variables	Males (N=166) Mean(±SD)	Females (N=128) Mean(±SD)
Age (years)	47.1±14.2	46.2±13.3
Weight (Kg)	67.4±14.5	60.5±13.04
Height (m)	24.0±4.6	25.5±5.1
BMI (Kg/m^2)	24.0±4.6	25.5±5.1
FVC (L)	2.8±0.89	1.96±0.67
FEV1 (L)	1.90±0.81	1.34±0.58
FEV1/FVC (%)	63.1±11.7	66.8±11.7

calculated. The FVC, FEV_1 and FEV_1/FVC (%) were strongly and positively correlated with the BMI along with the high statistical significance (r=0.13, P=0.01; r=0.28, P< 0.01; r=0.53, P<0.01) (Figure).

All the patients with COPD were divided into GOLD 2020 severity classification and four BMI grades as shown in table 3.

Out of 157 obese patients, maximum number of participants (n=74) were in GOLD class 1, whereas 60 patients were in GOLD class 2. Only 19 and 4 patients were in GOLD 3 and 4, respectively. This depicts less COPD severity among obese patients.

Discussion

It is a dictum that obesity leads to high mortality rate comparing with those having normal BMI. There also exists a new phenomenon known as "obesity paradox". In simple way, it is defined as inverse relationship in

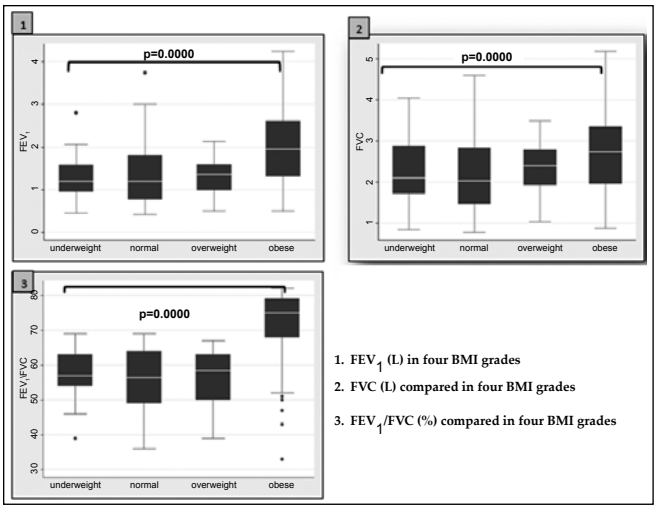

Figure. Boxplot depicting correlation of BMI grades with flow parameters.

obesity and survival, *i.e.* high BMI act as a protective factor against mortality.[17] Chronic diseases, like type-2 diabetes mellitus, cerebrovascular insults and chronic kidney diseases follow this phenomena.[18-20] However, still evidence in regard of obesity as a risk factor for COPD is not clear. However, a meta-analysis[17] on BMI and mortality in COPD concluded that those COPD patients who were obese had lower mortality rate.

Worldwide very few studies[21,22,24] has been done to observe the relationship between BMI and progression in COPD. Our retrospective study on 294 COPD patients has illustrated that BMI is positively correlated with the expiratory lung volumes in COPD. Result of our study showed that patients with low BMI had low FEV_1 and

Table 2. Clinical and spirometric profile of COPD patients as per BMI

Characteristics	Underweight (N=34) (BMI <18.5Kg/m^2) Mean(±SD)	Normal (N=76) (BMI 18.5–22.9Kg/m^2) Mean(±SD)	Overweight (N=27) (BMI 23–24.9 Kg/m^2) Mean(±SD)	Obese (N=157) (BMI ≥25Kg/m^2) Mean(±SD)	P value
Age (years)	44.8±14.1	46.4±14.12	47.3±17.1	47.16±12.9	<0.01
BMI (Kg/m^2)	16.5±1.4	21.11±1.2	24.09±0.65	28.2±3.1	<0.01
FVC (L)	2.19±0.74	2.30±0.97	2.29±0.69	2.67±0.94	<0.01
FEV_1 (L)	1.27± 0.74	1.34±0.68	1.29±0.43	1.95±0.78	<0.01
FEV_1/FVC (%)	57.0±7.4	56.0±8.5	56.5±7.8	72.0±9.6	<0.01

Table 3. Distribution of patients as per GOLD class and BMI

GOLD Class	Underweight (N=32) (BMI <18.5 Kg/m^2)	Normal Weight (N=76) (BMI 18.5–22.9 Kg/m^2)	Overweight (N=27) (BMI 23–24.9 Kg/m^2)	Obese (N=157) (BMI ≥25 Kg/m^2)	Total (N=294)
1	1	4	1	74	80
2	16	31	13	60	120
3	11	29	10	19	69
4	6	12	3	4	25

those with high BMI had greater FEV_1 values or better lung functions. A prospective cohort by Galesanu *et al*[21] on 190 stable COPD patients explain the mechanism behind the paradox. This proposed and concluded that obese patients when compared with the lean patients, possess better lung volume, high exercising capacity and better muscle mass.[21] Marquis *et al*[22] in his study elicited the role of high muscle mass in obese patient as a contributor of better survival of obese COPD. Thus, while managing COPD patients, BMI may be used as an indicator of prognosis, although larger studies are required for its validation.

In our study, out of four classes of COPD patients on the basis of BMI, *i.e.* underweight, normal, overweight and obese, obese patient had highest FEV_1, FVC and FEV_1 FVC than the other classes. In our study, classification of severity of COPD as per GOLD guidelines, approximately 90% of the obese COPD patients were in Class 1 and 2, *i.e.* less severe, thus, indicating that a higher BMI had better spirometric profile. Contrary to this, a multi-center, prospective, cohort study[23] on 3631 COPD participants concluded that obesity in COPD leads to worse clinical outcomes, like acute exacerbations and poor quality-of-life. But recently, number of studies has favoured the obesity paradox.[21,22,44] Another study[24] on 744 COPD patients concluded that BMI was positively correlated with the pulmonary functions. Thus, the controversy still remained, and keeping in mind, BMI is largely used as a marker of nutrition but body composition analysis with lean body mass as well as fat percentage can better help in understanding the mechanism behind this newly emerged obesity paradox. This also gives an insight, how important a holistic management of cases of COPD is important whether in regard of pulmonary rehabilitation or nutrition to improve the survival.

Conclusion

We conclude that BMI is strongly correlated with the spirometric profile of COPD patients, and as the BMI increases, spirometric variables improve, and thus, it may be used as a prognosis indicator in COPD.

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