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ORIGINAL ARTICLE

Obstructive Sleep Apnea in Chronic Obstructive Pulmonary Disease: A Prospective Observational Study

M. R. Dhanush Kumar,[1,*] Aswini Mohan Ram[2] and M. Vinoth Kumar[3]
[1]*Medical Officer, Department of Respiratory Medicine, K L Multispeciality Hospital, Chennai, India*
[2]*Department of General Medicine, Duchy Circle Hospital, Harrogate, UK*
[3]*Senior Resident, Department of Community Medicine, Sri Venkateswaraa Medical College Hospital and Research Institute, Chennai*

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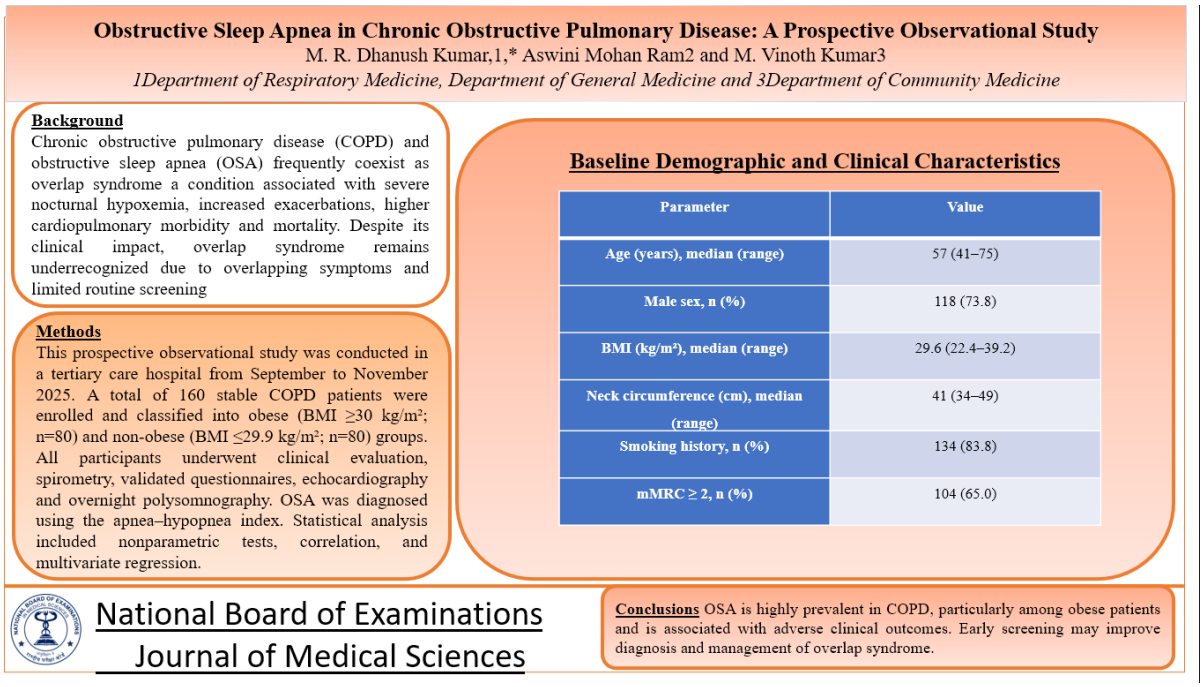
Abstract

Background: Chronic obstructive pulmonary disease (COPD) and obstructive sleep apnea (OSA) frequently coexist as overlap syndrome a condition associated with severe nocturnal hypoxemia, increased exacerbations, higher cardiopulmonary morbidity and mortality. Despite its clinical impact, overlap syndrome remains underrecognized due to overlapping symptoms and limited routine screening. **Objectives:** To determine the prevalence of OSA in COPD patients and assess its association with disease severity, exacerbations, hospitalizations and cardiopulmonary outcomes. **Methodology:** This prospective observational study was conducted in a tertiary care hospital from September to November 2025. A total of 160 stable COPD patients were enrolled and classified into obese (BMI ≥30 kg/m²; n=80) and non-obese (BMI ≤29.9 kg/m²; n=80) groups. All participants underwent clinical evaluation, spirometry, validated questionnaires, echocardiography and overnight polysomnography. OSA was diagnosed using the apnea–hypopnea index. Statistical analysis included nonparametric tests, correlation, and multivariate regression. **Results:** OSA was identified in 61.9% of patients with moderate-to-severe OSA in 33.7%. Obese patients had significantly higher neck circumference, sleepiness scores and apnea -hypopnea index ($p<0.001$). OSA was associated with increased exacerbations, hospitalizations, pulmonary hypertension and right ventricular dysfunction. Apnea - hypopnea index correlated positively with body mass index and daytime sleepiness and negatively with FEV_1. Obesity, increased neck circumference, excessive daytime sleepiness and reduced lung function independently predicted moderate-to-severe OSA. **Conclusion:** OSA is highly prevalent in COPD, particularly among obese patients and is associated with adverse clinical outcomes. Early screening may improve diagnosis and management of overlap syndrome.

Keywords: Chronic obstructive pulmonary disease, Obstructive sleep apnea, Overlap syndrome, Polysomnography, Obesity

*Corresponding Author: M. R. Dhanush Kumar
Email: dhanush110595@gmail.com

Graphical Abstract



Introduction

A common, preventable and treatable condition chronic obstructive pulmonary disease (COPD) is characterized by persistent respiratory symptoms and airflow limitation due to airway and additional alveolar abnormalities that are typically caused by critical exposure to hazardous particles or gases [1]. The sleep disease known as obstructive sleep apnea (OSA) causes arousals from sleep and hypoxemia at night by discontinuing or significantly reducing airflow in the midst of breathing exertion [2]. David Flenley first described the coexistence of COPD and OSA known as overlap syndrome (OS) thirty years ago. He noted that in order to identify the presence of associated OSA a sleep study should be taken into consideration in obese COPD patients those who snore or who report headaches after nocturnal oxygen therapy [3]. According to the Global Burden Disease Study, COPD which was the sixth leading cause of death in 1990 is expected to become the third leading cause of death globally in 2020. According to a more recent forecast COPD would rank as the fourth leading cause of death by 2030 [4]. Despite the fact that both OSA and COPD are extremely common illnesses, it is unknown if each condition predisposes patients to a higher prevalence of the other [5] but they can have an impact on one another's pathogenesis. [6] Significant morbidity and mortality are linked to these disorders which are marked by severe clinical symptoms [7,8] especially when they occur [9]. Compared to patients with either condition alone patients with COPD and OSA have a significantly higher risk of morbidity and mortality. The prevalence of overlap syndrome is 11% in patients with OSA and 14% in patients with mild COPD [10]. The concomitance of chronic obstructive pulmonary disease (COPD) and obstructive sleep apnea also known as overlap syndrome is a condition of notable yet overlooked importance due to the serious implications it holds for affected patients.

Sufferers with overlap syndrome experience more severe nocturnal hypoxemia more acute exacerbations of the disease, higher cardiovascular morbidity and a higher rate of mortality than in persons with only one of these conditions in other words the combined effects are even more severe when taking both conditions together. Notwithstanding the serious effects the combined condition holds it goes largely unseen because of the overlapping symptoms of the condition and the fact that sleeping disorders are not screened for in people with COPD. The purpose of this study was to assess the effect of obstructive sleep apnea in people with COPD with regard to the incidence of exacerbations of the condition, the rate of hospitalization and the severity of the disease.

Materials and Methods

This is a prospective observational study that was carried out in the single Centre multi-specialty hospital in Chest Department outpatient clinic of KL Multi specialty hospital over a period of 3 months extending from September 2025 to November 2025.

The sample size was calculated using a single population proportion formula with finite population correction. Assuming a confidence level of 95% ($Z = 1.96$), a margin of error of 5% and a population proportion (p) of 50%. Considering the total available population size of 270 patients the final sample size was adjusted using finite population correction. Based on the formula $n = [Z^2 \times p \times (1 - p) / e^2] / [1 + (Z^2 \times p \times (1 - p) / (e^2 \times N))]$ the calculated sample size was 159 participants. This sample size was considered adequate to ensure sufficient statistical power and representativeness of the study population.

The study initially enrolled a total of 200 patients who attended a chest out-patient clinic for a check-up. From these 160 patients who were stable chronic obstructive pulmonary disease (COPD) sufferers were selected based on their medical history, physical examination and pulmonary function test. Written consent has been sought prior to the involvement of all research participants.

Patients with COPD were divided into two groups based on their BMI:

Group A: Obese COPD patients (BMI ≥ 30 kg/m^2; n = 80)

Group B: Non-obese COPD patients (BMI ≤ 29.9 kg/m^2; n = 80)

Inclusion Criteria

Patients were diagnosed as having COPD based on the 2017 guidelines of the Global Initiative for Chronic Obstructive Pulmonary Disease. The inclusion criteria included presentation of cough, sputum production, difficulty in breathing and / or a history of exposure to risk factors along with spirometry-proven airflow limitation, ascertained by a post-bronchodilator FEV1/FVC fixed > 70%.

Exclusion Criteria

Patients were excluded if there was an acute COPD exacerbation, extreme COPD (post-BD FEV1 < 30% predicted or < 50% predicted in the presence of chronic respiratory insufficiency), decompensated heart failure, thyroid disturbances, ENT conditions as the cause of OSA of an obstructive type or evidence of liver and/or kidney dysfunction.

Evaluation of the Severity of COPD

The severity of COPD was determined according to the post-bronchodilator FEV_1 values

Mild FEV1 ≥ 80% predicted
Moderate (50% ≤ FEV_1 < 80% predicted)
Severe (30% ≤ FEV_1 < 50% predicted

Clinical Evaluation

All the candidates were assessed thoroughly which included the history and physical examination. General examination consisted of BMI and Neck circumference measurement while the Systemic examination included Chest, Oral and Ear, Nose and Throat examination.

Survey Assessment

Patients were surveyed using validated questionnaires:

Epworth Sleepiness Scale (ESS), Arabic version

STOP Bang Questionnaire SBQ

mMRC dyspnoea score, English version – modified version

Pulmonary & Laboratory Investigations

Spirometry tests were carried out by using a JAEGER CareFusion spirometer, when patients were stable. Other investigations included echocardiograms as well as blood tests like liver and renal function tests and thyroid function tests (T3, T4, and TSH).

All the patients underwent an overnight polysomnography using the SOMNO Screen Plus recording device (SOMNO Medics GmbH). Besides the following channels were studied during the polysomnography. Electroencephalogram, electrooculogram, electrocardiogram, electromyogram, pulse oximetry, thoracic and abdominal effort belts, body position sensors, nasal thermistor, nasal pressure cannula and limb movement channels.

Apnea was considered the halt of airflow for at least 10 seconds and hypopnea was considered a 30% reduction in airflow duration 10 seconds associated with 4% oxygen desaturation. The apnea-hypopnea index (AHI) was calculated by determining the total apnea and hypopnea events per hour of sleep. Severe obstructive sleep apnea was categorized into mild (AHI 5–14 events/hour), moderate (AHI 15–29 events/hour) and severe (AHI ⩾30 events/hour).

Analysis of the data was done using IBM SPSS Statistics for Windows version 24.0. The data is presented as frequencies and percentages for the qualitative variables and as median and range for the quantitative data because of the violation of the normality of distribution. Comparison between the groups is done by Chi-square or Fishers exact test for the qualitative data and the use of the Mann-Whitney U test for the quantitative data. Correlation between the data was done using the Spearman correlation coefficient. Multiple regression analysis was used to determine the predictors of the Apnea Hypopnea Index (AHI). P-value of <0.05 was taken as significance.

Results

A total of 160 patients with stable chronic obstructive pulmonary disease were included in the study. The median age of the study population was 57 years ranging from 41 to 75 years with males comprising 118 patients accounting for 73.8% of the population. The median body mass index was 29.6 kg/m² ranging from 22.4 to 39.2 kg/m² while the median neck circumference was 41 cm ranging from 34 to 49 cm. A history of smoking was present in 134 patients accounting for 83.8% while moderate-to-severe dyspnea (mMRC ≥ 2) was observed in 104 patients accounting for 65.0% of all patients (Table 1).

Table 1. Baseline Demographic and Clinical Characteristics (n = 160)

Parameter	Value
Age (years), median (range)	57 (41–75)
Male sex, n (%)	118 (73.8)
BMI (kg/m²), median (range)	29.6 (22.4–39.2)
Neck circumference (cm), median (range)	41 (34–49)
Smoking history, n (%)	134 (83.8)
mMRC ≥ 2, n (%)	104 (65.0)

According to post-bronchodilator FEV_1 values, the severity of COPD was classified as mild in 44 patients (27.5%) as moderate in 72 patients (45.0%) and as severe in 44 patients (27.5%) (Table 2). When comparing obese and non-obese COPD patients obese patients had a significantly higher median neck circumference (44 cm vs 38 cm) higher ESS scores (11 vs 7), a greater proportion of STOP-Bang scores ≥ 3 (77.5% vs 35.0%) and higher median AHI values (22 vs 9 events/hour) (Table 3).

Table 2. COPD Severity Distribution

Parameter	Value
Mild	44 (27.5%)
Moderate	72 (45.0%)
Severe	44 (27.5%)

Table 3. Comparison Between Obese and Non-Obese COPD Patients

Parameter	Value
Neck circumference (cm)	44 vs 38 ($p<0.001$)
ESS score	11 vs 7 ($p<0.001$)
STOP-Bang ≥3	77.5% vs 35.0% ($p<0.001$)
AHI (events/hr)	22 vs 9 ($p<0.001$)

It identified 99 patients with obstructive sleep apnea or 61.9% of the patients included. Of these 45 or 28.1% had mild disease while 33 or 20.6% had a moderate degree of the disease. Severe OSA was found in 21 or 13.1% of the patients. Sixty-one patients, 38.1% were without the disease as shown in Table 4. Increased severity of COPD was found to have a statistically significant correlation with worsening severity of OSA as seen in Table 5.

Table 4. OSA Severity Distribution

Parameter	Value
No OSA	61 (38.1%)
Mild OSA	45 (28.1%)
Moderate OSA	33 (20.6%)
Severe OSA	21 (13.1%)

Table 5. Association Between OSA Severity and COPD Severity

Parameter	Value
p-value	0.004

Among patients with OSA rates of adverse clinical outcomes were higher. Frequent exacerbations (≥2 per year) occurred in 55.6% of those with OSA and in 31.1% of those without OSA. The median number of hospitalizations per year was greater in patients with OSA than in those without it (2 vs 1) and pulmonary hypertension was more common in the OSA group than in the non-OSA group (40.4% vs 16.4%) (Table 6).

Table 6. Clinical Outcomes in COPD With and Without OSA

Parameter	Value
≥2 Exacerbations/year	55.6% vs 31.1% (p=0.003)
Hospitalizations/year	2 vs 1 (p=0.001)
Pulmonary hypertension	40.4% vs 16.4% (p=0.002)

By correlation analysis AHI was positively related to body mass index (r = 0.52), neck circumference (r = 0.58) and ESS score (r = 0.49) but negatively with FEV_1 (% predicted) (r = −0.41) (Table 7). Neck circumference (β = 0.38), body mass index (β = 0.34) and ESS score (β = 0.27) were positively related to AHI while FEV_1 (% predicted) was negatively related (β = −0.29) by multiple linear regression analysis (Table 8).

Table 7. Correlation of AHI With Clinical Variables

Parameter	Value
BMI	r=0.52
Neck circumference	r=0.58
ESS score	r=0.49
FEV_1 % predicted	r=-0.41

Table 8. Multiple Linear Regression Predicting AHI

Parameter	Value
Neck circumference	β=0.38
BMI	β=0.34
ESS score	β=0.27
FEV_1 % predicted	β=-0.29

Questionnaire-based comparisons revealed higher median ESS scores (11 vs 7), higher STOP-Bang scores (5 vs 2) and a greater proportion of mMRC scores ≥ 2 among obese patients versus non-obese patients (72.5% vs 57.5%; Table 9). Moderate-to-severe OSA was identified in 45.0% of obese patients compared to 22.4% of non-obese patients (Table 10).

Table 9. Questionnaire Score Comparison

Parameter	Value
ESS median	11 vs 7
STOP-Bang median	5 vs 2
mMRC ≥2	72.5% vs 57.5%

Table 10. OSA Severity by BMI

Parameter	Value
Moderate–Severe OSA	45.0% vs 22.4% (p<0.001)

Nocturnal oxygenation parameters were lower for mean nocturnal oxygen saturation (87% vs 91%), lower for minimum oxygen saturation (78% vs 84%) and longer in duration of oxygen saturation below 90% (32% vs 18%) in obese patients when compared with non-obese patients (Table 11). A STOP-Bang score ≥ 3 was found in 78.8% of the patients with OSA as compared with 34.4% of the patients without OSA (Table 12). The majority of the patients with ESS scores ≥ 10 had moderate-to-severe OSA (Table 13).

Table 11. Nocturnal Oxygenation Parameters

Parameter	Value
Mean SpO_2 (%)	87 vs 91
Minimum SpO_2 (%)	78 vs 84
Time <90% SpO_2	32% vs 18%

Table 12. STOP-Bang Score and OSA Diagnosis

Parameter	Value
STOP-Bang ≥3	78.8% OSA vs 34.4% non-OSA

Table 13. ESS Score and OSA Severity

Parameter	Value
ESS ≥10	Moderate–Severe OSA predominant

Of these patients with severe COPD 70.5% had frequent exacerbations (Table 14). Pulmonary hypertension as assessed by echocardiography was present in 40.4% of patients with OSA compared with 16.4% of patients without OSA and right ventricular dysfunction in 28.3% versus 13.1%, respectively (Table 15).

Table 14. COPD Severity and Exacerbations

Parameter	Value
Severe COPD with ≥2 exacerbations	70.5%

Table 15. Echocardiographic Findings

Parameter	Value
Pulmonary hypertension	40.4% vs 16.4%
RV dysfunction	28.3% vs 13.1%

In logistic regression analysis significant predictors of moderate-to-severe OSA included body mass index ≥30 kg/m², neck circumference ≥40 cm, ESS score ≥10 and FEV_1 < 50% predicted (Table 16).

Table 16. Predictors of Moderate–Severe OSA (Logistic Regression)

Parameter	Value
BMI ≥30	OR 3.4
Neck circumference ≥40 cm	OR 4.1
ESS ≥10	OR 2.8
FEV_1 <50%	OR 2.2

Discussion

Obstructive sleep apnea (OSA) was found in 61.9% of chronic obstructive pulmonary disease (COPD) patients with moderate-to-severe OSA seen in 33.7%. Prevalence rates for this condition appear higher than for the general population but as seen in other research studies can range from 40% to over 60% depending upon the criteria chosen for diagnosis as documented

in healthcare studies [11–13]. The "overlap syndrome" as a co-existing condition for both COPD and OSA was aptly identified for the first time by Flenley who further delineated the significance of this condition [1]. The overlap syndrome remains a condition that is otherwise underdiagnosed especially in obese chronic obstructive pulmonary disease individuals as documented in other studies [12,13].

Obesity as well as an increased neck circumference were found to be strongly linked to higher apnea-hypopnea indexes as well as to moderate to severe OSA. These findings have also been observed in previous studies where anthropometric parameters particularly an increased neck size have been recognized as valid predictors for the severity of OSA [14–16]. The observed increase in the STOP-Bang scores among obese patients with COPD in the current analysis also reconfirms the role of this scoring system in identifying susceptible patients for moderate to severe OSA [17].

The daytime sleepiness measured by the Epworth Sleepiness Scale (ESS) was found to be significantly increased in both obese patients and OSA patients and ESS ≥10 was found to be an independent predictor for moderate to severe OSA. Previous studies have already found a positive correlation between AHI and ESS but this correlation may not be significant in patients with COPD due to the chronic symptoms and disrupted sleep [17,18]. The current study supports other studies which found daytime sleepiness to remain a significant clinical predictor for OSA in overlap syndrome.

Patients with overlap syndrome in this study had a significantly lower level of nocturnal oxygenation as reflected by mean and minimal values of nocturnal SaO2 and time spent below 90% SaO2. This finding is attuned with previous physiological studies that showed that co-existing conditions of COPD and sleep apnea cause more severe degrees of nocturnal hypoxemia than when either condition is present [19,20]. Hypoxia intermittently imposed upon chronic airflow obstruction is postulated to cause pulmonary vascular changes and cardiovascular events [20].

Patients with OSA experienced poorer clinical outcomes in our cohort represented by higher rates of frequent exacerbations, hospitalizations, pulmonary hypertension and right ventricular dysfunction. These results are consistent with long-term outcome studies that document higher morbidity and mortality in patients with untreated overlap syndrome [12,21]. Marin et al. demonstrated that overlap syndrome is a predictor of hospitalization for and mortality by COPD and that its treatment by continuous positive airway pressure (CPAP) improves survival outcome [12]. Subsequent outcome studies of larger series have confirmed overlap patients higher rates of healthcare utilization and requirement for ventilatory support during hospitalizations due to acute exacerbation of COPD [22,23].

Pulmonary hypertension as well as the dysfunction of the right ventricle proved more common among the overlap population in our study. This has been confirmed by other investigations which found that the prevalence of pulmonary hypertension in overlap syndrome proved higher when compared to those patients suffering from COPD alone even if the pulmonary function proved relatively preserved [19,20]. Intermittent hypoxia activation of the sympathetic nerve system, as well as endothelial dysfunction can be considered crucial factors for the

development of pulmonary hypertension among these patients.

The independent predictors for moderate to severe OSA in the multivariate analysis in the current study were weight status (BMI) ≥30 kg/m², increased neck circumference ≥40 cm, preexisting daytime sleepiness (ESS-10) and FEV_1 < 50% predicted. These predictors confirm those previously published in the medical literature for the same patient group attending the respiratory outpatient clinics [14–17,24].

The results of this study are in keeping with the current literature in that overlap syndrome is recognized as being prevalent among sufferers of COPD and is linked to poor nocturnal oxygenation, higher exacerbation rates, more cardiac morbidity and increased healthcare utilization. Early identification and directed treatment of concomitant OSA in the presence of COPD may well offer an area where outcomes can be improved as supported by previous intervention and observational studies [12,21–23].

Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

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