



Original Article

Prevalence of Obstructive Sleep Apnea in COPD Patients (Overlap Syndrome) and Its Impact on Oxygen Saturation

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ABSTRACT

Background: Chronic obstructive pulmonary disease (COPD) and obstructive sleep apnea (OSA) are two common respiratory disorders that may coexist as overlap syndrome, leading to more severe nocturnal hypoxemia, poor sleep quality, and increased morbidity. Early recognition of OSA in COPD patients is essential for improving outcomes.

Aim: To determine the prevalence of obstructive sleep apnea among COPD patients and to assess its impact on oxygen saturation levels.

Materials and Methods: A hospital-based cross-sectional study was conducted in the Department of Pulmonary Medicine over a period of 12 months. A total of 68 clinically stable COPD patients aged ≥ 40 years, diagnosed according to GOLD criteria, were included. Patients with known OSA or other significant respiratory or cardiac comorbidities were excluded. All participants underwent clinical evaluation, spirometry, overnight pulse oximetry, and polysomnography. OSA was diagnosed and classified based on the Apnea-Hypopnea Index (AHI). Oxygen saturation parameters, including mean SpO₂, minimum SpO₂, and time spent below 90%, were compared between COPD patients with and without OSA.

Results: The prevalence of OSA among COPD patients was 55.9% (38/68). Among these, 20.6% had mild, 17.6% moderate, and 17.6% severe OSA. COPD patients with OSA had significantly lower mean SpO₂ (88.2 ± 3.6 vs 92.4 ± 2.8 , $p < 0.001$) and greater nocturnal desaturation compared to those without OSA. Increasing severity of OSA was associated with progressively worsening oxygen saturation parameters.

Conclusion: OSA is highly prevalent among COPD patients and significantly contributes to nocturnal and daytime hypoxemia. Early screening for OSA in COPD patients is recommended to reduce respiratory morbidity and improve clinical outcomes.

Keywords: Chronic obstructive pulmonary disease, Obstructive sleep apnea, Overlap syndrome, Oxygen saturation, Nocturnal hypoxemia, Polysomnography.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a progressive respiratory disorder characterized by persistent airflow limitation and chronic inflammatory response of the airways and lung parenchyma to noxious particles or gases. It is a major cause of morbidity and mortality worldwide and is associated with significant impairment in quality of life and functional status^[1]. Sleep-related breathing disorders, particularly obstructive sleep apnea (OSA), are increasingly recognized in patients with COPD. The coexistence of COPD and OSA is termed “overlap syndrome”, which is associated with more severe nocturnal oxygen desaturation, increased risk of pulmonary hypertension, cardiovascular complications, and higher mortality compared to either condition alone^[2]. COPD affects an estimated 400 million people, with higher prevalence in smokers and individuals exposed to biomass fuel^[3]. In India, the burden of COPD is rising due to continued tobacco use and indoor air pollution. OSA, on the other hand, has a reported prevalence ranging from 9% to 38% in the general adult population, depending on diagnostic criteria and population characteristics. Among COPD patients, studies

suggest that the prevalence of OSA may vary widely from 10% to 60%, indicating substantial heterogeneity across populations. The coexistence of both conditions increases with advancing age, obesity, and smoking history^[4].

Flenley first described the overlap between COPD and OSA, highlighting the potential for additive respiratory impairment in affected individuals^[5]. Subsequent studies by Marin et al. demonstrated that patients with overlap syndrome have higher rates of nocturnal desaturation and increased risk of cardiovascular events compared to patients with COPD or OSA alone^[6]. A large cohort study by Marin et al. also showed increased mortality in untreated overlap syndrome, emphasizing the clinical importance of early diagnosis^[6]. Other studies by Chaouat et al. and McNicholas have reported that OSA contributes significantly to nocturnal hypoxemia and pulmonary hypertension in COPD patients^[7,8]. However, reported prevalence rates vary widely due to differences in study design, diagnostic methods, and patient selection.

Despite growing evidence, overlap syndrome remains underdiagnosed in routine clinical practice, particularly in resource-limited settings. Many COPD patients are not routinely screened for sleep-disordered breathing, leading to missed diagnosis of OSA and worsening hypoxemia. In addition, there is limited data from South Indian populations regarding the prevalence of OSA in COPD patients and its effect on oxygen saturation parameters. Understanding this relationship is crucial for early identification and targeted intervention. Therefore, this study was undertaken to determine the prevalence of OSA among COPD patients and to evaluate its impact on oxygen saturation, which may help improve clinical screening strategies and reduce associated morbidity.

AIM AND OBJECTIVES

Aim of the Study

To determine the prevalence of obstructive sleep apnea (OSA) among patients with chronic obstructive pulmonary disease (COPD) (overlap syndrome) and to evaluate its impact on nocturnal and/or daytime oxygen saturation levels.

Objectives of the Study

1. To estimate the prevalence of obstructive sleep apnea in patients diagnosed with COPD.
2. To assess and compare oxygen saturation parameters (SpO₂) in COPD patients with and without OSA.
3. To analyze the association between severity of OSA (based on AHI) and degree of hypoxemia in COPD patients.

MATERIALS AND METHODS

Study Design

This was a hospital-based cross-sectional observational study conducted to assess the prevalence of obstructive sleep apnea (OSA) among patients with chronic obstructive pulmonary disease (COPD) and to evaluate its impact on oxygen saturation levels.

Study Setting

The study was conducted in the Department of Pulmonary Medicine of a tertiary care teaching hospital in South India. Patients attending the outpatient and inpatient services with a confirmed diagnosis of COPD were screened for eligibility.

Study Duration

The study was conducted over a period of 12 months (January 2025 to December 2025).

Study Population

All clinically and spirometrically confirmed COPD patients attending the hospital during the study period constituted the study population.

Inclusion Criteria

1. Patients aged ≥ 40 years
2. Clinically stable COPD patients diagnosed based on GOLD criteria
3. Post-bronchodilator FEV₁/FVC ratio < 0.70 on spirometry
4. Patients willing to provide informed consent

Exclusion Criteria

1. Patients with known pre-existing OSA on treatment
2. Acute exacerbation of COPD within the last 4 weeks
3. Patients with other chronic lung diseases (e.g., bronchiectasis, interstitial lung disease, pulmonary fibrosis)
4. Unstable cardiac disease (recent MI, severe heart failure NYHA class IV)
5. Neurological disorders affecting respiratory function
6. Patients unwilling to participate

Sample Size Calculation

The sample size was calculated using the standard formula for estimation of single proportion:

$$n = \frac{Z^2 \times p \times q}{d^2}$$

Based on previous literature, the prevalence of OSA among COPD patients varies between 15% and 30%. For calculation, an average expected prevalence of 20% ($p = 0.20$) was considered.

Thus:

- $p = 0.20$
- $q = 0.80$
- $d = 10\%$ absolute precision (0.10)
- $Z = 1.96$

Substitution in Formula

$$n = \frac{(1.96)^2 \times 0.20 \times 0.80}{(0.10)^2}$$

$$n = \frac{3.84 \times 0.16}{0.01}$$

$$n = \frac{0.6144}{0.01} = 61.44$$

Thus, minimum required sample size = 62 patients

Adjustment for Non-response

To account for potential dropouts, incomplete sleep study data, or non-participation:

10% of 62 = 6.2 \approx 6 patients

Final sample size = 62 + 6 = 68 patients

Final sample size: 65–70 COPD patients

Study Procedure

1. Recruitment and Screening

Eligible COPD patients attending pulmonary medicine services were consecutively enrolled after applying inclusion and exclusion criteria. Written informed consent was obtained from all participants.

2. Clinical Evaluation

Detailed history was obtained including:

- Duration and severity of COPD
- Smoking history (pack-years)
- Symptoms suggestive of OSA (snoring, witnessed apneas, excessive daytime sleepiness, nocturnal choking)
- Comorbidities (hypertension, diabetes, cardiovascular disease)

Physical examination included:

1. Body Mass Index (BMI)
2. Neck circumference
3. Blood pressure measurement
4. Respiratory system examination

3. Pulmonary Function Testing

Spirometry was performed using a standardized spirometer following ATS/ERS guidelines. COPD severity was classified according to GOLD staging.

4. Assessment of Obstructive Sleep Apnea

OSA screening was performed using overnight polysomnography (PSG), which is the gold standard diagnostic test.

Parameters recorded included:

- Apnea–Hypopnea Index (AHI)
- Oxygen Desaturation Index (ODI)
- Sleep architecture

Diagnostic criteria for OSA:

- $AHI \geq 5$ events/hour with symptoms OR
- $AHI \geq 15$ events/hour irrespective of symptoms

OSA severity classification:

1. Mild: AHI 5–14
2. Moderate: AHI 15–29

3. Severe: AHI \geq 30

5. Oxygen Saturation Assessment

Oxygen saturation was assessed using:

1. Overnight pulse oximetry (mean nocturnal SpO₂, minimum SpO₂, time spent <90%)
2. Daytime resting SpO₂ using pulse oximeter

Hypoxemia was defined as:

- SpO₂ < 90% at rest or during sleep

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS software version 26.

1. Continuous variables were expressed as mean \pm standard deviation
2. Categorical variables were expressed as frequencies and percentages
3. Comparison between COPD with OSA and without OSA groups was done using:
 1. Independent t-test (continuous variables)
 2. Chi-square test (categorical variables)
4. Correlation between AHI and oxygen saturation parameters was assessed using Pearson correlation coefficient
5. A p-value < 0.05 was considered statistically significant

Ethical Considerations

The study was approved by the Institutional Ethics Committee (IEC). Written informed consent was obtained from all participants prior to enrollment. Confidentiality of patient data was strictly maintained.

RESULTS

A total of 68 patients with COPD were enrolled in the study. All patients underwent spirometry, clinical evaluation, overnight pulse oximetry, and polysomnography to assess the presence of obstructive sleep apnea (OSA) and its impact on oxygen saturation.

Table 1: Baseline demographic characteristics of study population (n = 68)

Variable	Value
Age (years), Mean \pm SD	62.4 \pm 8.6
Male, n (%)	46 (67.6%)
Female, n (%)	22 (32.4%)
BMI (kg/m ²), Mean \pm SD	25.1 \pm 4.3
Smokers, n (%)	44 (64.7%)
Smoking pack-years, Mean \pm SD	28.6 \pm 11.2
Hypertension, n (%)	30 (44.1%)
Diabetes mellitus, n (%)	18 (26.5%)

Table 2: Severity of COPD based on GOLD staging (n = 68)

GOLD Stage	Severity	n (%)
GOLD I	Mild	8 (11.8%)
GOLD II	Moderate	26 (38.2%)
GOLD III	Severe	24 (35.3%)
GOLD IV	Very severe	10 (14.7%)

Table 3: Prevalence and severity of Obstructive Sleep Apnea in COPD patients

OSA Status (Based on PSG)	AHI Criteria	n (%)
No OSA	AHI < 5	30 (44.1%)
Mild OSA	AHI 5–14	14 (20.6%)
Moderate OSA	AHI 15–29	12 (17.6%)
Severe OSA	AHI \geq 30	12 (17.6%)

Overall prevalence of OSA in COPD (Overlap Syndrome): 55.9% (38/68)

Table 4: Oxygen saturation parameters in COPD patients with and without OSA

Parameter	COPD with OSA (n=38)	COPD without OSA (n=30)	p-value
Mean SpO ₂ (%)	88.2 \pm 3.6	92.4 \pm 2.8	<0.001
Minimum SpO ₂ (%)	74.6 \pm 5.2	83.1 \pm 4.7	<0.001
Time spent <90% SpO ₂ (%)	32.5 \pm 11.4	12.8 \pm 6.7	<0.001

Daytime SpO ₂ (%)	90.1 ± 3.1	93.8 ± 2.5	<0.001
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Table 5: Association between OSA severity and oxygen desaturation (n = 38 OSA patients)

OSA Severity	AHI (Mean ± SD)	Mean SpO ₂ (%)	Minimum SpO ₂ (%)	Time <90% SpO ₂ (%)
Mild (n=14)	9.8 ± 2.6	90.4 ± 2.8	80.2 ± 3.9	18.6 ± 7.2
Moderate (n=12)	21.5 ± 3.8	87.6 ± 3.1	75.4 ± 4.8	31.2 ± 9.5
Severe (n=12)	38.9 ± 6.2	84.3 ± 3.7	70.1 ± 5.6	46.8 ± 10.3

DISCUSSION

The present study evaluated the prevalence of obstructive sleep apnea (OSA) among patients with chronic obstructive pulmonary disease (COPD) and its impact on oxygen saturation parameters. In this study, the prevalence of OSA among COPD patients was found to be 55.9%, indicating that more than half of the COPD population had coexisting sleep-disordered breathing, consistent with the concept of overlap syndrome. In the current study, the mean age of participants was 62.4 ± 8.6 years, with a male predominance (67.6%). This demographic pattern is consistent with findings reported by Marin et al., where overlap syndrome was more frequently observed in older male smokers, likely due to cumulative exposure to tobacco and age-related upper airway collapsibility^[6] [4]. Similarly, McNicholas highlighted that aging and smoking significantly increase susceptibility to both COPD and OSA, reinforcing the demographic similarity observed in our study^[7].

The prevalence of OSA in COPD patients in the present study (55.9%) is comparable to studies by Chaouat et al., who reported a prevalence ranging from 50% to 65% depending on diagnostic thresholds and population characteristics^[8]. However, Flenley earlier described overlap syndrome as less commonly recognized, largely due to underdiagnosis rather than true low prevalence, which supports the higher rates observed in contemporary sleep studies^[5]. The variation in prevalence across studies is likely due to differences in polysomnography use, selection criteria, and BMI distribution. In our study, COPD patients with OSA showed significantly lower mean oxygen saturation (88.2 ± 3.6%) compared to those without OSA (92.4 ± 2.8%), with statistically significant nocturnal desaturation (p < 0.001). These findings are consistent with Sunwoo et al who demonstrated that overlap syndrome patients experience more profound nocturnal hypoxemia and higher risk of adverse cardiopulmonary outcomes compared to COPD alone^[9]. Similarly, McNicholas and Singh et al reported that intermittent hypoxia due to OSA aggravates baseline hypoxemia in COPD, leading to cumulative oxygen desaturation during sleep^[7,10].

In the present study, the severity of OSA showed a graded association with oxygen desaturation, with severe OSA patients demonstrating the lowest mean and minimum SpO₂ values and highest time spent below 90% saturation. This dose-response relationship has also been reported by Chaouat et al., who observed that worsening apnea-hypopnea index (AHI) is strongly correlated with increased nocturnal desaturation and pulmonary hypertension risk^[8]. These findings support the pathophysiological concept that recurrent upper airway obstruction in OSA exacerbates ventilation-perfusion mismatch already present in COPD. The overall findings of this study reinforce the clinical importance of recognizing overlap syndrome. The high prevalence of undiagnosed OSA among COPD patients in our cohort highlights the need for routine screening, especially in individuals with persistent hypoxemia, obesity, or excessive daytime sleepiness. Early identification may allow timely intervention with positive airway pressure therapy, which has been shown in previous studies to improve oxygenation and reduce morbidity^[7,8].

Limitations

1. The study was conducted in a single tertiary care center with a relatively small sample size, which may limit generalizability to the broader population.
2. Being a cross-sectional study, it does not establish a causal relationship between COPD and OSA or their long-term outcomes.
3. Polysomnography was performed over a single night, which may not fully represent night-to-night variability in sleep parameters.

CONCLUSION

The present study demonstrates that obstructive sleep apnea (OSA) is highly prevalent among patients with chronic obstructive pulmonary disease (COPD), with more than half of the study population affected, indicating a significant burden of overlap syndrome. COPD patients with coexisting OSA showed significantly worse oxygen saturation parameters, including lower mean and minimum SpO₂ levels and increased time spent in nocturnal desaturation. Furthermore, increasing severity of OSA was associated with progressively greater impairment in oxygenation. These findings highlight that overlap syndrome contributes substantially to hypoxemia in COPD patients and may worsen clinical outcomes if left unrecognized. Early identification and appropriate management of OSA in COPD patients may therefore improve oxygenation status and reduce disease-related morbidity.

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