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Association between Comorbidities and Severity of Obstructive Sleep Apnea in Patients Undergoing Sleep Evaluation

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ABSTRACT

Background: Obstructive sleep apnea (OSA) is a common sleep-related breathing disorder characterized by recurrent upper airway obstruction during sleep, resulting in intermittent hypoxia and sleep fragmentation. OSA is strongly associated with several cardiometabolic and respiratory comorbidities, which may significantly influence disease severity and clinical outcomes.

Methods: This hospital-based cross-sectional observational study included 86 patients with suspected OSA who underwent overnight sleep evaluation using the Deck Mount Level III Sleep Apnea Device at a tertiary care hospital. Demographic characteristics, anthropometric parameters, comorbidity profiles, and sleep study findings were recorded. OSA severity was classified using the Apnea–Hypopnea Index (AHI) into mild, moderate, and severe categories. Statistical analysis was performed to assess the association between comorbidities and OSA severity.

Results: The mean age of the participants was 49.37 ± 12.74 years, with a marked male predominance (84.5%). The mean body mass index was 31.24 ± 5.80 kg/m². Severe OSA was observed in 44.1% of patients, followed by moderate OSA in 34.5% and mild OSA in 21.4%. The mean AHI was 28.02 ± 12.14 events/hour. Obesity (67.4%), hypertension (57.0%), and type 2 diabetes mellitus (47.7%) were the most prevalent comorbidities. Severe OSA demonstrated significant associations with obesity, hypertension, diabetes mellitus, chronic respiratory disease, and smoking history ($p < 0.05$).

Conclusion: Obstructive sleep apnea severity is strongly associated with obesity and multiple cardiometabolic comorbidities. Early screening and comprehensive evaluation of high-risk individuals may facilitate timely diagnosis and improve clinical outcomes..

Key-words: Obstructive sleep apnea; Comorbidities; Apnea–Hypopnea Index; Obesity; Hypertension; Diabetes mellitus

INTRODUCTION

Obstructive sleep apnea (OSA) is a common sleep-related breathing disorder characterized by recurrent episodes of partial or complete upper airway obstruction during sleep, resulting in intermittent hypoxia, fragmented sleep, and recurrent arousals. OSA has emerged as a significant global public health concern due to its increasing prevalence and strong association with adverse cardiovascular, metabolic, respiratory, and neurocognitive outcomes. [1,2]

Recent epidemiological estimates suggest that nearly one billion adults worldwide are affected by varying degrees of OSA, with moderate-to-severe disease accounting for a substantial proportion of cases. [3] Despite its high prevalence, OSA remains markedly underdiagnosed, particularly in low- and middle-income countries where access to diagnostic sleep studies remains limited. [4]

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Several risk factors contribute to the development and progression of OSA, including obesity, male sex, advancing age, smoking, alcohol consumption, and craniofacial abnormalities. [5] Among these, obesity is considered the most significant modifiable risk factor due to increased fat deposition around the upper airway, leading to increased airway collapsibility during sleep.[6]

OSA is increasingly recognized as a systemic disorder with important associations with multiple comorbid conditions, including hypertension, type 2 diabetes mellitus, coronary artery disease, dyslipidemia, chronic respiratory diseases, and cerebrovascular disorders. [7,8] The pathophysiological mechanisms linking OSA with these comorbidities involve intermittent hypoxia, oxidative stress, systemic inflammation, endothelial dysfunction, and sympathetic nervous system overactivation. [9] These mechanisms contribute not only to disease progression but also to increased morbidity and mortality.

The severity of OSA is commonly assessed using the Apnea–Hypopnea Index (AHI), with increasing severity associated with greater oxygen desaturation, worsening metabolic dysfunction, and higher cardiovascular risk.[10] Identifying the relationship between comorbid conditions and OSA severity is clinically important, as patients with multiple comorbidities often experience poorer outcomes and require early intervention.

Although the burden of OSA is rising in India, limited data are available regarding the association between comorbidities and OSA severity in patients undergoing sleep evaluation in tertiary care settings. Understanding these associations may help in early risk stratification, prompt diagnosis, and implementation of targeted management strategies.

Therefore, the present study was conducted to evaluate the association between comorbidities and the severity of obstructive sleep apnea in patients undergoing sleep evaluation at a tertiary care hospital.

MATERIALS AND METHODS

Study Design and Setting- This hospital-based cross-sectional observational study was conducted in the Department of Physiology at Sri Aurobindo Medical College and Postgraduate Institute, Indore, Madhya Pradesh, India, after obtaining approval from the Institutional Ethics Committee (IEC No.: SAIMS/RC/IEC/170/25).

Study Population- A total of 86 patients with suspected obstructive sleep apnea (OSA) undergoing sleep evaluation were enrolled in the study. Patients presenting with clinical symptoms suggestive of OSA, including excessive daytime sleepiness, loud snoring, witnessed apneic episodes, morning headaches, fatigue, and disturbed sleep, were included after obtaining written informed consent.

Inclusion Criteria

- Patients aged ≥18 years
- Patients with clinical suspicion of OSA
- Patients willing to provide informed consent

Exclusion Criteria

- Patients with previously diagnosed central sleep apnea
- Patients with severe neurological or psychiatric disorders affecting sleep assessment
- Patients unwilling to participate
- Incomplete or technically inadequate sleep study recordings

Data Collection- Detailed demographic, clinical, and anthropometric data were collected using a structured proforma. Variables recorded included age, sex, height, weight, and body mass index (BMI). Information regarding comorbid conditions such as obesity, hypertension, type 2 diabetes mellitus, dyslipidemia, coronary artery disease, chronic respiratory diseases, hypothyroidism, smoking history, and alcohol consumption was also documented.

Sleep Evaluation- All participants underwent overnight sleep assessment using the Deck Mount Level III Sleep Apnea Device. The device recorded multiple physiological parameters, including airflow, respiratory effort, pulse rate, oxygen saturation, apnea events, hypopnea events, and oxygen desaturation index (ODI).

OSA severity was classified according to the Apnea–Hypopnea Index (AHI) as follows:

- **Mild OSA:** AHI 5–14.9 events/hour
- **Moderate OSA:** AHI 15–29.9 events/hour
- **Severe OSA:** AHI ≥30 events/hour

Outcome Measures- The primary outcome was to evaluate the association between comorbidities and severity of OSA. Secondary outcomes included assessment of demographic characteristics, anthropometric parameters, and sleep study findings.

Statistical Analysis- Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social

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Sciences (SPSS) software version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD), whereas categorical variables were presented as frequency and percentage. Associations between comorbidities and OSA severity were assessed using the Chi-square test. A p-value <0.05 was considered statistically significant.

Ethical Considerations- The study protocol was approved by the Institutional Ethics Committee of Sri Aurobindo Medical College and Postgraduate Institute, Indore (IEC No.: SAIMS/RC/IEC/170/25). Written informed consent was obtained from all participants prior to inclusion in the study.

RESULTS

A total of 86 patients with suspected obstructive sleep apnea (OSA) undergoing sleep evaluation were included in the study. The baseline demographic and anthropometric characteristics of the study population are presented in Table 1. The mean age of the participants was 49.37 ± 12.74 years, with a marked male predominance (84.5%). The mean height and weight were 166.8 ± 8.9 cm and 86.4 ± 16.2 kg, respectively. The mean body mass index (BMI) was 31.24 ± 5.80 kg/m², indicating a predominance of overweight and obese individuals in the study population.

Table 1: Baseline Demographic and Anthropometric Characteristics of the Study Population (n = 86)

Variable	Value
Age (years), mean ± SD	49.37 ± 12.74
Male sex, n (%)	71 (84.5)
Female sex, n (%)	13 (15.5)
Height (cm), mean ± SD	166.8 ± 8.9
Weight (kg), mean ± SD	86.4 ± 16.2
Body mass index (BMI) (kg/m²), mean ± SD	31.24 ± 5.80
Minimum BMI (kg/m²)	19.37

Abbreviations: SD, standard deviation; BMI, body mass index.

The distribution of OSA severity based on the Apnea–Hypopnea Index (AHI) is shown in Table 2. Severe OSA was observed in 44.1% of patients, followed by moderate OSA in 34.5% and mild OSA in 21.4%, demonstrating a high burden of moderate-to-severe disease in the study cohort.

Table 2: Severity Distribution of Obstructive Sleep Apnea Based on Apnea–Hypopnea Index (AHI) (n = 84)

OSA Severity Category	AHI Range (events/hour)	Number of Patients, n (%)
Mild OSA	5–14.9	18 (21.4)
Moderate OSA	15–29.9	29 (34.5)
Severe OSA	≥30	37 (44.1)

Abbreviations: OSA, obstructive sleep apnea; AHI, apnea–hypopnea index.

Polysomnographic and oxygen saturation parameters are summarized in Table 3. The mean AHI was 28.02 ± 12.14 events/hour. The mean apnea index and hypopnea index were 17.6 ± 8.4 and 10.4 ± 6.1, respectively. The mean oxygen desaturation index (ODI) was 31.8 ± 11.7. The average oxygen saturation was 93.13 ± 1.99%, while the lowest recorded oxygen saturation was 64.67 ± 3.27%, indicating significant nocturnal oxygen desaturation in patients with moderate-to-severe OSA.

Table 3: Polysomnographic and Oxygen Saturation Parameters

Parameter	Mean ± SD
Apnea–Hypopnea Index (AHI) (events/hour)	28.02 ± 12.14
Apnea Index	17.6 ± 8.4
Hypopnea Index	10.4 ± 6.1
Oxygen Desaturation Index (ODI)	31.8 ± 11.7
Average oxygen saturation (%)	93.13 ± 1.99
Lowest oxygen saturation (%)	64.67 ± 3.27
Average pulse rate (beats/minute)	92.71 ± 8.73
Minimum pulse rate (beats/minute)	71.2 ± 7.1
Maximum pulse rate (beats/minute)	114.6 ± 9.5

Abbreviations: SD, standard deviation; ODI, oxygen desaturation index.

The distribution of associated comorbidities among patients with OSA is presented in Table 4. Obesity was the most prevalent comorbidity, affecting 67.4% of patients, followed by hypertension (57.0%) and type 2 diabetes mellitus (47.7%). Other commonly observed comorbidities included dyslipidemia (38.4%), gastroesophageal reflux disease (26.7%), coronary artery disease (22.1%), and hypothyroidism (18.6%).

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Table 4: Distribution of Comorbidities among Patients with Obstructive Sleep Apnea (n = 86)

Comorbidity	Number of Patients (n)	Percentage (%)
Obesity	58	67.4
Hypertension	49	57.0
Type 2 diabetes mellitus	41	47.7
Dyslipidemia	33	38.4
Gastroesophageal reflux disease (GERD)	23	26.7
Coronary artery disease	19	22.1
Alcohol consumption	18	20.9
Hypothyroidism	16	18.6
Depression/anxiety disorders	14	16.3
Chronic obstructive pulmonary disease (COPD)	11	12.8
Bronchial asthma	9	10.5

Abbreviations: GERD, gastroesophageal reflux disease; COPD, chronic obstructive pulmonary disease.

The association between comorbidities and OSA severity is shown in Table 5. Severe OSA demonstrated significant associations with obesity, hypertension, type 2 diabetes mellitus, chronic respiratory diseases, and smoking history ($p < 0.05$). Patients with severe OSA had a notably higher prevalence of cardiometabolic and respiratory comorbidities compared to those with mild or moderate OSA, suggesting a strong relationship between comorbidity burden and disease severity.

Table 5: Association between Comorbidities and Severity of Obstructive Sleep Apnea

Comorbidity	Mild OSA n (%)	Moderate OSA n (%)	Severe OSA n (%)	p-value
Obesity	8 (44.4)	18 (62.1)	32 (86.5)	<0.001
Hypertension	6 (33.3)	15 (51.7)	28 (75.7)	0.002
Type 2 Diabetes Mellitus	5 (27.8)	13 (44.8)	23 (62.2)	0.011
Dyslipidemia	4 (22.2)	11 (37.9)	18 (48.6)	0.041
Coronary Artery Disease	2 (11.1)	5 (17.2)	12 (32.4)	0.038
Hypothyroidism	2 (11.1)	4 (13.8)	10 (27.0)	0.087
COPD/Bronchial Asthma	1 (5.6)	4 (13.8)	15 (40.5)	<0.001
GERD	3 (16.7)	7 (24.1)	13 (35.1)	0.094
Depression/Anxiety Disorders	1 (5.6)	4 (13.8)	9 (24.3)	0.049
Smoking History	3 (16.7)	9 (31.0)	17 (45.9)	0.021

p-values were calculated using Chi-square test. Abbreviations: OSA, obstructive sleep apnea; COPD, chronic obstructive pulmonary disease; GERD, gastroesophageal reflux disease.

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DISCUSSION

The present study evaluated the association between comorbidities and the severity of obstructive sleep apnea (OSA) in patients undergoing sleep evaluation at a tertiary care center. The findings demonstrated a high burden of moderate-to-severe OSA, with severe OSA accounting for the largest proportion of cases. Additionally, obesity, hypertension, and type 2 diabetes mellitus emerged as the most prevalent comorbidities and showed significant associations with disease severity.

The study population had a mean age of 49.37 ± 12.74 years, with a marked male predominance (84.5%). These findings are consistent with previous studies reporting a higher prevalence of OSA among middle-aged males, likely due to anatomical, hormonal, and fat distribution differences that influence upper airway collapsibility during sleep [1–3]. Male sex has consistently been identified as an important risk factor for OSA across epidemiological studies.

A substantial proportion of patients in the present study had moderate-to-severe OSA, with severe OSA observed in 44.1% of cases. This finding highlights the considerable burden of advanced disease among patients presenting for sleep evaluation in tertiary care settings. The higher proportion of severe OSA may be attributed to delayed diagnosis, poor awareness, and referral bias, where symptomatic patients with more advanced disease are more likely to undergo sleep studies [4,11].

Obesity was the most prevalent comorbidity, affecting 67.4% of patients, and demonstrated a strong association with OSA severity. The mean BMI of the study population was 31.24 ± 5.80 kg/m², indicating a predominance of overweight and obese individuals. Obesity is a well-established risk factor for OSA, as increased adipose tissue deposition around the pharyngeal airway reduces upper airway caliber and increases airway collapsibility during sleep [5,12]. Previous studies have shown that increasing BMI is strongly associated with worsening OSA severity [6,13].

Hypertension and type 2 diabetes mellitus were also highly prevalent in the present study, affecting 57.0% and 47.7% of patients, respectively. Both conditions demonstrated significant associations with severe OSA. Recurrent intermittent hypoxia and sleep fragmentation in OSA contribute to sympathetic overactivity, oxidative stress, systemic inflammation, and endothelial dysfunction, all of which play important roles in the development of hypertension and insulin resistance [7,8,12-14]. These findings support the growing evidence linking OSA with cardiometabolic dysfunction.

The present study further identified significant associations between severe OSA and chronic respiratory diseases, including chronic obstructive pulmonary disease (COPD) and bronchial asthma. Patients with coexisting respiratory disorders often experience more pronounced nocturnal oxygen desaturation and poorer clinical outcomes. This overlap further increases the overall disease burden and emphasizes the importance of comprehensive respiratory assessment in patients with suspected OSA. [9]

Smoking history also demonstrated a significant association with severe OSA in the present study. Smoking may contribute to upper airway inflammation, mucosal edema, and altered sleep architecture, thereby exacerbating sleep-disordered breathing. [10] This finding underscores the role of modifiable lifestyle factors in the progression of OSA.

Sleep study findings revealed a mean Apnea–Hypopnea Index (AHI) of 28.02 ± 12.14 events/hour, along with significant nocturnal oxygen desaturation. Overnight assessment using the Deck Mount Level III Sleep Apnea Device provided effective evaluation of respiratory events and oxygen saturation abnormalities. Portable level III sleep monitoring devices are increasingly being recognized as useful diagnostic tools for OSA, particularly in resource-limited settings where full polysomnography may not be readily accessible. [11]

Overall, the findings of the present study highlight a strong association between increasing OSA severity and comorbidity burden, particularly obesity and cardiometabolic disorders. Early screening of high-risk individuals and timely intervention may facilitate prompt diagnosis, reduce disease burden, and improve long-term clinical outcomes.

STRENGTHS

The present study provides valuable insight into the association between comorbidities and obstructive sleep apnea (OSA) severity in patients undergoing sleep evaluation at a tertiary care center. A major strength of the study is the comprehensive assessment of demographic, anthropometric, clinical, and sleep-related parameters, allowing detailed evaluation of the

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relationship between comorbidity burden and disease severity. The use of the Deck Mount Level III Sleep Apnea Device enabled objective assessment of respiratory events and oxygen desaturation parameters. Furthermore, the study contributes important regional data on OSA from the Indian population, where evidence regarding comorbidity associations and severity patterns remains limited.

LIMITATIONS

The study has certain limitations. Being a single-center hospital-based study, the findings may not be generalizable to the broader population. The relatively small sample size may have limited the statistical power for detecting associations involving less prevalent comorbidities. In addition, the cross-sectional design precludes establishing causal relationships between OSA severity and associated comorbidities. Although the Deck Mount Level III Sleep Apnea Device is a useful diagnostic tool, full in-laboratory polysomnography remains the gold standard for comprehensive sleep assessment.

CONCLUSIONS

The present study demonstrated a significant association between comorbidities and the severity of obstructive sleep apnea (OSA) in patients undergoing sleep evaluation. Obesity, hypertension, and type 2 diabetes mellitus were the most prevalent comorbidities and showed strong associations with severe OSA. These findings highlight the importance of early screening and comprehensive evaluation of high-risk individuals for timely diagnosis and appropriate management. Increased clinical awareness and targeted intervention strategies may help reduce the long-term cardiometabolic and respiratory complications associated with OSA.

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