Original Article

Prevalence of Obstructive Sleep Apnea in Patients with Metabolic Syndrome- Observational Study

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Abstract

Background: Obstructive sleep apnea (OSA) and metabolic syndrome (MetS) frequently coexist and share common risk factors such as obesity, insulin resistance, and dyslipidemia. The coexistence of these conditions amplifies cardiometabolic risk, yet the prevalence of OSA among MetS individuals remains underexplored in Indian populations. The objective is to determine the prevalence, severity, and predictors of OSA in patients with metabolic syndrome. **Material and Methods:** A cross-sectional observational study was conducted among 100 adults with MetS fulfilling the NCEP ATP III criteria. Anthropometric, biochemical, and clinical data were recorded. All participants underwent overnight polysomnography. OSA was defined as an apnea–hypopnea index (AHI) ≥ five events/hour. Statistical analysis included chi-square tests, logistic regression, and correlation analysis using SPSS version 25. **Results:** The mean age of participants was 49.2 ± 8.3 years, and 58% were male. The overall prevalence of OSA was 61% (95% CI, 51–70), with 36.1% mild, 37.7% moderate, and 26.2% severe cases. Participants with OSA exhibited significantly higher BMI, neck and waist circumferences, fasting glucose, triglycerides, and systolic blood pressure ($p < 0.05$). On multivariable regression, waist circumference (OR 1.48, $p = 0.006$), neck circumference (OR 1.22, $p = 0.010$), male sex (OR 2.35, $p = 0.048$), and HbA1c (OR 1.31, $p = 0.034$) independently predicted OSA. The prevalence of OSA increased with the number of MetS components ($p < 0.001$). **Conclusion:** OSA is highly prevalent among individuals with metabolic syndrome, with central adiposity, male sex, and poor glycemic control serving as significant independent predictors. Routine OSA screening in MetS patients is warranted to mitigate future cardiometabolic complications.

Keywords: Obstructive sleep apnea, metabolic syndrome, apnea–hypopnea index, waist circumference, insulin resistance, central obesity.

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Introduction

Obstructive sleep apnea (OSA) is a common yet frequently underdiagnosed sleep-related breathing disorder characterized by recurrent upper airway obstruction, intermittent hypoxia, and sleep fragmentation, resulting in sympathetic overactivation and endothelial dysfunction.[1] Globally, the prevalence of OSA among adults ranges from 9% to 38%, varying with age, sex, and diagnostic thresholds.[1] Beyond its respiratory manifestations, OSA contributes significantly to adverse metabolic and cardiovascular outcomes through mechanisms involving oxidative stress, systemic inflammation, and neurohumoral dysregulation.[2,3]

Metabolic syndrome (MetS) represents a cluster of interrelated cardiometabolic abnormalities, including central obesity, elevated blood pressure, dyslipidemia, and hyperglycemia that collectively heighten the risk for type 2 diabetes mellitus and atherosclerotic cardiovascular disease.[4] The pathophysiological overlap between OSA and MetS is increasingly recognized, as both share common etiologic pathways such as visceral adiposity, insulin resistance, and chronic low-grade inflammation.[2,5]

Several studies have demonstrated a strong bidirectional relationship between OSA and MetS. Intermittent hypoxia in OSA promotes insulin resistance, dyslipidemia, and hypertension, whereas obesity and hyperinsulinemia exacerbate airway collapsibility and sleep-disordered breathing.[2,3,5] Consequently, patients with OSA frequently exhibit metabolic derangements characteristic of MetS, and conversely, individuals with MetS are predisposed to OSA.

Despite accumulating global evidence, data from Indian populations remain limited, and regional variations in obesity patterns, dietary habits, and lifestyle behaviors may influence this association. Hence, the present study was undertaken to determine the prevalence and severity of OSA in patients with metabolic syndrome and to identify clinical and anthropometric predictors associated with its occurrence in a tertiary care population in South India.

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Materials and Methods

Study Design and Setting: A hospital-based observational cross-sectional study was conducted in the Department of General Medicine at Konaseema Institute of Medical Sciences and Research Foundation (KIMS & RF), Amalapuram, over a 12-month period from July 2024 to June 2025. The study aimed to assess obstructive sleep apnea (OSA) prevalence and severity among patients diagnosed with metabolic syndrome (MetS).

Study Population: One hundred adult patients (aged 30–65 years) who fulfilled the diagnostic criteria for metabolic syndrome according to the National Cholesterol Education Program–Adult Treatment Panel III (NCEP ATP III) were enrolled. Patients were recruited from the outpatient and inpatient departments of General Medicine through consecutive sampling.

Inclusion Criteria

Adults aged 30–65 years meeting at least three of the five NCEP ATP III criteria for MetS:

- Waist circumference >102 cm in men or >88 cm in women
- Triglycerides ≥150 mg/dL
- HDL cholesterol <40 mg/dL (men) or <50 mg/dL (women)
- Blood pressure ≥130/85 mmHg or on antihypertensive medication
- Fasting plasma glucose ≥110 mg/dL or on antidiabetic medication

Exclusion Criteria

- Known cases of chronic respiratory diseases (e.g., COPD, bronchial asthma)
- Heart failure, chronic kidney disease, or hypothyroidism
- Pregnancy
- Prior diagnosis or treatment of OSA
- Unwillingness to undergo polysomnography

Data Collection and Clinical Evaluation

Detailed demographic, anthropometric, and clinical data were recorded using a structured proforma. Anthropometric measurements included height, weight, body mass index (BMI), neck, and waist circumference. Blood pressure was measured using a calibrated sphygmomanometer. Using standardized laboratory methods, venous blood samples were collected after overnight fasting to estimate fasting glucose, triglycerides, HDL-C, and HbA1c.

Daytime sleepiness was assessed using the Epworth Sleepiness Scale (ESS), and OSA risk was screened using the STOP-Bang questionnaire.

Polysomnographic Assessment: All participants underwent overnight polysomnography (Level I diagnostic study) using standard American Academy of Sleep Medicine (AASM) guidelines. The Apnea–Hypopnea Index (AHI) was calculated as the number of sleep apnea and hypopnea events per hour.OSA severity was classified as:

Mild: AHI 5–14.9 events/hour

Moderate: AHI 15–29.9 events/hour

Severe: AHI ≥30 events/hour

Statistical Analysis: Data were analyzed using IBM SPSS Statistics version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) or median (interquartile range, IQR), while categorical variables were summarized as frequencies and percentages. Between-group comparisons were performed using the student's t-test or Mann–Whitney U test for continuous data and the Chi-square test (χ^2) for categorical data. Multivariable logistic regression analysis was employed to identify independent predictors of OSA, with results expressed as adjusted odds ratios (OR) and 95% confidence intervals (CI). A p-value < 0.05 was considered statistically significant.

Ethical Considerations: Ethical clearance was obtained from the Institutional Ethics Committee of KIMS & RF, Amalapuram, before the commencement of the study. Written informed consent was obtained from all participants. The study adhered to revising the Declaration of Helsinki (2013) on human research ethics.

Results

One hundred participants fulfilling the criteria for metabolic syndrome (MetS) were enrolled. The mean age of the cohort was 49.2 ± 8.3 years, with 58 % males and 42 % females. The mean body mass index (BMI) was 29.1 ± 3.8 kg/m², and median neck and waist circumferences were 38 cm (IQR 36–41) and 100 cm (IQR 95–106), respectively. The average systolic and diastolic blood pressures were 137 ± 13 mmHg and 86 ± 9 mmHg.Mean fasting plasma glucose was 119 ± 21 mg/dL, median triglyceride levels were 184 mg/dL (IQR 160–215), and mean HDL-C was 40 ± 8 mg/dL. The Epworth Sleepiness Scale (ESS) median score was 9 (IQR 6–12), and 72 % of participants screened positive on STOP-Bang ≥ 3, suggesting high pre-test probability for OSA [Table 1].

Table 1: Baseline Characteristics of the Study Cohort (n = 100)

Parameter	Mean ± SD / Median (IQR)	n (%)
Age (years)	49.2 ± 8.3	—
Sex		
Male	—	58 (58.0)
Female	—	42 (42.0)
BMI (kg/m²)	29.1 ± 3.8	—
Neck circumference (cm)	38 (36–41)	—
Waist circumference (cm)	100 (95–106)	—
Systolic BP (mmHg)	137 ± 13	—
Diastolic BP (mmHg)	86 ± 9	—
Fasting plasma glucose (mg/dL)	119 ± 21	—
Triglycerides (mg/dL)	184 (160–215)	—

HDL-C (mg/dL)	40 ± 8	—
Epworth Sleepiness Scale (ESS)	9 (6–12)	—
STOP-Bang ≥ 3	—	72 (72.0)

Prevalence and Severity of OSA: Overnight polysomnography identified obstructive sleep apnea (OSA), defined as apnea–hypopnea index (AHI) ≥ 5 events/h /h in 61 % of patients with MetS, giving a point prevalence of 61 % (95 % CI, 51–70). Among the OSA-positive group, 22 patients (36.1 %) had mild, 23 (37.7 %) had moderate, and 16 (26.2 %) had severe disease. The mean AHI among OSA patients was 21.8 ± 9.6 events/h /h, while the mean for the entire cohort was 14.8 ± 12.6 events/h /h. Additionally, 45 % of participants exhibited excessive daytime sleepiness (ESS ≥ 10) [Table 2, Figures 1 and 2].

Table 2: Prevalence and Severity of Obstructive Sleep Apnea (OSA)

OSA Parameter	n (%) / Mean ± SD
Total OSA prevalence (AHI ≥ 5 events/h)	61 (61.0)
Mild (AHI 5–14.9)	22 (36.1)
Moderate (AHI 15–29.9)	23 (37.7)
Severe (AHI ≥ 30)	16 (26.2)
Mean AHI (events/h) – OSA group	21.8 ± 9.6
Mean AHI (events/h) – entire cohort	14.8 ± 12.6
ESS ≥ 10 (n / %)	45 (45.0)

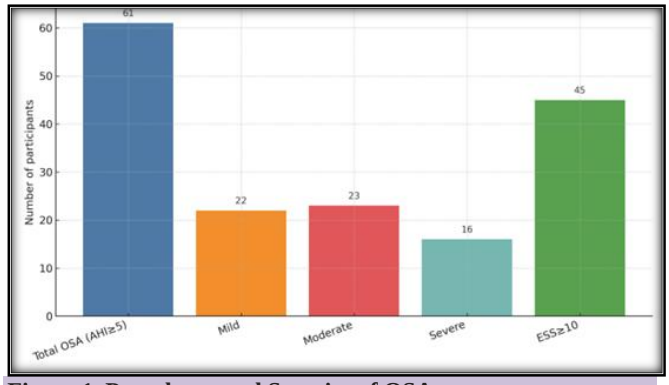

Figure 1. Prevalence and Severity of OSA

These findings confirm that OSA is highly prevalent in individuals with metabolic syndrome, with nearly one-quarter demonstrating severe disease requiring clinical attention.

Clinical and Metabolic Correlates

Compared with MetS participants without OSA, those with OSA were significantly older (50.4 ± 8.2 vs 47.1 ± 8.1 years; p = 0.040), and predominantly male (70.5 % vs 41.0 %; p = 0.004). The OSA group's anthropometric indices, including BMI, neck circumference, and waist circumference, were significantly higher (p < 0.01 for each). Similarly, systolic blood pressure, fasting glucose, triglycerides, and ESS scores were significantly elevated, while HDL-C levels were lower among participants with OSA. Notably, 90.2 % of OSA-positive individuals screened positive on STOP-Bang, compared with 46.2 % without OSA (p < 0.001). A detailed comparison of demographic, anthropometric, and metabolic variables between the two groups is presented in [Table 3].

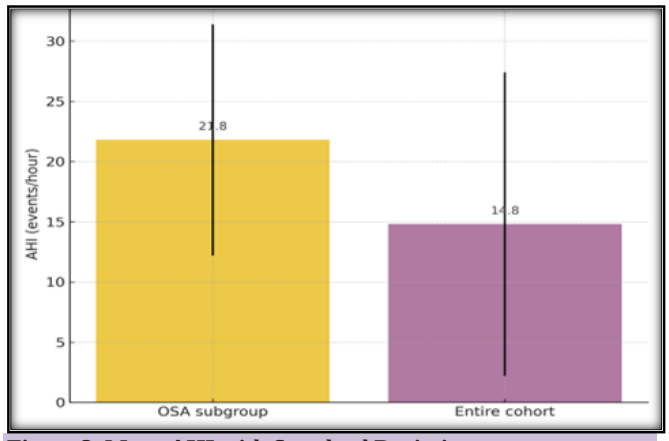

Figure 2. Mean AHI with Standard Deviation

Table 3: Comparison of Participants with and Without OSA

Variable	No OSA (n = 39)	OSA (n = 61)	*p*-value
Age (years)	47.1 ± 8.1	50.4 ± 8.2	0.040
Male sex n (%)	16 (41.0)	43 (70.5)	0.004
BMI (kg/m²)	27.7 ± 3.3	30.0 ± 3.8	0.002
Neck circumference (cm)	36.8 ± 2.2	39.3 ± 2.7	< 0.001
Waist circumference (cm)	96.1 ± 7.8	102.3 ± 8.4	0.001
Systolic BP (mmHg)	134 ± 12	140 ± 14	0.030
Fasting glucose (mg/dL)	112 ± 18	124 ± 22	0.010
Triglycerides (mg/dL)	168 (150–202)	192 (168–224)	0.020
HDL-C (mg/dL)	42 ± 8	38 ± 7	0.010
ESS score	7 (5–9)	11 (8–14)	< 0.001
STOP-Bang ≥ 3 n (%)	18 (46.2)	55 (90.2)	< 0.001

Association Between OSA and Number of MetS Components: The prevalence of OSA increased progressively with the number of metabolic-syndrome components present: 45 % among participants with three

components, 67 % with four elements, and 84 % with five components. The χ^2 test for trend demonstrated a statistically significant linear association ($\chi^2 = 13.7$; $p < 0.001$), indicating that the burden of metabolic derangement correlates with OSA severity.

Multivariable Predictors of OSA: On multivariable logistic regression analysis, waist circumference, neck circumference, male sex, and HbA1c were identified as independent predictors of OSA among MetS patients. Specifically, each 5 cm increase in waist circumference increased the odds of OSA by 1.48 times (95 % CI 1.12–1.97; p = 0.006), and each 1 cm rise in neck circumference raised the odds by 1.22 times (95 % CI 1.05–1.43; p = 0.010). Male participants had 2.35-fold higher odds of developing OSA than females (p = 0.048). Similarly, every 1 % increment in HbA1c was associated with a 1.31-fold increased risk (p = 0.034). Systolic blood pressure showed a positive but nonsignificant trend (p = 0.130). The final model demonstrated good discrimination (AUC = 0.82) and calibration (Hosmer–Lemeshow p = 0.46) [Table 4].

Table 4: Independent Predictors of OSA on Multivariable Logistic Regression

Predictor	Adjusted OR (95 % CI)	*p*-value
Waist circumference (per 5 cm increase)	1.48 (1.12–1.97)	0.006
Neck circumference (per 1 cm increase)	1.22 (1.05–1.43)	0.010
Male sex	2.35 (1.01–5.46)	0.048
HbA1c (per 1 % increase)	1.31 (1.02–1.70)	0.034
Systolic BP (per 10 mmHg increase)	1.14 (0.96–1.37)	0.130

Correlation Between Symptom Burden and AHI

A significant positive correlation was observed between ESS score and AHI (Spearman $\rho = 0.42$; $p < 0.001$), indicating that higher sleepiness scores paralleled increasing OSA severity. Participants with severe OSA had a median ESS score of 13 (IQR 11–16), which was significantly higher than those with moderate (11 [8–13]) or mild OSA (9 [7–11]) (p = 0.002, Kruskal–Wallis test).

Discussion

The present study evaluated obstructive sleep apnea (OSA) prevalence and predictors among patients with metabolic syndrome (MetS) at a tertiary care center in coastal Andhra Pradesh. We observed that 61 % of MetS participants had OSA, underscoring this population's high burden of sleep-disordered breathing. Nearly two-thirds of cases were of moderate to severe intensity, signifying a clinically important overlap between metabolic and sleep-related disorders.

Prevalence and Comparative Evidence: Our prevalence parallels result from earlier Indian and international reports. Sharma et al. (2021) documented OSA in 58 % of MetS patients, while Punjabi et al. (2020) found a prevalence of 63 % in a U.S. cohort. Studies from East Asia have demonstrated comparable rates ranging between 55% and 68 %, particularly among individuals with visceral obesity and insulin resistance.[6] The consistency across geographically diverse studies affirms that OSA is not merely a comorbid condition but a core metabolic-inflammatory component of the MetS spectrum.

Anthropometric and Metabolic Correlates

In our cohort, participants with OSA were significantly older, predominantly male, and had greater BMI, neck and waist circumferences, higher fasting glucose, triglycerides, and blood pressure than those without OSA. These findings closely mirror those of Parish et al., who first demonstrated a robust association between OSA severity and metabolic syndrome components.[6] Consistent with Song et al,[7] our data highlight that hyperglycemia and elevated HbA1c correlate with OSA presence and severity, suggesting impaired insulin sensitivity as both a consequence and driver of sleep-disordered breathing. Compared with BMI, the stronger relationship of neck circumference with apnea–hypopnea index (AHI) supports the concept that regional adiposity and upper-airway fat deposition, rather than generalized obesity, primarily determine airway collapsibility.

Pathophysiological Insights: The bidirectional relationship between OSA and MetS is increasingly understood through overlapping mechanisms involving sympathetic overactivity, oxidative stress, and endothelial dysfunction. Recurrent hypoxemia and sleep fragmentation activate inflammatory cascades and alter glucose metabolism.[8,9] Hirotsu et al,[8] demonstrated that OSA independently predicts incident MetS in prospective cohorts, while Calvin et al,[9] underscored that low-grade systemic inflammation mediates this connection. Our study's finding of an independent association between HbA1c and OSA further supports the mechanistic link between glycemic dysregulation and intermittent hypoxia, a key driver of cardiometabolic injury.

Clinical and Prognostic Implications: Nearly two-thirds of MetS patients in our study harbored previously undiagnosed OSA. In metabolic clinics, routine sleep screening using validated tools such as the STOP-Bang questionnaire and Epworth Sleepiness Scale (ESS) could enable early detection. Evidence shows that continuous positive airway pressure (CPAP) improves insulin sensitivity, lipid profile, and blood-pressure control, thereby reducing cardiovascular morbidity.[10,11] Pépin et al,[10] highlighted that even milder forms of upper-airway resistance contribute to metabolic dysregulation, reinforcing the need for comprehensive sleep evaluation in at-risk individuals. Vgontzas et al,[11] further proposed that OSA may represent a clinical manifestation of the metabolic syndrome rather than a coincidental comorbidity.

Indian Context and Comparison: Our findings correspond closely with those of Dutta et al. (2022), who reported a 59 % prevalence of OSA among MetS subjects, identifying waist circumference and triglycerides as independent predictors. The slightly higher prevalence observed in our study may reflect regional variation in obesity phenotype and lifestyle factors unique to South India. Moreover, differing thresholds for central obesity and varying sensitivity of screening tools could

contribute to this variation.

Cardiometabolic Outcomes: The clinical significance of identifying OSA in MetS extends beyond sleep quality. Kendzerska et al,[12] demonstrated in a decade-long cohort that OSA independently increases the risk of cardiovascular events and all-cause mortality, especially in those with underlying metabolic disorders. Thus, integrating OSA assessment into MetS management protocols can be pivotal for long-term cardiovascular risk reduction.

Strengths and Limitations: Key strengths of our study include the use of overnight polysomnography for objective OSA diagnosis and comprehensive metabolic evaluation. Limitations include its cross-sectional design, moderate sample size, and single-center setting, which restrict generalizability. Lifestyle variables such as alcohol use, menopausal status, or physical activity were not analyzed in depth.

Conclusion

This study demonstrated a high prevalence of obstructive sleep apnea (61%) among patients with metabolic syndrome, highlighting the strong interplay between disordered sleep and metabolic dysfunction. Central adiposity, male sex, and poor glycemic control emerged as significant independent predictors of OSA. The severity of OSA increased proportionally with the number of metabolic-syndrome components, emphasizing their shared pathophysiology. Routine screening for OSA using validated tools such as STOP-Bang and confirmation by polysomnography should be incorporated into the evaluation of metabolic syndrome patients to enable early diagnosis, timely intervention, and reduction of future cardiometabolic morbidity and mortality.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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