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Prevalence of Obstructive Sleep Apnea Among Patients with Obesity and Metabolic Syndrome: A Cross-Sectional Observational Study.

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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, leading to intermittent hypoxia and sleep fragmentation. Obesity and metabolic syndrome are well-established risk factors for OSA, and their coexistence substantially increases the risk of cardiovascular disease, insulin resistance, hypertension, dyslipidemia, and impaired quality of life. Despite its clinical importance, OSA remains underdiagnosed among high-risk individuals. ***Objectives:*** To determine the prevalence of obstructive sleep apnea among patients with obesity and metabolic syndrome and to evaluate its association with demographic, anthropometric, and metabolic parameters. ***Materials and Methods:*** A hospital-based cross-sectional observational study was conducted in the Department of General Medicine over 18 months. A total of 110 adult patients diagnosed with obesity and metabolic syndrome were enrolled using consecutive sampling. Demographic characteristics, clinical history, anthropometric measurements, blood pressure, fasting blood glucose, glycated hemoglobin (HbA1c), and lipid profile were recorded. Participants were screened using the STOP-BANG questionnaire and underwent overnight sleep evaluation for confirmation and grading of OSA. Statistical analysis was performed using SPSS version 26.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. A p-value of <0.05 was considered statistically significant. ***Results:*** Among the 110 participants, 66 (60.0%) were diagnosed with obstructive sleep apnea. Patients with OSA had significantly higher mean age (55.3 ± 9.8 vs. 46.6 ± 10.7 years), body mass index (34.8 ± 3.9 vs. 31.6 ± 3.1 kg/m^2), waist circumference (110.2 ± 9.4 vs. 102.4 ± 8.5 cm), neck circumference (41.8 ± 2.7 vs. 37.5 ± 2.5 cm), fasting blood glucose, HbA1c, triglyceride levels, and blood pressure compared with participants without OSA ($p<0.05$ for all). OSA severity increased significantly with increasing BMI, and severe OSA was most common among patients with morbid obesity. Hypertension and diabetes mellitus were also significantly more prevalent among patients with OSA. ***Conclusion:*** Obstructive sleep apnea is highly prevalent among patients with obesity and metabolic syndrome. Increasing obesity, central adiposity, hypertension, diabetes mellitus, and adverse metabolic parameters are significantly associated with OSA. Routine screening using validated questionnaires and timely confirmation with sleep studies should be incorporated into the evaluation of high-risk patients to facilitate early diagnosis and comprehensive management, thereby reducing long-term cardiometabolic complications.

Keywords: Obstructive sleep apnea, obesity, metabolic syndrome, prevalence, STOP-BANG questionnaire, polysomnography.

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INTRODUCTION

Obstructive sleep apnea (OSA) is a common sleep-related breathing disorder characterized by recurrent episodes of complete or partial upper airway obstruction during sleep, resulting in intermittent hypoxia, sleep fragmentation, intrathoracic pressure fluctuations, and excessive daytime sleepiness. These repeated events trigger sympathetic activation, oxidative stress, systemic inflammation, endothelial dysfunction, and metabolic disturbances, increasing the risk of cardiovascular and cerebrovascular diseases. OSA has become a significant public health problem because of its high prevalence and its adverse effects on morbidity, mortality, healthcare utilization, and quality of life. Despite its clinical importance, OSA remains substantially underdiagnosed, particularly among individuals with obesity and metabolic syndrome who represent one of the highest-risk groups.[1,2]

The worldwide prevalence of obesity has risen markedly due to sedentary lifestyles, unhealthy dietary habits, and urbanization. Obesity is recognized as the strongest modifiable risk factor for OSA. Excess adipose tissue around the neck and upper airway narrows the pharyngeal lumen and increases airway collapsibility during sleep, while visceral obesity reduces lung volumes, further promoting airway obstruction. Several studies have demonstrated a strong association between increasing body mass index (BMI), waist circumference, neck circumference, and OSA severity.[3,4]

Metabolic syndrome comprises a cluster of metabolic abnormalities including central obesity, hypertension, hyperglycemia, elevated triglycerides, and reduced high-density lipoprotein cholesterol. These abnormalities increase the risk of type 2 diabetes mellitus and cardiovascular disease. OSA and metabolic syndrome share a bidirectional relationship, as intermittent hypoxia and sleep fragmentation promote insulin resistance, dyslipidemia, inflammation, and neurohormonal activation, while obesity and metabolic dysfunction further aggravate upper airway obstruction, creating a vicious cycle of worsening cardiometabolic health.[4,5]

The coexistence of OSA with obesity and metabolic syndrome has major clinical implications. Patients frequently develop resistant hypertension, poorly controlled diabetes, non-alcoholic fatty liver disease, arrhythmias, heart failure, stroke, and impaired quality of life. Evidence suggests that treatment with continuous positive airway pressure (CPAP), along with weight reduction and lifestyle modification, improves blood pressure, insulin sensitivity, and daytime functioning. Therefore, early identification of OSA has become an important component of comprehensive cardiometabolic care.[6]
Although overnight polysomnography remains the gold standard for diagnosing OSA, its limited availability and high cost restrict routine use in many healthcare settings. Consequently, validated screening tools such as the STOP-BANG questionnaire, Berlin Questionnaire, and Epworth Sleepiness Scale are widely used to identify individuals at high risk who require confirmatory sleep studies.[7]

India is witnessing a rapid increase in obesity, diabetes mellitus, hypertension, and metabolic syndrome, accompanied by a growing burden of OSA. However, awareness and diagnosis remain inadequate, leading to delayed treatment and increased cardiovascular morbidity. Although several international studies have explored the association between obesity, metabolic syndrome, and OSA, data from Indian tertiary care centers remain limited. Regional differences in ethnicity, body fat distribution, and lifestyle warrant further investigation to better define the disease burden in the Indian population.[2,8,9]

Therefore, the present study was undertaken to determine the prevalence of obstructive sleep apnea among patients with obesity and metabolic syndrome and to evaluate its association with anthropometric measurements, metabolic abnormalities, and other clinical risk factors. The findings are expected to support early diagnosis, targeted screening, and comprehensive management of this high-risk population.

MATERIALS AND METHODS

Study Design

A hospital-based cross-sectional observational study was conducted to determine the prevalence of obstructive sleep apnea (OSA) among patients with obesity and metabolic syndrome and to evaluate its association with demographic, anthropometric, and metabolic risk factors.

Study Setting

The study was carried out in the Department of General Medicine of a tertiary care hospital. Eligible patients attending the outpatient department or admitted to inpatient wards were recruited after informed consent.

Study Duration

The study was conducted over 18 months following approval from the Institutional Ethics Committee.

Study Population

Adult patients diagnosed with obesity and metabolic syndrome attending the Department of General Medicine during the study period were included.

Sample Size

A total of 110 patients were enrolled. The sample size was calculated using the prevalence formula:

$$n = Z^2pq/d^2$$

Where Z = 1.96, p = 50%, q = 50%, and d = 10%. The calculated sample size was 96, which was increased to 110 after considering a 10% non-response rate.

Sampling Technique
Consecutive sampling was employed until the required sample size was achieved.

Inclusion Criteria
- Adults aged ≥18 years.
- Patients with obesity (BMI ≥30 kg/m² or ≥27.5 kg/m² for Asian Indians).
- Patients fulfilling accepted diagnostic criteria for metabolic syndrome (IDF/NCEP ATP III).
- Willingness to provide written informed consent.

Exclusion Criteria
- Previously diagnosed OSA receiving treatment.
- Central sleep apnea or other primary sleep disorders.
- Pregnancy.
- Severe chronic respiratory or neuromuscular disorders.
- Critically ill or psychiatric patients unable to cooperate.
- Incomplete clinical data or refusal to participate.

Diagnostic Criteria for Metabolic Syndrome
Metabolic syndrome was diagnosed according to standard international criteria based on central obesity plus at least two of the following:
- Hypertension,
- Elevated fasting blood glucose,
- Hypertriglyceridemia,
- Reduced HDL cholesterol.

Data Collection
Demographic details, medical history, smoking and alcohol status, duration of obesity, diabetes and hypertension, family history, symptoms suggestive of OSA (snoring, witnessed apnea, daytime sleepiness, morning headache, fatigue, and sleep quality), and medication history were recorded using a structured proforma.

Clinical Assessment
Each participant underwent detailed physical examination including measurement of:
- Height, weight and BMI,
- Waist and hip circumference,
- Waist-to-hip ratio,
- Neck circumference,
- Blood pressure,
- Pulse rate,
- Respiratory rate,
- Oxygen saturation (SpO_2).

Upper airway examination including Mallampati grading was performed when appropriate.

Laboratory Investigations
Routine laboratory investigations included complete blood count, fasting and postprandial blood glucose, HbA1c, lipid profile (total cholesterol, triglycerides, HDL, LDL, VLDL), renal function tests, liver function tests, and thyroid function tests whenever indicated.

Assessment of Obstructive Sleep Apnea
Participants were initially screened using the STOP-BANG questionnaire. Patients identified as intermediate- or high-risk underwent overnight polysomnography or a validated sleep study.
OSA severity was classified according to the Apnea-Hypopnea Index (AHI) as:
- Normal: <5 events/hour
- Mild: 5–14.9 events/hour
- Moderate: 15–29.9 events/hour
- Severe: ≥30 events/hour

Outcome Measures

Primary Outcome

- Prevalence of obstructive sleep apnea among patients with obesity and metabolic syndrome.

Secondary Outcomes

- Severity of OSA.
- Association of OSA with BMI, waist and neck circumference.
- Relationship with hypertension, diabetes mellitus, and lipid abnormalities.
- Identification of independent predictors of OSA.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 26.0. Continuous variables were expressed as mean ± SD, while categorical variables were presented as frequencies and percentages. Comparisons were performed using the independent Student's t-test or Mann–Whitney U test for continuous variables and the Chi-square or Fisher's exact test for categorical variables. One-way ANOVA, correlation analysis, and multivariable logistic regression were performed where appropriate. Odds ratios with 95% confidence intervals were calculated, and a p-value <0.05 was considered statistically significant.

RESULTS

A total of **110 patients** with obesity and metabolic syndrome were included in the present study. The mean age of the participants was **51.8 ± 10.9 years** (range: 28–74 years). Males constituted **61 (55.5%)** participants, while females accounted for **49 (44.5%)**.

Based on overnight sleep evaluation, **66 patients (60.0%)** were diagnosed with obstructive sleep apnea (OSA), whereas **44 patients (40.0%)** did not have OSA. Among patients diagnosed with OSA, the majority had moderate or severe disease. Increasing obesity, greater neck circumference, central obesity, hypertension, and diabetes mellitus were significantly associated with the presence of OSA.

Table 1. Baseline demographic and clinical characteristics of the study population according to OSA status

Variable	OSA Present (n=66)	OSA Absent (n=44)	p value
Age (years)	55.3 ± 9.8	46.6 ± 10.7	<0.001*
Male gender	42 (63.6%)	19 (43.2%)	0.034*
BMI (kg/m²)	34.8 ± 3.9	31.6 ± 3.1	<0.001*
Waist circumference (cm)	110.2 ± 9.4	102.4 ± 8.5	<0.001*
Neck circumference (cm)	41.8 ± 2.7	37.5 ± 2.5	<0.001*
Hypertension	49 (74.2%)	22 (50.0%)	0.009*
Diabetes mellitus	46 (69.7%)	21 (47.7%)	0.021*
STOP-BANG score	6.4 ± 1.2	3.8 ± 1.1	<0.001*

Among the 110 participants, **60.0%** were diagnosed with OSA, demonstrating a high disease burden in patients with obesity and metabolic syndrome. Patients with OSA were significantly older (55.3 vs. 46.6 years), had higher BMI (34.8 vs. 31.6 kg/m²), larger waist circumference (110.2 vs. 102.4 cm), and greater neck circumference (41.8 vs. 37.5 cm) compared with those without OSA (all **p<0.001**).

Hypertension was present in **74.2%** of patients with OSA compared with **50.0%** without OSA (**p=0.009**), while diabetes mellitus was observed in **69.7%** versus **47.7%**, respectively (**p=0.021**). The mean STOP-BANG score was also significantly higher among OSA patients (**6.4 ± 1.2 vs. 3.8 ± 1.1; p<0.001**).

Table 2. Severity of obstructive sleep apnea according to obesity category

BMI Category	Mild OSA	Moderate OSA	Severe OSA	Total OSA	p value
30–34.9 kg/m² (n=44)	18 (40.9%)	8 (18.2%)	3 (6.8%)	29 (65.9%)	
35–39.9 kg/m² (n=45)	9 (20.0%)	14 (31.1%)	10 (22.2%)	33 (73.3%)	
≥40 kg/m² (n=21)	1 (4.8%)	2 (9.5%)	18 (85.7%)	21 (100%)	**<0.001***

OSA severity increased significantly with increasing BMI (**p<0.001**). Among patients with BMI **30–34.9 kg/m²**, **65.9%** had OSA, predominantly mild disease. In the BMI **35–39.9 kg/m²** category, **73.3%** had OSA, with moderate and severe forms becoming more frequent.

Every participant with **BMI ≥40 kg/m²** had OSA, and **85.7%** of them had severe disease, demonstrating a strong positive association between increasing obesity and OSA severity.

Table 3. Association of metabolic abnormalities with obstructive sleep apnea

Variable	OSA Present (n=66)	OSA Absent (n=44)	p value
Fasting blood glucose (mg/dL)	148.6 ± 36.5	127.4 ± 28.8	0.002*
HbA1c (%)	7.8 ± 1.2	6.9 ± 1.0	<0.001*
Triglycerides (mg/dL)	198.7 ± 42.4	168.5 ± 35.6	<0.001*
HDL cholesterol (mg/dL)	37.9 ± 6.1	42.6 ± 5.8	<0.001*
Systolic BP (mmHg)	146.4 ± 14.8	134.8 ± 13.2	<0.001*
Diastolic BP (mmHg)	90.8 ± 8.9	84.6 ± 7.5	<0.001*

Patients with OSA demonstrated significantly worse metabolic profiles than those without OSA. Mean fasting blood glucose (**148.6 vs. 127.4 mg/dL; p=0.002**) and HbA1c (**7.8% vs. 6.9%; p<0.001**) were significantly higher among OSA patients, indicating poorer glycemic control.

Serum triglyceride levels were also significantly elevated (**198.7 vs. 168.5 mg/dL; p<0.001**), while HDL cholesterol was significantly lower (**37.9 vs. 42.6 mg/dL; p<0.001**). Both systolic and diastolic blood pressures were significantly higher in patients with OSA (**p<0.001**), supporting the close association between OSA and adverse cardiometabolic risk factors.

DISCUSSION

The present study demonstrated that 60.0% of patients with obesity and metabolic syndrome had obstructive sleep apnea (OSA), indicating a high burden of sleep-disordered breathing in this high-risk population. Patients with OSA exhibited significantly higher body mass index (BMI), neck circumference, waist circumference, blood pressure, fasting blood glucose, HbA1c, and triglyceride levels than those without OSA. Furthermore, the severity of OSA increased progressively with increasing BMI, suggesting that obesity and metabolic abnormalities play a central role in the development and progression of OSA.

The findings of the present study support the recommendations of the American College of Physicians regarding the diagnosis and management of OSA. Qaseem et al. emphasized that adults with symptoms suggestive of OSA or those with significant risk factors such as obesity should undergo appropriate diagnostic evaluation, preferably with polysomnography or validated sleep testing. They further highlighted that early diagnosis and treatment improve daytime symptoms, sleep quality, and overall health outcomes. The high prevalence observed in the present study reinforces the importance of routine screening for OSA among individuals with obesity and metabolic syndrome, particularly in tertiary care settings where cardiometabolic disorders are highly prevalent (9).

Although the present study focused on prevalence, the observed association between OSA and adverse metabolic parameters is consistent with previous evidence demonstrating that untreated OSA contributes to long-term systemic complications. Kendzerska et al. reported that OSA is associated with an increased incidence of chronic diseases and adverse health outcomes, emphasizing that intermittent hypoxia, oxidative stress, and persistent inflammation contribute to progressive metabolic and cardiovascular dysfunction. Their findings support the concept that OSA should be regarded as a multisystem disorder requiring comprehensive evaluation rather than merely a nocturnal respiratory condition (10).

The increasing prevalence of OSA observed in obese individuals in the present study is also in agreement with the epidemiological findings of Peppard et al., who documented a substantial rise in sleep-disordered breathing among adults over recent decades. They attributed this increase largely to the global obesity epidemic and demonstrated that moderate-to-severe OSA has become considerably more common than previously estimated. Similar observations in the present study indicate that obesity remains the principal driver of OSA and that many affected individuals continue to remain undiagnosed until evaluated specifically for sleep disorders (11).

Screening for OSA is particularly important because many patients are asymptomatic or attribute symptoms such as fatigue and daytime sleepiness to obesity itself. Aurora and Quan emphasized that primary care physicians should routinely screen high-risk individuals using validated tools such as the STOP-BANG questionnaire before referring them for confirmatory sleep studies. In the present study, patients with OSA had significantly higher STOP-BANG scores, confirming the usefulness of this questionnaire as an effective and practical screening instrument in routine clinical practice (12).

The significant association between OSA and poor glycemic control observed in this study is supported by the work of Ip et al., and Young T et al. who demonstrated that OSA independently contributes to insulin resistance even after adjustment for obesity. Recurrent nocturnal hypoxia and sleep fragmentation impair glucose metabolism through sympathetic

activation, increased cortisol secretion, inflammatory cytokine release, and endothelial dysfunction. Consequently, patients with OSA frequently exhibit higher fasting glucose levels and HbA1c values, findings that closely resemble those observed in the present study (13,14).

Similarly, Bonsignore et al. highlighted that the diagnosis of OSA should not rely solely on respiratory symptoms but should include a comprehensive assessment of anthropometric characteristics, cardiovascular risk factors, metabolic abnormalities, and validated sleep questionnaires. Their review emphasized individualized treatment strategies based on disease severity and associated comorbidities, including lifestyle modification, weight reduction, continuous positive airway pressure (CPAP), and management of accompanying metabolic diseases. These recommendations are particularly relevant because patients with OSA in the present study had multiple coexisting cardiometabolic abnormalities requiring multidisciplinary management (15).

More recently, Meyer and Jun described obesity and OSA as mutually reinforcing disorders sharing several pathophysiological mechanisms. They reported that excess visceral and cervical adiposity promotes upper airway collapse, whereas untreated OSA further aggravates obesity through hormonal alterations affecting appetite regulation, insulin sensitivity, and energy expenditure. Their review further demonstrated that weight reduction significantly improves apnea severity and metabolic outcomes. The present study similarly showed that patients with higher BMI experienced more severe forms of OSA, supporting aggressive weight management as an essential component of treatment (16).

The increasing global burden of OSA has also been emphasized by Iannella et al., who reported that rising obesity prevalence, sedentary lifestyles, and metabolic diseases have contributed substantially to the worldwide increase in sleep-disordered breathing. They advocated greater public awareness, systematic screening of high-risk populations, and timely therapeutic interventions to reduce cardiovascular morbidity and healthcare costs. The high prevalence identified in the present study further supports these recommendations and highlights the need for incorporating OSA screening into routine evaluation of patients attending obesity and metabolic clinics (17).

The present study has certain limitations. It was conducted at a single tertiary care center with a relatively small sample size of 110 participants, which may limit generalizability. Because of the cross-sectional design, causal relationships between obesity, metabolic syndrome, and OSA could not be established. Nevertheless, the use of standardized anthropometric measurements, validated screening methods, and objective sleep assessment strengthens the reliability of the findings.

CONCLUSION

Obstructive sleep apnea was highly prevalent among patients with obesity and metabolic syndrome, affecting nearly two-thirds of the study population. Increasing BMI, neck circumference, hypertension, diabetes mellitus, dyslipidemia, and poor glycemic control were significantly associated with OSA.

These findings underscore the importance of routine screening using validated questionnaires followed by confirmatory sleep studies in high-risk individuals. Early diagnosis combined with weight reduction, lifestyle modification, optimization of metabolic risk factors, and appropriate OSA therapy may substantially reduce long-term cardiovascular and metabolic complications while improving overall quality of life.

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