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Prevalence and Severity of Obstructive Sleep Apnea Among Patients with Type 2 Diabetes Mellitus: A Cross-Sectional Study

Dr. Gopalrao Ganeshrao Gondchar[1], Dr Paritosh Gajanan Mallurwar[2]

[1]Assistant Professor, Department of Respiratory Medicine, Dr. Ulhas Patil Medical College and Hospital Jalgaon Kh., India.

[2]Junior Resident, Department of Respiratory Medicine, Dr Ulhas Patil Medical College and Hospital, Jalgaon Kh., India.

Correspondence:
Dr. Gopalrao Ganeshrao Gondchar

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Abstract

Background: Obstructive sleep apnea (OSA) is increasingly recognized as a common comorbidity in patients with Type 2 Diabetes Mellitus (T2DM). Shared risk factors such as obesity, insulin resistance, and systemic inflammation contribute to the coexistence of these conditions. However, OSA remains underdiagnosed in diabetic populations, particularly in resource-limited settings. ***Objectives:*** To determine the prevalence and severity of obstructive sleep apnea among patients with Type 2 Diabetes Mellitus and to evaluate the association between OSA severity and selected clinical and anthropometric parameters. ***Materials and Methods:*** A hospital-based cross-sectional study was conducted on 180 patients with T2DM. Demographic and clinical data were collected using a structured proforma. Anthropometric measurements and biochemical parameters, including HbA1c, were recorded. Screening for OSA was performed using validated questionnaires, followed by sleep studies for high-risk individuals. OSA severity was classified based on the apnea-hypopnea index. Statistical analysis was performed using standard software, with $p < 0.05$ considered statistically significant. ***Results:*** OSA was detected in 57.2% of patients, with moderate-to-severe OSA present in 34.4% of the study population. Patients with moderate-to-severe OSA were significantly older and had higher body mass index, larger neck circumference, longer duration of diabetes, higher HbA1c levels, and greater prevalence of hypertension compared to those with no or mild OSA ($p < 0.05$). These findings indicate a strong association between OSA severity and adverse metabolic and cardiovascular risk profiles. ***Conclusion:*** Obstructive sleep apnea is highly prevalent among patients with Type 2 Diabetes Mellitus, with a significant proportion exhibiting moderate-to-severe disease. Routine screening and early intervention for OSA should be incorporated into diabetes care to improve metabolic control and reduce cardiovascular morbidity.

Keywords: Obstructive Sleep Apnea. Type 2 Diabetes Mellitus. Glycemic Control.

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INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) is a rapidly growing global public health problem characterized by chronic hyperglycemia and associated metabolic derangements. The rising prevalence of T2DM has been attributed to increasing urbanization, sedentary lifestyles, obesity, and aging populations. In parallel, obstructive sleep apnea (OSA) has emerged as a highly prevalent but underdiagnosed sleep-related breathing disorder, characterized by recurrent episodes of upper airway collapse during sleep, leading to intermittent hypoxia, sleep fragmentation, and sympathetic activation. Increasing evidence suggests a strong bidirectional relationship between OSA and T2DM, with each condition adversely influencing the other's progression and outcomes.[1]

OSA is particularly common among individuals with T2DM due to shared risk factors such as obesity, central adiposity, insulin resistance, and systemic inflammation. Repeated episodes of intermittent hypoxia and sleep disruption in OSA contribute to oxidative stress, endothelial dysfunction, and activation of inflammatory pathways, which in turn worsen insulin resistance and impair glucose metabolism. Conversely, chronic hyperglycemia and diabetic neuropathy may predispose individuals to upper airway muscle dysfunction, thereby increasing the risk and severity of OSA. This complex interplay underscores the clinical importance of early identification and management of OSA in diabetic populations.[2]

Several epidemiological studies have reported a higher prevalence of OSA among patients with T2DM compared to the general population, with estimates ranging from 40% to 80%, depending on diagnostic criteria and population characteristics. Furthermore, the severity of OSA has been shown to correlate with poor glycemic control, increased cardiovascular risk, and higher prevalence of microvascular and macrovascular complications. Untreated OSA in patients with T2DM has been associated with hypertension, coronary artery disease, stroke, diabetic nephropathy, and retinopathy,

thereby contributing to increased morbidity and healthcare burden.

Despite growing awareness, OSA remains under-recognized in routine diabetic care, especially in low- and middle-income countries where access to sleep laboratories and polysomnography is limited. Screening tools such as the STOP-BANG questionnaire, Berlin questionnaire, and Epworth Sleepiness Scale have been increasingly utilized to identify high-risk individuals and prioritize diagnostic evaluation. Understanding the prevalence and severity distribution of OSA among patients with T2DM in different demographic and clinical settings is essential for developing targeted screening strategies and integrated management approaches.[3][4]

According to the American Academy of Sleep Medicine (AASM), OSA diagnosis requires objective sleep study documentation with AHI ≥5 events/hour with symptoms or ≥15 events/hour irrespective of symptoms.

AIM

To determine the prevalence and severity of obstructive sleep apnea among patients with Type 2 Diabetes Mellitus.

OBJECTIVES

1. To estimate the prevalence of obstructive sleep apnea among patients with Type 2 Diabetes Mellitus.
2. To assess the severity of obstructive sleep apnea in the study population.
3. To evaluate the association between obstructive sleep apnea severity and selected clinical and anthropometric parameters in patients with Type 2 Diabetes Mellitus.

MATERIALS AND METHODS

Source of Data

The data were collected from patients diagnosed with Type 2 Diabetes Mellitus attending the outpatient and inpatient departments of the study hospital during the study period.

Study Design

This study was conducted as a hospital-based cross-sectional observational study.

Study Location

The study was carried out at a tertiary care teaching hospital, including the Departments of General Medicine and Endocrinology.

Study Duration

The study was conducted over a period of 12 months.

Sample Size

Sample size was calculated using:

$n = Z^2 \times p \times (1 – p) / d^2$

Where:

Z = 1.96 (95% confidence)

p = anticipated prevalence (50%)

d = 7.5% precision

$n = (1.96)^2 \times 0.5 \times 0.5 / (0.075)^2$

$n \approx 171$

After adjusting for 5% non-response, final sample size = 180.

A total of 180 patients with Type 2 Diabetes Mellitus were included in the study. The sample size was calculated based on an anticipated prevalence of OSA among diabetic patients, with a confidence level of 95% and an allowable error of 5%, and was adjusted to account for possible non-response.

Inclusion Criteria

- Patients aged ≥18 years diagnosed with Type 2 Diabetes Mellitus.
- Patients willing to participate and providing written informed consent.
- Patients attending the outpatient department or admitted during the study period.

Exclusion Criteria

- Patients with previously diagnosed and treated obstructive sleep apnea.
- Patients with Type 1 Diabetes Mellitus.
- Pregnant women.
- Patients with chronic respiratory diseases such as COPD, interstitial lung disease, or active pulmonary tuberculosis.
- Patients with severe cardiac failure, chronic kidney disease (end-stage), or neurological disorders affecting respiration.
- Patients unwilling to provide consent.

Procedure and Methodology

After obtaining approval from the Institutional Ethics Committee, eligible patients were enrolled in the study. Written informed consent was obtained from all participants. A detailed clinical evaluation was performed, including demographic details, duration of diabetes, comorbidities, medication history, and lifestyle factors. Anthropometric measurements such as height, weight, body mass index (BMI), neck circumference, and waist circumference were recorded using standardized methods.

Patients were screened for obstructive sleep apnea using a validated questionnaire such as STOP-BANG. Individuals identified as high-risk were further evaluated using overnight polysomnography or portable sleep monitoring devices, wherever available. The apnea-hypopnea index (AHI) was used to classify OSA severity as mild (5-14 events/hour), moderate (15-29 events/hour), or severe (≥30 events/hour).

Sample Processing

Blood samples were collected under aseptic precautions for estimation of fasting blood glucose and HbA1c levels using standard laboratory protocols. Samples were analyzed in the central laboratory using automated analyzers with regular quality control procedures.

Statistical Methods

Data were entered into Microsoft Excel and analyzed using statistical software such as SPSS version 25.0. Descriptive statistics were expressed as mean ± standard deviation for continuous variables and frequency with percentage for categorical variables. The Chi-square test was used to assess associations between categorical variables. Independent t-test or ANOVA was applied for comparison of continuous variables across groups. Pearson or Spearman correlation analysis was used to assess the relationship between OSA severity and clinical parameters. A p-value of <0.05 was considered statistically significant.

Data Collection

Data were collected using a pre-designed and pre-tested structured proforma. Information regarding demographic profile, clinical history, anthropometric measurements, questionnaire scores, laboratory parameters, and sleep study findings was systematically recorded and verified for completeness and accuracy before analysis.

Ethics Approval Number

The study was approved by the Institutional Ethics Committee of Dr. Ulhas Patil Medical College (IEC Approval No: IEC/UPMC/2025/Resp/112).

RESULTS

The reported prevalence of OSA represents confirmed cases among individuals who screened high-risk and underwent sleep study evaluation. Since full polysomnography was not performed in all 180 participants, the true prevalence of OSA in the overall diabetic population may be underestimated or overestimated.

Table 1: Baseline Demographic and Clinical Characteristics of Study Participants (N = 180)

Variable	Category / Mean ± SD	n (%)	Test of Significance	95% CI	p value
Age (years)	Mean ± SD	54.7 ± 9.6		53.2 - 56.1	
Gender	Male	108 (60.0)	Chi-square	52.6 - 67.1	0.018
Female	72 (40.0)		32.9 - 47.4		
BMI (kg/m²)	Mean ± SD	27.9 ± 3.8		27.3 - 28.6	
Duration of Diabetes (years)	Mean ± SD	8.4 ± 4.2		7.8 - 9.1	
Hypertension	Present	121 (67.2)	Chi-square	60.2 - 73.6	0.006
Absent	59 (32.8)		26.4 - 39.8		
HbA1c (%)	Mean ± SD	8.1 ± 1.4		7.9 - 8.4	
Waist Circumference (cm)	Mean ± SD	98.6 ± 8.7		97.2 - 100.0	

Table 1 summarizes the baseline demographic and clinical characteristics of the 180 study participants with Type 2 Diabetes Mellitus. The mean age of the study population was 54.7 ± 9.6 years (95% CI: 53.2-56.1), indicating a predominance of middle-aged and elderly individuals. Males constituted a significantly higher proportion of the study population (60.0%) compared to females (40.0%), and this gender distribution was statistically significant (p = 0.018). The mean body mass index was 27.9 ± 3.8 kg/m² (95% CI: 27.3-28.6), reflecting an overall overweight to obese profile. The mean duration of diabetes was 8.4 ± 4.2 years (95% CI: 7.8-9.1), suggesting long-standing disease in a substantial proportion of patients. Hypertension was present in 67.2% of participants, which was significantly higher than those without hypertension (p = 0.006), highlighting the high burden of cardiovascular comorbidity in this cohort. The mean HbA1c level was 8.1 ± 1.4% (95% CI: 7.9-8.4), indicating suboptimal glycemic control in the study population. Additionally, the mean waist circumference was 98.6 ± 8.7 cm (95% CI: 97.2-100.0), reflecting a high prevalence of central obesity among participants.

Table 2: Prevalence of Obstructive Sleep Apnea Among T2DM Patients (N = 180)

OSA Status	n (%)	Test of Significance	95% CI	p value
OSA Present	103 (57.2)	Chi-square	49.7 - 64.4	<0.001
OSA Absent	77 (42.8)		35.6 - 50.3	
Total	180 (100.0)			

Table 2 depicts the prevalence of obstructive sleep apnea among patients with Type 2 Diabetes Mellitus. OSA was detected in 103 patients (57.2%; 95% CI: 49.7-64.4), whereas 77 patients (42.8%; 95% CI: 35.6-50.3) did not have OSA. The prevalence of OSA was 57.2% (95% CI: 49.7–64.4), indicating that more than half of the diabetic patients in the study population were affected by OSA.

Table 3: Severity Distribution of Obstructive Sleep Apnea (N = 180)

OSA Severity (AHI)	n (%)	Test of Significance	95% CI	p value
No OSA (AHI <5)	77 (42.8)	Chi-square	35.6 - 50.3	<0.001
Mild (5-14)	41 (22.8)		17.1 - 29.4	
Moderate (15-29)	36 (20.0)		14.8 - 26.1	
Severe (≥30)	26 (14.4)		9.8 - 20.3	
Total	180 (100.0)			

Table 3 shows the severity distribution of obstructive sleep apnea based on the apnea-hypopnea index. Among the 180 participants, 42.8% had no OSA, while 22.8% had mild OSA, 20.0% had moderate OSA, and 14.4% had severe OSA. The overall distribution of OSA severity was statistically significant ($p < 0.001$). Notably, moderate-to-severe OSA was observed in 34.4% of patients, indicating that over one-third of the study population had clinically significant disease requiring active intervention. This highlights the high disease burden and the potential impact of untreated OSA on metabolic control and cardiovascular risk in patients with T2DM.

Table 4: Association Between OSA Severity and Clinical & Anthropometric Parameters (N = 180)

Parameter	No/Mild OSA (n=118) Mean ± SD	Moderate/Severe OSA (n=62) Mean ± SD	Test	95% CI	p value
Age (years)	52.6 ± 8.8	58.3 ± 9.2	Independent t-test	3.2 - 8.1	<0.001
BMI (kg/m²)	26.7 ± 3.2	30.1 ± 3.6	Independent t-test	2.3 - 4.1	<0.001
HbA1c (%)	7.6 ± 1.2	8.9 ± 1.3	Independent t-test	0.9 - 1.7	<0.001
Neck Circumference (cm)	37.8 ± 2.9	41.2 ± 3.1	Independent t-test	2.6 - 4.1	<0.001
Duration of Diabetes (years)	7.2 ± 3.6	10.3 ± 4.1	Independent t-test	1.8 - 4.3	0.002
Hypertension (%)	69 (58.5)	52 (83.9)	Chi-square	11.4 - 39.8	<0.001

Table 4 illustrates the association between OSA severity and selected clinical and anthropometric parameters. Patients with moderate-to-severe OSA were significantly older (58.3 ± 9.2 years) compared to those with no or mild OSA (52.6 ± 8.8 years; $p < 0.001$). A significantly higher BMI was observed in the moderate-to-severe OSA group (30.1 ± 3.6 kg/m²) than in the no/mild OSA group (26.7 ± 3.2 kg/m²; $p < 0.001$). Glycemic control was also poorer among patients with moderate-to-severe OSA, as reflected by higher HbA1c levels (8.9 ± 1.3% vs. 7.6 ± 1.2%; $p < 0.001$). Similarly, neck circumference was significantly greater in the moderate-to-severe OSA group (41.2 ± 3.1 cm) compared to the no/mild OSA group (37.8 ± 2.9 cm; $p < 0.001$), indicating a strong association between upper body adiposity and OSA severity. The duration of diabetes was significantly longer among patients with moderate-to-severe OSA (10.3 ± 4.1 years) than those with no or mild OSA (7.2 ± 3.6 years; $p = 0.002$). Furthermore, the prevalence of hypertension was significantly higher in patients with moderate-to-severe OSA (83.9%) compared to those with no or mild OSA (58.5%; $p < 0.001$).

Table 5 Multivariate Logistic Regression

Independent Predictors of Moderate-to-Severe OSA:

Variable	Adjusted OR	95% CI	p-value
BMI ≥30 kg/m²	3.12	1.78–5.48	<0.001
HbA1c ≥8%	2.45	1.32–4.55	0.004
Neck circumference ≥40 cm	3.89	2.01–7.52	<0.001
Duration of DM ≥10 yrs	1.94	1.05–3.61	0.034
Hypertension	2.18	1.17–4.05	0.014

Multivariate logistic regression analysis identified several independent predictors of moderate-to-severe obstructive sleep apnea among patients with Type 2 Diabetes Mellitus. Obesity (BMI ≥30 kg/m²) was associated with a more than threefold increased risk of clinically significant OSA (AOR 3.12; 95% CI: 1.78–5.48; $p < 0.001$). Similarly, patients with poor glycemic control (HbA1c ≥8%) had a 2.45 times higher likelihood of moderate-to-severe OSA (95% CI: 1.32–4.55; $p = 0.004$). Increased neck circumference (≥40 cm) emerged as the strongest predictor, conferring nearly fourfold higher odds (AOR 3.89; 95% CI: 2.01–7.52; $p < 0.001$). Longer duration of diabetes (≥10 years) was also independently associated with OSA severity (AOR 1.94; 95% CI: 1.05–3.61; $p = 0.034$), as was the presence of hypertension (AOR 2.18; 95% CI: 1.17–4.05; $p = 0.014$). These findings indicate that obesity-related anthropometric factors, poor metabolic control, chronicity of diabetes, and cardiovascular comorbidity independently contribute to increased risk of moderate-to-severe OSA in this population.

DISCUSSION

The present study evaluated the demographic profile, prevalence, severity, and clinical associations of obstructive sleep apnea (OSA) among patients with Type 2 Diabetes Mellitus (T2DM). The mean age of participants in this study was 54.7 ± 9.6 years, which is comparable to findings reported by Singh A et al. (2021)[5], who documented mean ages of 53–56 years in diabetic cohorts undergoing sleep assessment. The predominance of male participants (60.0%) observed in the present study is consistent with earlier epidemiological studies that have demonstrated a higher risk of OSA among males due to differences in upper airway anatomy, fat distribution, and hormonal factors Dong M et al. (2020)[6]. The mean BMI of 27.9 ± 3.8 kg/m² and waist circumference of 98.6 ± 8.7 cm reflect a high burden of overweight and central obesity, which are well-established risk factors for both OSA and insulin resistance. Similar anthropometric profiles have been reported by Abdissa D. (2020)[7], who observed significantly higher BMI and central adiposity in diabetic patients with coexisting OSA.

The prevalence of hypertension in the present cohort was 67.2%, which aligns with the findings of Wondie A et al. (2021)[8], who reported a strong coexistence of hypertension among patients with OSA and metabolic disorders. The mean HbA1c level of 8.1 ± 1.4% indicates suboptimal glycemic control, comparable to the values reported by Wang C et al. (2022)[9], who demonstrated that patients with moderate-to-severe OSA had significantly higher HbA1c levels than those without sleep-disordered breathing.

In the present study, the prevalence of OSA among patients with T2DM was 57.2%, which is consistent with previously reported prevalence rates ranging from 40% to 70% in diabetic populations. Andayeshgar B et al. (2022)[1] reported an OSA prevalence of approximately 58% among obese patients with T2DM, while Abdissa D. (2020)[7] reported a prevalence of 46% in a hospital-based diabetic cohort. The statistically significant high prevalence observed in the current study reinforces the growing evidence that OSA is highly underdiagnosed in patients with diabetes and highlights the need for routine screening in this population.

Regarding disease severity, moderate-to-severe OSA was identified in 34.4% of participants, which is comparable to findings reported by Singh A et al. (2021)[5], who observed moderate-to-severe OSA in approximately one-third of diabetic patients. These findings suggest that a substantial proportion of diabetic individuals harbor clinically significant OSA that may contribute to poor metabolic control and increased cardiovascular risk.

The association analysis revealed that patients with moderate-to-severe OSA were significantly older, had higher BMI, larger neck circumference, longer duration of diabetes, poorer glycemic control, and higher prevalence of hypertension. Similar associations have been documented by Chiang JF et al. (2021)[10], who reported strong correlations between OSA severity, obesity indices, and metabolic derangements. The observed higher HbA1c levels in patients with moderate-to-severe OSA in the present study further support the hypothesis that intermittent hypoxia and sleep fragmentation worsen insulin resistance and impair glucose homeostasis. Additionally, the significantly higher prevalence of hypertension in patients with severe OSA is consistent with the findings of Andayeshgar B et al. (2022)[1], who established OSA as an independent risk factor for systemic hypertension.

CONCLUSION

This cross-sectional study demonstrates a high burden of obstructive sleep apnea among patients with Type 2 Diabetes Mellitus. Moderate-to-severe OSA was independently associated with obesity, poor glycemic control, longer diabetes duration, and hypertension. While these findings suggest clinically meaningful associations, causality cannot be inferred. Comprehensive screening strategies using validated tools followed by confirmatory sleep testing may improve identification of OSA in diabetic populations.

LIMITATIONS OF THE STUDY

1. The cross-sectional design limited the ability to establish a causal relationship between obstructive sleep apnea and metabolic or cardiovascular parameters.
2. The study was conducted at a single tertiary care center, which may limit the generalizability of the findings to the wider population.
3. Selection bias may have occurred as the study included hospital-attending patients who may have more severe disease profiles.
4. The use of screening questionnaires and portable sleep monitoring in some cases, instead of full polysomnography for all participants, may have influenced diagnostic accuracy.
5. Lifestyle factors such as physical activity, dietary habits, alcohol consumption, and smoking were not assessed in detail.
6. The effect of treatment modalities such as continuous positive airway pressure (CPAP) therapy on glycemic control and cardiovascular outcomes was not evaluated.
7. Long-term follow-up data were not available to assess the progression of OSA and its impact on diabetes-related complications.
8. Because polysomnography was performed only in high-risk individuals, the overall prevalence estimate may be influenced by partial verification.
9. Verification bias may have occurred because only high-risk individuals based on questionnaire

screening underwent confirmatory sleep study testing. This may have led to differential misclassification of OSA status.

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