



# Prevalence of obstructive sleep apnea risk and associated factors among patients with type 2 diabetes mellitus on follow up at Jimma Medical Center, Southwest Ethiopia



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## ABSTRACT

**Background:** Obstructive sleep apnea (OSA) is a periodic, partial or complete obstruction in the upper airway during sleep that disrupts normal sleep pattern. Despite its significant morbidities and mortality, the majority of patients with OSA remain undiagnosed. The purpose of this study was to assess the prevalence and associated factors of OSA risk among type 2 diabetes patients on follow up at Jimma Medical Center from January 13 to March 2, 2020.

**Method:** A hospital based cross-sectional study was conducted and consecutive sampling technique was employed. The stop bang questionnaire was used to assess OSA risk. Data were collected using structured questionnaire and entered into EPI data 3.1 and exported to SPSS version 20 for analysis. Logistic regression was employed to identify factors associated with high risk OSA. A variable having a p-value of < 0.2 in the bivariate model was subjected to multivariate analysis. Adjusted odds ratios were calculated at 95% confidence interval and considered significant with a p-value of  $\leq 0.05$ .

**Result:** 253 patients seen in the outpatient clinic were involved with mean age and mean duration of diabetes was  $50.27 \pm 14.08$  and  $6.48 \pm 5.20$  years respectively. The study finding showed that the prevalence of high risk OSA was 45.5%. According to multivariate analysis comorbid hypertension (AOR = 2; 95% CI: 1.04, 3.89), physical inactivity (AOR = 2.11; 95% CI: 1.11,4), BMI  $\geq 30$  kg/m<sup>2</sup>: (AOR = 5.41; 95% CI: 1.68,17.3 and neck circumference > 40 cm: (AOR = 6.3; 95% CI: 2.8,14.2 were independently associated with an increased risk of OSA.

**Conclusion:** There is high number of participants with high risk of OSA. BMI of  $\geq 30$  kg/m<sup>2</sup>, physical inactivity, neck circumference of > 40 cm and comorbid hypertension were associated with high risk OSA among participants. Early detection and appropriate interventions are important among high risk groups.

## Introduction

Obstructive sleep apnea (OSA) is a common medical condition characterized by repetitive episodes of upper airway closure or partial collapse during sleep, resulting in intermittent hypoxia and fragmented sleep. Its clinical manifestations include witnessed apneas, snoring, choking/gasping episodes, excessive daytime sleepiness and non-restorative sleep. It is clinically recognized as a heterogeneous group of disorders characterized by recurrent apneas and/or hypopneas during sleep [1–3].

OSA and diabetes mellitus (DM) are growing health challenges in both high and low-income countries. OSA is a prevalent sleep breathing disorder affecting 9–25% of the general adult population [4]. The

estimated overall prevalence of OSA has substantially increased, and it is highly prevalent among obese patients with type two DM between 58 and 86% [5,6].

Untreated OSA has many deleterious impacts on the human body such as daytime somnolence, headaches, increased risk of a stroke, increased risk of cardiac arrest, arrhythmias, hypertension, and DM [1,2],[7]. The chance of death or cardiovascular disease in patients with OSA is estimated to be 2.5 and 4.5 respectively [8].

The majority of patients with OSA are not aware of any illness and they remain undiagnosed. Up to 83% of patients with type 2 diabetes suffer from unrecognized OSA [9]. Although OSA affects people in all parts of the world, there's little data on the state of the disorder in developing countries, particularly those in Africa. In Africa, the delivery

**Abbreviations:** AHI, Apnea-hypopnea index; BMI, Body mass index; CI, Confidence interval; DM, Diabetes mellitus; HTN, hypertension; JMC, Jimma Medical Center; OSA, Obstructive sleep apnea; SBQ, STOP-Bang questionnaire; WHO, World health organization

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of sleep medicine services is at its embryonic stage. The state of OSA in African countries, including its prevalence, clinical presentations and consequences is largely unknown [10].

According to previous studies obesity, old age, male sex, diabetic retinopathy, hypertension, smoking and alcohol intake are the risk factors for OSA [11,12],[13]. Moreover, abnormalities in craniofacial and upper airway structure increase the chance of developing OSA [14].

Screening is needed in diabetes patients because to get treatment in time, prevent complications and to save resources. The International Diabetes Federation recommends OSA screening for type 2 DM patients with the two-stage approach in which a structured questionnaire used first followed by formal sleep study for high-risk patients [15]. The gold standard for diagnosis of OSA is overnight polysomnography. However, in its absence, questionnaire based surveys are good screening tools for efficient identification of patients with a high risk for OSA. Several tools exist for screening patients for OSA with variable degrees of ease of administration, specificity and sensitivity. The most sensitive and easy to administer screening tool is the STOP-BANG (SBQ). SBQ is a validated, feasible and reliable screening tool for risk identification and triaging patients at high risk of OSA [16]. Compared with the Berlin questionnaire, STOP questionnaire, and Epworth sleepiness scale, the SBQ is a more accurate tool with both a higher sensitivity and diagnostic odds ratio for detecting OSA [17].

To my knowledge, OSA screening practices in diabetes patients on follow up at Jimma Medical Center (JMC) has not been previously explored. Therefore the aim of this study was to assess the prevalence and associated factors of obstructive sleep apnea among type 2 diabetic patients on their follow-up at JMC using SBQ.

## Methods and materials

### Study setting, design and subjects

An institution-based descriptive cross sectional study was conducted from January 13 to March 2, 2020 at JMC diabetes outpatient clinic, which is located in Jimma town, 335 km Southwest of Addis Ababa. The hospital is the largest referral hospital for southwestern part of Ethiopia. It gives different specialized clinical services including chronic follow up for diabetes mellitus, hypertension and other chronic illnesses. All type 2 adult diabetic patients attending the chronic clinic of JMC were our source population, while those fulfilling our inclusion criteria during the study period were taken as study participants. Consecutive sampling technique was applied to recruit study participants during the study period.

### Participants inclusion and exclusion criteria

All type 2 adult diabetic patients aged 18 years or older and willing to participate and gave informed consent were included. Individuals who were age < 18 years, type 1 DM, pregnant women, with chronic obstructive pulmonary disease, critically ill and psychiatric disorder were excluded.

### Data collection tool and procedures

Data were collected using a structured interviewer-administered questionnaire through face to face interviews, patient record reviews and physical examination. The questionnaire was developed from WHO stepwise approach for surveillance of chronic disease risk factors and from different scientific journals. It is subdivided into four parts; Socio-demographic characteristics, clinical variables, STOP-Bang questionnaire and anthropometric measurements.

The STOP BANG questionnaire was used to assess OSA risk. It is a validated, feasible, precise, simple and easy to use for screening and risk stratification for OSA. It includes STOP (S- Snore loudly, T- Tired or

sleepy during daytime, O- Observed apnea, P- Pressure-blood pressure high and the BANG (B- BMI, A-Age, N-Neck circumference and G-Gender). For each question, answering "Yes" scores 1, a "No" response scores 0. The total score ranges from 0 to 8 [16]. Patients can be classified for OSA risk based on their respective scores. The accuracy of the SBQ was measured according to the apnea hypopnea index (AHI). The pooled mean sensitivity and specificity of SBQ in diabetic patients varies from 47%, 51.7% and 56.1% to 87.5%, 75% and 67% respectively for mild, moderate and severe OSA matched to apnea hypopnea index of the respective category [18].

Body weight was measured with digital scale with light cloth at standing position, while body height was measured with portable stadiometer with 0.1 cm accuracy. BMI was calculated as body weight in kilograms divided by the square of height in meters ( $\text{kg}/\text{m}^2$ ). Neck circumference was measured using standard non-elastic measuring tape at the level of cricothyroid with 0.1 cm accuracy. Blood pressure was measured at sitting position from left arm three times and average was taken after at least five minutes rest. Clinical variables were taken from patient record review. Behavioral variables were assessed based on WHO STEP wise approach for chronic disease risk factor surveillance [19]. Data collection was carried out by three bachelors of Nurses with supervision of principal investigator.

### Operational definition

*High risk for OSA:* A total score of  $\geq 3$  stop bang questionnaire.

*Low risk for OSA:* A total score of  $< 3$  stop bang questionnaire.

*Critically ill:* Patients who are unable to communicate and abnormal conscious.

*DM duration:* the duration of DM was calculated as age at data collection minus age at onset of DM.

### Data entry, processing and analysis

Data were cleaned and entered into the Epi-Data version 3.1 and exported to the SPSS version 20 for analysis. Frequency, percentage and mean were computed for descriptive statistics. The data were tested for data entry errors and outlying values. A bivariate relationship between high risk OSA and a number of independent variables were examined for statistical significance. All variables with p-value  $< 0.2$  on bivariate analysis were included in multivariate logistic regression analysis. Multivariate logistic regression was performed using a backward method to identify independent predictors. Finally, variables which had independent association with outcome variable was identified on basis of AOR, with 95% confidence interval and a p-value of  $\leq 0.05$ . The Hosmer and Lemeshow goodness of fit test were checked and gave a p-value of 0.607, indicating evidence of fitness of the model.

### Data quality assurance

The following measures were taken to assure quality of data: Before data collection, data collectors were trained by the principal investigator for one day on the objectives of the study, interviewing, on chart review contents and measurement techniques. The data collection instruments were pre-tested on diabetes patients at Shenan Gibe hospital and necessary modifications was made based on results. The collected data were checked daily for consistency and completeness immediately at the end of the interview and continuous follow-up and supervision were made by principal investigator.

## Result

### Socio-demographic characteristics of participants

A total of 253 participants with mean age of  $50.27 \pm 14.08$  years were involved in this study. More than three fourth (79.1%) of

**Table 1**  
Socio-demographic characteristics of participants according to OSA status at JMC 2020, Jimma, Ethiopia.

Variables	Category	Number (%)	Category Based on SBQ Score		P value
			< 3, [n (%)]	≥ 3, [n (%)]	
Sex	male	152 (60.1)	75 (49.3)	77 (50.7)	0.041
	female	101 (39.9)	63 (62.4)	38 (37.6)	
Age	< 30 years	28 (11.1)	22 (78.6)	6 (21.4)	≤ 0.001
	30 to 39 years	24 (9.5)	17 (70.8)	7 (29.2)	
	40 to 49 years	60 (23.7)	44 (73.4)	16 (26.6)	
	≥ 50 years	141 (55.7)	55 (39.1)	86 (60.9)	
Marital status	married	200 (79.1)	107 (53.5)	93 (46.5)	0.426
	single	14 (5.5)	10 (71.4)	4 (28.6)	
	others*	39 (15.4)	21 (53.8)	18 (46.2)	
Religion	muslim	123 (48.6)	67 (54.5)	56 (45.5)	0.586
	orthodox	89 (35.2)	51 (57.3)	38 (42.7)	
	protestant	32 (12.6)	17 (53.1)	15 (46.9)	
	others†	9 (3.6)	3 (33.3)	6 (66.7)	
Educational status	illiterate	76 (30)	37 (48.7)	39 (51.3)	0.317
	primary	112 (44.3)	68 (60.7)	44 (39.3)	
	secondary	32 (12.6)	15 (46.9)	17 (53.1)	
	college and above	33 (13)	18 (54.5)	15 (45.5)	
Residence	urban	127 (50.2)	74 (58.3)	53 (41.7)	0.233
	rural	126 (49.8)	64 (50.8)	62 (49.2)	
Ethnicity	Oromo	146 (57.7)	80 (54.8)	66 (45.2)	0.202
	Amhara	69 (27.3)	33 (47.8)	36 (52.2)	
	Others‡	38 (15)	25 (65.8)	13 (34.2)	
Family history of OSA	yes	63 (24.9)	38 (60.3)	25 (39.7)	0.288
	no	190 (75.1)	100 (52.6)	90 (44.7)	
Average monthly income (ETB)	< 1000	73 (28.9)	41 (56.2)	32 (43.8)	0.935
	1000 to 1999	33 (13)	18 (54.5)	15 (45.5)	
	2000 to 2999	57 (22.5)	29 (50.9)	28 (49.1)	
	≥ 3000	90 (35.6)	50 (55.6)	40 (44.4)	

\*Widowed, divorced; † catholic, Wakefata; ‡Yem, Keffa, Tigre.

participants were married and almost half (48.6%) of them were muslim in religion. Among participants of age ≥ 50 years about two third (60.9%) of them were at high risk of OSA. Using chi-square analysis age and sex were associated with high risk OSA (Table 1).

#### Clinical, anthropometric and behavioral characteristics of participants

A total of 153 (60.5%) of study participants were in normal category of BMI. Among obese participants (9.1%) almost three quarters (78.3%) of them were at high risk of OSA. The mean duration of diabetes was  $6.48 \pm 5.20$  years and almost one third (35.6%) of them had comorbid hypertension. Few patients were current smokers. Using chi-square analysis comorbid hypertension, BMI, physical exercise and neck circumference were associated with high risk OSA (Table 2).

#### Prevalence of high risk obstructive sleep apnea

Of the 253 type 2 diabetic patients screened for OSA by the STOP-Bang questionnaire, 115 (45.5%) [95% CI: (39, 51.4)] were classified as high risk of OSA as defined by the STOP-Bang score ≥ 3. Almost one third (32%) of participants had STOP-Bang score of 2 and 1.6% of participants had score of 7 (Fig. 1).

#### Factors independently associated with high risk OSA

On bivariate evaluation, seven variables showed evidence of some association with the outcome at a p-value < 0.2, hence included in the multivariate logistic regression analysis. Those variables include age, comorbid hypertension, sex, BMI, physical inactivity, neck circumference and duration of DM. In multivariate analysis; comorbid hypertension (AOR = 2; 95% CI: 1.04, 3.89; P = 0.035), physical inactivity (AOR = 2.11; 95% CI: 1.11,4; p = 0.023), BMI ≥ 30 kg/m<sup>2</sup>: (AOR = 5.41; 95% CI: 1.68,17.3; p = 0.05) and neck circumference > 40 cm: (AOR = 6.3; 95% CI: 2.8,14.2; p = ≤ 0.001)

were independently associated with an high risk of obstructive sleep apnea (Table 3).

#### Discussion

This study determines the prevalence and associated risk factors of high risk OSA using SBQ. The prevalence of high risk OSA was 45.5% 95% CI (39, 51.4) among study participants. This result was in line with findings from Texas using berlin questionnaire, Saudi Arabia and India using SBQ which reported the prevalence of high risk OSA 48.6%,45.8% and 47.3% respectively [20,21],[22].However, the present study finding was higher than a studies conducted in Nigeria and Jordan which reported high risk prevalence of OSA using berlin questionnaire among type 2 DM was 27% and 31% respectively [23,24]. This variability might be due to difference in tools used to assess OSA and study population.

On the other hand, the current finding was lower than a study done in Egypt 60% [25], USA 86% [26], and UK 57% [27],. The possible reasons for high prevalence of those studies may be due to the difference population studied, study settings and tool used to evaluate OSA. For instance, USA and Egyptian study used polysomnography which is the gold standard tool for diagnosis of OSA, whereas UK study used berlin questionnaire and used large study population. Furthermore, USA study was multicenter study and included only obese participants.

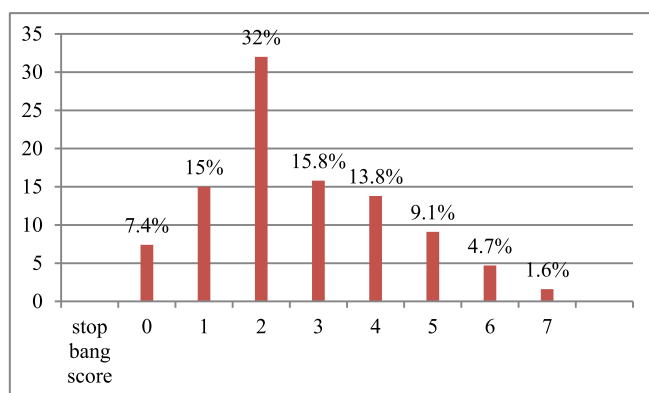
According to the current finding patient neck circumference of > 40 cm was significantly associated with high risk OSA. This finding consistent with previous studies [21,28]. The possible explanation for this association might be its relation with obesity as localized adipose tissue distribution around the neck could be associated with OSA. However, the direct role of neck circumference in the development of OSA has not fully clarified.

This study demonstrated that BMI of ≥ 30 kg/m<sup>2</sup> was significantly associated with high risk OSA. This finding is consistent with prior studies [21],[29–31]. This association could be explained by excess

**Table 2**  
Clinical and behavioral characteristics of participants according to OSA status at JMC 2020, Jimma, Ethiopia.

Variables	Category	Number (%)	Category based on SBQ Score		P value
			< 3,[n (%)]	≥3,[n (%)]	
Duration of DM (years)	< 5	142 (56.1)	85 (59.9)	57 (40.1)	0.097
	5 to 10	68 (26.9)	35 (51.5)	33 (48.5)	
	≥10	43 (17)	18 (41.9)	25 (58.1)	
Comorbid HTN	yes	90 (35.6)	33 (36.7)	57 (63.3)	≤0.001
	no	163 (64.4)	105 (64.4)	58 (35.6)	
Treatment regimen	noninsulin	72 (28.5)	40 (55.6)	32 (44.4)	0.518
	insulin	164 (64.8)	91 (55.5)	73 (44.5)	
	both	17 (6.7)	7 (41.2)	10 (58.8)	
BMI (kg/m <sup>2</sup> )	18.5 to 24.9	153 (60.5)	97 (63.4)	56 (36.6)	≤0.001
	< 18.5	28 (11.1)	16 (57.1)	12 (42.9)	
	25 to 29.9	49 (19.4)	20 (40.8)	29 (59.2)	
	≥30	23 (9.1)	5 (21.7)	18 (78.3)	
Alcohol intake	current	31 (12.3)	16 (51.6)	15 (48.4)	0.884
	former	24 (9.5)	14 (58.3)	10 (41.7)	
	never	198 (78.3)	108 (54.5)	90 (45.5)	
Smoking	current	22 (8.7)	10 (45.4)	12 (54.5)	0.64
	former	30 (11.9)	16 (53.3)	14 (46.7)	
	never	201 (79.4)	112 (55.7)	89 (44.3)	
Physical exercise	active	104 (41.1)	70 (67.3)	34 (32.7)	0.001
	inactive	149 (58.9)	68 (45.6)	81 (54.4)	
Other NCD*	yes	45 (17.8)	26 (57.8)	19 (42.2)	0.63
	No	208 (82.2)	112 (53.8)	96 (46.2)	
Neck circumference (cm)	> 40	56 (22.1)	11 (19.6)	45 (80.4)	≤0.001
	≤40	197 (77.9)	127 (64.5)	70 (35.5)	

\*Chronic kidney disease, congestive heart failure and Asthma.



**Fig. 1.** Distribution of STOP-Bang score among study participants at JMC 2020, Jimma, Ethiopia.

weight gain can change normal upper airway mechanics during sleep by increasing parapharyngeal fat deposition resulting in a smaller upper airway, reducing the functional residual capacity and affects the chemosensitivity to oxygen and carbon dioxide which reduces ventilator drive [32].

In agreement with previous studies, the current study identified that physical inactivity was significantly associated with high risk OSA [21,33,34]. The possible explanation for this relation can be justified by physical exercise causes upper airway muscle activation to extend upper airway diameter, reduce airway resistance, and restrict pharyngeal collapse during sleep [35].

Finally, in the present study the prevalence of high risk OSA was twice higher in comorbid hypertension than normotensive patients. These findings are compatible with previous studies [31,36,37]. The possible explanation for this is OSA induces chronic intermittent hypoxia, that results in exaggerated sympathetic activity, systemic inflammation, endothelial dysfunction and oxidative stress that promote the development of high blood pressure [38].

#### Limitation of the study

OSA screening questionnaires tend to have high sensitivity but poor specificity thereby increasing the number of false-positive results. Therefore screening questionnaires alone are inadequate for confirming a diagnosis. Another limitation of this study is that facial malformations and jaw anatomy, as other contributing factors for OSA, have not been included in the SBQ. Moreover most of the subject information was obtained from self-assessment questionnaires that might be affected by recall bias.

#### Conclusion

From the present study, it can be concluded that the prevalence of high risk for OSA was considerably high. BMI of  $\geq 30$  kg/m<sup>2</sup>, physical inactivity, neck circumference of  $> 40$  cm and comorbid hypertension were associated with high risk OSA among participants. Early detection and appropriate interventions should be important actions among patients with the identified risk factors.

#### Ethical consideration

The ethical clearance was obtained from Jimma university institutional review board. Official letter of permission was obtained from Jimma institute of health Ethical review board and given to Jimma Medical Center director office to conduct the study. Then selected respondents were well informed about the purpose, benefit and method of the study. Then information was collected after written consent from each participant was obtained. Information was recorded anonymously and confidentiality and beneficence were assured throughout the study period.

#### Data availability

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

**Table 3**

Bivariate and multivariate logistic regression analysis of factors associated with high risk of OSA among diabetes patients at JMC 2020, Jimma, Ethiopia.

Variables	Category	OSA		Bivariate Analysis		Multivariate analysis	
		High risk	Low risk	P-value	COR (95%CI)	P-value	AOR (95%CI)
Age (years)	< 30	6	22	1	1	1	1
	30 to 39	7	17	0.522	1.51 [0.43,5.33]	0.725	0.76 [0.17,3.32]
	40 to 49	16	44	0.598	1.33 [0.45,3.88]	0.740	0.82 [0.25,2.64]
	≥50	86	55	≤0.001	5.73 [2.18,15]	0.075	2.6 [0.9,7.53]
Sex	male	77	75	0.042	1.7 [1.02,2.8]	0.077	1.7 [0.94,3.24]
	female	38	63	1	1	1	1
BMI (kg/m <sup>2</sup> )	18.5 to 24.9	56	97	1	1	1	1
	< 18.5	12	16	0.53	1.29 [0.57,2.94]	0.997	0.99 [0.39,2.51]
	25 to 29.9	29	20	0.006	2.51 [1.3,4.84]	0.374	1.45 [0.64,3.3]
	≥30	18	5	0.001	6.23 [2.19,17.7]	0.005*	5.41 [1.68,17.4]
Neck circumference (cm)	> 40	45	11	≤0.001	7.4 [3.6,15.2]	≤0.001	6.3 [2.8,14.2]
	≤40	70	127	1	1	1	1
Comorbid hypertension	yes	57	33	≤0.001	3.12 [1.83,5.34]	0.035*	2 [1.05,3.89]
	no	58	105	1	1	1	1
Physical exercise	active	40	59	1	1	1	1
	inactive	75	79	0.001	2.4 [1.45,4.13]	0.023*	2.1 [1.11,4]
Duration of DM (years)	< 5	57	85	1	1	1	1
	5 to 10	33	35	0.25	1.4 [0.78,2.51]	0.839	0.93 [0.45,1.88]
	≥10	18	25	0.04	2 [1.03,4.1]	0.450	0.71 [0.29,1.72]

\*Value statistically significant; AOR-Adjusted Odds ratio; COR-Crude odds ratio; CI-Confidence interval; 1-reference.

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Nil.

### Author statement

I agree with journal guidelines.

### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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