Al-Rafidain J Med Sci. 2023;5(Suppl 1):S2-7.
DOI: https://doi.org/10.54133/ajms.v5i1S.252

Research Article

Prevalence and Risk Factors of Obstructive Sleep Apnea among Patients Attending Tertiary Care Teaching Hospital in Odisha, India: A Retrospective Observational Study

Tapaswini Mishra[1]*, Manika Bose[2], Debasish Misra[2], Ellora Devi[1], Dipti Mohapatra[1]

[1] Department of Physiology, IMS and SUM Hospital, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, India; [2] Department of Pharmacology, IMS and SUM Hospital, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, India

Received: 18 August 2023; Revised: 30 September 2023; Accepted: 9 October 2023

Abstract

Background: Although obstructive sleep apnea is the most common sleep-disordered breathing, there are fewer studies estimating the prevalence of OSA and its risk factors in urban and rural populations in Odisha. ***Objective***: To estimate the prevalence and risk factors of obstructive sleep apnea in a tertiary care teaching hospital in Odisha, India. ***Method***: It is an observational, retrospective study that was conducted in a sleep study lab for a duration of 4 years (January 2016 to December 2019) by the Department of Physiology and Department of Pulmonology of a tertiary care teaching hospital in Odisha. Patients were first screened for high-risk sleep apnea disorder by the Berlin questionnaire, and then they underwent a level 1 sleep study. ***Results***: Total study patients were 1423, of whom 718 and 705 were from urban and rural areas. The mean age of urban and rural patients was 50.81±12.5 years and 51.63±15.3 years, respectively. The prevalence of OSA in urban areas by AHI criteria was 5.9%, and in rural areas it was 4.9%. The mean AHI of urban OSA patients was 37.86±23.46 and that of rural patients was 16.96±13.8. ***Conclusion***: The prevalence of OSA was higher in urban areas than in rural areas. Both BMI and NC were higher for urban patients than for rural patients. The risk factors were mainly diabetes mellitus and hypertension.

Keywords: Berlin questionnaire, Level 1 sleep study, Obstructive sleep apnea, Urban and rural population.

انتشار وعوامل خطر انقطاع النفس الانسدادي النومي بين المرضى في مستشفى الرعاية الثالثية التعليمي في أوديشا، الهند: دراسة رصدية بأثر رجعي

الخلاصة

الخلفية: على الرغم من أن انقطاع النفس الانسدادي النومي هو أكثر أنواع التنفس المضطربة أثناء النوم شيوعا، إلا أن هناك عددا أقل من الدراسات التي تقدر انتشار انقطاع النفس الانسدادي النومي وعوامل الخطر الخاصة به في سكان الحضر والريف في أوديشا. **الهدف**: تقدير مدى انتشار وعوامل خطر انقطاع النفس الانسدادي النومي في مستشفى تعليمي للرعاية الثالثية في أوديشا، الهند. **الطريقة**: دراسة رصدية بأثر رجعي أجريت في مختبر دراسة النوم لمدة 4 سنوات (يناير 2016 إلى ديسمبر 2019) من قبل قسم علم وظائف الأعضاء وقسم أمراض الرئة في مستشفى تعليمي للرعاية الثالثية في أوديشا. تم فحص المرضى أولا بحثا عن اضطراب توقف التنفس أثناء النوم عالي الخطورة من خلال استبيان برلين، ثم خضعوا لدراسة النوم من المستوى 1. **النتائج**: كان إجمالي مرضى الدراسة 1423 ، منهم 718 و 705 من المناطق الحضرية والريفية. كان معدل انتشار انقطاع النفس الانسدادي النومي في المناطق الحضرية وفقا لمعايير AHI 5.9٪ ، وفي المناطق الريفية كان 4.9٪. كان متوسط AHI لمرضى انقطاع النفس الانسدادي النومي في المناطق الحضرية 37.86±23.46 والمرضى الريفيين 16.96±13.8. **الأستنتاج**: كان انتشار انقطاع النفس الانسدادي النومي أعلى في المناطق الحضرية منه في المناطق الريفية. كان كل من مؤشر كتلة الجسم و NC أعلى بالنسبة للمرضى في المناطق الحضرية منه للمرضى الريفيين. كانت عوامل الخطر بشكل رئيسي داء السكري وارتفاع ضغط الدم.

* ***Corresponding author***: Tapaswini Mishra, Department of Physiology, IMS and SUM Hospital, Siksha 'O' Anusandhan (Deemed to be) University, Bhubaneswar, India; Email: tapaswinimishra@soa.ac.in

Article citation: Mishra T, Bose M, Misra D, Devi E, Mohapatra D. Prevalence and risk factors of obstructive sleep apnea among patients attending tertiary care teaching hospital in Odisha, India: A retrospective observational study. *Al-Rafidain J Med Sci*. 2023;5(Suppl 1):S2-7. doi: https://doi.org/10.54133/ajms.v5i1S.252

INTRODUCTION

Sleep apnea syndrome, or obstructive sleep apnea (OSA), is one of the most common sleep-related breathing disorders. Patients with OSA have obstruction of the upper airway due to relaxation of throat muscles and have episodes of apnea and hypoxemia, which cause symptoms like loud snoring, apnea during sleep, which is witnessed, excessive daytime sleepiness (EDS), observed episodes of stopped breathing during sleep, waking during the night and choking or gasping, morning headaches, and increased risk for road traffic accidents due to EDS [1,2]. OSA is usually complicated by hypertension (HTN), cardiovascular diseases, stroke, and decreased libido, which results in a low quality of life and needs medical treatment and lifestyle changes [3-6]. Overnight polysomnography (PSG) is the gold standard to confirm the presence and severity of OSA [7]. The number of apneas and hypopneas on polysomnography is scored as the apnea-hypopnea index (AHI). The severity of OSA is confirmed by a sleep study with an AHI score of more than 5 hours. Globally, various epidemiological studies show that the prevalence of OSA is lower in women (6.5–9%) than in men (17%–31%) [2,8]. In recent times, the prevalence of OSA has been more prominent in the age group of 30 to 70 years. According to Young *et al*., 1 in 20 middle-aged adults has clinically undiagnosed OSA [9]. There are very few studies on the prevalence of OSA in Asia, according to Mirrakhimov *et al*. [10]. In India, OSA is 7.5% in urban areas, according to the Udwadia *et al*. study, whereas the Sharma et al. study showed 13.5% [11,12]. Approximately 1.2 billion people in India live in rural areas, but due to advancements in technology and infrastructure, the rural population adopted changes in lifestyle like smoking and obesity due to the intake of junk foods, etc., which led to an increase in the incidence of OSA [13,14]. In India, people believe that snoring during sleep is normal; therefore, many people with OSA remain undiagnosed, which is a main non-communicable public health risk [11]. Very few studies have revealed factors associated with OSA in urban and rural areas in Odisha. OSA can be treated if diagnosed earlier, so preventive measures can be taken and morbidity can be reduced. The present study was undertaken to screen high-risk patients for OSA using the Berlin questionnaire in the OPD of the Pulmonary Department, IMS and SUM Hospital, Odisha, and to assess the prevalence of OSA, referred to the Sleep Lab after categorizing the population as rural and urban, besides assessing the associated risk factors.

METHODS

It is an observational, retrospective cross-sectional study that was conducted in a sleep study lab for the duration of 4 years (from 2016 to 2019) by the Department of Physiology and Department of Pulmonology of a tertiary care teaching hospital in Odisha. Patients who came with the symptoms of daytime sleepiness and snoring to the pulmonary department were administered a Berlin questionnaire, and those high-risk categories for OSA were referred for polysomnography (Level I sleep study) for diagnosis and risk factors associated with it. Participants were diagnosed with OSA by sleep study after obtaining informed consent and a proper history.

Sample size calculation

To estimate the sample size, the prevalence rate of OSA was 10%, the confidence level was 90%, and the relative precision was 25% for the urban population of 380 subjects. To estimate an OSA prevalence of 6% with a power of 80%, the sample size for rural areas was 268. We enrolled 1423 patients who were referred for a sleep study with a history of snoring or clinically suspected OSA attending the OPD of the respiratory medicine department in a tertiary care center.

Inclusion criteria

All patients referred for sleep study and the patients who had the symptoms of EDS and snoring in the OPD of the pulmonary department, both genders, between 20 and 80 years old, and who have given consent for polysomnography.

Exclusion criteria

Patients with a history of recent cardiac arrest and resuscitation, upper airway surgery, congestive heart failure (class III/IV), pregnancy, acromegaly, chronic renal disease, systemic steroid treatment, hormone replacement therapy, and terminally ill subjects were excluded from the study.

Data collection and outcome measurement

Data was collected from the case history and polysomnography according to AASM criteria [15]. The whole-night sleep study was recorded by the sleep technician in the Sleep Lab, and the interpretation of the study was done. Data analysis was done for each patient. Anthropometric parameters like height in meters, weight in kilograms, body mass index (BMI), neck circumference (NC), waist circumference, and hip circumference in centimeters were measured. BMI was calculated in kg/m^2. A BMI of more than 25 kg/m^2 was considered to be obese. Comorbid conditions like diabetes mellitus, metabolic syndrome, hypothyroidism, hypertension, smoking history, COPD, etc. were noted and-investigated. The risk factors associated with OSA were analyzed by taking a proper history of the patients.

Apnea-hypopnea index (AHI) of more than five events per hour was used as a cut-off score for the diagnosis of obstructive sleep apnea by polysomnography (according to the AASM scoring manual). AHI (times/hr) was categorized into mild: 5–15, moderate: 16–30, and severe: >30 [16].

Ethical consideration

The research was approved by the Ethical Committee of IMS and SUM Hospital (Ref. No.: IEC/IMS.SH/SOA/2021/218).

Statistical analysis

The collected data were exported to SPSS v25 for analysis. The data were divided into categorical data in the form of numbers and percentages and continuous data in the form of mean ± SD. The Chi-square test of association was applied for categorical data, whereas the mean significant difference between continuous variables was analyzed by the t-test. Statistical significance was set at $p<0.05$.

RESULTS

The total study population comprised 1423 patients who came with symptoms of EDS, snoring, and headaches to the OPD of the pulmonary department. A total of 718 and 705 patients from urban and rural areas, respectively, were selected for the study and given a Berlin questionnaire for screening. After screening, 51 patients from urban areas and 39 patients from rural areas were referred for a whole-night sleep study. Of the 51 urban patients, 6 withdrew their consent and 1 patient study was unsatisfactory, and of the 39 rural patients, 3 withdrew their consent and 1 study was unsatisfactory, so 43 patients were from urban areas and 35 patients were from rural areas who were diagnosed with OSA, for a total of 78 patients (Figure 1).

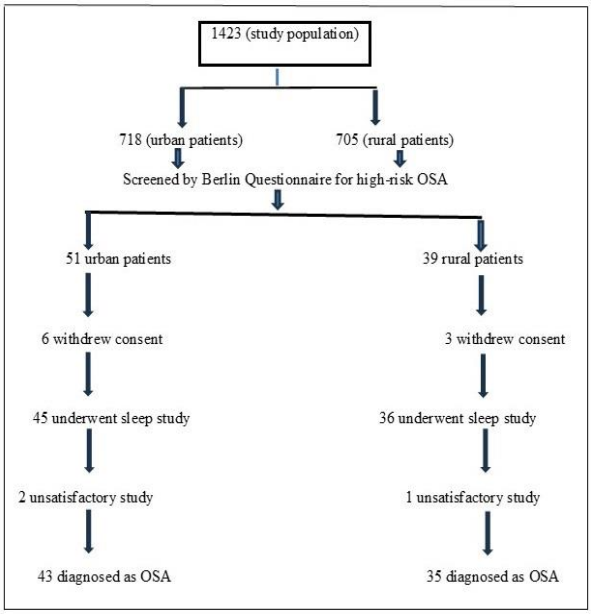

Figure 1: Study design chart.

Thus, in urban populations, the OSA prevalence was 5.9%, and in rural populations, it was 4.9% by AHI criteria. Table 1 shows that the urban population develops OSA earlier than the rural population. Males were more prone to OSA in urban populations than female patients. Urban patients were more obese than rural patients and had a high proportion of snoring. Urban OSA patients were more engaged in sedentary occupations.

Table 1: Differences in attributes between Urban and Rural OSA patients

Attributes	Urban (n=43)	Rural (n=35)	*p*	confidence limit
Age (mean age in years)	50.81±12.5	51.63±15.3	0.797	-7.10-5.47
Gender(male)	27(62.79)	25(71.42)	0.421	OR: 0.675 (0.259-1.762)
AHI	37.86±23.46	16.96±13.8	<0.001	11.95-29.84
BMI	32.68±7.2	29.34±5.4	0.027	0.68-6.29
NC	40.25±4.17	36.68±3.23	<0.001	1.85-5.28
Diabetes	15(34.88)	9(25.71)	0.383	OR: 1.54 (0.57-4.33)
HTN	15(34.88)	12(34.28)	0.956	OR: 1.02 (0.40-2.62)
Snoring	28(65.11)	19(54.28)	0.331	OR: 1.57 (0.63-3.92)
Hypothyroidism	13(30.23)	9(25.71)	0.659	OR: 1.25 (0.46-3.40)
CVD	9(20.93)	7(20)	0.919	OR: 1.05 (0.35-2.30)
Occupation (W, B, H)				
White collar workers(W)	25(58.13)	6(17.14)		
Blue collars workers(B)	6(13.95)	17(48.57)		
Homemaker/unemployed(H)	12(27.90)	12(34.28)	<0.001	
Waist-to-hip ratio	0.88±.24	0.90±1.4	0.751	-0.10-0.07

*OR, odds ratio

Diabetes and hypothyroidism were more prevalent in urban OSA patients as co-morbid conditions. BMI and NC were significantly high in urban OSA patients. The severity of OSA was significantly higher in urban patients than in rural patients. Table 2 showed that the mean AHI of urban OSA patients was 37.86±23.46 and that of rural patients was 16.96±13.8. The urban population had more severe OSA (54%) than the rural population (17%).

Table 2: Comparison between the severity of AHI among urban and rural OSA patients.

Variables	AHI: 5-15	AHI: 16-30	AHI > 30	Total number of OSA patients
Urban OSA patients *n*(%)	10(23)	10(23)	23(54)	43(100)
Rural OSA patients *n*(%)	20(58)	9 (25)	6(17)	35(100)
Total number of patients	30	19	29	78

DISCUSSION

The diagnosis of OSA is still not done properly in some parts of India due to a lack of awareness. It is also a budding profession in our zone, and many individuals in both the health and general sectors do not have awareness of obstructive sleep apnea [17]. OSA has been the causative factor for many diseases like stroke, hypertension, cardiac arrest, etc. [18]. It also results in cognitive dysfunction and road traffic accidents because of excessive daytime sleepiness and decreased concentration while driving [19,20]. Based on the AHI criteria, polysomnography is the gold standard to diagnose OSA, which is treatable with CPAP therapy. In the urban population, many studies have reported on the prevalence of OSA [12,21,22], but in rural populations, very few studies have been conducted [10,11]. There are also fewer studies showing a comparison between the prevalence of OSA in both populations. The current study is of the first kind to compare the prevalence of OSA and its associated risk factors in Eastern India. Globally, the prevalence of OSA varies from two percent to forty-nine percent and seventy-one percent [2,16,23]. In the present study, the prevalence of OSA in the urban population was 5.9%, which is lower than other studies (9.3%, 13.7%, and 19.5%), as reported in the North of India [11,12,21]. Our result was higher than that reported from the southern part of India (4.6%) [24]. Our study showed that the mean age, BMI, and prevalence of hypertension for those with OSA were 50.81±12.5 years, 32.68±7.2 kg/m^2, and 35%, while the study in the North Indian population showed that the mean age was 45.8±8.3 years and the BMI was 27±5.2 kg/m2, which was lower than our study and a higher proportion of hypertension (55%) than our study. A study in South India shows that the mean age was 35.5±10.6 years, the BMI was 24.4±5.3 kg/m^2, and the prevalence of hypertension was 33%, which was also lower than our present study. So, the prevalence of OSA is different in different parts of the country, depending on the geographic region. Very few studies have reported the prevalence of OSA in rural populations around the world, and in some of the studies, it was found to be 18.6%, 6.0%, and 4.1% [25–27]. One of the studies done in Odisha to assess the prevalence of the risk of OSA was reported to be 25% by the Berlin questionnaire [28]. There are very few studies reported in rural populations in India where OSA was confirmed mainly by polysomnography [29,30]. The prevalence of OSA in our study was higher for the urban population than for the rural population, and each had different risk factors associated with OSA. The rural patients were significantly older than the urban patients. OSA was diagnosed more in males in urban patients. The urban OSA patients also had a significantly higher BMI (27.6 *vs*. 24.2 kg/m2) and NC (38.9 *vs*. 34.4 cm) than the rural OSA patients, according to Devaraj *et al*. This is as per our study of BMI (32.68±7.2 *vs*. 29.34±5.4), neck circumference (40.25±4.17 *vs*. 36.68±3.23), and AHI (37.86±23.46 *vs*. 16.96±13.8) in urban vs. rural populations [24]. According to Devaraj *et al*., male gender, snoring, and an ESS score >10 were reported as risk factors in urban patients with an OR of 2.6, 8.5, and 5.5, but in our study, the odds ratio of male gender and snoring was 0.675, 1.57. These factors may be the reasons for the high percentage of OSA in urban patients. It was difficult to convince the rural population to participate in the screening and conduct the sleep study as well. The occupation of the rural population was mostly agricultural work, with workers as manual laborers; thus, they were more physically active, but in the urban population, the workers were mainly white-collar workers who had a sedentary lifestyle. The comorbidities of urban and rural OSA patients were found to be hypertension and diabetes. The urban patients (55%) had severe OSA as compared to the rural patients (17%), which may be due to the high BMI, neck circumference, and sedentary lifestyle, and the males are affected more. In our study, polysomnography rather than a questionnaire served as the method of OSA diagnosis.

Limitations of the study

There was no control group where sleep studies would be done in non-snorer or nonobese populations where the lesser risk factors of OSA would have been missed. The participants were the ones who reported to the Pulmonary Department OPD with symptoms, so the patients were randomly selected.

Conclusion

OSA is ubiquitous in both urban and rural populations in Odisha, India. Our study suggests that the urban

population has a higher prevalence than the rural population in eastern India based on AHI criteria. OSA is still an underdiagnosed condition in patients attending tertiary care hospitals. People are unaware of the clinical features of OSA, both in urban and rural areas. Because of the increase in mortality and morbidity associated with OSA, there should be more educational programs about OSA and its diagnosis and treatment.

ACKNOWLEDGEMENT

The authors thank IMS and SUM Hospital, Siksha 'O' Anusandhan, for the facilities. Authors are grateful to the President, Professor Manojranjan Nayak, Siksha 'O' Anusandhan (Deemed to be University), and Dr Dattatreya Kar and Mr. Nihar Ranjan Panda of Department of Medical Research, IMS and SUM Hospital, Siksha 'O' Anusandhan (Deemed to be University) for assisting in editing the manuscript and helping us during the statistical data analysis.

Conflict of interests

No conflict of interest was declared by the authors

Funding source

The authors did not receive any source of fund.

Data sharing statement

Supplementary data can be shared with the corresponding author upon reasonable request.

REFERENCES

1. Rodenstein D. Sleep apnoea: traffic and occupational accidents—individual risks, socioeconomic and legal implications. *Respiration*. 2009;78(3):241-248. doi: 10.1159/000222811.
2. Young T, Palta M, Dempsey J, Skatrud J, Weber S, Badr S. The occurrence of sleep-disordered breathing among middle-aged adults. *N Engl J Med*. 1993;328(17):1230-1235. doi: 10.1056/NEJM199304293281704.
3. Parish JM, Shepard JW. Cardiovascular effects of sleep disorders. *Chest*. 1990;97(5):1220-1226. doi: 10.1378/chest.97.5.1220.
4. Ifergane G, Ovanyan A, Toledano R, Goldbart A, Abu-Salame I, Tal A, Stavsky M, et al. Obstructive sleep apnea in acute stroke: A role for systemic inflammation. *Stroke*. 2016;47(5):1207-1212. doi: 10.1161/STROKEAHA.115.011749.
5. Soriano JB, Yáñez A, Renom F, de la Peña M, Gómez A, Duro R, et al. Set up and pilot a population cohort for the study of the natural history of COPD and OSA: the PULSAIB study. *Prim Care Respir J*. 2010;19(2):140-147. doi: 10.4104/pcrj.2010.00010.
6. Gay P, Weaver T, Loube D, Iber C. Evaluation of positive airway pressure treatment for sleep-related breathing disorders in adults. *Sleep*. 2006;29(3):381–3401. doi: 10.1093/sleep/29.3.381.
7. Kushida CA, Morgenthaler TI, Littner MR, Alessi CA, Bailey D, Coleman J, et al. Practice parameters for the indications for polysomnography and related procedures: An update for 2005. *Sleep*. 2005;28:499-521. doi: 10.1093/sleep/28.4.499.
8. Heinzer R, Vat S, Marques-Vidal P, Marti-Soler H, Andries D, Tobback N, et al. Prevalence of sleep-disordered breathing in the general population: The HypnoLaus study. *Lancet Resp Med*. 2015;3:310-318. doi: 10.1016/S2213-2600(15)00043-0.
9. Peppard PE, Young T, Barnet JH, Palta M, Hagen EW, Hla KM, et al. Increased prevalence of sleep-disordered breathing in adults. *Am J Epidemiol*. 2013;177:1006-1014. doi: 10.1093/aje/kws342.
10. Mirrakhimov AE, Sooronbaev T, Mirrakhimov EM. Prevalence of obstructive sleep apnoea in Asian adults: A systematic review of the literature. *BMC Pulm Med*. 2013;13:10. doi: 10.1186/1471-2466-13-10.
11. Udwadia ZF, Doshi AV, Lonkar SG, Singh CI. Prevalence of sleep-disordered breathing and sleep apnoea in middle-aged urban Indian men. *Am J Respir Crit Care Med*. 2004;169:168-173. doi: 10.1164/rccm.200302-265OC.
12. Sharma SK, Kumpawat S, Banga A, Goel A. Prevalence and risk factors of obstructive sleep apnoea syndrome in a population of Delhi, India. *Chest*. 2006;130:149-156. doi: 10.1378/chest.130.1.149.
13. Gupta R, Gupta VP. Meta-analysis of coronary heart disease prevalence in India. *Indian Heart J*. 1996;48:241-245. PMID: 8755007.
14. Mishra S, Joseph RA, Gupta PC, Pezzack B, Ram F, Sinha DN, et al. Trends in bidi and cigarette smoking in India from 1998 to 2015, by age, gender and education. *BMJ Glob Health*. 2016;1:e000005. doi: 10.1136/bmjgh-2015-000005.
15. Iber C, Ancoli- Isreal S, Chesson A, Quan S, (Eds.), The AASM Manual for the scoring of sleep and Associated Events, (1st Ed.), Westchester, II; American Academy of Sleep Medicine; 2007.
16. Nickerson J, Lee E, Nedelman M, Aurora RN, Krieger A, Horowitz CR. Feasibility of portable sleep monitors to detect obstructive sleep apnea (OSA) in a vulnerable urban population HHS public access. *J Am Board Fam Med*. 2015;28(2):257-264. doi: 10.3122/jabfm.2015.02.140273.
17. Singh A, Prasad R, Garg R, Kant S, Hosmane GB, Dubey A, et al. A study to estimate prevalence and risk factors of obstructive sleep apnoea syndrome in a semi-urban Indian population. *Monaldi Arch Chest Dis*. 2017;87:40-48. doi: 10.4081/monaldi.2017.773.
18. Adesanya AO, Lee W, Greilich NB, Joshi GP. Perioperative management of obstructive sleep apnoea. *Chest*. 2010;138(6):1489-1498. doi: 10.1378/ chest.10-1108.
19. Coman AC, Borzan C, Vesa CS, Todea DA. Obstructive sleep apnoea syndrome and the quality of life. *Clujul Med*. 2016;89(3):390-395. doi: 10.15386/cjmed-593.
20. Vakulin A, Baulk SD, Catcheside PG, Antic NA, van den Heuvel CJ, et al. Driving simulator performance remains impaired in patients with severe OSA after CPAP treatment. *J Clin Sleep Med*. 2011;7(3):246-253. doi: 10.5664/ JCSM.1062.
21. Reddy EV, Kadhiravan T, Mishra HK, Sreenivas V, Handa KK, Sinha S, et al. Prevalence and risk factors of obstructive sleep apnea among middle-aged urban Indians: a community-based study. *Sleep Med*. 2009;10(8):913-918. doi: 10.1016/j.sleep.2008.08.011.
22. Sharma SK, Reddy EV, Sharma A, Kadhiravan T, Mishra HK, Sreenivas V, et al. Prevalence and risk factors of syndrome Z in urban Indians. *Sleep Med*. 2010;11(6):562–568. doi: 10.1016/j.sleep.2010.02.008.
23. Burgess KR, Havryk A, Newton S, Tsai WH, Whitelaw WA. Targeted case finding for OSA within the primary care setting. *J Clin Sleep Med*. 2013;9(7):681-686. doi: 10.5664/jcsm.2838.
24. Devaraj U, Krishnaswamy U, Ramachandran P, Balla S, Pinto A, Venkatnarayan K, et al. Prevalence and risk factors for OSA among urban and rural subjects in Bengaluru District, South India: A Cross-sectional study. *Indian J Sleep Med*. 2021;16:5-9. doi: 10.5005/jp-journals-10069-0064.
25. de Paula LK, Alvim RO, Pedrosa RP, Horimoto AR, Krieger JE, Oliveira CM, et al. Heritability of OSA in a rural population. *Chest*. 2016;149(1):92-97. doi: 10.1378/chest.15- 0843.
26. Gjevre JA, Pahwa P, Karunanayake C, Hagel L, Rennie D, Lawson J, et al. Excessive daytime sleepiness among rural

residents in Saskatchewan. *Can Respir J*. 2014;21(4):227-233. doi: 10.1155/2014/921541.
27. Liu J, Wei C, Huang L, Wang W, Liang D, Lei Z, et al. Prevalence of signs and symptoms suggestive of obstructive sleep apnea syndrome in Guangxi, China. *Sleep Breath*. 2014;18(2):375-382. doi: 10.1007/s11325-013- 0896-2.
28. Choudhury A, Routray D, Swain S, Das AK. Prevalence and risk factors of people at-risk of obstructive sleep apnea in a rural community of Odisha, India: a community-based cross-sectional study. *Sleep Med*. 2019;58:42-47. doi: 10.1016/j.sleep.2019.03.014.
29. Pinto AM, Devaraj U, Ramachandran P, Joseph B, D'Souza GA. Obstructive sleep apnea in a rural population in South India: feasibility of health care workers to administer level III sleep study. *Lung India*. 2018;35(4):301-306. doi: 10.4103/lungindia.lungindia_433_17.
30. Rout RN, Bhuyan SK, Priyadarshini A, Bhindhani D, Singh M, Mohapatra S. Obstructive sleep apnea: Dental perspective from upright to supine. *J Indian Acad Oral Med Radiol*. 2021;33:177-182. doi: 10.4103/jiaomr.jiaomr_254_20.