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Original Article

Ear, Nose and Throat Section

# Role of Obstructive Sleep Apnoea in Sensorineural Hearing Loss: A Cross-sectional Study

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## ABSTRACT

**Introduction:** Obstructive Sleep Apnoea Syndrome (OSAS) affects millions globally. The condition significantly impacts the inner ear's ability to transduce sound due to the essential oxygen supply required for hair cells in the cochlea. Given the increasing prevalence of OSAS, there is an urgent need for greater awareness and research on its implications for hearing health.

**Aim:** To assess hearing functions in patients with OSAS, aiming to elucidate the relationship between the disorder and sensorineural hearing loss.

**Materials and Methods:** A cross-sectional study was conducted at Chettinad Hospital and Research Institute, a tertiary care centre in Chengalpattu district, Tamil Nadu, India, from August 2024 to January 2025. A total of 60 participants with symptoms of Obstructive Sleep Apnoea (OSA) took part in the study. The participants were assessed using the Snoring, Tiredness, Observed apnoea, high blood Pressure, Body Mass Index, Age, Neck circumference, and Gender (STOP-BANG) questionnaire to evaluate the severity of OSA, polysomnography to confirm sleep apnoea, and pure tone audiometry to assess hearing loss. The test for association was performed using Fisher's Exact test, and correlation was assessed through Spearman's Correlation.

**Results:** A total of 60 participants with symptoms of OSA took part in the study with an average age of 41.2 years. Approximately 48% of the participants were found to have a high risk of severe OSA according to the STOP-BANG scoring. About half of the participants (53.3%) were found to have sensorineural hearing loss. Only 60% of the participants exhibited symptoms of OSA such as snoring, daytime sleepiness, and tiredness. The Spearman correlation coefficient between the STOP-BANG risk grade and the presence of sensorineural hearing loss was 0.596, and with the severity of hearing loss, it was 0.576, both demonstrating a moderate correlation.

**Conclusion:** The present research shows an association between OSA and sensorineural hearing loss, indicating that individuals with higher OSA risk scores experience more significant hearing impairment. The severity of hearing loss correlates with the elevation of OSA risk levels. Early detection and management of OSA are crucial not only for controlling the condition but also for preventing complications such as hearing loss or progression of its severity, thereby promoting better auditory health outcomes.


**Keywords:** Day time sleepiness, Hearing loss, STOP-BANG score, Tiredness

## INTRODUCTION

Obstructive Sleep Apnoea Syndrome (OSAS) is a serious condition affecting breathing during sleep. It causes repeated blockages in the upper airways, leading to interruptions in normal airflow. These obstructions can vary in duration and severity, sometimes resulting in complete pauses in breathing [1].

Sleep-disordered breathing, including obstructive sleep apnoea, affects approximately 9% of women and 24% of men. Many people experience sleep issues that can lead to health problems, but only a small percentage receive a formal diagnosis. Approximately 2% of middle-aged women and 4% of middle-aged men meet the criteria for sleep apnoea syndrome [2]. Factors such as male gender and obesity increase the risk of developing these sleep disorders. Habitual snorers, regardless of gender, show a higher prevalence of apnoea-hypopnea. This suggests that habitual snoring may indicate more serious sleep issues, requiring further evaluation and treatment [3]. Geographically, the distribution of obstructive sleep apnoea is not uniform. The highest number of affected individuals is found in China, followed by the United States, Brazil, and India, which rank next in terms of the number of individuals diagnosed with this condition [2].

The common mechanisms behind hearing loss in Obstructive Sleep Apnoea (OSA), based on current research, include hypoxia, ischaemia, inflammation, and oxidative stress. OSA often leads to repeated periods of hypoxia and ischaemia, which can harm the cochlea and auditory pathways. The inner ear and auditory nerve rely on terminal arteries for blood supply, leaving them highly vulnerable to reduced oxygen levels [4]. In patients with OSA, prolonged hypoxaemia may impair processes essential for sound conversion and signal transmission within the auditory system. Over time, such disruptions could contribute to measurable hearing loss or dysfunction, particularly in severe or untreated cases [5].

OSA is also linked to systemic inflammation and increased oxidative stress, both of which may adversely affect auditory function. These physiological changes can damage cells in the auditory system, affecting their ability to function effectively over time. Although research into the exact mechanisms is ongoing, evidence suggests that these systemic effects play a role in the hearing loss associated with OSA. Identifying specific pathways involved remains important for understanding how to minimise the potential auditory impacts [6]. Some of the evidence supporting the aforementioned association involves audiometric findings, where several studies reveal notable differences in hearing thresholds between OSA patients and individuals without the condition. Patients with OSA typically exhibit higher pure-tone thresholds, with greater sensitivity loss at high frequencies [4, 7]. Moderate OSA is linked to high-frequency hearing impairment, whereas severe OSA affects all hearing ranges, indicating a more widespread auditory impact [4].

Patients with OSA tend to demonstrate reduced Otoacoustic Emissions (OAE) reproducibility and lower amplitude levels, indicative of cochlear dysfunction. Additionally, abnormal Auditory Brainstem Response (ABR) results have been observed, with delayed wave V response latencies noted in OSA patients. These findings suggest that OSA may disrupt auditory signal integrity at the neural level [8].

The degree of hearing impairment appears to be linked to OSA severity, as measured by the Apnoea-Hypopnea Index (AHI). Higher AHI scores correlate with poorer hearing thresholds and diminished distortion-product OAE responses, particularly at higher frequencies [9]. This connection suggests that greater OSA severity might exacerbate auditory system damage, potentially impacting overall communication ability and quality of life.

This study aims to investigate the link between obstructive sleep apnoea and sensorineural hearing loss. Understanding this relationship could provide important insights into how OSAS affects hearing health. Ultimately, the goal is to improve patient care and management related to this condition.

## MATERIALS AND METHODS

A hospital-based cross-sectional study was conducted in the ENT department at Chettinad Hospital and Research Institute, Tamil Nadu, India, from August 2024 to January 2025. Approval from the Ethics Committee (IHEC-II/0507/24) was obtained before the study commenced, and patient privacy was protected at each stage.

**Sample size calculation:** The sample size was calculated using the formula:

$$n=\frac{Z^2_{(1-\alpha/2)}\ P\ Q}{d^2}$$

where Z=1.96, P=41.66% from Martines F et al.; Q=100 - P, and d (margin of error)=15%. This resulted in a required minimum sample size of 42 participants. After adding 20% for potential missing data or errors, we required a minimum sample of 51 participants for the study [10]. Hence, 60 participants were included in the study.

**Inclusion and Exclusion criteria:** Adults aged 18 to 65 years with obstructive sleep apnoea confirmed by a sleep test called polysomnography were included. Individuals over the age of 65 years were excluded to avoid confounding factors related to presbycusis. Additionally, those with a history of past or present ear diseases, such as otosclerosis or Meniere's disease, as well as individuals who have undergone ear surgery or those with known hearing loss due to ototoxicity or noise-induced hearing loss, were also excluded.

### Study Procedure

A detailed history and thorough clinical examination were conducted for each participant. Examinations of the ear, nose, and throat were performed on all patients. The study participants underwent detailed otoscopic examinations, alongside Rinne's, Weber's, and Absolute Bone Conduction tests, administered by the same otolaryngologist. This was followed by tympanometry, pure tone audiometry, and Transient Evoked Otoacoustic Emissions (TEOAE) tests. OSA was diagnosed through polysomnography for all participants.

The severity of obstructive sleep apnoea was assessed based on the STOP-BANG score (S - Snoring, loud enough to be heard through closed doors; T - Tiredness during the day; O - Observed apnoea; P - High blood pressure; B - BMI >35 kg/m$^2$; A - Age over 50 years; N - Neck circumference >40 cm; G - Gender is male). A score of 1 was given for each positive response. A total score of 0-2 out of eight indicated a low risk for OSA, a score of 3-4 was calculated as intermediate risk, and a score of 5-8 indicated a high risk for OSA [11]. The severity and type of hearing loss were assessed based on the pure tone audiometry results of the participants.

## STATISTICAL ANALYSIS

The collected data were arranged in Microsoft Excel (Office 16) and subsequently coded and analysed using Statistical Package for Social Sciences (SPSS) v.26. The descriptive statistics were tabulated in tables. The test for association was conducted using Fisher's Exact Test and assessed for correlation through Spearman's Correlation.

## RESULTS

The majority of the participants were male (60%), uneducated (not having completed school) (56.7%), and held some form of employment (60%) [Table/Fig-1]. A majority of the participants did not have any hearing loss in at least one of their ears (over 50%). Approximately 60% of the participants exhibited visible symptoms of Obstructive Sleep Apnoea (OSA). The STOP-BANG score categorised a majority as being at high risk for developing severe OSA (48.3%) [Table/Fig-2].

| Variables | Sub-groups | Frequency | Percentage |
|---|---|---|---|
| Age (years) | 41.2 (13.62) {Mean (SD)} | | |
| Gender | Male | 36 | 60.0 |
| | Female | 24 | 40.0 |
| Education | Uneducated | 34 | 56.7 |
| | Educated | 26 | 43.3 |
| Occupation | Unemployed/Not working | 24 | 40.0 |
| | Employed | 36 | 60.0 |

**[Table/Fig-1]:** The Sociodemographics of the participants (N=60).

| Variables | Sub-groups | Frequency | Percentage |
|---|---|---|---|
| PTA (Right ear)* | Normal | 32 | 53.3 |
| | CHL | 8 | 13.3 |
| | SNHL | 20 | 33.3 |
| PTA (Left ear)* | Normal | 33 | 55.0 |
| | CHL | 5 | 8.3 |
| | SNHL | 22 | 36.7 |
| Symptoms of OSA (snoring, daytime sleepiness) | Absent | 24 | 40.0 |
| | Present | 36 | 60.0 |
| STOP-BANG score grading | Low-risk | 20 | 33.3 |
| | Midrange-risk | 11 | 18.3 |
| | High-risk | 29 | 48.3 |
| Type of hearing loss# | Normal | 17 | 28.3 |
| | CHL | 11 | 18.3 |
| | SNHL | 32 | 53.3 |
| Severity of hearing loss | NA | 17 | 28.3 |
| | Mild | 6 | 10.0 |
| | Moderate | 31 | 51.7 |
| | Moderately-severe | 6 | 10.0 |

**[Table/Fig-2]:** The pure tone audiometry results of the participants (N=60).
*Higher number in normal range due to presence of unilateral hearing loss; #Lower number in normal range as affected ear was considered for this study; PTA: Pure tone average; CHL: Conductive hearing loss; SNHL: Sensory neural hearing loss

[Table/Fig-3] shows the association between the independent variables (Symptoms, STOP-BANG Questionnaire) and the dependent variable (hearing loss). Participants not displaying any symptoms of OSA were found to be associated with normal hearing, while those with symptoms were associated with sensorineural hearing loss. The risk status of the participants based on the STOP-BANG score showed an association with the presence of hearing loss, as an increase in risk corresponded with a higher number of participants exhibiting sensorineural hearing loss.

[Table/Fig-4] demonstrates that when the risk grade is more severe, the severity of hearing loss is also greater, indicating an association between

| Category | Subcategory | | Type of hearing loss (Based on PTA) Normal | CHL | SNHL | Total |
|---|---|---|---|---|---|---|
| Symptoms of OSA | Absent | Count | 17 | 3 | 4 | 24 |
| | | Percentage | 70.8% | 12.5% | 16.7% | 100.0% |
| | Present | Count | 0 | 8 | 28 | 36 |
| | | Percentage | 0.0% | 22.2% | 77.8% | 100.0% |
| | Total | Count | 17 | 11 | 32 | 60 |
| | | Percentage | 28.3% | 18.3% | 53.3% | 100.0% |
| STOP-BANG score risk grading | Low-risk | Count | 13 | 3 | 4 | 20 |
| | | Percentage | 65.0% | 15.0% | 20.0% | 100.0% |
| | Mid-risk | Count | 4 | 1 | 6 | 11 |
| | | Percentage | 36.4% | 9.1% | 54.5% | 100.0% |
| | High-risk | Count | 0 | 7 | 22 | 29 |
| | | Percentage | 0.0% | 24.1% | 75.9% | 100.0% |
| | Total | Count | 17 | 11 | 32 | 60 |
| | | Percentage | 28.3% | 18.3% | 53.3% | 100.0% |

**[Table/Fig-3]:** Association between presence of symptoms of OSA and type of hearing loss.
Fisher's-Exact test; p-value <0.01 (Significant if p-value <0.05)

the two. The STOP-BANG risk grade, the presence of Sensorineural Hearing Loss (SNHL), and the severity of hearing loss were found to have a significant moderate degree of correlation [Table/Fig-5].

| STOP-BANG score risk grading | | Severity of hearing loss NA | Mild | Moderate | Moderately severe | Total |
|---|---|---|---|---|---|---|
| Low risk for severe OSA | Count | 13 | 0 | 7 | 0 | 20 |
| | Percentage | 65.0% | 0.0% | 29.2% | 0.0% | 100.0% |
| Mid risk for severe OSA | Count | 4 | 1 | 6 | 0 | 11 |
| | Percentage | 36.4% | 9.1% | 54.5% | 0.0% | 100.0% |
| High risk for severe OSA | Count | 0 | 5 | 18 | 6 | 29 |
| | Percentage | 0.0% | 17.2% | 62.1% | 20.7% | 100.0% |
| Total | Count | 17 | 6 | 31 | 6 | 60 |
| | Percentage | 28.3% | 10.0% | 51.7% | 10.0% | 100.0% |

**[Table/Fig-4]:** Association between STOP-BANG score grading and severity of hearing loss.
Fisher's-Exact test; p-value <0.01 (Significant if p-value <0.05)

| Independent variable | Dependent variable | Spearman correlation (p-value) | Correlation degree |
|---|---|---|---|
| OSA symptoms + | Sensorineural hearing loss | 0.720 (<0.001) | Strong correlation |
| STOP-BANG grade of high risk for severe OSA | Sensorineural hearing loss | 0.596 (<0.001) | Moderate correlation |
| STOP-BANG risk grading | Severity of sensorineural hearing loss | 0.576 (<0.001) | Moderate correlation |

**[Table/Fig-5]:** Correlation between the dependent and independent variables.

# DISCUSSION

The present analysis to explore the potential associations between various measured variables revealed a significant association between the presence of symptoms indicative of Obstructive Sleep Apnoea (OSA) and the likelihood of an individual experiencing sensorineural hearing loss. Individuals presenting with higher-risk scores on the STOP-BANG assessment were more likely to report cases of sensorineural hearing loss. Additionally, as the severity of hearing loss escalated, there was a corresponding increase in the risk scores derived from the STOP-BANG questionnaire. These findings underscore the potential utility of the STOP-BANG risk assessment not only as a tool for identifying individuals at risk for severe OSA but also as an indirect indicator of possible sensorineural hearing loss.

Recent findings from research have established a noteworthy association between OSA and sensorineural hearing loss. Kasemsuk N et al., concluded, from their meta-analysis of several studies, that individuals with OSA were found to have poorer hearing and were more likely to experience hearing loss [7]. The odds were found to be approximately 1.5 times higher for mid-frequency hearing loss and 1.2 times higher for high-frequency hearing loss compared to individuals without sleep apnoea.

Similarly, Chauhan P et al., involved 58 participants in their study and reported significantly increased levels in individuals who had a higher Body Mass Index (BMI) and greater neck circumference, both of which are included in the STOP-BANG assessment criteria [5]. Additionally, the mean Pure Tone Average (PTA) at frequencies of 10 kHz and above was also significantly higher among those with OSA. Research from the last decade by Sheu JJ et al., concluded that male patients with sensory neural hearing loss were more likely to have OSA (Odds ratio - 1.48; with a 95% Confidence Interval of 1.02-2.16 and a p-value of 0.04) [6].

Not only was there an increased probability of hearing loss with higher risk grades, but the severity of the hearing loss also tended to be more pronounced in individuals classified within higher risk categories. This finding is similar to that from the recent research conducted by Kalathingal N et al., who found the severity of hearing loss to be greater in individuals with moderate to severe Obstructive Sleep Apnoea Syndrome (OSAS) (p-value <0.05) [9]. This correlation underscores the importance of closely monitoring individuals with symptoms of OSA, not only for their sleep-related health complications but also for potential auditory impairments.

An early diagnosis of OSA is crucial, as it plays a significant role in managing the condition's severity. Identifying OSA at an early stage not only enables healthcare professionals to implement appropriate treatment strategies but also serves to mitigate the risks associated with the condition. Further research can focus on the correlation between metabolic diseases and hearing loss and its role as a confounding factor between OSAS and sensorineural hearing loss.

## Limitation(s)

This study could not compare risk factors such as diabetes or other possible metabolic diseases that could affect hearing loss with the outcomes of this study. The confirmation of comorbidities through investigations and their current level of control could not be assessed, as this was beyond the scope of the study.

# CONCLUSION(S)

This research has revealed a strong link between Obstructive Sleep Apnoea (OSA) and sensorineural hearing loss. Individuals with higher OSA risk scores experience greater hearing impairment. The severity of hearing loss increases with higher risk levels. Early detection and treatment of OSA are crucial for managing the condition and preventing complications such as hearing loss. Addressing OSA can improve sleep quality and hearing health, thereby enhancing overall well-being.

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