



The relationship between vertigo severity, psychiatric symptoms and obstructive sleep apnoea

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ABSTRACT

Objectives: This study assessed the connection between vertigo severity and OSA. **Material and methods:** 111 patients (78 men and 33 women, 48.35 ± 9.24 years) patients with OSA accompanied by vertigo were included in the investigation. These patients underwent respiratory polygraphy, and completed self-reported questionnaires, including the Dizziness Handicap Inventory (DHI), Beck Depression Inventory (BDI), and the Symptom Checklist-90-Revised (SCL-90-R) questionnaires. **Results:** In the study, 25.2% of the patients did not have OSA, 40.5% presented with mild symptoms, 9.9% had moderate symptoms, and 24.3% exhibited severe OSA symptoms. Although the difference in DHI scores based on OSA severity was statistically insignificant ($p=0.35$, $H=3.21$, Kruskal–Wallis test), there was a noticeable trend indicating higher DHI values in patients with severe OSA. A logistic regression model observed depression ($p=0.010^*$; OR = 190.252, 95% CI = 3.587–10090.086) and BMI obese category ($p=0.019^*$; OR = 141.068, CI = 2.290–8688.383) as significant predictors for vertigo in OSA. When analysing the correlations between psychiatric symptoms and vertigo in OSA, significant relationships were observed between BDI and total DHI ($\rho=0.332$, $p=0.002^*$), and the SCL-90-R depression ($\rho=0.480$, $p=0.000^*$) and anxiety points ($\rho=0.480$, $p=0.000^*$) and the total DHI, respectively. **Conclusions:** Our analysis indicates a connection between the severity of vertigo symptoms and the severity of OSA. Additionally, the significant correlation between psychiatric symptoms and OSA severity emphasises the need to consider these factors when managing OSA patients in everyday practice.

KEYWORDS

obstructive sleep apnoea, vertigo, vestibular disorders, depression, anxiety.

1 Introduction

Obstructive sleep apnoea (OSA) is the most common type of sleep-related breathing disorder, characterised by symptoms such as excessive daytime sleepiness and various comorbid conditions (Sansom et al., 2024). Vertigo is a common complaint that can greatly affect a person's daily functioning (van Leeuwen et al., 2024). Vertigo is a key symptom of vestibular dysfunction, indicating the need for further assessment. Vestibular symptoms can arise from various factors, including central and peripheral vestibular disorders. Some of the most significant conditions include benign paroxysmal positional vertigo (BPPV), Ménière's disease (MD), vestibular migraine, and posterior circulation ischaemia (Xing et al., 2024). The relationship between OSA and co-occurring vestibular symptoms is complex and requires careful consideration. First, it is important to note that the peripheral vestibular end-organ is particularly sensitive to changes in blood flow, as it relies on terminal arteries without a collateral circulation

system (Lazarini and Camargo, 2006). Additionally, hypoxia is known to reduce the activity of calcium-activated potassium channels, leading to abnormal spontaneous activity in the medial vestibular nuclei (Xie et al., 2015). A prior study identified a significant link between blood oxygen levels and the gain values of the anterior and posterior semicircular canals, further reinforcing these findings (Cengiz and Büyüklü, 2023). Furthermore, hypoxia, causing cerebrovascular disorders, can also impact the central vestibular system (Foster and Machala, 2020). Both OSA and vestibular disorders have been significantly correlated with psychiatric comorbidities (Gupta and Simpson, 2015; Lahmann et al., 2015).

Given the significant connections between OSA, vestibular disorders, and psychiatric symptoms, this study aimed to analyse how the severity of OSA impacts the degree of vertigo and mental symptoms in patients with suspected OSA experiencing vertigo. While some studies have explored the links between OSA and psychiatric symptoms, these connections have not been evaluated

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within the same population to our knowledge. Thus, our investigation focused on this aspect.

2 Material and Methods

2.1 Study sample

111 patients with OSA who reported experiencing vertigo (78 men and 33 women, $48.35 \text{ years} \pm 9.24 \text{ SD}$) were studied. All participants who exhibited snoring and were suspected of having OSA during the examinations were considered. All participants underwent overnight respiratory polygraphy, which was conducted as described below. Vestibular symptoms were also assessed during the initial evaluations. The exclusion criteria consisted of neurological and psychiatric issues, regular drug and alcohol use, history of otorhinolaryngological or oral surgeries, craniofacial deformities, soft tissue conditions, and endocrine disorders. Furthermore, potential causes of vertigo, including peripheral or central vestibular disorders, neurological diseases, previously diagnosed psychiatric disorders, internal medical issues, or viral infections, have been ruled out through thorough questioning and a detailed case history. Participants gave their written informed consent to participate in this investigation. The study was conducted according to the Declaration of Helsinki and received approval from the Hungarian ETT TUKEB (approval number: BM/29864-1/2024).

2.2 Sleep test

An overnight cardiorespiratory polygraphy examination was performed on each participant using the Resmed ApneaLink Air device. A sleep specialist conducted a manual analysis of the cardiorespiratory polygraphy results. The criteria for diagnosing OSA are based on the most recent guidelines (Berry et al., 2012). Apnoea is defined as a significant reduction in nasal airflow, of 90% or more, that lasts for at least 10 seconds, according to American Academy of Sleep Medicine (AASM) recommendations. In contrast, hypopnoea is defined by a reduction in airflow of 30% or more, along with either a drop in oxyhaemoglobin saturation of 3% or greater, or an arousal from sleep. OSA severity is assessed by the apnoea-hypopnoea index (AHI), representing the average number of apnoeas/hypopnoeas per hour of sleep. Patients were categorised based on their AHI values as follows: not having OSA (AHI under 5), mild OSA (5–15), moderate OSA (15–30) and severe OSA (AHI over 30) (Budhiraja et al., 2019).

2.3 Vestibular assessments

In each case, a thorough case history was taken, along with a detailed assessment of vestibular symptoms. An experienced examiner conducted a comprehensive physical examination of the vestibular system, following international guidelines (Eggers et al., 2019). During the examination, spontaneous and gaze-evoked nystagmus were assessed using Frenzel glasses. Additionally, provocative tests were performed, including the Halmágyi-Curthoys test, the Dix-Hallpike manoeuvre, and the supine-roll test. Statokinetic tests, such as the Romberg's test, modified Romberg's test, and Bárány test, were also carried out. All patients participated in the HINTS+ examination, which includes the head-impulse test, nystagmus evaluation, test for skew deviation, and hearing assessment. For more in-depth investigations related to vestibular symptoms, all patients underwent carotid and vertebral ultrasonography, as well as contrast-enhanced brain MRI scans. Using the latter examinations, cerebrovascular causes and vertigo related to carotid artery changes have been ruled out. Since alter-

ations in the cervical spine can also affect vertigo, MRI scans of the neck or neck X-rays were performed as needed. Patients with any significant alterations impacting their vertigo were excluded from the current investigation. Hearing tests, including pure-tone audiometry, were conducted as required. If an audiogram indicated potential inner ear disorders, those patients were not allowed to participate in the current investigation.

3 Self-reported Questionnaires

3.1 Dizziness Handicap Inventory (DHI)

The DHI is a tool for assessing the severity of vertigo, as well as their impact on patients' daily functioning (Formeister et al., 2020). It consists of 25 domains; answer 'yes' for 4 points, 'sometimes' for 2 points, and 'no' for 0 points. The categories of questions include 7 physical, 9 functional, and 9 emotional. Scores are categorised as normal (under 14 points), mild (16–34 points), moderate (36–52 points), and severe (over 54 points).

3.2 Beck Depression Inventory (BDI)

To assess depressive symptoms, an abbreviated 13-item version of the Beck Depression Inventory (BDI) was utilised. Patients can provide responses ranging from 0 ('not at all') to 3 ('very much'), with the highest possible total being 39. Depression can be categorised into four levels: normal outcomes (0–5), mild depression (6–11), moderate depression (12–15), and severe depression (over 16) (Datzler et al., 2024). All participants completed a Hungarian BDI version.

3.3 Symptom Checklist-90-Revised (SCL-90-R)

The Symptom Checklist-90-Revised (SCL-90-R) questionnaire evaluates various symptoms, including depression and anxiety, which are the focus of the current investigation. The questionnaire comprised 90 questions, with responses ranging from 0 ('not at all') to 4 ('extremely'). In this study, the results for depression (13 items) and anxiety symptoms (10 items) were analysed consistently (Prinz et al., 2013).

3.4 Statistical analysis

Data processing was carried out applying IBM SPSS version 25 (IBM Corporation, Armonk, NY, USA). The Shapiro-Wilk test assessed data normality, revealing a non-normal distribution. Continuous variables were reported using mean values and standard deviations (SD). To determine significant differences among the parameters, the Mann-Whitney U test and the Kruskal-Wallis test were used. Additionally, Spearman's correlation and simple linear correlation tests were applied to examine correlations. A logistic regression model was also utilised. The significance level was set at $p < 0.05$.

4 Results

Patients were categorised based on their AHI values as follows: not having OSA ($n = 28$, 25.2%), mild OSA ($n = 45$, 40.5%), moderate OSA ($n = 11$, 9.9%), and severe OSA ($n = 27$, 24.3%). The average duration since the first onset of symptoms was defined as 60.7 ± 46.5 months.

Initially, the relationships between the severity of OSA (AHI) and vertigo (DHI), were analysed. The results are depicted in Fig 1.

As Fig 1 depicts, no statistically significant differences were

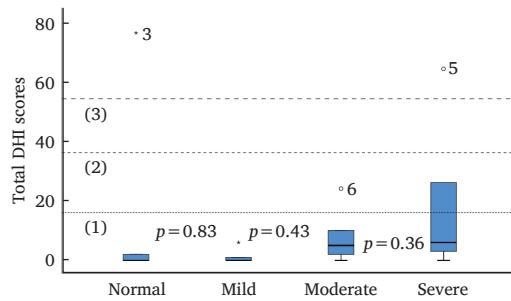


Figure 1 Boxplots displaying the total DHI scores based on the OSA severity levels mentioned earlier. The Mann-Whitney *U* test was used to determine if there were any statistical differences ($p < 0.05$). DHI = Dizziness Handicap Inventory, OSA = obstructive sleep apnoea. 1 = mild, 2 = moderate, and 3 = severe total DHI scores. The circles, asterisk, and numbers depict the outliers.

revealed in the total DHI values of the groups ($p = 0.35$, $H = 3.21$, Kruskal-Wallis test). However, the severe OSA group exhibited a trend towards higher DHI values, suggesting that individuals with more severe OSA experienced a greater impact of vertigo on their daily functioning.

In the next step, the potential differences regarding depression scores among OSA severity groups were analysed.

As Fig 2 presents, although the difference did not reach statistical significance ($p = 0.93$, Kruskal-Wallis test) in BDI scores among the OSA severity groups, a trend suggests higher depression scores in those with severe OSA. Individuals with more severe OSA symptoms are likely to experience depression.

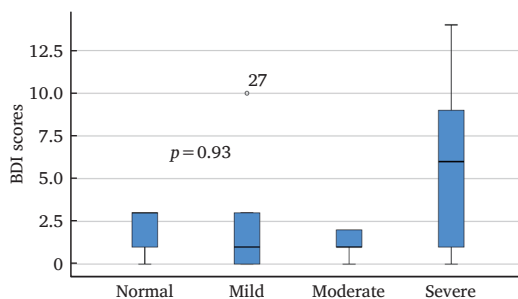


Figure 2 Comparison between BDI scores according to OSA severities (mild, moderate or severe). The Kruskal-Wallis test was used to determine if there were any statistical differences ($p < 0.05$). BDI = Beck Depression Inventory, OSA = obstructive sleep apnoea. The circle and number in the figure depict the outlier.

A logistic regression model was applied for further analysis of the correlations between OSA and vertigo, and the results are given in Table 1. This analysis included more factors, such as OSA severity and sex; however, only the significant results are presented.

Table 1 illustrates that among the parameters examined, two factors significantly predicted vertigo in patients with OSA. These factors are depression ($p = 0.010^*$; OR: 190.252, 95% CI = 3.587–10090.086) and the obese category based on BMIs ($p = 0.019^*$; OR: 141.068, 95% CI = 2.290–8688.383). This finding

indicates that OSA patients who experience depression and have higher BMI values are at an increased risk of developing vertigo. However, it is important to note that the high CIs and ORs may be influenced by the relatively small sample sizes; therefore, these findings should be interpreted cautiously.

Given the significant predictive value of depression, the relationships between vertigo, depression, and anxiety was further analysed, with results presented in Figs 3–4.

As can be observed from Fig 3, significant correlations were observed between the total DHI and BDI scores. By further analysing their relationships, Spearman's correlation test revealed a significant correlation both with BDI depression ($\rho = 0.332$, $p = 0.002^*$) and SCL-90-R depression ($\rho = 0.480$, $p = 0.000^*$) and the DHI scores. This indicates a higher risk of depression occurring in OSA patients with vertigo.

As Fig 4 illustrates, a significant relationship was noted between anxiety and vertigo in OSA as well. A significant correlation was observed when applying Spearman's correlation test ($\rho = 0.592$, $p = 0.000^*$). This indicates that patients with OSA who also experience vertigo are at a higher risk of developing anxiety. Additionally, when comparing the correlation coefficients for depression and vertigo, a stronger correlation was found, suggesting that anxiety has a greater impact on vertigo symptoms.

5 Discussion

The study's findings indicate a strong link between the severity of obstructive sleep apnoea and the intensity of vertigo symptoms as well as psychiatric symptoms, such as depression and anxiety. Specifically, we observed that as OSA severity increases, both vertigo severity, measured using the DHI, and depression scores, assessed with the BDI, tend to rise as well. Among these factors, the correlation between psychiatric symptoms and vertigo severity was strongest for anxiety. This finding should be considered in everyday clinical practice. Additionally, our logistic regression model revealed that the obese category of BMI and levels of depression significantly predicted the severity of vertigo symptoms associated with OSA. However, the extremely high ORs and wide CIs likely reflect the relatively small sample size and sparse data within some categories. Therefore, although depression and obesity were identified as significant predictors of vertigo in patients with OSA, these estimates should be interpreted with caution because the precision of the effect estimates is limited.

Recent studies have identified OSA as a risk factor for vertigo (Tsai et al., 2018), which can significantly affect an individual's mental health. In our sample population, we observed a noticeable trend showing a high vertigo incidence among OSA patients. Notably, those in the severe OSA group tended to have higher DHI scores, even if the differences were not statistically significant. This indicates that individuals with more severe OSA may experience a greater impact of vertigo on their daily functioning. The interplay between OSA and vertigo severity may stem from circulatory disruptions caused by apnoea episodes, potentially leading to vestibular dysfunction and vertigo. Additionally, a recent study has indicated that patients with vertigo are more likely to have a

Table 1 Logistic regression model to analyse the potential effects of various parameters on vertigo in patients with OSA. Note that only the significant results are presented ($p < 0.05^*$). BMI = body mass index, CI = confidence interval, OR = Odds ratio. The asterisk (*) denotes a statistically significant result.

Model	Dependent	β	Standard error	<i>p</i> -value	OR	95% CI	95% CI
Depression	Vertigo	5.248	2.026	0.010*	190.252	3.587	10090.086
BMI category (obese)		4.949	2.102	0.019*	141.068	2.290	8688.383

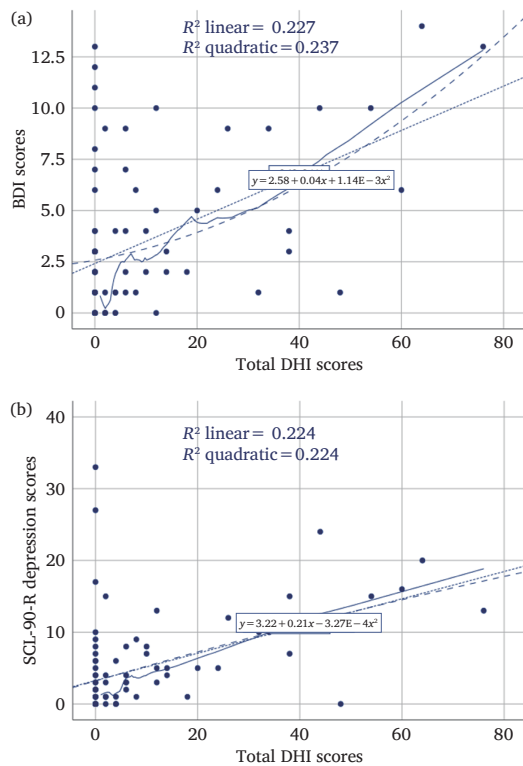


Figure 3 The relationships between total DHI scores and the BDI (a) and depression scores from the SCL-90-R (b). The figures display the R^2 -values for both the simple linear and quadratic regression analyses. BDI = Beck Depression Inventory, DHI = Dizziness Handicap Inventory, SCL-90-R = Symptom Checklist-90-Revised.

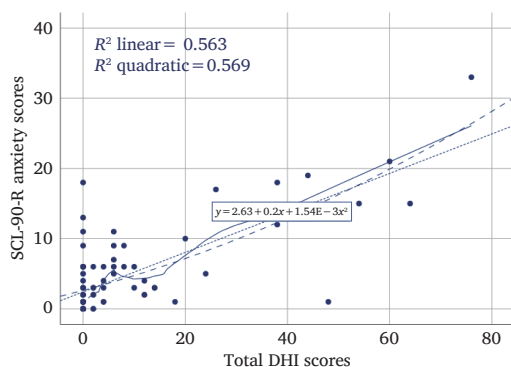


Figure 4 The relationships between total DHI scores and the anxiety scores from the SCL-90-R. The figures display the R^2 -values for both the simple linear and quadratic regression analyses. DHI = Dizziness Handicap Inventory, SCL-90-R = Symptom Checklist-90-Revised.

higher prevalence of OSA (Chen et al., 2024). BPPV, the most frequent peripheral vestibular disorder, shows a significant correlation with sleep disturbances, particularly in women (Iranfar and Azad, 2022). Moreover, a recent study has shown a significantly higher prevalence of poor sleep quality in the BPPV group compared to the control group (Bener et al., 2024). Recent research indicates that BPPV notably impacts sleep quality and mental health, significantly increasing the risk of falls (Cengiz et al., 2022).

Severe OSA leads to frequent sleep arousals, significantly disrupting sleep architecture and reducing the quality of restorative sleep. This fragmentation is a well-established contributor to mood disturbances and depression. Consistent with our findings,

higher scores on the DHI were significantly associated with increased anxiety and depression scores, indicating that psychiatric symptoms worsen the impact of vertigo. However, this was examined primarily in general vertigo populations and rarely in vertigo related to OSA. A previous study investigated the link between vestibular functions and obstructive sleep apnoea syndrome (OSAS). The study found that the BMI and the canal paresis (CP) parameter observed during caloric testing were significantly correlated. Additionally, abnormal CP ratios were significantly elevated in patients with OSAS than in controls. The study also revealed that the longest apnoea durations and the scores on the DHI were significantly correlated (Li et al., 2022). Factors contributing to this trend include hypoxia, fatigue, impaired functioning, psychological stress, systemic inflammation, and oxidative stress. Supporting this, Vanek et al. (2020) examined the correlation between OSA, depression, and cognitive impairment, highlighting a significant overlap between depression, anxiety, and OSA. The relationship between vertigo, depression, and anxiety is bidirectional and complex, involving shared neurological, psychological, and social factors. Our findings show that not only did the BDI scores indicate a significant correlation, but the SCL-90-R depression and anxiety scores did as well. This indicates a higher risk of depression and anxiety in patients with OSA experiencing vertigo. Gharsalli et al. (2011) investigated depression and anxiety prevalences in patients with OSA, reporting that 35%, and 43.8% of the examined patients experienced these conditions, respectively (Gharsalli et al., 2022). The co-occurrence of psychiatric symptoms is crucial; without proper management of these comorbidities, patients' primary symptoms—especially vertigo—can persist even with appropriate treatment for OSA.

Hobzova et al. (2017) emphasised the importance of assessing depression symptoms in patients with OSA. Conversely, psychiatrists should not only focus on treating depression but also screen for OSA in high-risk individuals, especially when evaluating patients with treatment-resistant depression. Additionally, chronic inflammation and obesity, which are both associated with OSA, may contribute to depressive symptoms. In our population, logistic regression analysis identified depression and obesity, as measured by BMI, as significant predictors of vertigo in OSA. Guglielmi et al. (2011) observed higher levels of depression and anxiety in individuals with OSAS compared to the control group. The variables that best predicted mood symptoms in these patients were BMI and total sleep time (Bardwell et al., 2011). Considering the complex nature of OSA, which includes sleep disturbances, vestibular dysfunction, and psychiatric symptoms, it is essential to involve various specialists to ensure comprehensive care. An integrated approach is therefore more effective for identifying and managing overlapping symptoms and comorbidities, ultimately leading to improved patient outcomes. For example, a previous study indicated that postural stability and dizziness-related issues in OSA enhanced after a 12-month continuous positive airway pressure (CPAP) therapy; however, vestibulo-ocular reflex (VOR) gains did not significantly change (Alessandrini et al., 2019). However, another investigation found higher rates of REM-related OSA and lower acceptance rates for CPAP (Chen et al., 2024). Therefore, identifying the most effective treatment options for OSA with vertigo is also challenging.

The study had a sample size of only 111 patients, which is relatively small and may limit the generalisability of the findings. For instance, there were only 11 cases in the moderate group of OSA severity, which may impact the reliability of the comparison between groups. Additionally, we could not include a group of

patients with OSA who did not also have vestibular symptoms. Additionally, using tools like the DHI, BDI, and SCL-90-R may introduce subjective bias, as responses depend on participants' self-perceptions and interpretations of the questions. Furthermore, objective vestibular testing was not conducted in the current study. However, it is essential to recognise that both polysomnography and objective vestibular tests are not always readily available in everyday practice. Therefore, utilising more accessible tools is essential. Although previous investigations did not find significant differences between cardiorespiratory polygraphy and polysomnography results; the reliance on polygraphy is a limitation, as it may lead to overestimating the AHI values. However, previous studies have shown that there are not significant differences between the results obtained from cardiorespiratory polygraphy and polysomnography. For example, in the study conducted by de la Luz Alonso Álvarez et al. (2008), significant correlations were found between the results of cardiorespiratory polygraphy and polysomnography. Another investigation also identified strong positive correlations between the two methods, indicating that cardiorespiratory polygraphy can effectively detect sleep-disordered breathing when polysomnography is not available (Nishida et al., 2013; Gursoy et al., 2021). Furthermore, previous research has indicated higher rates of certain vestibular disorders, such as BPPV (Byun et al., 2022) and MD (Nakayama et al., 2015), in relation to OSA. Therefore, it would be valuable for future research to analyse the correlations between specific vestibular diagnoses, rather than just focusing on general cases of vertigo. Despite these limitations, the findings of this study can significantly impact clinical practice, particularly in managing patients with OSA and associated conditions, such as vertigo and psychiatric symptoms. The study enhances screening and diagnosis processes and suggests the incorporation of psychological support or therapy, as depression and anxiety significantly predict the occurrence of vertigo in OSA patients. Moreover, considering the relationship between obesity (as indicated by BMI) and vertigo, emphasising lifestyle modifications could be beneficial for patients with OSA and related symptoms.

6 Conclusions

The study emphasises the relationship between OSA severity and the severity of vertigo symptoms and mental health issues, highlighting their combined impact on patients' quality of life and daily activities. Severe OSA was associated with a trend toward higher DHI scores, while depression and anxiety were significant predictors of vertigo. These findings highlight the importance of implementing a comprehensive strategy for diagnosing and managing OSA, vertigo, and associated psychiatric symptoms to enhance patient outcomes. Clinicians should routinely screen for vertigo and psychiatric symptoms in patients with OSA to identify those at greater risk and implement holistic treatment strategies. Additional research is necessary to confirm these findings and to create comprehensive management protocols involving multiple disciplines.

Data Availability Statement

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethical Approval

The investigation has been approved by the Hungarian ETT TUKEB, with approval number BM/29864-1/2024.

Informed Consent Statement

All participants gave their informed consent to participate in the study.

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