Effect of Vestibular Rehabilitation on Sleep Quality and Depression in the Elderly With Chronic Dizziness: A Prospective Study

Zahra Hosseini Dastgerdi, Nasrin Gohari, Mobina Mehrabifard, Hasti Seifi, and Bahare Khavarghazalani

1Department of Audiology, Isfahan University of Medical Sciences, Isfahan, Iran
2Department of Audiology, Hamadan University of Medical Sciences, Hamadan, Iran
3Hearing Disorders Research Center, Hamadan University of Medical Sciences, Hamadan, Iran
4Department of Audiology, Tehran University of Medical Sciences, Tehran, Iran

Background and Objectives: Dizziness and the accompanying complaints, including sleep disorders and depression, are common among the elderly. This study investigated the effect of vestibular rehabilitation on complaints of dizziness, sleep problems, and the severity of depression in older people with chronic dizziness. Subjects and Methods: The study included 25 participants with chronic dizziness accompanied by comorbid sleep disturbance (Pittsburgh Sleep Quality Index [PSQI] global score >5). Participants completed the Dizziness Handicap Inventory (three sub-scales: physical, emotional, and functional), the PSQI, and the Persian version of the shortened Beck Depression Inventory (BDI-13) before and after the vestibular rehabilitation. Results: The findings showed that the handicap caused by dizziness, the severity of depression, and the quality of sleep in the study participants improved significantly after the intervention (p<0.05). Conclusions: Vestibular rehabilitation is an effective intervention to reduce dizziness handicap, comorbid sleep disturbance, and depression.

Keywords: Dizziness; Sleep disorders; Dizziness Handicap Inventory; Vestibular; Depression.
ing in the elderly found a positive relationship between sleep disorders and the risk of dropping in the elderly over 75 years old [11].

Dizziness and sleep disorders are common complaints in the elderly, which increase anxiety and depression and decrease the quality of life. Accordingly, a question arises: Is vestibular rehabilitation effective for the disability caused by confusion disorder, sleep disorders, and depression in the elderly? Therefore, this prospective study aims to investigate the effect of the intervention based on vestibular rehabilitation on dizziness handicap, sleep disturbance, and severity of depression in a group of elderly with chronic dizziness.

**Subjects and Method**

**Participants**

In this study, men and women ≥60 years old who complained of dizziness and sleep disorders were selected through convenience sampling from the daycare centers for the elderly in Hamadan according to the inclusion criteria. During the last year, they had visited an otolaryngologist for treatment of dizziness and imbalance. Their cause of dizziness was based on the diagnosis of otorhinolaryngologist and information and clinical tests in the medical record (including neurological, audiometric, tympanometric, and acoustic reflex evaluations, videonystagmography test, orthopedic and vision evaluations).

The inclusion criteria for participants included: 1) people ≥60 years old; 2) complaining of dizziness, vertigo, and imbalance for at least 3 months [8]; 3) obtaining a score >5 in the PSQI questionnaire [8]; 4) absence of cognitive disorders and a score above 25 in the Mini-Mental State Examination test; 5) absence of severe vascular and respiratory problems, lack of cervical, neurological, and orthopedic disorders, and independence from a wheelchair [12,13]; 6) independence in performing daily activities [12]; 7) no history of receiving vestibular rehabilitation exercises; and 8) willingness to do a vestibular rehabilitation program.

**Evaluations**

**Persian version of the Dizziness Handicap Inventory**

The Persian version of the Dizziness Handicap Inventory (DHI) questionnaire are useful for investigating the consequences of vestibular and balance disorders. The overall score is graded from 0 (no disability) to 100 (severe disability) and includes 3 subscales: physical (DHI-P), emotional (DHI-E), and functional (DHI-F). In the Persian version, a cut-off point of 10 can distinguish ordinary people from people with vertigo disabilities (sensitivity and specificity=100%) [14].

**Persian version of Pittsburgh Sleep Quality Index**

The Persian version of the Pittsburgh Sleep Quality Index (PSQI) is a self-assessed version for evaluating sleep disorders and quality in the past month. It consists of 18 questions includes various factors, including subjective sleep quality, sleep latency, duration and disturbances, habitual sleep efficiency, and the use of sleeping medication examines daytime dysfunction. A score higher than 5 on the whole questionnaire means poor sleep quality [15].

**Persian version of shortened Beck Depression Inventory**

The Persian version of shortened Beck Depression Inventory (BDI-13) was developed to facilitate rapid implementation in clinical and research settings. This inventory includes 13 self-report statements that express the specific symptoms of depression. It was compiled through the study of the original 21 items developed by Beck, et al. [16] in 1961. Beck, et al. [17] reported the correlation between the 21-item form and the 13-item short form from 0.89 to 0.97 and introduced the short form as an acceptable substitute for the long form. In Iranian cases, Cronbach's alpha ranged from 0.89 to 0.94 [18].

The inventory scores were classified as typical cases (0–3), mild depression (4–7), mild-to-moderate depression (8–11), moderate depression (12–15), and severe depression (16–39) [18].

**Vestibular rehabilitation**

The DHI, PSQI, and BDI-13 questionnaires were completed with the help and guidance of the project manager and colleagues before starting vestibular rehabilitation. After that, a group of older adults with the inclusion criteria underwent conventional vestibular rehabilitation voluntarily, according to the Cawthorne and Cooksey protocol (Supplementary Materials in the online-only Data Supplement). An audiologist with sufficient experience in providing vestibular rehabilitation (an author of this study) carried out this intervention twice a week, each session lasting 50 minutes for 2 months at the rehabilitation center for the elderly [13,19]. Information related to DHI, PSQI, and BDI-13 questionnaires were compared and analyzed before and after rehabilitation.

**Data analysis**

Data were analyzed using the SPSS statistical package, version 23 (IBM Corp., Armonk, NY, USA). Descriptive statistics revealed that some data were normally distributed and appropriate for parametric analysis methods. For data that did not have normal distribution, nonparametric analysis is used. To test changes in DHI and its component, PSQI and BDI-13 scores before and after the vestibular rehabilitation,
the pair t-test and Wilcoxon signed-rank test were performed. A significance level of 0.05 was considered for all the analyses. This study was approved by Hamadan University of Medical Sciences with ethics code: IR.UMSHA.REC.1400.888, and informed consent forms were obtained from all participants.

Results

The present study investigated 25 participants with an average age of 67.5±7.8 years. Among participants, 11 (52.4%) were women with an average age of 66.0±6.1 years, and 10 (47.6%) were men with an average age of 69.2±9.7 years. Complaining of dizziness, vertigo, and imbalance was between 6–24 months among the participants. During the evaluation and rehabilitation period, there was no change in the treatment pattern and the amount of drug consumption of the study subjects.

The cause of dizziness, according to tests and otorhinolaryngologist diagnosis was as follows: among 25 participants, 3 had a unilateral vestibular disorder, 11 had benign paroxysmal positional vertigo (BPPV), and 2 had vestibular migraine. In 9 participants, dizziness was caused by presbystasis because no specific cause was identified after multiple evaluations. According to the obtained results, the total score of the DHI questionnaire (DHI-T) showed improvement in participants after vestibular rehabilitation. Only the DHI-T scores and its subtypes worsened in 4 persons after rehabilitation. According to the statistical analysis results, the average scores of DHI-T (p<0.001) and its subcomponents (DHI-F and DHI-E: p<0.001; DHI-P: p=0.002), PSQI (p=0.002), and BDI-13 (p=0.006) decreased significantly after the intervention, generally indicating that dizziness handicaps, the severity of depression, and the quality of sleep in the participants improved significantly after the intervention. The changes in the average scores of the DHI-T, total score of PSQI, and BDI-13 questionnaires before and after the intervention are illustrated in Fig. 1.

Discussion

In the present study, handicaps caused by dizziness, complaints of sleep problems, and severity of depression in the elderly with chronic dizziness improved to some extent after receiving vestibular rehabilitation therapy (VRT), but complete improvement was not occurred for anyone. In only 4 of the participants, the DHI scores had worsened. In this group, sleep scores were unchanged or improved by 1 point.

The impact of vestibular rehabilitation on DHI score and sleep quality was highest and lowest, respectively. Although the improvement of depression severity was statistically significant, the average of depression scores after rehabilitation were still in the range of severe depression. This study, like other studies, shows that VRT has a positive effect on the symptoms of vestibular disorders, disability, and functional limitation caused by these disorders [13,20,21]. Studies on the impact of vestibular rehabilitation on sleep disorders are limited, and no study was available in this field that was conducted only in the elderly population. Sugaya, et al. [8] investigated the relationship between improvements in dizziness symptoms and sleep disturbances after vestibular rehabilitation in patients with chronic dizziness. The results revealed that dizziness handicaps, sleep, and anxiety problems of patients with chronic dizziness significantly improved after rehabilitation. Besides, they found that individuals who continued to have sleep disturbance had greater dizziness handicaps and anxiety compared with those without sleep disturbance. They proposed that improving sleep, emotional stress, and quality of life improved dizziness handicaps after receiving VRT in patients with chronic dizziness and sleep disorders [8].

Since studies have emphasized the relationship between dizziness, vestibular, sleep, and mood disorders, including anxiety and depression, the relative improvement of sleep quality and depression following vestibular intervention is expected. Various mechanisms can explain the association between vestibular and sleep problems. The vestibular system is a sensor of the position of the head in the gravitational field, which may provide vital signs for starting and maintaining sleep [22]. Vestibular sensory inputs, primarily otolithic receptors, directly affect the suprachiasmatic nuclei. The suprachiasmatic nucleus is a structure in the hypothalamus’s anterior region responsible for regulating the body’s circadian rhythms [22-24]. The results of animal studies showed that the vestibular sys-
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The correlation between psychological problems such as depression and anxiety with reduced sleep quality [26] and vestibular disorders (Meniere’s, vestibular migraine, and BPPV) [27] has been confirmed in young to elderly age groups. Older people with chronic dizziness experience various psychological problems such as panic, anxiety, and depression more than other young people and adults due to the personal and social limitations caused by dizziness and other vestibular disorder symptoms and the inability to compensate for the limitations [27]. Additionally, sleep disturbance is a predictor of depression in the elderly with dizziness, possibly because sleep problems and reduced sleep quality interfere with the quality of life, reducing the capacity of older adults to concentrate, pay attention, and remember things [28]. Studies have pointed out the effect of vestibular stimulation and vestibular rehabilitation in reducing the severity of depression [29,30]. Notably, depression in the elderly with dizziness is influenced by several factors, which require comprehensive medical treatment covering predisposing factors, including vestibular disorders, sleep disorders, hearing loss, vision problems, and the use of medications for modulating the brain biochemistry, economic and cultural conditions and likewise [4,27].

In the present study, the maximum rate of improvement in DHI and its components was observed. VRT is an exercise-based approach that maximizes central nervous system compensation in vestibular pathology [6]. VRT accelerates and improves central compensation through mechanisms of habituation, which enhances the adaptation of vestibulo-ocular and vestibular-spatial reflexes and substitution. This therapy method has been effective in treating the elderly, improving their quality of life, and reducing their anxiety level [6]. Vestibular disorders caused dizziness in most of the participants of this study. Meanwhile, presbystasis was diagnosed in 5 people because no specific cause for dizziness was found. Presbystasis means multisensory involvement with various pathologies in vestibular, proprioceptive, and visual organs. The more organs are involved and the disorder aggravated, the more the central compensation ability decreases [31]. In addition to dizziness, the elderly in the present study had some degree of depression and sleep disorders, which can reduce the effectiveness of interventions and treatment. Therefore, one of the reasons for the incomplete recovery of dizziness handicaps in some patients can be multiple disorders in the sensory organs and associated problems, including depression and sleep disorders. Notably, the participants in this study did not receive another special treatment for sleep problems and depression. Undoubtedly, the effect of rehabilitation to improve dizziness and vestibular disorders is maximized by enhancing and providing appropriate treatment for psychological problems and accompanying sleep disorders.

Limitation
One of the limitations of this study was the lack of assessment of the causes of sleep disorders and depression. Due to the coronavirus disease (COVID-19) restrictions and evaluation in the high-risk group, studying a larger population was impossible. In this study, no control group was used to investigate the effect of vestibular rehabilitation. This study needs to be conducted using a control group, a larger statistical population, and a detailed investigation of the cause of sleep and psychological disorders to determine the exact mechanism of the effect of vestibular rehabilitation on sleep and psychological disorders. Furthermore, the effect of vestibular rehabilitation on dizziness, sleep, and psychological disorders should be investigated using precise laboratory tools, objective indicators of sleep disorders, and vestibular tests.

Conclusion
This prospective study revealed that after vestibular rehabilitation, the dizziness handicaps, sleep quality, and depression improved significantly. In this study, the exact causes of sleep disorders and depression were not determined. Due to their improvement after vestibular rehabilitation, these disorders may be the consequences of vestibular disease in some patients. Thus, investigating comorbid complaints associated with vestibular disorders such as sleep disturbance and depression is vital in the elderly. Therefore, vestibular rehabilitation can be an essential treatment to reduce sleep and psychological disorders. This study needs to be conducted on a larger group and by examining the causes of sleep and psychological disorders to clarify the exact mechanism of this type of rehabilitation.

Supplementary Materials
The online-only Data Supplement is available with this article at https://doi.org/10.7874/jao.2023.00171.

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