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Can Different Underlying Pathophysiology of Hearing Loss Impact the Effects of Hearing Aids on Decreasing Tinnitus Annoyance and Improving Sleep Quality in Tinnitus Sufferers?

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ABSTRACT

Background: Tinnitus is a common and often distressing symptom, affecting up to 80% of individuals with hearing loss. It can significantly impair emotional well-being, sleep quality, and overall quality of life. This study aimed to assess the effectiveness of hearing aids in reducing tinnitus annoyance and improving sleep among patients with noise-induced hearing loss (NIHL) and presbycusis. Given the different underlying pathophysiology in these conditions, their responses to amplification may differ.

Methods: Seventy adults participated, including 35 patients aged 20-40 years with NIHL and 35 aged 50-65 years with presbycusis. Participants completed the Tinnitus Functional Index (TFI) and Insomnia Severity Index (ISI) questionnaires before and 6 months after consistent hearing aid use. Outcomes were compared between the 2 groups.

Results: Significant improvements in overall TFI scores and most subscales were observed in both groups after hearing aid use. Participants with NIHL initially reported more severe tinnitus than those with presbycusis (53.77 and 48.16, respectively); however, the post-intervention results were nearly identical in both groups (30.56 in NIHL group and 30.05 in presbycusis group), which indicates a higher degree of improvement in the NIHL group with *P* values smaller than .001 when comparing pre- and post-intervention scores. The ISI scores also decreased in both groups, reflecting improved sleep, though changes were less marked than those seen in tinnitus severity.

Conclusion: Hearing aids can effectively reduce tinnitus-related distress and improve sleep in individuals with different types of hearing loss. While both groups benefited, those with presbycusis reported milder symptoms overall, possibly due to greater adaptation to chronic hearing changes.

Keywords: Hearing aids, noise-induced hearing loss, presbycusis, tinnitus

Introduction

Tinnitus is a prevalent condition in which individuals perceive sound without any external auditory source. It frequently co-occurs with hearing loss, with research indicating that approximately 90% of individuals experiencing tinnitus also have varying degrees of hearing impairment.[1] While definitive treatment for tinnitus remains elusive, several management and rehabilitation techniques have been developed to mitigate its effects, including counseling and sound therapy.[2-4] Sound therapy involves exposure to various sounds such as music, white noise, or environmental sounds, which may help reduce the perception of tinnitus by either masking it or fostering habituation.[2] One of the common methods of sound therapy for individuals with hearing loss is through the use of hearing aids.[5,6]

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Hearing aids have been shown to be an effective approach for alleviating bothersome tinnitus in patients with hearing impairment, and their efficacy has been assessed using various questionnaires, including the Tinnitus Handicap Inventory, Tinnitus Functional Index (TFI), and Tinnitus Reaction Questionnaire.[7-9]

Tinnitus can also adversely affect sleep quality, with sufferers reporting difficulties with both sleep onset and duration, which in turn diminishes their overall quality of life and disrupts daily activities. External sounds such as white noise or nature sounds have been reported to alleviate tinnitus annoyance, particularly during sleep.[10,11]

Why Hearing Aids Help with Tinnitus?

There are 2 primary neurophysiological explanations for the efficacy of hearing aids in managing bothersome tinnitus. First, hearing aids amplify ambient environmental sounds, which can diminish the perceived loudness of tinnitus by partially or fully masking it.[12] This reduction in tinnitus prominence allows the individual to shift their attention from the tinnitus to external sounds, facilitating the habituation process and gradually decreasing the loudness and annoyance of the condition.[13]

The second rationale pertains to the coexistence of bothersome tinnitus with hearing loss. The 2 most common causes of hearing loss are noise exposure and age-related degeneration (presbycusis), both of which typically result in high-frequency hearing loss. From a neurological standpoint, the sensory deprivation caused by hearing loss can lead to permanent alterations in auditory neural pathways.[14,15] Studies have suggested that these adverse changes may be reversible when the individual is exposed to appropriate auditory stimuli.[16,17] In cases of high-frequency hearing loss, the absence of these frequencies may trigger the perception of subjective tinnitus. By amplifying these lost sounds through hearing aids, the function of auditory neural pathways is gradually restored, potentially reducing tinnitus severity.[16]

As mentioned, there are 2 common etiologies of high-frequency hearing loss: noise-induced hearing loss (NIHL) and presbycusis or age-related hearing loss.[18] These conditions differ in their pathophysiological impact on cochlear structures and neural pathways. Presbycusis, a degenerative condition, leads to anatomical and physiological changes in the auditory system, including the cochlea and the vestibulocochlear nerve.[19] In contrast, NIHL is primarily caused by damage to the cochlear hair cells due to prolonged exposure to loud sounds, such as industrial noise or loud music, leading to high-frequency hearing loss.[19,20]

Given the distinct pathophysiology of these 2 types of hearing loss, the involved neural network, the neural plasticity changes and response to different tinnitus management strategies, particularly those involving hearing aids, may vary. This study aimed to compare the effects of hearing aids on bothersome tinnitus in individuals with presbycusis and NIHL. Additionally, the impact of hearing aids on sleep quality was explored in both groups, assessing improvements in sleep and overall quality of life.

MAIN POINTS

- *Hearing aids significantly reduced tinnitus distress in both noise-induced hearing loss (NIHL) and presbycusis groups, as measured by the Tinnitus Functional Index (TFI).*
- *Clinically meaningful (>20%) improvement in TFI scores was observed in 79.41% of NIHL patients and 54.29% of presbycusis patients.*
- *Sleep quality improved in both groups after hearing aid use, as indicated by decreased Insomnia Severity Index scores.*
- *A strong correlation was found between reduced tinnitus distress and improved sleep quality in both groups.*
- *Despite differing pathophysiology, both hearing loss types responded positively to hearing aid intervention, supporting neural plasticity-based rehabilitation.*

Material and Methods

After receiving the appropriate approvals from the cooperative center and the research ethics code from University of Social Welfare and Rehabilitation Sciences, on May 29, 2024 with the following ID: IR.USWR.REC.1403.051, data from 70 individuals with bothersome tinnitus attending the Tinnitus Clinic at Tinnitus Clinic reviewed and analyzed in this prospective cohort study. All participants agreed to take part in the study by filling out an informed written consent. In this study, the minimum required sample size was calculated using a sample size formula for comparing 2 means[21] and based on data from a similar study,[22] resulting in 33 participants per group with a power of 0.84. Therefore, accounting for potential dropouts during follow-up, 35 participants were included in each group, for a total of 70 participants in the study.

All participants reported bilateral non-pulsatile tinnitus. The first group consisted of 35 patients, aged 20-40, who had a history of noise exposure and presented with bilateral mild-moderate high-frequency hearing loss. This group was classified as the NIHL group. The second group included 35 patients aged 50-65, with the same type and degree of hearing loss, identified as the presbycusis group.[23] The onset age of presbycusis was considered at 50 years old[24] and the age range included the age of up to 65 years old to decrease the possibility of cognitive decline impacting the results.[25] Audiometry was performed with an Affinity PC-based audiometer, Interacoustics, Denmark. Although cognitive decline can be evident from 45-49 years old,[26] the selected age range for this group aimed to minimize the potential influence of age-related cognitive decline on the study outcomes. None of the individuals had a history of otological issues or cognitive impairment and were all first-time hearing aid users. Tympanometry was performed on all participants to confirm normal middle ear function (Titan tympanometer, Interacoustics, Denmark). Tinnitus mapping was not performed in this study, consistent with BSA guidelines,[27] though this omission represents a limitation as mapping could have provided more detailed characterization of tinnitus profiles. None of the subjects were taking any kind of medications for sleep. All 70 participants reported chronic tinnitus for at least a year.

All subjects were fitted with bilateral open-fit Oticon Engage hearing aids, with fittings verified using Real Ear Measurements using NAL-NL2 prescription formula.[28] Tinnitus programs such as noise-generator programs on the hearing aids were disabled. Individualized adjustments were performed in the fitting appointment to accommodate personal preferences and to provide better sound quality. Participants completed the TFI questionnaire and the Insomnia Severity Index (ISI) before receiving their hearing aids and used the devices consistently for 6 months. Data logging was used to monitor

the consistent use of hearing aids, with a minimum of 6 hours of daily use. After this period, both questionnaires were re-administered, and the results were compared. No randomization or blinding procedures were applied in this study; outcome assessments were based solely on participant-reported questionnaires.

Tinnitus Functional Index

The TFI is a highly validated self-report questionnaire designed to assess both the severity and the negative impact of bothersome tinnitus.[29] It is widely used for evaluating the efficacy of tinnitus treatments. The TFI covers 8 subscales, each reflecting an area potentially affected by tinnitus: intrusive, sense of control, cognitive, sleep, auditory, relaxation, quality of life, and emotional. The questionnaire contains 25 items, and results are expressed as percentages. A score of 0%-17% indicates that tinnitus is not a problem, 18%-31% reflects a small problem, 32%-53% indicates a moderate problem, 54%-72% signifies a significant problem, and 73%-100% suggests a very severe problem.[30] A 20% improvement in the total score is considered clinically significant, indicating a meaningful reduction in tinnitus annoyance.[29]

Insomnia Severity Index

The ISI is a brief screening tool used to assess the severity of insomnia.[31] Taking approximately 5 minutes to complete, it comprises 7 questions focused on the individual's symptoms, satisfaction with sleep patterns, the interference of insomnia with daily functioning, the visibility of insomnia to others, and the overall distress caused by sleep difficulties. While multiple cutoff scores have been reported in the literature, a cutoff score of 11 was used in this study to indicate significant sleep difficulties.[31,32]

Results

Data was extracted from 70 individuals, 35 of these individuals were in the NIHL group and 35 in the age-related hearing loss (presbycusis) group. Across the total sample, the mean age was 42.71 years, and the age range was from 20 to 65 years. The participants' gender was equally distributed (50% female and 50% male). In the NIHL group, the mean age was 32.85 years, and the age range was 20 to 40 years, with 55% female and 45% male participants. In the presbycusis group, the mean age was 57.86 years, and the age range was 50 to 65 years, with 54.3% female and 45.7% male participants. This information indicates that, from a descriptive statistics standpoint, there was no significant gender difference between the NIHL and presbycusis groups.

In all studied individuals, frequency thresholds from 250 Hz to 2000 Hz in both ears were within the normal range (less than 20 dB HL). Frequencies from 3 kHz to 8 kHz were examined in both groups, and the average hearing thresholds at these frequencies were also measured. The mean pure tone averages (PTA) at these frequencies were 43.65 ± 9.65 dB in the NIHL group and 51.67 ± 9.81 dB in the presbycusis group. In the NIHL group, the mean thresholds at 8, 6, 4, and 3 kHz were 37.65, 49.56, 48.89, and 38.50 dB, respectively. In the presbycusis group, these thresholds were 58.32, 58.11, 49.91, and 40.34 dB, respectively. There was no statistically significant difference in the thresholds between the 2 groups at any frequency, with *P*-values greater than .05 (Figures 1 and 2). The mean PTA thresholds for the right and left ears are presented separately to facilitate visual interpretation; however, no significant asymmetries in hearing levels were observed in either group.

The data collected from the TFI questionnaire, used to assess the severity of tinnitus before and after intervention for both groups, is presented in Table 1. In the NIHL group, the pre-intervention mean TFI score was 53.77, indicating moderate (nearly significant) tinnitus symptoms. After the intervention, the mean TFI score decreased to 30.56, which corresponds to a mild problem, demonstrating a significant improvement in the score. Further analysis showed that 79.41% of participants in the NIHL group had more than a 20% improvement in their TFI scores. Details of the statistical analysis of both groups are presented in Tables 2 and 3.

In the presbycusis group, the pre-intervention mean TFI score was 48.16, indicating significant tinnitus symptoms. After the intervention, the mean TFI score decreased to 30.05, showing improvement

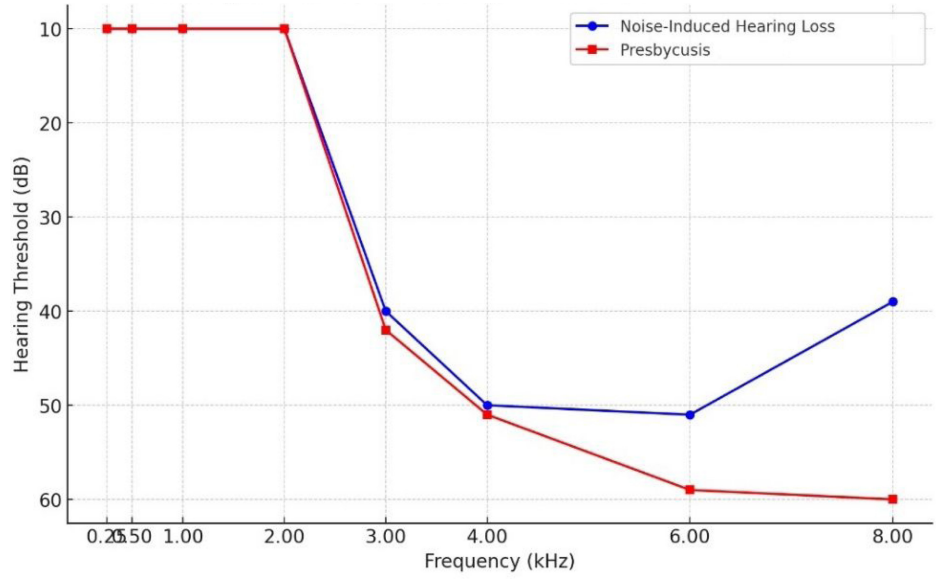

Figure 1. Line art indicating mean PTA for noise-induced and presbycusis group in the right ear.

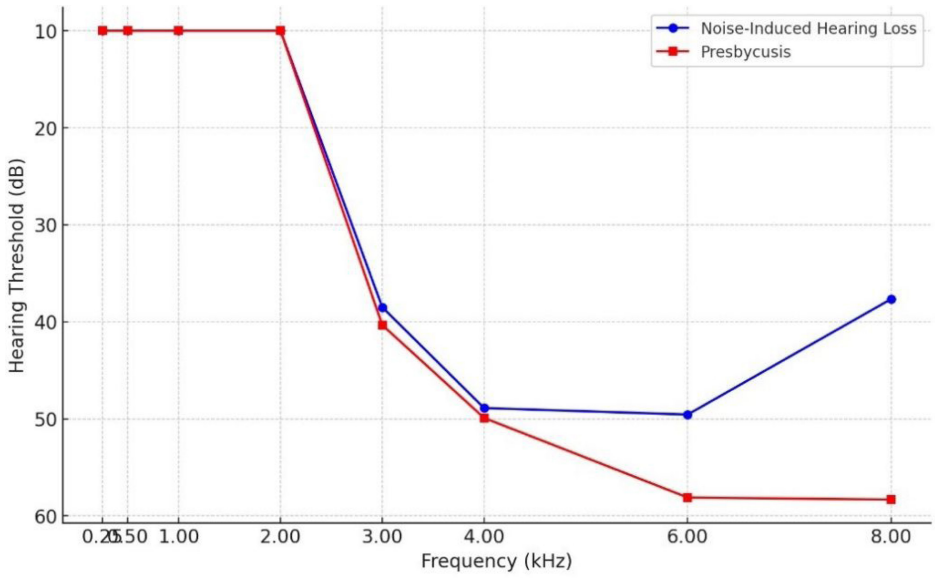

Figure 2. Line art indicating mean PTA for noise-induced and presbycusis group in the left ear.

in the score. A total of 54.29% of participants in this group had more than a 20% improvement in their TFI scores.

The results of TFI subscale scores for the 2 groups—NIHL and presbycusis—are presented in Table 4. Accordingly, paired-samples *t*-tests were employed for the statistical inferences. For each variable, the mean and standard deviation are provided for both the pre- and post-intervention phases. In the NIHL group, the mean of most components decreased after the intervention, indicating that the intervention had a positive impact on improving the performance of these variables. A similar trend is observed in the age-related hearing loss group, where the mean of most variables also decreased after the intervention. These results suggest that the intervention had a positive effect on improving the performance of these variables in this group as well. As indicated, there is no significant difference in the mean scores of variables between the NIHL group and the age-related hearing loss group. This lack of significant difference was consistent both before and after hearing aid prescription. Furthermore, concurrent with the TFI score improvement, there was also an enhancement in sleep quality scores.

Analysis of the ISI-total variable, used to assess sleep quality among participants with NIHL and age-related hearing loss before and after intervention, is presented in Table 5. In the NIHL group, the pre-intervention mean score for this variable was 11.82, which decreased to 5.60 after the intervention. Similarly, in the presbycusis group, the pre-intervention mean score was 9.28, which decreased to 5.20 after the intervention. This data indicates that the intervention led to a reduction in ISI-total scores in both groups.

In both groups, this positive correlation suggests that improvements in tinnitus distress are associated with improvements in sleep quality (Table 6). These findings indicate that hearing aid prescriptions can have a positive impact on both tinnitus distress and sleep quality despite the different pathophysiology of tinnitus in NIHL or age-related hearing loss (presbycusis).

Table 1. Comparison of Overall TFI Scores in Presbycusis and Noise-Induced Hearing Loss Group Before and After Fitting Hearing Aids

		Presbycusis		Noise-Induced Hearing Loss	
Variable	**Intervention**	**Mean**	**SD**	**Mean**	**SD**
TFI score	Before	48.16	17.78	53.77	17.02
	After	30.05	17.28	30.56	17.39
Frequency of individuals with 20% or more in improvement		54.29		79.41	

TFI, Tinnitus Functional Index.

Discussion

Comparison of Tinnitus Functional Index Scores Before and After Hearing Aid Use in the Noise-Induced Hearing Loss and Presbycusis Group

The average overall TFI score before and after the intervention was 53.77% and 30.50%, respectively, indicating a reduction in tinnitus distress from severe to mild. On average, the tinnitus distress in this group showed a notable improvement. The score differences in all subgroups were statistically significant, with the greatest improvement observed in the "relaxation" subgroup.

This reduction in tinnitus distress following hearing aid prescription appears to align with neural compensation pathways theories.

Table 2. Comparison of Mean Tinnitus Distress Scores Before and After Hearing Aid Fitting (Noise-Induced Hearing Loss Group)

Variable	Mean Difference (Pre–Post)	Standard Deviation	Lower 95% CI	Upper 95% CI	Paired *t*-value	*df*	*P*
Tinnitus distress	23.21	17.04	17.35	29.06	8.05	34	<.001

df, degrees of freedom.

Table 3. Comparison of Mean Tinnitus Distress Scores Before and After Hearing Aid Fitting (Age-Related Hearing Loss Group)

Variable	Mean Difference (Pre–Post)	Standard Deviation	Lower 95% CI	Upper 95% CI	Paired *t*-value	*df*	*P*
Tinnitus distress	18.10	12.14	11.24	24.45	5.79	34	<.001

High-frequency hearing loss, which may lead to tinnitus through neuroplastic changes, can be compensated for by auditory stimulation. Therefore, hearing aids, by stimulating neural plasticity in the brain, partially restore the function of auditory pathways and manage the potential cause of tinnitus.

These results are consistent with findings from studies by Noreña and Eggermont,[15] Noguchi et al,[9] and Gabriel et al,[17] all of which reported improvements in quality of life and reductions in tinnitus distress following continuous hearing aid use. Although 1 study did not define the effects of hearing aids on tinnitus as positive, it is likely that the use of analog hearing aids at the time (1987) influenced the study's outcomes.[33]

Similar to the first group, the presbycusis group also demonstrated significant clinical improvement, with scores decreasing from moderate to mild tinnitus distress (48.16%-30.05%), and participants reported less distress after the intervention. Statistically significant improvements were observed in the subscales of cognition, sleep, auditory performance, and emotions, although overall improvement was seen across all subscales.

Table 4. Comparison of Subscales of TFI Questionnaire in Both Groups Before and After Fitting of Hearing Aids

		Presbycusis		Noise-Induced Hearing Loss	
Subscale	**Intervention**	**Mean**	**SD**	**Mean**	**SD**
Intrusive	Before	61.81	18.84	65.52	17.60
	After	47.90	20.82	44.19	21.76
Sense of control	Before	57.05	18.34	66.10	18.36
	After	35.52	23.37	40.67	22.68
Cognitive	Before	45.14	23.00	53.62	21.70
	After	26.95	24.10	29.14	20.88
Sleep	Before	50.00	31.24	45.62	35.29
	After	30.00	26.20	28.95	31.12
Auditory	Before	41.05	32.52	48.95	25.36
	After	27.71	25.38	23.33	22.08
Relaxation	Before	58.86	23.85	65.71	26.04
	After	35.71	24.79	35.81	25.60
Quality of life	Before	41.71	29.66	54.57	28.37
	After	19.81	24.33	27.90	23.87
Emotional	Before	45.71	26.97	48.00	22.77
	After	26.86	20.47	24.67	20.18

Table 5. Comparison of Overall ISI Scores in Presbycusis and Noise-Induced Hearing Loss Group Before and After Fitting Hearing Aids

		Presbycusis		Noise-Induced Hearing Loss	
Variable	**Intervention**	**Mean**	**SD**	**Mean**	**SD**
ISI score	Before	9.28	6.85	11.82	9.73
	After	5.20	5.29	5.60	6.97

ISI, Insomnia Severity Index.

The effects of neural compensation due to hearing aid use in this group, similar to those with NIHL, may have contributed to the reduction in tinnitus distress. Another reason for the positive effect of hearing aids on tinnitus distress could be the masking effect. Hearing aids, by amplifying background sounds, can reduce the perceived loudness of tinnitus. Thus, hearing aids may act as a form of sound therapy, gradually habituating the brain to tinnitus and reducing its interference and distress. This hypothesis could also apply to the NIHL group.

The findings of this study align with studies by Sweetow and Sabes (2010),[34] Stacey (1980),[35] and Melin et al (1987),[33] all of which confirm the positive impact of hearing aids on tinnitus distress.

Comparison of Tinnitus Functional Index Scores in the Noise-Induced Hearing Loss and Presbycusis Groups

The scores in both groups showed significant improvement after the intervention. Before the intervention, the NIHL group experienced severe tinnitus distress, while the presbycusis group experienced moderate distress. However, post-intervention scores were nearly identical in both groups.

Despite the differing pathophysiology, hearing aids had a positive effect on tinnitus annoyance. Since the site of damage in both groups involves hair cells, hearing aids, by compensating for sensory deprivation, positively influence tinnitus perception, quality of life, and overall tinnitus distress. However, the average scores in the NIHL group were worse than in the presbycusis group, possibly because the gradual onset of hearing loss and tinnitus in the presbycusis group helps individuals adapt to their symptoms and report less distress.

Pre-intervention TFI results are consistent with Kang et al's study (2021),[36] which analyzed tinnitus in individuals with NIHL and presbycusis. In individuals with presbycusis, the damage to outer hair cells and the perceived loudness of tinnitus were reported to be lower than in the other group, supporting the findings of this study.

Comparison of Insomnia Severity Index Scores Before and After Hearing Aid Use in the Noise-Induced Hearing Loss and Presbycusis Group

The ISI scores in this group decreased from 11.82 (indicative of sleep disturbance) to 5.60. Although the reduction did not meet the threshold for confirming significant clinical improvement (7 points), it still indicates an improvement in sleep quality for the participants.

Hearing loss, regardless of age, can affect cognitive function, which in turn can directly impact sleep quality and vice versa. Additionally, sleep quality and duration are often reduced in individuals with tinnitus. Therefore, it seems that the neural changes and improved cognitive function following hearing aid use directly impacted sleep quality, leading to its improvement. Although individuals do not wear hearing aids while sleeping, long-term changes in auditory pathways and cognitive performance could contribute to this improvement.

In presbycusis group, the ISI score decreased from 9.28 to 5.20. Although the pre-intervention ISI score did not indicate clinical sleep

Table 6. Correlation Between Improved ISI and Improved TFI Scores After Hearing Aid Fitting by Hearing Loss Group

Group	Correlation Coefficient	Lower Confidence Limit	Upper Confidence Limit	R-squared	*P*
Noise induced	0.57	0.39	0.71	0.33	.0001
Age related	0.58	0.31	0.76	0.34	.0002

ISI, Insomnia Severity Index; TFI, Tinnitus Functional Index.

disturbance, an improvement in mean scores was still observed in this group.

Since the participants in this group were aged 50-65, their cognitive functions may not have been as affected by age. However, different stress levels and coping mechanisms in this age group may have contributed to better adaptation to tinnitus and its impact on sleep.[37] The difference between the 2 groups in terms of sleep quality was not significant.

Comparison of Insomnia Severity Index Scores in the Noise-Induced Hearing Loss and Presbycusis Groups

Similar to the TFI questionnaire, improvement in sleep quality was observed in both groups in the ISI questionnaire. Pre-intervention ISI scores were worse in the NIHL group than in the presbycusis group.

As with the TFI scores, the adaptation process in individuals with presbycusis seems to contribute to better sleep quality. Additionally, as previously mentioned, differing stress and anxiety levels across age groups may explain this variation.

Correlation Between Tinnitus Functional Index and Insomnia Severity Index Scores

The results showed a significant correlation between TFI and ISI scores, indicating that improvements in TFI scores were associated with improvements in ISI scores.

Improvement in negative symptoms caused by tinnitus can also lead to better sleep quality. This finding may be attributed to an enhancement in emotional well-being and reduced anxiety, which, as previously mentioned, could result in improved sleep. On the other hand, better sleep in tinnitus sufferers might lead to a reduced negative reaction to tinnitus and decreased discomfort. These improvements could mutually influence each other through neurological effects in the limbic system, frontal lobe, and temporal lobe, leading to further positive outcomes. This finding is consistent with other studies that have examined the relationship between tinnitus and sleep, including a study by Koning et al (2019),[38] which directly investigated the link between tinnitus and sleep disorders, concluding that distressing tinnitus leads to sleep disturbances. However, the precise mechanism of how tinnitus affects sleep quality remains unclear, although many patients perceive tinnitus as a cause of poor sleep. Sleep problems, in turn, can increase anxiety and cognitive changes, which may worsen tinnitus discomfort.[39]

Comparison Between the Sleep Subscale of Tinnitus Functional Index and Insomnia Severity Index Scores

Some inconsistencies emerged when comparing the results between the sleep-related items of the TFI and the total scores of the ISI. While both instruments indicated an overall improvement in sleep-related outcomes following the intervention, a discrepancy was observed in the group-specific patterns. Specifically, the TFI sleep subscale yielded higher scores—indicating greater sleep disturbance—in the presbycusis group, whereas the ISI scores were higher in individuals with NIHL. This pattern was consistent both before and after the intervention. These findings suggest potential variability in how each instrument captures the subjective experience of sleep disturbances among individuals with tinnitus. Therefore, further research is warranted to examine the reliability, sensitivity, and construct validity of the TFI and ISI in assessing sleep-related complaints in this population. Such investigations could help clarify whether these inconsistencies reflect actual differences in sleep disruption or are artifacts of how the 2 questionnaires operationalize and measure sleep disturbance.

Age Group Differences

The differences observed between age groups may also partly explain variations in baseline TFI and ISI scores. Younger individuals with NIHL appeared to experience higher pre-intervention tinnitus distress and poorer sleep quality compared to the older presbycusis group. This could reflect less adaptation and coping in younger patients versus gradual habituation in older adults. These age-related variations may have contributed to the group differences observed in this study.

Limitations

This study has several limitations that should be acknowledged. First, the absence of a control group (placebo or no-treatment) limits causal inference, as spontaneous improvement or habituation cannot be excluded. Second, no blinding or randomization procedures were implemented, which raises the potential for observer bias in outcome assessment. Third, tinnitus mapping was not performed, which may have influenced individual responses. Fourth, individualized device settings beyond basic fitting protocols were not systematically reported, limiting reproducibility. Finally, the relatively short follow-up period of 6 months may not fully capture the long-term sustainability of improvements in tinnitus distress and sleep quality. Larger, randomized controlled trials with extended follow-up and comprehensive tinnitus characterization are required to strengthen the evidence base. These methodological limitations should be considered when interpreting the results, and future studies should incorporate control groups, blinding, longer follow-up, and detailed tinnitus profiling to provide a more robust understanding of hearing aid effectiveness.

Hearing aids can be considered one of the most effective methods for reducing tinnitus distress and improving the quality of life for a wide range of patients with hearing loss who visit audiology centers. By compensating for sensory deprivation and relying on neural plasticity, hearing aids can influence the perception of tinnitus and reduce its negative impact on the individual. The current study approves that regardless of the underlying pathology causing high-frequency hearing loss in 2 groups of NIHL and presbycusis, hearing aids improve the distressing symptoms of tinnitus, and these long-term neural changes can also affect sleep quality, positively influencing the sleep experience of these individuals.

However, the role of adaptation in different groups should not be overlooked. For instance, individuals with presbycusis, who experience more gradual symptoms, report less tinnitus distress compared to those with NIHL. The absence of a control group, lack of blinding, limited tinnitus profiling, and relatively short follow-up mean that the improvements observed cannot be attributed solely to hearing aid use. Future randomized controlled trials with extended follow-up and detailed tinnitus characterization are necessary to confirm and strengthen these results.

Data Availability Statement: *The data that support the findings of this study are available on request from the corresponding author.*

Artificial Intelligence (AI) Use Declaration: *The authors declared that no artificial intelligence (AI) tools were used in the generation, writing, or editing of this manuscript, and all content was produced solely by the authors.*

Ethics Committee Approval: *This study was approved by the ethics committee of University of Social Welfare and Rehabilitation Sciences(Approval No: IR.USWR.REC.1403.051, Date:.May 29, 2024).*

Informed Consent: *Written informed consent was obtained from all participants prior to their inclusion in the study.*

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