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Investigation of Hyperacusis in Patients with Tinnitus

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Abstract

***Introduction*:**
Hyperacusis is defined as a decreased tolerance to common everyday sounds. A numer of the sufferers have tinnitus. Therefore, this study aimed to compare the hyperacusis scores between tinnitus sufferers and people without tinnitus.

Materials and Methods:
This case-control study had 80 participants (the case group or hyperacusis-tinnitus sufferers= 40 and the control group or normal subjects=40). Data were collected using tympanometry, pure tone audiometry, word-in-noise perception test, loudness discomfortable (LDL) test and the Persian-version of the Khalfa hyperacusis questionnaire (HQ). Data analysis was done using independent samples t-test, Mann-Whitney, Chi-square and Kruskal-Wallis tests. The significance level of less than 0.05 was considered.

Results:
In hyperacusis-tinnitus sufferers, the mean scores of hyperacusis (24.17±6.83) were meaningly (p=0.00) more than of normal subjects (8.38±9.16). The causal relations were found between them in terms of hearing loss (P=0.00). The differences among the two groups in terms of hyperacusis scores were significant, in patients over 40 years of age (p=0.01), but not in those under 40 years of age (p=0.06). In hyperacusis-tinnitus sufferers, no causal relationships were found among hyperacusis scores with sex, degree of hearing loss and its type.

Conclusion:
Hyperacusis is more common in old patients combined tinnitus and hearing loss. Gender, severity and nature of hearing loss are not related to the grade of hyperacusis. A common mechanism of central auditory processing disorder is related to tinnitus and hyperacusis, which can them to occur concomitantly. The complete and careful evaluation of patients with tinnitus and hyperacusis is essential.

Keywords: Tinnitus, Hyperacusis, Hearing loss

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Introduction

Hearing impairments do not mostly display as hearing damage, and somewhen they appear in the shape of abnormal sound sensitivity, which is called hyperacusis. In this condition, tolerable noises for the general public will be highly loud and intolerable for sufferers. Hyperacusis makes several difficulties in standards of daily living for their victims and damages to their educational, occupational and social positions depending on the patient's age. Hyperacusis sufferers typically have negative emotional relation with their surrounding noise. Their responses to generating sources can be annoyance, impatience, increased heart rate, sweating, nervousness, and etc. They may have central auditory processing disorders (CAPD), since they are more attentive and aware of the circumstantial noises compared to people without CAPD, who can easily filter out background noise (1-5).

Researchers have shown that its incidence is 7% to 23% in the general public (1,2), and in patients with the chief complaint of tinnitus, its occurrence is 40% (3). Approximately 90% of the patients combined hyperacusis report tinnitus, suggesting an association among them (4). The underlying mechanisms of hyperacusis and tinnitus are unknown. They can happen without hearing loss and are associated with increased sound-induced arousal in the brainstem and the auditory cortex (4). Another possibility is that they may result from increased neural coherence and reorganization of the tonotopic map in the auditory brain (6).

The brain activity in patients with hyperacusis are enlarged in the frontal and occipital hemispheres. Indeed, their extra-auditory cortices are cooperative for the sound feedback (1). While, the right superior temporal gyrus of the auditory brain is principal in normal people (3). Hyperacusis can occur due to various neurological and structural causes, such as chronic fatigue syndrome (3), head trauma, facial paralysis, depression, anxiety, post-traumatic stress disorder, hearing loss, autism (1), metabolic conditions, infections and genetic diseases (5). Hyperacusis can distract the health aspects of the sufferers, which consist of emotional comfort, hearing, communication, sleep, and attention (3,7). The routine measures of auditory evaluations are not suitable for hyperacusis (2,3,6). The appropriate methods including the LDL and hyperacusis questionnaires, which are commonly recommended. They are the most reliable approaches to study of its symptoms (2-4). Also, two Persian version of the questionnaires {the Inventory of Hyperacusis Symptoms (2) and HQ (3)} show no significant correlation with the pure tone audiometry (2). They estimate three parts of attentional, social, emotional significance and also have high validity/reliability for routine procedure of diagnosing and following up the rehabilitation (2,3). The essential treatments of hyperacusis are cognitive behavioral therapy and sound treatment, which emphasis on responses, emotions and thoughts. They are also two main portion of tinnitus retraining therapy.

Cognitive behavioral therapy comprises instructions, shifting person’s wrong opinions, practical easing, helpful imaginings and trainings to adjust considerations. Sound treatment can be effective by declining noise levels at the source, using hearing protections, decreasing the length of noise exposure and rest taking (2-4).

Also, there is the increasing signs to present the relevancy among the hyperacusis and anxiety. But, causal relationship between them is not strong. Thus, in the lack of a specified therapy, the hyperacusis-associated anxiety treatment using cognitive behavioral therapy can be helpful (1).

It is important to note that using of tinnitus questionnaires, for example the Persian-version of the Iowa tinnitus primary function (ITPF) are not suitable for the assessment of hyperacusis, to distinct each of these two symptoms, to know the complications and to offer treatment recommendations (2,6). The benefit of the Persian-version of ITPF over other tinnitus questionnaires is its ability to distinct and estimate all destructive dimensions of tinnitus consequences (sleep, attention, hearing and public communication).

But it cannot evaluate the biggest problem of hyperacusis sufferers, which is sound intolerance. The ITPF is unable to distinguish between the symptoms of hypersensitivity to sound and their complications on all aspects of the sufferers (8), (Appendices 1,2) (3,8). Consequently, this study aimed to compare the hyperacusis scores between tinnitus sufferers and people without tinnitus.

Materials and Methods

This survey was a case/control study conducted in 2025. The participants were all patients referred to the ENT clinic of Besat hospital affiliated with Hamadan University of Medical Sciences. The case group or hyperacusis-tinnitus sufferers (n=40) were selected from patients with tinnitus and the control group or normal subjects were included from the people without tinnitus (n=40). Hyperacusis-tinnitus sufferers were included 22 (0.55%) males and 18 (0.45%) females. Normal subjects were contained 20 (0.50%) males and 20 (0.50%) females.

Data collection tools were personal information recording, audiological tests andthe Persian-version of the Khalfa hyperacusis questionnaire (HQ), which is a valid and reliable document with total score of content validity value above 0.69 (its items: Relevance=1, clarity= 0.95, and simplicity=0.97). Its internal consistency coefficient for reliability is 0.9 (its subsets: Social, emotional, and attentional dimensions= 0.83), (3). Audiological evaluations included otoscopic examination, tympanometry (using clarinet middle-ear analyzer) pure tone audiometry, word-in-noise perception test at signal-to-noise ratio of +5 dB (7), and LDL (using AC33 audiometer, Interacoustics, Denmark). LDL were estimated at 0.25, 0.5, 1, 2, 4, 6 and 8 kHz. Reduced sound tolerance was noted as abnormal, when average LDL were 90 dB HL or lower and the patient had hypersensitivity to sounds (1). The study samples were selected using a non-randomized available method. Inclusion criteria were suffering from tinnitus in the case group, lack of tinnitus and normal results of audiologic findings in the control group, being monolingual (Persian language with Iranian dialect), consent to participate in the study, the participants aged older than 14 years (the right ear matures at the age of 10, whereas the maturation of the left ear is about 14 years old (7). Exclusion criteria were unwillingness to undergo audiometric tests.

Data analysis method: SPSS version 26 software was used for data analysis. Descriptive information related to qualitative variables was displayed in the form of tables. Descriptive information related to quantitative variables was presented in the form of central and dispersion indices. Student's t-test was done to compare two groups in terms of quantitative variables that had the normal distribution. Mann-Whitney and Kruskal-Wallis tests were used for quantitative variables with the non-normal distribution. Chi-square test was done for qualitative variables. All tests were two-sided and the significance level of less than 0.05 was considered.

Results

The mean and standard deviation of age in hyperacusis-tinnitus sufferers and in normal subjects were 41.35±14.73 and 37.95±7.85, respectively. Based on Student's t-test, no significant difference was observed between the ages of them (P = 0.20). Based on the chi-square test, no significant difference was observed between the gender of two groups (p=0.65). The significant differences were not found among the hyperacusis-tinnitus sufferers in terms of severity (P=0.46) and type of hearing loss (P=0.35), (Table1).

Table1: Mean and standard deviation (SD)of hyperacusis scores in hyperacusis-tinnitus sufferers on base of degree and type of hearing loss.

Variable	Scale*	Number (%)	Mean (SD)of hyperacusis scores	P-value
Degree of hearing loss	Mild (26-40 dB HL)	7 (17.50)	28.00 (3.00)	**0.46
	Moderate (41-55 dB HL)	11 (27.50)	23.18 (7.06)	
	Moderate-severe (56-70 dB HL)	8 (20.00)	25.00 (7.95)	
	Severe (71-85 dB HL)	9 (22.50)	21.56 (8.51)	
	Profound (85< dB HL)	5 (12.50)	24.40 (4.04)	
	Total	40 (100.00)		
Type of hearing loss	Sensorineural	26 (30.00)	24.78 (6.02)	***0.35
	Mixed	14 (37.50)	18.75 (11.74)	
	Total	40 (100.00)		

*[7], **Kruskal-Wallis test, ***Mann-Whitney test.

The significant differences were observed between two groups in terms of hearing loss (P=0.00) and hyperacusis scores (P=0.00), (Table-2).

Table2: Mean and standard deviation (SD) of hearing loss and hyperacusis scores of participants

Variable	Group		P-value
	Control (normal subjects) Mean (SD)	) Casehyperacusis-tinnitus sufferers(Mean (SD)	
Hearing loss	(14) 20.74	(20.74) 49.21	0.00*
Hyperacusis scores	***(9.16) 8.38	(6.83) 24.17	0.00**

***.Mann-Whitney test** Cut-off point of HQ = 17.5 (3).

In the age under 40 years, there was no significant difference in the hyperacusis scores between hyperacusis-tinnitus sufferers and normal subjects (P=0.06). But, in the age over 40 years, the hyperacusis scores in the case group was significantly higher than the control group (P=0.01). The hyperacusis scores in men (P=0.04) and women (P=0.01) of hyperacusis-tinnitus sufferers were significantly higher than of normal subjects (Tables1,2,3).

Table3: Mean and standard deviation of hyperacusis scores in participants on base of age and gender

Variable	Group		P-value
	Control (normal subjects) Mean (SD)	**Case (hyperacusis-tinnitus sufferers) Mean (SD)**	
Age under 40 years	8.86 (8.97)	23.50 (7.58)	0.056
Age over 40 years	7.70 (9.83)	25.19 (5.61)	***0.012**
P-value	0.679	0.451	
Male	6.65 (9.81)	22.36 (7.05)	***0.048**
Female	10.10 (8.34)	26.39 (5.88)	***0.013**
P-value	0.24	0.06	

*Mann-Whitney test

In the intra-group comparison and in hyperacusis-tinnitus sufferers (P=0.06) and in control group (P=0.24), there were no significant differences between men and women in terms of the severity of hyperacusis. There were no significant differences in HQ and loudness discomfort level (LDL) scores between the two sexes {male= 88 (68) and female= 90 (34) dB HL} in hyperacusis-tinnitus sufferers (P=0.28) and also in normal subjects {male= 110 (32) and female= 108 (87) dB HL}, (P=0.33). But, the difference among cases {89 (56)} and controls {109 (48)} was significant (P=0.04).

Discussion

In the present study, hyperacusis scores in hyperacusis-tinnitus sufferers were significantly higher than that in normal subjects. Haro-Hernandez et al. (2025) also reported that their patients with vestibular migraine combined tinnitus had higher scores in hyperacusis questionnaire (9). In study conducted by Aydin et al. (2025) to investigate the relation among tinnitus and hyperacusis, the meaningful correlation was found between their scores. In other words, high tinnitus severity was associated to increased hyperacusis scores (4). in our present study, tinnitus severity was not directly measured, the finding of Aydin et al. (2025) which showing a positive relationship between tinnitus severity and hyperacusis scores, could be an indirect confirmation of our findings. Indeed, the degree of central auditory processing disorder may be related to the severity of tinnitus and hyperacusis scores (1,6).

Shin et al. (2022) reviewed clinical findings related to the co-occurrence of tinnitus and hyperacusis and found that more than a quarter of their patients reported subjective auditory intolerance along with tinnitus. Higher scores on the tinnitus handicap inventory questionnaire were independently associated with the co-occurrence of tinnitus and hyperacusis (10). In line with their study, our findings also emphasize the importance of using reliable questionnaires (such as HQ) for the subjective .assessment of hyperacusis

In a study by Jafari et al. (2022) on war wounded, 78% of patients had tinnitus. Hyperacusis was observed in 76.5% of them. They found a significant relationship between

hyperacusis and tinnitus (11). Sedruth et al. (2020) that there was the mutual connection among the severity of tinnitus and hyperacusis scores (12). In a research conducted by Fioretti et al. (2013) aiming to determine the connection among hyperacusis and tinnitus, the significant relation was observed between the degree of annoyance of tinnitus and hyperacusis scores (13). The main finding of our study, that there is more severe hyperacusis in patients with tinnitus, is completely consistent with the results ,of their studies. This strong convergence despite different methods and different sample sizes, strengthens the hypothesis of a common pathophysiological mechanism or same central .auditory processing disorder for them

In a study by Guimarães et al. (2014) to investigate the relationship between tinnitus severity and hyperacusis scores, its severity was present with a mean grade of 5 in 57 patients (18.4%). The level of tinnitus annoyance in patients with hyperacusis was similar to that in patients without it. Hyperacusis was present in 18.4% of patients with tinnitus (14). Unlike our study, they found no association between .hyperacusis scores and the severity of tinnitus This difference could be due to differences in their measurement tools, which included a visual analog scale (VAS) unlike ours, which used the HQ questionnaire, or differences in the demographic and clinical characteristics of the .study samples

Duman et al. (2004) reported that the correlation between tinnitus severity and hyperacusis scores was not significant (15). The results of our study are in contrast to the findings of them, which found a weak correlation between the two. This seems to be due to differences in methodology and operational definition of hyperacusis. They used a single question to define hyperacusis (Do sounds cause you physical pain or discomfort?). Whereas, our study used a comprehensive and validated questionnaire or HQ, that measures the three areas of attentional, social, and emotional consequences in patients with hyperacusis (3). This increases the importance of using standard and multidimensional tools.

In the study by Jacquemin et al. (2022), the prevalence of hyperacusis was 10.9%. Patients with hyperacusis reported a higher tinnitus severity than patients without it (16). The results of their study are consistent with ours and confirm that hyperacusis is associated with greater tinnitus severity. This convergence strengthens the main basis for the association between these two lesions. The case-control method used in the our study provides more direct evidence for the claim that tinnitus can be a factor associated with increased hyperacusis scores. In other words, this design further confirms the correlation of this association.

The differences observed in some studies are likely due to variations in measurement methods, research instruments, demographic characteristics of the samples, and not due to the lack of an association between the two diseases. These results emphasize the need for routine screening for hyperacusis in all patients with tinnitus and combined treatment approach to the management of both conditions.

Although some studies have reported a higher prevalence of tinnitus (9,12) and hyperacusis (16) in women than in men, this finding was not observed in our study, and hyperacusis scores in our hyperacusis-tinnitus sufferers were significantly higher than that in normal subjects in both men and women. In other words, tinnitus is a stronger determinant of hyperacusis and the patient's gender has no effect on it. These results emphasize the importance of considering hyperacusis as a significant symptom in all patients with tinnitus, regardless of their gender.

In the present study, no significant difference was observed between the degree of hyperacusis and the severity and type of hearing loss in the two groups. In a cross-sectional, multicenter study conducted by Haro-Hernandez et al. (2025) on patients with vestibular migraine, hyperacusis was not associated with hearing thresholds (9).

In the study by Jafari et al. (2022), tinnitus was the main problem in 0.35% of cases and hearing loss in 0.28% of cases (11). In the study by Schecklmann et al. (2014), patients with hyperacusis rated their subjective auditory function worse than those without hyperacusis (17), and in the study by Dauman et al. (2004), no significant difference was observed between the severity of hyperacusis and audiometric results, while self-rated hearing loss was associated with the degree of annoyance of hyperacusis (18). Our findings, which showed no relationship between hyperacusis and the degree and type of hearing loss in hyperacusis-tinnitus sufferers, are directly consistent with the

results of the Haro-Hernandez (9) and Duman (15). This strong agreement may indicate that hyperacusis is essentially a central auditory processing disorder. This means that the underlying mechanism of hyperacusis is due to a disruption in the processing and interpretation of sounds in the central nervous system, rather than simply damage to the ear. This explains why hyperacusis can occur in both people with normal hearing and patients with any type and degree of hearing loss. In Jafari's (2022) study, hearing loss was considered the main problem of patients with hyperacusis and cannot be interpreted as a causal relationship between hearing loss and hyperacusis (11). This finding simply reflects the patients' subjective prioritization of their problems. Hearing loss may be a greater problem for patients, while hyperacusis has fewer consequences. However, their finding is consistent with our finding that the significant differences were observed between hyperacusis-tinnitus sufferers and normal subjects in terms of hearing loss and hyperacusis scores.

The findings of Sheckleman's study complement ours, because their study method was a questionnaire and assessed patients' subjective perception of their hearing status (17), whereas we used pure-tone audiometry, which is an objective assessment of hearing thresholds and is unrelated to hyperacusis (1). The findings of Sheckleman's study emphasize that hyperacusis is a perceptual disorder. Affected patients, even with normal audiogram, may feel that they do not hear well because sounds are distorted, unpleasant, or painful to them. The co-existence of hyperacusis and tinnitus is a useful criterion for defining a subgroup of tinnitus characterized by a greater need for treatment (17). This is fully consistent with the centrality model of hyperacusis. Differentiating the pathophysiological mechanisms between these two conditions in cases of severe tinnitus will be challenging, and optimal study designs are essential to better understand the causal mechanisms of the strong association between hyperacusis and tinnitus. In our study, the differences among hyperacusis-tinnitus sufferers and normal subjects in terms of hyperacusis scores were significant, in patients over 40 years of age, but not in those under 40 years of age. Similar to ours, Aazh and Moore (2016) found a significant relationship between the aging and the decreased scores of tinnitus retraining therapy (comprehensive educational counseling and sound therapy) in patients with tinnitus (aged between 25-79 years old) (19). Emami et al. (2023) also reported that there is a positive relation between reduced ability to the meaning understanding in competing situations and aging. Indeed, the older adults are weaker than youngs in most cognitive skills; long-term memory, temporal resolution, central reaction time, speech in noise perception, peripheral and central auditory processing. While, cognitive abilities are guaranteed in them, which contain short-term memory and sustained attention (7).

Similar to hyperacusis and tinnitus, the other auditory acuity symptoms with reduced power tolerance include recruitment and misophonia (5). They are analogous but are distinctable by experienced clinician through case history, appropriate test batteries and special questionnaires (3). Recruitment is the peripheral impairment (18).

While, the evidence indicates abnormalities at the cortical levels in hyperacusis, tinnitus and misophonia, which have the irregular stimulation of the non-classical auditory pathway with working memory and the central auditory processing deficits (5,7).

Misophonia is reduced tolerance to certain noises (breathing, eating, drinking sounds…) that may be normal for others. Patient reactions to triggering noises can be irritation, increased heart rate, sweating, nervousness and etc. Neuroimaging studies showed involved right insula, anterior angulate and superior temporal cortices in the sufferers. They also have stronger mirroring neurons, which are more sensitive to trigger noises (5).

Recruitment is fast growing of received sounds intensity, which placed in the pitch area of the basilar membrane injury. Indeed, the normal hair cells adjacent to the damaged sets of the inner ear cochlea. Consequently, they perceived loudness shoots up rapidly, causing discomfort. The various desensitization protocols do not help in these cases (18). Overall, the findings of our study emphasize the strong relation between tinnitus and hyperacusis. However, the novel and important point of our work is introducing the aging as an important moderating factor in this relationship. This finding suggests that patients with tinnitus over 40 years of age are more vulnerable population to developing

hyperacusis and should be screened and managed more sensitively for this symptom.

Conclusion

Hyperacusis is more common in old patients combined tinnitus and hearing loss. Gender, severity and nature of hearing loss are not related to the grade of hyperacusis. A common mechanism of central auditory processing disorder is related to tinnitus and hyperacusis, which can them to occur concomitantly. The complete and careful evaluation of patients with tinnitus and hyperacusis is essential.

Recommendations tionnaires be used as part of the routine assessment of patients with hyperacusis in the clinical field. Education on strategies for reducing sensitivity to sound and managing tinnitus should be provided. Hearing rehabilitation programs should be designed and implemented for patients with severe hyperacusis. The effect of pharmacological and non-pharmacological interventions on reducing hyperacusis should be investigated. Neuroimaging methods should be used to study the central mechanisms of hyperacusis. The effectiveness of different methods of managing hyperacusis should be investigated in clinical trials.

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