CLINICAL STUDY

EVALUATION OF AUDIO-VESTIBULAR FINDINGS IN INDIVIDUALS WITH PRESBYCUSIS: A SELF-REPORT STUDY

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SUMMARY

Objective: The aim of the present study was to evaluate the levels of speech perception (SP), spatial hearing (SH), and hearing quality (HQ) in individuals diagnosed with presbycusis, and to examine the effects of dizziness and tinnitus on these parameters.

Materials and Methods: A total of 50 individuals (19 women, 31 men) with presbycusis were included in the study. Participants ranged in age from 56 to 70 years, with a mean age of 68.42 ± 5.41 years. All individuals underwent pure-tone and speech audiometry, as well as assessments using the Tinnitus Handicap Inventory (THI), Dizziness Handicap Inventory (DHI), and the Speech, Spatial and Qualities of Hearing Scale (SSQ).

Results: A weak but statistically significant negative correlation was found between pure-tone average and overall SSQ scores (r = -0.361; p = 0.010). A strong and statistically significant negative correlation was observed between the total DHI score and the mean SSQ-SH (spatial hearing) scores (r = -0.723; p = 0.043). On the other hand, no significant differences were identified between the presence of tinnitus and the SSQ subscales or overall score (p > 0.05).

Conclusion: Hearing loss and dizziness observed in individuals with presbycusis may negatively affect perceived auditory performance and quality of life. These findings highlight the importance of incorporating both audiological assessments and subjective scales in the clinical evaluation process.

Keywords: Presbycusis, Speech Perception, Spatial Hearing, Tinnitus

PRESBİAKUZİLİ BİREYLERDE ODYO-VESTİBÜLER BULGULARIN DEĞERLENDİRİLMESİ: BİR ÖZ-BİLDİRİM ÇALIŞMASI

ÖZET

Amaç: Mevcut çalışmanın amacı, presbiakuzi tanısı almış bireylerde konuşma algısı (Speech Perception- SP), uzamsal işitme (Spatial Hearing- SH) ve işitme kalitesi (Hearing Quality- HQ) düzeylerini değerlendirmek ve dizziness ile tinnitusun bu parametreler üzerindeki etkilerini incelemektir.

Gereç ve Yöntemler: Çalışmaya, presbiakuzili toplam 50 birey (19 kadın, 31 erkek) dâhil edilmiştir. Katılımcıların yaşları 56 ile 70 arasında değişmekte olup, ortalama yaş 68,42 ± 5,41"dir. Tüm bireylere saf ses ve konuşma odyometrisi ve ayrıca Tinnitus Handicap Inventory (THI), Dizziness Handicap Inventory (DHI) ve Speech, Spatial and Qualities of Hearing Scale (SSQ) uygulanmıştır.

Bulgular: Saf ses ortalaması ile SSQ genel skorları arasında negatif yönlü ve zayıf düzeyde anlamlı bir ilişki saptanmıştır (r=-0,361; p=0,010). DHI toplam puanı ile SSQ-SH ortalama puanları arasında negatif yönlü ve yüksek düzeyde anlamlı bir ilişki gözlenmiştir (r=-0,723; p=0,043). Öte yandan, tinnitus varlığı ile SSQ alt ölçekleri ve genel skor arasında anlamlı bir fark bulunmamıştır (p>0,05).

Sonuç: Presbiakuzili bireylerde görülen işitme kaybı ve baş dönmesi, algılanan işitsel performansı ve yaşam kalitesini olumsuz yönde etkileyebilmektedir. Bu bulgular, klinik değerlendirme sürecinde hem odyolojik hem de subjektif ölçeklerin birlikte kullanılmasının önemini ortaya koymaktadır.

Anahtar Sözcükler: Presbiakuzi, Konuşma Algısı, Uzamsal İşitme, Tinnitus

INTRODUCTION

Presbycusis is a condition characterized by sensorineural hearing loss, typically affecting both ears, that arises as a result of the aging-related effects on the auditory system[1].

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Hearing thresholds may progressively deteriorate, making communication more difficult and potentially leading to social isolation, cognitive decline, and a reduction in quality of life[2,3]. In individuals with presbycusis, hearing loss affects not only the intensity of sound but also its quality and the ability to interpret it. A previous study reported that elevated hearing thresholds were associated with lower speech discrimination scores, and a statistically significant relationship was found between these two variables[4]. This indicates that individuals with presbycusis experience not only difficulty in hearing but also in understanding speech.

Presbycusis is often accompanied by additional symptoms such as tinnitus and dizziness. Tinnitus is defined as the perception of sound in the absence of an external auditory stimulus, and its prevalence increases with age[5,6]. This condition may adversely affect an individual"s psychological well-being and overall quality of life. Tinnitus has been shown to exert significant impacts on functional capacity[7]. Moreover, tinnitus associated with presbycusis has been shown to increase the risk of developing depression and anxiety in affected individuals[8]. These findings indicate that the coexistence of presbycusis and tinnitus leads to significant consequences not only in auditory functioning but also in emotional and psychological domains.

Spatial perception is a complex process that enables individuals to accurately identify the source, direction, and distance of a sound. Studies using the Speech, Spatial and Qualities of Hearing Scale (SSQ) have reported that this ability is significantly impaired in individuals with hearing loss[9]. Auditory impairments have been shown to negatively affect not only communication but also cognitive functions, potentially increasing the risk of developing dementia[10]. Hearing loss, particularly in older adults, leads to impairments in attention, memory, and executive functions, and is considered an independent risk factor in the progression toward dementia[11].

The literature includes various findings regarding tinnitus and spatial perception in individuals with presbycusis[12,13]. However, to the best of our knowledge, no studies have specifically examined the relationship between tinnitus and dizziness and the components of auditory performance in individuals with presbycusis. Therefore, the aim of this study was to evaluate the levels of speech perception (SP), spatial hearing (SH), and hearing quality (HQ) in individuals diagnosed with presbycusis and to investigate the effects of dizziness and tinnitus on these parameters.

MATERIAL and METHODS

Participant

This study was designed as a prospective descriptive investigation. Prior to the initiation of the research, approval was obtained from the Ethics Committee of Ankara Medipol University (Decision No: 12, 15/01/2025), and the study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants. The study population consisted of individuals aged between 56 and 75 years who had been clinically diagnosed with presbycusis. Participation in the study was voluntary. Inclusion criteria were a diagnosis of presbycusis, being between 50 and 75 years of age, and willingness to participate in the study. Exclusion criteria included a history of psychiatric or neurological disorders, a history of otologic surgery, the presence of conductive or mixed-type hearing loss, and/or asymmetric hearing loss.

Procedure

The data collection process was carried out in the Audiology Unit of the Department of Otorhinolaryngology at Gülhane Training and Research Hospital. Training and Research Hospital. Individuals presenting to the outpatient clinic with complaints of hearing loss first underwent a clinical evaluation by an otorhinolaryngologist. Based on otoscopic examination, detailed medical history, and audiological test results, the diagnosis of presbycusis was established by the otorhinolaryngologist in individuals of advanced age presenting with bilateral and symmetrical high-frequency sensorineural hearing loss on pure-tone audiometry. Face-to-face interviews were conducted with the participants, and tests were administered based on the results of the audiological evaluations. Within the scope of the study, following pure-tone and speech audiometry, data were collected subjectively using the Tinnitus Handicap Inventory (THI), Dizziness Handicap Inventory (DHI), and the Speech, Spatial and Qualities of Hearing Scale (SSQ). The data obtained were analyzed using descriptive and comparative statistical methods.

Tinnitus Handicap Inventory (THI)

The Tinnitus Handicap Inventory (THI) is a self-report assessment tool used to evaluate the impact of tinnitus on individuals" daily lives. Consisting of 25 items, the scale is scored by having participants respond to each item with one of three options: yes (4 points), sometimes (2 points), or no (0 points). The total score ranges from 0 to 100, with higher scores

indicating a more severe negative impact of tinnitus on the individual"s quality of life[14].

Dizziness Handicap Inventory (DHI)

This 25-item scale assesses the physical, emotional, and functional impacts of dizziness. Each item is rated on a scale of 0 (never), 2 (sometimes), or 4 (always). The total score ranges from 0 to 100, with higher scores indicating greater disability[15].

The Speech, Spatial and Qualities of Hearing Scale (SSQ)

Auditory performance is evaluated across three subdomains: speech perception (SP), spatial hearing (SH), and hearing quality (HQ). Each item is rated on a scale from 0 (very poor) to 10 (excellent). Subscale scores are calculated by averaging the scores of the relevant items, and the overall SSQ score is determined by calculating the mean of the three subscale scores[9].

Statistical Analysis

Data were analyzed using IBM SPSS version 23. The normality of distribution was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. For comparisons of quantitative variables with two independent categories, the Independent Samples t-test was used when the data followed a normal distribution, while the Mann-Whitney U test was employed for data not normally distributed. Relationships between normally distributed quantitative variables were examined using Pearson"s correlation coefficient, whereas Spearman"s rho correlation analysis was used for non-normally distributed variables. Descriptive statistics for quantitative data are presented as mean ± standard deviation and median (minimum?maximum), while categorical variables are expressed as frequencies and percentages. The significance level was set at $p < 0.05$.

RESULTS

A total of 50 individuals diagnosed with presbycusis were included in the study. Among the participants, 19 were women (38%) and 31 were men (62%), with ages ranging from 56 to 70 years and a mean age of 68.42 ± 5.41 years. Comorbid conditions included hypertension in 23 participants (46%), coronary artery disease in 9 (18%), thyroid disorders in 7 (14%), and diabetes in 15 (30%). Additionally, tinnitus was reported by 10 individuals (20%) and dizziness by 8 individuals (16%). A total of 7 participants (14%) used hearing aids, with 2 reporting use in the right ear and 5 reporting bilateral use (Table 1).

Pure-tone averages (PTA), speech recognition thresholds (SRT), and speech discrimination scores (SD) for the right and left ears of all participants are presented (Table 2).

A statistically significant, positive, and strong correlation was found between the DHI physical subscale and the DHI total scores ($r = 0.708$; $p = 0.049$). Similarly, a statistically significant, positive, and very strong correlation was observed between the DHI functional subscale and the DHI total scores ($r = 0.982$; $p < 0.001$). A statistically significant, negative, and strong correlation was identified between the DHI physical subscale and the mean SSQ-SH scores ($r = -0.798$; $p = 0.018$). Similarly, significant, negative, and strong correlations were observed between the DHI functional subscale and the mean SSQ-SH scores ($r = -0.723$; $p = 0.043$), as well as between the DHI total scores and the mean SSQ-SH scores ($r = -0.723$; $p = 0.043$) (Table 3).

A statistically significant, positive, and strong correlation was found between SSQ-SP and SSQ-SH scores ($r = 0.800$; $p < 0.001$), as well as between SSQ-SP and SSQ-HQ scores ($r = 0.803$; $p < 0.001$). The correlation between SSQ-SH and SSQ-HQ scores was positive and very strong ($r = 0.912$; $p < 0.001$). A statistically significant, negative, and strong correlation was found between the DHI physical subscale and the overall SSQ score ($r = -0.737$; $p = 0.037$). Additionally, statistically significant, positive, and very strong correlations were observed between the overall SSQ score and the mean scores of SSQ-SP ($r = 0.911$; $p < 0.001$), SSQ-SH ($r = 0.958$; $p < 0.001$), and SSQ-HQ ($r = 0.964$; $p < 0.001$) (Table 3).

A statistically significant, negative, and moderate correlation was found between overall PTA and SSQ-SP mean scores ($r = -0.430$; $p = 0.002$). Additionally, a statistically significant, negative, and weak correlation was identified between overall PTA and SSQ-SH mean scores ($r = -0.301$; $p = 0.033$). Similarly, statistically significant, negative, and weak correlations were

observed between overall PTA and SSQ-HQ mean scores (r = -0.320; p = 0.024), as well as between overall PTA and the overall SSQ score (r = -0.361; p = 0.010). On the other hand, a statistically significant, positive, and moderate correlation was found between overall SD and SSQ-SP mean scores (r = 0.407; p = 0.003). No statistically significant relationships were identified among the other variables (p > 0.05) (Table 4). Additionally, no statistically significant differences were found between SSQ overall scores and the presence of hypertension, coronary artery disease, thyroid disorders, diabetes, or hearing aid use (p > 0.05) (Table 5).

No statistically significant differences were found in SSQ subscale or overall scores based on gender (p > 0.05) (Table 6).

Table 1. Descriptive Statistics of the Variables

	Mean±Standard Deviation	Median (Min-Max)
Age	68.42 ± 5.41	70 (56 - 75)
Duration of Hearing Aid Use (months)	38.86 ± 50.17	24 (2 - 144)
	Frequency	Percentage
Gender		
Female	19	38
Male	31	62
Hypertension		
Yes	23	46
No	27	54
Coronary Artery Disease		
Yes	9	18
No	41	82
Thyroid Disorder		
Yes	7	14
No	43	86
Diabetes		
Yes	15	30
No	35	70
Tinnitus		
Yes	10	20
No	40	80
Side of Tinnitus		
Right Ear	1	10
Left Ear	3	30
Bilateral	6	60
Dizziness		
Yes	8	16
No	42	84
Use of Hearing Aid		
Yes	7	14
No	43	86
Side of Hearing Aid		
Right Ear	2	28.6
Bilateral	5	71.4

Min: Minimum, Max: Maximum

Table 2: Comparison of dependent variables by side

	Right Ear		Left Ear		Test Statistic	r	p
	M ± SD	Min-Max	M ± SD	Min-Max			
PTA	33 ± 12.41	13- 75	33 ± 11.20	12- 68	444.500	0.692	0.930[x]
SRT	35 ± 12.59	10- 75	35 ± 10.34	10- 65	337.000	0.752	0.486[x]
SD	72 ± 18.80	12- 100	77 ± 16.85	36- 96	358.000	0.803	0.921[x]

[x]Wilcoxon test; M ± SD; Mean ± Standard deviation, Min; Minimum, Max; Maximum; r: Spearman's rho correlation, PTA; Pure tone average, SRT; Speech recognition threshold, SD; Speech discrimination

Table 3. Analysis of the Relationship Between Quantitative Variables

		1	2	3	4	5	6	7	8
1-THI									
2-DHI-Physical	r	-							
	p	.							
3-DHI-Emotional	r	-	0.454						
	p	.	0.259[x]						
4-DHI-Functional	r	-	0.640	0.536					
	p	.	0.088[x]	0.171[x]					
5-DHI-Total	r	-	0.708	0.536	0.982				
	p	.	**0.049[x]**	0.171[x]	**<0.001[x]**				
6-SSQ-SP Mean	r	0.237	-0.442	0.082	-0.542	-0.506			
	p	0.510[x]	0.273[x]	0.846[x]	0.165[x]	0.201[x]			
7-SSQ-SH Mean	r	0.255	-0.798	-0.302	-0.723	-0.723	0.800		
	p	0.476[x]	**0.018[x]**	0.467[x]	**0.043[x]**	**0.043[x]**	**<0.001[y]**		
8-SSQ-HQ Mean	r	0.450	-0.687	-0.302	-0.578	-0.578	0.803	0.912	
	p	0.192[x]	0.060[x]	0.467[x]	0.133[x]	0.133[x]	**<0.001[y]**	**<0.001[y]**	
9-SSQ Overall Score	r	0.377	-0.737	-0.206	-0.651	-0.663	0.911	0.958	0.964
	p	0.283[x]	**0.037[x]**	0.624[x]	0.081[x]	0.073[x]	**<0.001[y]**	**<0.001[y]**	**<0.001[y]**

[x] Spearman's rho correlation; [y] Pearson correlation; correlation results are not reported for sections where p-values were not calculated due to insufficient n number; THI; Tinnitus Handicap Inventory, DHI; Dizziness Handicap Inventory, SSQ; The Speech, Spatial and Qualities of Hearing Scale, SP; Speech Perception, SH; Spatial Hearing, HQ; Hearing Quality

Table 4. Analysis of the Relationship Between Quantitative Variables and SSQ Scores

		Age	Overall PTA	Overall SD	Duration of Hearing Aid Use
SSQ-SP Mean	r	-0.003	-0.430	0.407	0.072
	p	0.986	**0.002**	**0.003**	0.878
SSQ-SH Mean	r	-0.050	-0.301	0.267	-0.541
	p	0.728	**0.033**	0.060	0.210
SSQ-HQ Mean	r	-0.055	-0.320	0.202	-0.468
	p	0.705	**0.024**	0.159	0.289
SSQ Overall Score	r	-0.029	-0.361	0.273	-0.541
	p	0.844	**0.010**	0.055	0.210

r Spearman's rho correlation, SSQ; The Speech, Spatial and Qualities of Hearing Scale, SP; Speech Perception, SH; Spatial Hearing, HQ; Hearing Quality, PTA; Pure Tone Average, SD; Speech Discrimination.

Table 5. Comparison of SSQ Overall Scores by Presence of Chronic Illness and Hearing Aid Use

SSQ Overall Score	Yes	No	Total	Test Statistics	p
Hypertension	4.93 ± 1.64 5.07 (2.09 – 8.1)	4.38 ± 2.16 4.03 (0.72 – 9.55)	4.63 ± 1.93 4.27 (0.72 – 9.55)	0.997	0.324[x]
Coronary Artery Disease	4.26 ± 1.65 3.87 (1.77 – 6.54)	4.71 ± 2 4.48 (0.72 – 9.55)	4.63 ± 1.93 4.27 (0.72 – 9.55)	-0.638	0.526[x]
Thyroid Disease	5.07 ± 1.84 5.92 (2.52- 7)	4.56 ± 1.96 4.12 (0.72- 9.55)	4.63 ± 1.93 4.27 (0.72- 9.55)	0.642	0.524[x]
Diabetes Mellitus	4.38 ± 1.39 4.03 (2.77 – 7.65)	4.74 ± 2.13 5.31 (0.72 – 9.55)	4.63 ± 1.93 4.27 (0.72 – 9.55)	-0.703	0.486[x]
Hearing Aid Use Status	3.66 ± 2.2 3.2 (0.72- 7)	4.79 ± 1.87 4.41 (1.18- 9.55)	4.63 ± 1.93 4.27 (0.72- 9.55)	-1.447	0.154[x]

[x] Independent Samples t-test; Mean ± Standard Deviation; Median (Minimum–Maximum) SSQ; The Speech, Spatial and Qualities of Hearing Scale

Table 6. Comparison of SSQ Scores by Gender

	Female	Male	Total	Test Statistics	p
SSQ-SP Mean	3.99 ± 1.35 3.8 (1.57 - 7.3)	4.51 ± 2.13 4.57 (0.71 - 9.64)	4.31 ± 1.87 4.36 (0.71 - 9.64)	-1.049	0.350[x]
SSQ-SH Mean	4.39 ± 1.74 4.18 (1.88 - 7.2)	4.76 ± 2.1 4.65 (1.18 - 9.35)	4.62 ± 1.96 4.41 (1.18 - 9.35)	-0.642	0.524[x]
SSQ-HQ Mean	4.68 ± 2 4.56 (1.33 - 8.06)	5.14 ± 2.48 5 (0.28 - 9.67)	4.97 ± 2.3 4.92 (0.28 - 9.67)	-0.69	0.494[x]
SSQ Overall Score	4.35 ± 1.56 4.03 (1.77 - 7)	4.8 ± 2.14 4.48 (0.72 - 9.55)	4.63 ± 1.93 4.27 (0.72 - 9.55)	-0.799	0.428[x]

[x] Independent Samples t-test; Mean ± Standard Deviation; Median (Minimum–Maximum); SSQ; The Speech, Spatial and Qualities of Hearing Scale, SP; Speech Perception, SH; Spatial Hearing, HQ; Hearing Quality

DISCUSSION

In the present study, SP, SH, and HQ levels were evaluated in individuals diagnosed with presbycusis. Additionally, the effects of dizziness and tinnitus on these auditory parameters were examined. The findings indicate that dizziness, in particular, has a significant impact on auditory-related quality of life. The strong negative correlation identified between DHI total scores and the SSQ-SH subscale suggests that dizziness adversely affects individuals" ability to localize environmental sounds and maintain auditory spatial awareness. Furthermore, the significant negative correlation between PTA and overall SSQ scores supports the notion that hearing loss directly influences perceived auditory performance. However, the lack of a significant relationship between tinnitus and SSQ scores implies that this symptom may involve a more complex interaction influenced by individual variability and perceptual tolerance levels.

Ghahraman et al. (2020) examined the effects of aging on spatial hearing using the SSQ questionnaire. In their study, the mean total SSQ score of older participants (7.25) was found to be significantly lower compared to that of younger participants (8.91)[16]. This decline was observed across all subscales, with a particularly pronounced decrease in the SP and SH subscales. Similarly, Singh and Pichora-Fuller (2010) reported a mean total SSQ score of 7.70 for older adults, compared to 8.80 for younger individuals[17]. In our study, the mean overall SSQ score among individuals with presbycusis was found to be 4.63 ± 1.93. This finding aligns with the results reported by Ghahraman et al. (2020) and Singh and Pichora-Fuller (2010), further supporting the observation that SSQ scores decline with advancing age. However, the

decline in scores observed in our study is more pronounced. This discrepancy may be attributed to the fact that older adults in previous studies had hearing thresholds better than 25 dB HL. In individuals with presbycusis, elevated hearing thresholds may have a more substantial impact on spatial hearing performance. Therefore, the negative impact of aging on spatial hearing is not solely attributable to age-related cognitive and sensory changes, but is further exacerbated by the presence of hearing loss. While spatial hearing tends to decline with age, the presence of hearing loss makes this deterioration more pronounced.

Maeda et al. (2018) conducted a cross-sectional study investigating the relationship between pure-tone hearing thresholds and SP in older adults. The study identified a negative correlation between pure-tone thresholds and SP. Based on their findings, the authors concluded that pure-tone audiometry is a strong predictor of speech perception and provides valuable information in the context of hearing aid fitting and cochlear implantation processes[4]. Similarly, in the present study, statistically significant negative correlations were observed between PTA and the SSQ subscale and overall mean scores in individuals diagnosed with presbycusis. In addition, a significant positive correlation was identified between SD scores and the SSQ-SP subscale mean scores. These findings indicate that deterioration in hearing thresholds and PTA adversely affects individuals" speech perception.

Another important finding of our study is the statistically significant, negative, and strong correlation between DHI total scores and SSQ-SH subscale mean scores. This result is consistent with previous studies demonstrating that as hearing loss increases, the risk of balance disturbances and falls also rises in affected individuals[18,19]. In other words, the presence of reduced auditory performance in individuals with high levels of dizziness, or the increase in dizziness severity due to diminished SP in individuals with presbycusis, supports the existence of a strong relationship between hearing and balance. These findings indicate that hearing plays a critical role not only in communication but also in maintaining postural stability. Therefore, in health and well-being interventions aimed at preventing balance disturbances and dizziness in older adults, auditory rehabilitation should be addressed as part of a comprehensive, holistic approach.

In our study, no statistically significant difference was found in overall SSQ scores between individuals with presbycusis who had chronic illnesses and those who did not. Baiduc et al. (2023) reported that chronic systemic conditions such as hypertension, diabetes, and coronary artery disease increase the likelihood of hearing loss in individuals[20]. There are studies in the literature that have examined the relationship between chronic diseases and hearing loss[21,22]. To date, no studies have specifically addressed the relationship between SSQ scores and chronic diseases. In our study, it was concluded that the presence of chronic illnesses in individuals with presbycusis did not have a significant impact on their subjective auditory performance. While the association between chronic diseases and hearing loss is well-documented in the literature, the specific effects of these conditions on more distinct auditory domains, such as spatial hearing, remain unclear. Therefore, future research is needed to examine this relationship in greater detail.

CONCLUSION

Hearing loss and dizziness in individuals with presbycusis negatively affect auditory-related quality of life, with spatial hearing being particularly impacted by dizziness. Therefore, the inclusion of subjective assessment scales in routine clinical evaluations of presbycusis is of considerable importance.

Conflict of Interest

The authors declare that they have no competing interests.

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