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Frequency, Type, and Degree of Hearing Loss Among Patients Presenting with Tinnitus: A Cross-Sectional Study at Pakistan Institute of Medical Sciences, Islamabad, Pakistan.

Zara Riaz Khan[1]*, Maarij Maqsood Khan[2], Manza Maqsood Khan[3], Syed Ansab Hasnain[4], Saleh Khurshied[5], Ghazal Iftakhar[6].

[1]*Senior Registrar, HBS Medical and Dental College Islamabad.*
[2]*House Officer, ENT Department, PAF Hospital, Islamabad.*
[3]*Associate Consultant, Maroof International Hospital, Islamabad.*
[4]*Assistant professor, Pakistan Institute of Medical Sciences, Islamabad.*
[5]*Speciality Registrar, Pakistan Institute of Medical Sciences, Islamabad.*
[6]*Post graduate trainee Otolaryngology, Pakistan Institute of Medical Sciences, Islamabad.*

Correspondence:
Zara Riaz Khan.
Senior Registrar, HBS Medical and Dental College Islamabad.

Email: zarariaz77@gmail.com

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Abstract

Background: Tinnitus is a common otological symptom that may be associated with underlying auditory dysfunction and hearing impairment. The coexistence of tinnitus and hearing loss can significantly affect communication, sleep, psychological well-being, and quality of life. However, limited data are available regarding the audiological characteristics of tinnitus patients in the Pakistani population. This study aimed to determine the frequency, type, degree, and laterality of hearing loss among patients presenting with tinnitus. ***Methods:*** This observational cross-sectional study was conducted in the Department of Otorhinolaryngology (ENT), Pakistan Institute of Medical Sciences (PIMS), Islamabad, from June 2024 to May 2026. A total of 132 consecutive patients presenting with unilateral or bilateral tinnitus were enrolled using a non-probability consecutive sampling technique. Both ears were evaluated separately, resulting in 263 ear observations. All participants underwent otoscopic examination and pure tone audiometry. Hearing loss was categorized as conductive, sensorineural, or mixed, and its severity was classified according to pure tone average thresholds. The association between gender and type of hearing loss was assessed using Pearson's chi-square test. ***Results:*** Among 263 examined ears, hearing loss was identified in 114 (86.36%) right ears and 113 (86.26%) left ears. Sensorineural hearing loss was the most common type, affecting 67 (50.76%) right ears and 60 (45.80%) left ears. Mixed hearing loss was observed in 26 (19.70%) right ears and 35 (26.72%) left ears, while conductive hearing loss was present in 21 (15.91%) right ears and 18 (13.74%) left ears. Mild hearing loss was the most frequently observed degree of impairment in both right (43.94%) and left (41.22%) ears. The association between gender and hearing loss type was not statistically significant in the right ear (p=0.414), whereas a significant association was observed in the left ear (p=0.002). Tympanic membrane abnormalities, including healed changes, retraction, and perforations, were identified in a proportion of examined ears. ***Conclusion:*** Hearing loss is highly prevalent among patients presenting with tinnitus, with sensorineural hearing loss being the predominant audiological abnormality. Comprehensive assessment using pure tone audiometry and otoscopic examination should be an integral part of tinnitus evaluation. Early detection of associated hearing impairment may facilitate appropriate counselling, rehabilitation, and individualized management to improve patient outcomes.

Keywords: Tinnitus; Hearing loss; Sensorineural hearing loss; Pure tone audiometry; Otoscopy; Audiological assessment; Pakistan.

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INTRODUCTION

Tinnitus is a frequently encountered symptom in otology, described as the perception of sound without the presence of an identifiable external sound source. Patients may perceive it in various forms, including ringing, buzzing, humming, whistling, or clicking sensations. Although tinnitus is considered a symptom rather than an independent disease entity, it may indicate dysfunction within the auditory system and can have a considerable impact on daily activities. Persistent tinnitus has been associated with sleep disturbance, difficulty concentrating, emotional distress, reduced productivity, and

impaired quality of life. Epidemiological studies have shown that tinnitus is prevalent worldwide, with increasing occurrence among individuals of advanced age and those exposed to prolonged noise [1,2].

The coexistence of tinnitus and hearing loss has been widely recognized, suggesting a close relationship between auditory deprivation and abnormal sound perception. Hearing loss may develop from pathology affecting different levels of the auditory pathway. Disorders involving the external ear or middle ear, including cerumen impaction, tympanic membrane disease, middle ear infections, and ossicular abnormalities, interfere with sound conduction and result in conductive hearing loss. In contrast, sensorineural hearing loss occurs due to impairment of cochlear structures or the auditory nerve and may develop because of aging, noise exposure, ototoxic agents, hereditary factors, or other inner ear conditions. When both conductive and sensorineural components coexist, the resulting impairment is classified as mixed hearing loss [3,4].

The mechanisms linking hearing loss with tinnitus are multifactorial and involve both peripheral and central auditory changes. Damage to cochlear structures can reduce normal auditory input, leading to compensatory alterations in the central auditory system. These changes may include increased neural activity, enhanced central auditory gain, and reorganization of auditory pathways, which can contribute to the perception of tinnitus. Previous studies have also demonstrated that tinnitus may be associated with high-frequency auditory dysfunction, and some patients may exhibit underlying cochlear abnormalities despite having apparently normal hearing thresholds on routine audiometry [5,6].

The occurrence and characteristics of hearing loss among individuals with tinnitus differ between populations. Variations may be related to differences in age, occupational and environmental noise exposure, underlying ear disease, duration of tinnitus, and methods used for hearing assessment. Existing literature indicates that sensorineural hearing loss is the most frequently observed type among tinnitus patients, reflecting the significant contribution of cochlear pathology. Nevertheless, conductive and mixed hearing losses may also play an important role, particularly in patients with middle ear disease, tympanic membrane abnormalities, or previous ear injuries [7,8].

Pure tone audiometry is an essential diagnostic investigation for evaluating hearing function and provides information regarding the presence, severity, and type of hearing impairment. Since patients with tinnitus may have measurable hearing deficits despite minimal subjective hearing complaints, audiological assessment is considered an important component of tinnitus evaluation. Identification of associated hearing loss allows clinicians to provide appropriate counselling, hearing rehabilitation, and individualized management [9].

In Pakistan, hearing impairment remains an important clinical concern due to the contribution of preventable factors such as chronic ear infections, environmental noise exposure, and delayed access to specialized hearing services. Despite the frequent association between tinnitus and hearing loss, limited information is available regarding the audiological characteristics of tinnitus patients in the local population. Data regarding the pattern of hearing loss, including its type, severity, laterality, and associated tympanic membrane abnormalities, are essential for improving clinical evaluation and management.

The present study was therefore conducted to determine the frequency, type, degree, and laterality of hearing loss among ears of patients presenting with tinnitus. The study also assessed tympanic membrane findings and evaluated the relationship between gender and hearing loss type. The results aim to provide further understanding of the audiological profile of tinnitus patients and emphasize the importance of comprehensive hearing assessment in routine tinnitus management.

MATERIALS AND METHODS

Study Design and Setting

This observational cross-sectional study was conducted in the Department of Otorhinolaryngology (ENT) at Pakistan Institute of Medical Sciences (PIMS), Islamabad, Pakistan. The study was carried out over a period of two years, from June 2024 to May 2026. The study was designed to determine the frequency, type, and degree of hearing loss among examined ears of patients presenting with tinnitus.

Study Population and Sampling Technique

Patients presenting with tinnitus to the ENT outpatient department during the study period were assessed for eligibility. A total of 132 consecutive patients fulfilling the predefined inclusion criteria were enrolled using a non-probability consecutive sampling technique.

Both ears of each participant were evaluated separately; therefore, audiological and otoscopic findings were analyzed on an ear-wise basis. A total of 263 ear observations were included in the final analysis.

Inclusion Criteria

Participants were included if they fulfilled the following criteria:

- Patients of either gender, and any age presenting with unilateral or bilateral tinnitus.
- Patients willing to participate in the study and provide written informed consent.
- For participants younger than 18 years, consent was obtained from a parent or legal guardian.

Exclusion Criteria

Patients were excluded if they had:

- Previous history of ear surgery.
- Congenital hearing impairment.
- Inability to undergo pure tone audiometry due to poor cooperation, cognitive impairment, or other limitations.
- Incomplete clinical or audiological records.
- Refusal to provide informed consent.

Data Collection Procedure

After obtaining informed consent, demographic information including age and gender was recorded using a structured data collection proforma. A detailed clinical history was obtained regarding tinnitus characteristics, including duration, laterality, severity, and associated symptoms.

Information regarding hearing difficulty, ear discharge, vertigo, previous ear infections, history of trauma, occupational or recreational noise exposure, and use of potentially ototoxic medications was also documented.

All participants underwent a comprehensive otorhinolaryngological examination. Otoscopic evaluation was performed to assess the external auditory canal and tympanic membrane status. Tympanic membrane findings were categorized as intact, dull, retracted, healed, or perforated. In cases of perforation, the size and type of perforation were recorded.

Audiological Assessment

Pure tone audiometry (PTA) was performed for all participants in a sound-treated environment using a calibrated diagnostic audiometer according to standard audiological protocols. Testing was conducted by a qualified audiologist.

Air conduction thresholds were measured at frequencies of 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, and 8000 Hz. Bone conduction thresholds were assessed from 250 Hz to 4000 Hz. The pure tone average (PTA) was calculated using thresholds at 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz.

Hearing loss was classified according to audiometric findings into:

- Normal hearing
- Conductive hearing loss
- Sensorineural hearing loss (SNHL)
- Mixed hearing loss

The degree of hearing impairment was categorized according to PTA values as:

- Normal hearing: ≤25 dB HL
- Mild hearing loss: 26–40 dB HL
- Moderate hearing loss: 41–55 dB HL
- Moderately severe hearing loss: 56–70 dB HL
- Severe hearing loss: 71–90 dB HL
- Profound hearing loss: >90 dB HL

Audiological findings were recorded separately for the right and left ears.

Study Variables

The primary outcome measure was the frequency of hearing loss among patients presenting with tinnitus.

Secondary outcome measures included:

- Type of hearing loss (sensorineural, conductive, or mixed)
- Degree of hearing loss
- Laterality of hearing impairment
- Tympanic membrane findings on otoscopy
- Association between gender and type of hearing loss

Ethical Considerations

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Ethical approval was obtained from the Institutional Review Board/Ethics Committee of Shaheed Zulfiqar Ali Bhutto Medical University, Islamabad (**Reference No: F.1-1/2015/ERB/SZABMU/792**) before initiation of the study.

Written informed consent was obtained from all participants before enrolment. For participants younger than 18 years, consent was obtained from a parent or legal guardian. All collected information was kept confidential, and patient identities were protected through anonymization of study data.

Statistical Analysis

Data were entered and analyzed using Statistical Package for the Social Sciences (SPSS) version 27.0 (IBM Corp., Armonk, NY, USA). Continuous variables were summarized using mean ± standard deviation (SD) or median with interquartile range (IQR), depending on data distribution. Categorical variables were expressed as frequencies and percentages.

Descriptive statistics were used to determine the frequency, type, and degree of hearing loss. Since both ears were assessed independently, audiological findings were analyzed separately for the right and left ears. The association between gender and type of hearing loss was evaluated using Pearson's chi-square test. A two-tailed p-value <0.05 was considered statistically significant.

RESULTS

A total of 263 ear observations from patients presenting with tinnitus were analyzed, including 132 right ears and 131 left ears. Pure tone audiometry was performed to determine the type and degree of hearing loss, while otoscopic examination was conducted to evaluate tympanic membrane findings. The distribution of different types of hearing loss is presented in Table 1. In the right ear, hearing loss was present in 114 (86.36%) ears, whereas 18 (13.64%) ears demonstrated normal hearing thresholds. Sensorineural hearing loss (SNHL) was the most common type identified in the right ear, affecting 67 (50.76%) ears, followed by mixed hearing loss in 26 (19.70%) ears and conductive hearing loss in 21 (15.91%) ears.

In the left ear, hearing loss was present in 113 (86.26%) ears, while 18 (13.74%) ears had normal hearing thresholds. Similar to the right ear, SNHL was the predominant type of hearing loss, observed in 60 (45.80%) ears. Mixed hearing loss was identified in 35 (26.72%) ears, whereas conductive hearing loss was present in 18 (13.74%) ears.

Table 1: Type of Hearing Loss in Examined Ears (N=263)

Type of Hearing Loss	Right Ear N (%)	Left Ear N (%)
Normal hearing	18 (13.64)	18 (13.74)
Sensorineural hearing loss (SNHL)	67 (50.76)	60 (45.80)
Mixed hearing loss	26 (19.70)	35 (26.72)
Conductive hearing loss	21 (15.91)	18 (13.74)
Total	**132 (100.00)**	**131 (100.00)**

The degree of hearing loss among examined ears is summarized in Table 2. In the right ear, mild hearing loss was the most frequently observed category, present in 58 (43.94%) ears, followed by severe hearing loss in 24 (18.18%) ears, moderately severe hearing loss in 19 (14.39%) ears, and profound hearing loss in 13 (9.85%) ears. Normal hearing thresholds were observed in 18 (13.64%) right ears.

In the left ear, mild hearing loss was also the most common degree of impairment, affecting 54 (41.22%) ears. Severe hearing loss was observed in 27 (20.61%) ears, followed by profound hearing loss in 18 (13.74%) ears and moderately severe hearing loss in 14 (10.69%) ears. Normal hearing thresholds were present in 18 (13.74%) left ears.

Table 2: Degree of Hearing loss in Examined Ears (N=263)

Degree of Hearing Loss	Right Ear N (%)	Left Ear N (%)
Normal hearing	18 (13.64)	18 (13.74)
Mild	58 (43.94)	54 (41.22)
Moderately severe	19 (14.39)	14 (10.69)
Severe	24 (18.18)	27 (20.61)
Profound	13 (9.85)	18 (13.74)
Total	**132 (100.00)**	**131 (100.00)**

The association between gender and type of hearing loss in the right ear is presented in Table 3. Among males, SNHL was the most frequent hearing loss category, observed in 37 (45.68%) ears, followed by mixed hearing loss in 16 (19.75%) ears and conductive hearing loss in 15 (18.52%) ears. Among females, SNHL was also the most common finding, present in 30 (58.82%) ears, followed by mixed hearing loss in 10 (19.61%) ears and conductive hearing loss in 6 (11.76%) ears.

Pearson's chi-square test demonstrated that the association between gender and type of hearing loss in the right ear was not statistically significant (p=0.416).

Table 3: Association Between Gender and Type of Hearing Loss in Right Ear (N=132)

Gender	Normal N (%)	SNHL N (%)	Mixed N (%)	Conductive N (%)	Total N (%)
Male	13 (16.05)	37 (45.68)	16 (19.75)	15 (18.52)	81 (100.00)
Female	5 (9.80)	30 (58.82)	10 (19.61)	6 (11.76)	51 (100.00)
Total	18 (13.64)	67 (50.76)	26 (19.70)	21 (15.91)	132 (100.00)
Pearson Chi-square test: p = 0.414 (not statistically significant)					

The relationship between gender and type of hearing loss in the left ear is demonstrated in Table 4. Among males, SNHL was observed in 27 (35.06%) ears, followed by mixed hearing loss in 22 (28.57%) ears and conductive hearing loss in 15 (19.48%) ears. Among females, SNHL was the predominant type of hearing loss, affecting 33 (61.11%) ears, followed by mixed hearing loss in 13 (24.07%) ears and conductive hearing loss in 3 (5.56%) ears.
Pearson's chi-square test demonstrated a statistically significant association between gender and type of hearing loss in the left ear (p=0.002).

Table 4: Association Between Gender and Type of Hearing Loss in Left Ear (N=131)

Gender	Normal N (%)	SNHL N (%)	Mixed N (%)	Conductive N (%)	Total N (%)
Male	13 (16.88)	27 (35.06)	22 (28.57)	15 (19.48)	77 (100.00)
Female	5 (9.26)	33 (61.11)	13 (24.07)	3 (5.56)	54 (100.00)
Total	18 (13.74)	60 (45.80)	35 (26.72)	18 (13.74)	131 (100.00)
Pearson Chi-square test: p = 0.002 (statistically significant)					

The otoscopic findings of the tympanic membrane are summarized in Table 5. In the right ear, an intact tympanic membrane was the most common finding, observed in 48 (36.4%) ears, followed by healed tympanic membrane changes in 27 (20.5%) ears. Dull tympanic membranes were observed in 17 (12.9%) ears, while retraction was noted in 11 (8.3%) ears. Among tympanic membrane perforations in the right ear, large-sized perforations were most frequent, occurring in 10 (7.6%) ears, followed by small-sized perforations in 7 (5.3%), subtotal perforations in 7 (5.3%), medium-sized perforations in 4 (3.0%), and total perforations in 1 (0.8%) ear.

In the left ear, an intact tympanic membrane was present in 39 (29.8%) ears, while healed tympanic membrane changes were observed in 29 (22.1%) ears. Dull tympanic membranes were found in 18 (13.7%) ears and retraction in 17 (13.0%) ears. Large-sized perforations were the most common perforation type, affecting 12 (9.2%) ears, followed by small-sized perforations in 9 (6.9%), total perforations in 3 (2.3%), and subtotal and medium-sized perforations in 2 (1.5%) ears each. Overall, sensorineural hearing loss was the predominant audiological abnormality among patients presenting with tinnitus, while tympanic membrane abnormalities were identified in a proportion of examined ears.

Table 5: Tympanic Membrane Findings in Examined Ears (N=263)

Tympanic Membrane Findings	Right Ear N (%)	Left Ear N (%)
Intact	48 (36.4)	39 (29.8)
Healed	27 (20.5)	29 (22.1)
Dull	17 (12.9)	18 (13.7)
Retracted	11 (8.3)	17 (13.0)
Large-sized perforation	10 (7.6)	12 (9.2)
Small-sized perforation	7 (5.3)	9 (6.9)
Subtotal perforation	7 (5.3)	2 (1.5)
Medium-sized perforation	4 (3.0)	2 (1.5)
Total perforation	1 (0.8)	3 (2.3)
Total	**132 (100.0)**	**131 (100.0)**

DISCUSSION

Tinnitus is a common otological symptom associated with dysfunction of the auditory system. The present study evaluated the frequency, type, and degree of hearing loss among patients presenting with tinnitus using an ear-wise analysis approach. A total of 263 ear observations were assessed, including 132 right ears and 131 left ears. Hearing impairment was highly prevalent, with hearing loss identified in 114 (86.36%) right ears and 113 (86.26%) left ears. These findings demonstrate a strong association between tinnitus and auditory dysfunction and emphasize the importance of routine audiological evaluation in patients presenting with tinnitus.

The high prevalence of hearing loss observed in this study is consistent with previous research demonstrating a close relationship between tinnitus and auditory impairment. Waechter and Brännström reported that tinnitus-related distress is associated with extended high-frequency hearing loss, supporting the contribution of cochlear dysfunction to tinnitus perception [10]. Similarly, Martines et al. observed that hearing loss was frequently associated with tinnitus, with sensorineural hearing loss being the predominant audiological abnormality [11]. Differences in reported prevalence among studies may be attributed to variations in age distribution, tinnitus characteristics, duration of symptoms, noise exposure, underlying ear pathology, and differences in audiological assessment methods.

In the current study, sensorineural hearing loss (SNHL) was the predominant type of hearing impairment in both ears. SNHL was identified in 67 (50.76%) right ears and 60 (45.80%) left ears. Mixed hearing loss was the second most frequent category, affecting 26 (19.70%) right ears and 35 (26.72%) left ears, while conductive hearing loss was observed in 21 (15.91%) right ears and 18 (13.74%) left ears. These findings are consistent with previous studies indicating that sensorineural abnormalities represent the most common form of hearing impairment associated with tinnitus.

The predominance of SNHL may be explained by cochlear injury and subsequent alterations in central auditory processing. Damage to cochlear hair cells or auditory nerve structures reduces normal auditory input and may result in increased spontaneous neural activity, enhanced central auditory gain, and cortical reorganization, which contribute to tinnitus perception [12–14]. Furthermore, cochlear synaptopathy or hidden hearing loss may contribute to tinnitus symptoms even in patients with normal conventional audiograms, highlighting the importance of detailed audiological evaluation in tinnitus patients [6].

The degree of hearing loss varied among examined ears, with mild hearing loss being the most frequently observed category. Mild hearing loss was present in 58 (43.94%) right ears and 54 (41.22%) left ears. Severe hearing loss was identified in 24 (18.18%) right ears and 27 (20.61%) left ears, while profound hearing loss was observed in 13 (9.85%) right ears and 18 (13.74%) left ears. Similar findings have been reported in previous studies, where tinnitus patients commonly demonstrated mild-to-moderate hearing impairment [10,11]. The presence of tinnitus despite relatively mild hearing loss suggests that tinnitus perception is not determined solely by peripheral hearing thresholds but may also involve central auditory processing, neural plasticity, and individual susceptibility [6].

The association between gender and hearing loss type was evaluated separately for both ears. In the right ear, SNHL was the most frequent category among both males and females, affecting 37 (45.68%) male ears and 30 (58.82%) female ears, with no statistically significant association between gender and hearing loss type ($p=0.414$). In the left ear, SNHL was most frequent among females (61.11%), and a statistically significant association between gender and hearing loss type was observed ($p=0.002$). Although gender differences were observed, hearing outcomes may also be influenced by additional factors such as age, duration of tinnitus, occupational exposure, environmental noise exposure, and underlying ear disease.

Otoscopic examination demonstrated a variety of tympanic membrane abnormalities among examined ears. In the right ear, intact tympanic membranes were observed in 48 (36.4%) ears, while healed changes were present in 27 (20.5%) ears. Perforations of different sizes were also identified, including large-sized perforations in 10 (7.6%) ears, small-sized perforations in 7 (5.3%), subtotal perforations in 7 (5.3%), medium-sized perforations in 4 (3.0%), and total perforation in 1 (0.8%) ear. In the left ear, intact tympanic membranes were present in 39 (29.8%) ears, healed changes in 29 (22.1%) ears, and various perforation patterns were observed. These tympanic membrane abnormalities may contribute to conductive and mixed hearing loss among tinnitus patients. Previous studies have reported the association between tympanic membrane perforation and hearing impairment, supporting the importance of otoscopic evaluation during tinnitus assessment [15].

Environmental and occupational noise exposure represents another important factor contributing to auditory dysfunction and tinnitus. Previous epidemiological evidence has demonstrated that noise exposure is associated with increased risk of hearing loss through cochlear damage and may contribute to tinnitus development [16]. This highlights the importance of assessing relevant exposure history during the evaluation of tinnitus patients.

The findings of this study have important clinical implications. Since more than 85% of examined ears demonstrated measurable hearing impairment, comprehensive audiological assessment should be considered an essential component of tinnitus evaluation. Identification of associated hearing loss allows appropriate counselling, hearing rehabilitation, and individualized management. Hearing amplification, when indicated, may improve auditory input and reduce tinnitus-related distress by reducing the effects of auditory deprivation [17].

This study has several limitations. The cross-sectional design prevents assessment of the temporal relationship between tinnitus and hearing loss. The single-centre setting may limit generalizability of the findings. Additionally, advanced investigations such as extended high-frequency audiometry, otoacoustic emissions, and validated tinnitus severity questionnaires were not performed, which could have provided further information regarding cochlear function and tinnitus severity.

Despite these limitations, this study provides valuable information regarding the audiological profile of patients presenting with tinnitus. The high prevalence of sensorineural hearing loss, presence of tympanic membrane abnormalities, and significant frequency of hearing impairment emphasize the importance of comprehensive otological and audiological assessment. Early identification and appropriate management of hearing loss may improve functional outcomes and quality of life among individuals with tinnitus.

CONCLUSION

This study demonstrates that hearing impairment is highly prevalent among patients presenting with tinnitus, with more than 85% of examined ears showing measurable hearing loss. Sensorineural hearing loss was the predominant audiological abnormality, followed by mixed and conductive hearing loss. Mild hearing loss was the most frequently observed degree of impairment; however, a considerable proportion of patients also had severe and profound hearing deficits, indicating variable degrees of auditory involvement.

The association between gender and hearing loss type showed no significant relationship in the right ear, while a significant association was observed in the left ear. Tympanic membrane abnormalities were identified in a proportion of examined ears, highlighting the contribution of middle ear pathology to conductive and mixed hearing loss. Comprehensive evaluation using pure tone audiometry and otoscopic examination should be considered an essential part of tinnitus assessment. Early identification of associated hearing impairment may facilitate timely counselling, rehabilitation, and individualized management, ultimately improving functional outcomes and quality of life in patients with tinnitus.

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