



Original Research Article

Influence of Type 2 Diabetes Mellitus on Age-Related Hearing Decline in the Elderly: A Cross-Sectional Study

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Abstract: Background: Age-related hearing loss, or Presbycusis, is a common condition in the elderly and may be influenced by systemic disorders. Type 2 Diabetes Mellitus has been proposed as a contributing factor due to its microvascular and neuropathic effects. However, the relationship between diabetes and hearing impairment remains uncertain. The present study aimed to determine the prevalence of sensorineural hearing loss among elderly individuals with Type 2 Diabetes Mellitus. **Materials and Methods:** This cross-sectional comparative study was conducted over a period of 6 months in a tertiary care hospital. A total of 140 participants aged 60 years and above were included, comprising 70 patients with Type 2 Diabetes Mellitus and 70 age-matched non-diabetic controls. All participants underwent detailed clinical evaluation and pure tone audiometry. Only cases with bilateral symmetrical sensorineural hearing loss were considered. Data were analyzed using appropriate statistical tests, and a p-value <0.05 was considered statistically significant. **Results:** Sensorineural hearing loss was observed in 74.3% of diabetic participants compared to 48.6% of non-diabetics, showing a statistically significant difference ($p = 0.002$). Diabetic individuals demonstrated higher mean hearing thresholds across all frequencies, with greater involvement at higher frequencies. The severity of hearing loss was also significantly greater in the diabetic group ($p = 0.012$). An increasing trend in hearing loss was noted with longer duration of diabetes ($p = 0.04$). **Conclusion:** Type 2 Diabetes Mellitus is associated with a higher prevalence and increased severity of sensorineural hearing loss in the elderly. Early audiological screening in diabetic patients may aid in timely identification and management of hearing impairment.

Keywords: Presbycusis; Type 2 Diabetes Mellitus; Sensorineural Hearing Loss; Pure Tone Audiometry; Elderly.

INTRODUCTION

Age-related hearing loss, commonly referred to as Presbycusis, is one of the most prevalent chronic conditions affecting the elderly population worldwide. It is characterized by a progressive, bilateral, and symmetrical decline in auditory

sensitivity, with predominant involvement of higher frequencies [1]. This form of hearing impairment not only affects the ability to perceive sounds but also interferes with speech discrimination, especially in noisy environments. As a result, it has a significant negative impact on communication, social

engagement, emotional well-being, and overall quality of life in older adults [2].

With increasing life expectancy and a growing aging population, the burden of hearing impairment is expected to rise substantially in the coming decades. Hearing loss in the elderly is often multifactorial in origin, involving both intrinsic aging processes and extrinsic contributing factors. While degeneration of cochlear structures such as hair cells, spiral ganglion neurons, and the stria vascularis plays a central role, systemic conditions are increasingly recognized as important modifiers of auditory function [3].

Among these, Type 2 Diabetes Mellitus has emerged as a significant factor of interest. Diabetes mellitus is a global health concern with rapidly increasing prevalence, particularly among the elderly. It is associated with a wide spectrum of microvascular and macrovascular complications affecting organs such as the eyes, kidneys, nerves, and cardiovascular system. Given the rich vascular supply and metabolic demands of the cochlea, it is plausible that similar pathological processes may also affect auditory structures [4].

The pathophysiological mechanisms linking diabetes to hearing loss are complex and multifactorial. Chronic hyperglycemia can lead to microangiopathy, resulting in reduced blood flow to the cochlea and subsequent ischemic damage [5]. Additionally, accumulation of advanced glycation end products and increased oxidative stress may contribute to cellular dysfunction and apoptosis within cochlear tissues [6]. Neural involvement, including degeneration of the auditory nerve and central auditory pathways, has also been proposed. These changes may ultimately manifest as sensorineural hearing loss, potentially accelerating the natural course of presbycusis.

Previous studies investigating the association between diabetes and hearing impairment have yielded variable results. Some studies have demonstrated a higher prevalence and greater severity of hearing loss among diabetic individuals, while others have reported no significant association. Such inconsistencies may be attributed to differences in study design, sample size, diagnostic criteria, and control of confounding variables such as age, noise exposure, and comorbid conditions. Furthermore, important factors such as duration of diabetes and level of glycemic control have not been uniformly evaluated, limiting the ability to draw definitive conclusions.

In the context of an aging population with a rising prevalence of diabetes, understanding the relationship between these two conditions assumes considerable clinical importance. Early identification

of hearing impairment in diabetic patients may facilitate timely intervention, including hearing rehabilitation and improved metabolic control. This, in turn, may help reduce the impact of disability and enhance quality of life in the elderly.

Therefore, the present study was undertaken to evaluate the influence of Type 2 Diabetes Mellitus on age-related hearing decline in elderly individuals, with particular emphasis on the prevalence, severity, and audiometric characteristics of sensorineural hearing loss.

METHODOLOGY

Study Design and Setting

This cross-sectional comparative study was carried out in the Department of Otorhinolaryngology at a tertiary care teaching hospital over a period of 6 months from July 2025 to December 2025.

Study Population

The study enrolled individuals aged 60 years and above attending the outpatient department during the study period. Written informed consent was obtained from all participants prior to inclusion in the study. Participants were categorized into two groups: patients with Type 2 Diabetes Mellitus (diabetic group) and age-matched individuals without diabetes (control group). A total of 140 participants were included, comprising 70 diabetic and 70 non-diabetic individuals. The sample size was determined based on feasibility and reference to similar previously published studies.

Inclusion Criteria:

- Age ≥ 60 years
- Willingness to participate with provision of written informed consent
- Confirmed diagnosis of Type 2 Diabetes Mellitus for the diabetic group

Exclusion Criteria:

- History of middle ear disease, including chronic otitis media
- Previous ear surgery or trauma
- Significant exposure to occupational noise
- Intake of known ototoxic medications
- Presence of conductive or mixed hearing loss

Clinical Assessment

All participants underwent a detailed clinical evaluation, including history taking and general physical examination. Information regarding duration of diabetes, treatment status, and associated comorbidities was recorded for diabetic participants. Glycemic status was assessed using available laboratory parameters, including fasting blood glucose and postprandial blood glucose.

Audiological Evaluation

Hearing assessment was performed using pure tone audiometry in a sound-treated environment. Air conduction thresholds were measured at frequencies ranging from 250 Hz to 8000 Hz, and bone conduction thresholds where required.

Hearing loss was classified according to standard World Health Organization criteria [7]. Presbycusis was defined as bilateral, symmetrical sensorineural hearing loss predominantly involving higher frequencies in elderly individuals. Type of hearing loss was determined based on air and bone conduction thresholds. Only cases with bilateral symmetrical sensorineural hearing loss were included in the analysis.

Outcome Measures

The primary outcome was the prevalence and

severity of sensorineural hearing loss among diabetic and non-diabetic participants. Secondary outcomes included comparison of mean hearing thresholds between groups and evaluation of the relationship between sensorineural hearing loss and duration or control of diabetes.

Statistical Analysis

Data were compiled and analyzed using Statistical Package for the Social Sciences (SPSS) software version 26.0. Continuous variables were expressed as mean and standard deviation, while categorical variables were presented as frequencies and percentages. Comparisons between groups were performed using the independent samples t-test for continuous variables and the chi-square test for categorical data. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 140 participants were included in the study, comprising 70 individuals with Type 2 Diabetes Mellitus and 70 age-matched non-diabetic controls. The age distribution of participants in both groups was comparable, with the majority belonging to the 60–65 years age group. There was no statistically significant difference in age distribution between diabetics and non-diabetics ($p = 0.87$) (Table 1). Similarly, gender distribution was comparable between the two groups, with a slight male predominance observed overall. However, the difference was not statistically significant ($p = 0.73$) (Table 2).

Table 1: Age Distribution of Study Participants

Age Group (years)	Diabetics (n=70)	Non-diabetics (n=70)	Total	p-value
60–65	28 (40.0%)	30 (42.9%)	58	
66–70	22 (31.4%)	20 (28.6%)	42	
71–75	12 (17.1%)	11 (15.7%)	23	
>75	8 (11.4%)	9 (12.9%)	17	
Total	70 (100%)	70 (100%)	140	0.87

Values expressed as number (%). Comparison performed using Chi-square test.

Table 2: Gender Distribution of Study participants

Gender	Diabetics (n=70)	Non-diabetics (n=70)	Total	p-value
Male	38 (54.3%)	36 (51.4%)	74	
Female	32 (45.7%)	34 (48.6%)	66	
Total	70 (100%)	70 (100%)	140	0.73

Values expressed as number (%). No statistically significant difference between groups.

Sensorineural hearing loss (SNHL) was observed in 52 (74.3%) diabetic participants compared to 34 (48.6%) non-diabetic individuals. This difference was statistically significant ($p = 0.002$), indicating a higher prevalence of SNHL among diabetic patients (Table 3).

Table 3: Prevalence of Sensorineural Hearing Loss (SNHL)

Hearing Status	Diabetics (n=70)	Non-diabetics (n=70)	p-value
SNHL Present	52 (74.3%)	34 (48.6%)	
Normal Hearing	18 (25.7%)	36 (51.4%)	
Total	70	70	0.002

SNHL – Sensorineural hearing loss

Analysis of the degree of hearing loss showed that diabetic participants had a higher proportion of moderate to severe SNHL compared to non-diabetics. In contrast, normal hearing was more commonly observed in the non-diabetic group. The difference in distribution of severity between the two groups was statistically significant ($p = 0.012$) (Table 4).

Table 4: Degree of Sensorineural Hearing Loss (WHO Classification)

Degree of SNHL	Diabetics (n=70)	Non-diabetics (n=70)	p-value
Normal	18 (25.7%)	36 (51.4%)	
Mild SNHL	20 (28.6%)	18 (25.7%)	
Moderate SNHL	18 (25.7%)	10 (14.3%)	
Moderately Severe SNHL	10 (14.3%)	4 (5.7%)	
Severe SNHL	4 (5.7%)	2 (2.9%)	
Total	70	70	0.012

Values expressed as number (%). Comparison between groups was performed using Fisher's Exact test due to small expected frequencies in some cells.

The mean hearing thresholds were higher in diabetic individuals across all tested frequencies. The difference was statistically significant at all frequencies, with more pronounced elevation at higher frequencies (2000 Hz, 4000 Hz, and 8000 Hz), suggesting predominant high-frequency involvement (Table 5).

Table 5: Comparison of Mean Hearing Thresholds (dB) in SNHL

Frequency	Diabetics (Mean $\pm$ SD)	Non-diabetics (Mean $\pm$ SD)	p-value
500 Hz	28.5 $\pm$ 6.2	24.1 $\pm$ 5.8	0.01
1000 Hz	32.4 $\pm$ 7.1	27.6 $\pm$ 6.3	0.003
2000 Hz	38.7 $\pm$ 8.5	31.2 $\pm$ 7.4	<0.001
4000 Hz	52.6 $\pm$ 10.2	41.8 $\pm$ 9.6	<0.001
8000 Hz	60.3 $\pm$ 11.5	48.7 $\pm$ 10.8	<0.001

Values represent air conduction thresholds. Findings are consistent with high-frequency SNHL. Independent t-test applied.

An increasing trend in the prevalence of SNHL was observed with longer duration of diabetes. Participants with duration greater than 10 years showed the highest prevalence of hearing loss. This association was statistically significant ($p = 0.04$) (Table 6).

Table 6: Association Between Duration of Diabetes and SNHL

Duration of Diabetes	SNHL Present	Total	p-value
<5 years	12 (60.0%)	20	
5–10 years	20 (76.9%)	26	
>10 years	20 (83.3%)	24	
Total	52	70	0.04

Increasing duration of diabetes showed a significant association with SNHL. Chi-square test applied.

DISCUSSION

The present study was undertaken to evaluate the influence of Type 2 Diabetes Mellitus on age-related hearing decline in elderly individuals. The findings of this study demonstrate a significantly higher prevalence as well as greater severity of sensorineural hearing loss among diabetic participants when compared to age-matched non-diabetic controls, suggesting a meaningful association between metabolic dysfunction and auditory impairment. In the current study, a substantially higher proportion of diabetic individuals exhibited

sensorineural hearing loss. This observation supports the concept that diabetes may act as an accelerating factor in auditory degeneration, beyond the expected effects of physiological aging alone. Comparable findings have been reported in several earlier investigations, where an increased burden of hearing impairment was noted among individuals with diabetes [4,8-10]. The findings of the present study are consistent with previous meta-analyses, which have reported a significantly higher prevalence of hearing loss among individuals with Type 2 Diabetes Mellitus [6]. However, the literature remains

heterogeneous, with some studies failing to establish a statistically significant association [11,12]. Such discrepancies may be attributed to variations in study design, sample characteristics, diagnostic criteria, and control of confounding variables such as age, occupational noise exposure, and coexisting systemic illnesses.

An important observation in this study was the greater severity of hearing loss among diabetic participants. A higher proportion of individuals in the diabetic group demonstrated moderate to severe degrees of impairment compared to controls, indicating that diabetes may influence not only the occurrence but also the progression of hearing loss [3,13]. This finding is clinically relevant, as increasing severity of hearing impairment is associated with greater functional disability. The progression may be explained by cumulative structural and functional damage within the cochlea resulting from long-standing metabolic derangements.

The comparison of hearing thresholds revealed significantly elevated values in diabetic individuals across all tested frequencies, with a more marked difference at higher frequencies. This pattern is characteristic of Presbycusis, which predominantly affects the basal turn of the cochlea responsible for high-frequency sound perception. The greater degree of high-frequency involvement observed in diabetic participants suggests an additive or synergistic effect of diabetes-related cochlear damage on the natural aging process[14].

The present study also demonstrated a significant association between duration of diabetes and the prevalence of hearing loss. Similar findings were reported by Srinivas et al.[15], who observed a high prevalence of sensorineural hearing loss among diabetic patients, with significant association with longer duration of disease and poor glycemic control. Participants with a longer duration of the disease exhibited a higher frequency of sensorineural hearing loss, indicating a cumulative effect over time. Chronic hyperglycemia is known to induce progressive microvascular and neural damage, and prolonged exposure may exacerbate cochlear dysfunction [16]. This temporal relationship highlights the importance of long-term metabolic control in preserving auditory function.

The pathophysiological basis of hearing impairment in diabetes is multifactorial and involves both vascular and neural mechanisms. Microangiopathy affecting the cochlear vasculature can lead to reduced oxygen and nutrient supply, resulting in ischemic damage to the stria vascularis and hair cells. In addition, oxidative stress and the accumulation of advanced glycation end products may contribute to

cellular degeneration and apoptosis within cochlear structures[10,14]. Neural involvement, including degeneration of spiral ganglion cells and the eighth cranial nerve, may further impair signal transmission. Structural changes such as thickening of the basilar membrane and loss of outer hair cells have also been described, collectively leading to sensorineural hearing loss.

From a clinical perspective, the findings of this study underscore the importance of early detection of hearing impairment in diabetic patients. Hearing loss in the elderly often goes unrecognized and untreated, leading to social isolation, depression, and reduced quality of life. Incorporating routine audiological evaluation into the management of patients with Type 2 Diabetes Mellitus may facilitate early diagnosis and timely rehabilitation, including the use of hearing aids and counseling. Furthermore, awareness of this association may encourage clinicians to adopt a more holistic approach in the management of diabetes, emphasizing not only glycemic control but also the prevention of sensory complications.

Despite these important findings, the study has certain limitations. As a cross-sectional study, it does not establish a causal relationship between diabetes and hearing loss. Longitudinal studies would be required to determine the temporal sequence and progression of auditory impairment in diabetic individuals. The study was conducted in a single center with a relatively limited sample size, which may restrict the generalizability of the results to the broader population. Additionally, although efforts were made to exclude major confounding factors, the influence of variables such as subclinical noise exposure, nutritional status, and genetic susceptibility cannot be entirely ruled out.

Future research with larger sample sizes, multicentric designs, and longitudinal follow-up is warranted to further elucidate the relationship between diabetes and hearing loss. Studies incorporating advanced audiological and imaging techniques may provide deeper insights into the underlying mechanisms. Evaluation of the role of glycemic control and therapeutic interventions in preventing or slowing auditory decline would also be of significant clinical value.

CONCLUSION

The present study demonstrates that Type 2 Diabetes Mellitus is associated with a higher prevalence and greater severity of sensorineural hearing loss in the elderly population. Diabetic individuals showed significantly elevated hearing thresholds, particularly at higher frequencies, indicating an additive effect of metabolic factors on age-related auditory decline. A longer duration of diabetes was also found to be

associated with an increased occurrence of hearing impairment, suggesting a cumulative impact of chronic hyperglycemia on cochlear function. These findings highlight the importance of early identification of hearing loss in diabetic patients. Routine audiological evaluation should be considered as part of the clinical assessment of elderly individuals with diabetes to facilitate timely intervention and improve overall quality of life.

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