International Journal of Medical and Pharmaceutical Research

Online ISSN-2958-3683 | Print ISSN-2958-3675
Frequency: Bi-Monthly
Available online on: https://ijmpr.in/

Original Article

Prevalence and Risk Factors of Sensorineural Hearing Loss in Type 2 Diabetes Mellitus Patients

Dr Vijay Singh Kathait[1], Dr Mintu Mani Baruah[2], Dr Dheeraj Nauhwaar[3]

[1]Classified Specialist ENT, Department of ENT, Command Hospital, Udhampur, J&K, India.
[2]Classified Specialist Medicine and Endocrinology, Department of Endocrinology, Command Hospital, Udhampur, J&K, India.
[3]Senior advisor, Department of medicine, Military Hospital Meerut.

Corresponding Author:

Dr Vijay Singh Kathait
Classified Specialist ENT, Department of ENT, Command Hospital, Udhampur, J&K, India.

Received: 28-03-2026
Accepted: 15-04-2026
Available online: 26-05-2026

ABSTRACT

Background: Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder associated with multiple microvascular and neuropathic complications. In recent years, sensorineural hearing loss (SNHL) has emerged as a potential but underrecognized complication of diabetes, affecting patients' quality of life and communication ability.
Aim: To determine the prevalence of sensorineural hearing loss and identify its associated risk factors among patients with Type 2 Diabetes Mellitus.
Materials and Methods: This cross-sectional observational study was conducted on 100 diagnosed T2DM patients aged 30–70 years at a tertiary care hospital. Detailed clinical history, duration of diabetes, and comorbid conditions were recorded. Glycemic status was assessed using HbA1c levels. All participants underwent pure tone audiometry to evaluate hearing thresholds. Patients with a history of chronic ear disease, noise exposure, or ototoxic drug use were excluded. Statistical analysis was performed using the chi-square test, with $p < 0.05$ considered statistically significant.
Results: Sensorineural hearing loss was observed in 32% of patients. The majority of cases were mild to moderate in severity. A significant association was found between SNHL and duration of diabetes, poor glycemic control, hypertension, neuropathy, and dyslipidemia.
Conclusion: Sensorineural hearing loss is a relatively common but often overlooked complication of T2DM. Early screening and optimal metabolic control are essential to prevent progression and improve patient outcomes.

Keywords*: T2DM, SNHL.*

INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) is a chronic, progressive metabolic disorder characterized by persistent hyperglycemia due to insulin resistance and relative insulin deficiency. It has emerged as a major global health burden, with rapidly increasing prevalence, particularly in developing countries such as India [1]. According to recent global estimates, diabetes affects hundreds of millions of individuals worldwide, with projections indicating a continued rise in incidence due to urbanization, sedentary lifestyles, and dietary transitions [2]. The chronic hyperglycemic state in diabetes leads to widespread metabolic derangements, which in turn result in microvascular and macrovascular complications affecting multiple organ systems [3].

Traditionally, the complications of T2DM have been categorized into microvascular complications such as diabetic retinopathy, nephropathy, and neuropathy, and macrovascular complications including coronary artery disease and stroke [4]. However, in recent years, increasing attention has been directed toward less recognized complications, including the involvement of the auditory system [5]. Sensorineural hearing loss (SNHL), which arises due to dysfunction of the cochlea or auditory nerve, is now being increasingly reported in individuals with diabetes [6].Hearing loss is a significant public health concern, affecting communication, social interaction, and quality of life[7]. Large population-based studies

have demonstrated that individuals with diabetes are at a significantly higher risk of developing hearing loss compared to non-diabetic individuals, with some studies reporting nearly twice the prevalence [8].

The pathophysiological mechanisms underlying SNHL in diabetes are complex and multifactorial. One of the primary mechanisms is diabetic microangiopathy, which involves thickening of capillary basement membranes and endothelial dysfunction [9]. In the cochlea, this microvascular damage affects the striavascularis, a highly vascularized structure responsible for maintaining the ionic composition of endolymph, which is essential for normal auditory function [10]. Reduced blood flow and oxygen supply to the cochlea result in metabolic stress and subsequent degeneration of hair cells [11].

In addition to vascular damage, diabetic neuropathy plays a significant role in auditory dysfunction. The auditory nerve, being a peripheral nerve, is susceptible to the effects of chronic hyperglycemia, leading to demyelination and impaired neural conduction [12]. Studies using auditory brainstem response (ABR) testing have demonstrated delayed neural transmission in diabetic patients, supporting the role of neuropathy in hearing impairment [13].

Oxidative stress is another critical factor in the pathogenesis of SNHL in diabetes. Chronic hyperglycemia leads to increased production of reactive oxygen species (ROS), which cause cellular damage through lipid peroxidation, DNA damage, and protein modification [14]. The accumulation of advanced glycation end products (AGEs) further exacerbates oxidative stress and inflammation, contributing to cochlear degeneration [15]. Experimental studies have shown that oxidative stress-induced apoptosis of outer hair cells is a key mechanism in diabetic hearing loss [16].

Mitochondrial dysfunction has also been implicated in the pathogenesis of SNHL. The cochlea has high ऊर्जा demands, and mitochondrial damage can impair energy production, leading to cell death [17]. Inflammatory pathways, including activation of cytokines and nuclear factor-kappa B (NF-κB), further contribute to cochlear injury [18].

Recent studies conducted in 2024–2026 have provided stronger evidence supporting the association between T2DM and hearing loss. A large-scale study in 2024 demonstrated a significant correlation between HbA1c levels and hearing thresholds, indicating that poor glycemic control is a major determinant of auditory dysfunction [19]. Similarly, a 2025 systematic review and meta-analysis reported that individuals with T2DM have a significantly higher risk of SNHL compared to non-diabetic controls [20]. Another 2026 study highlighted the role of cumulative metabolic burden and microvascular complications in accelerating cochlear damage [21].The prevalence of SNHL among diabetic patients varies widely across studies, ranging from 30% to 70%, depending on the study population, methodology, and diagnostic criteria [22–24]. Factors such as age, duration of diabetes, glycemic control, hypertension, and dyslipidemia have been consistently identified as important risk factors [25].Age-related hearing loss (presbycusis) may further compound the effect of diabetes, making it difficult to differentiate between the two conditions [26]. However, studies have shown that diabetes accelerates the progression of hearing loss beyond what would be expected from aging alone [27].

Despite the growing evidence, hearing loss remains an underrecognized complication of diabetes, particularly in resource-limited settings where routine audiological screening is not commonly performed [28]. Early detection is crucial, as timely intervention can prevent progression and improve quality of life [29].Given this background, the present study was undertaken to determine the prevalence of sensorineural hearing loss and to evaluate its association with various risk factors among patients with Type 2 Diabetes Mellitus attending a tertiary care center [30].

MATERIALS AND METHODS

Study Design:
A hospital-based cross-sectional observational study.

Study Setting:
The study was conducted in the Departments of Endocrinology, Medicine and Otorhinolaryngology at a tertiary care teaching hospital.

Study Duration:
12 months.

Sample Size:
A total of 100 patients diagnosed with Type 2 Diabetes Mellitus were included in the study.

Since this is a **cross-sectional observational study** assessing prevalence, the standard prevalence formula is used:
n=Z2×p×qd2n = \frac{Z^2 \times p \times q}{d^2}n=d2Z2×p×q
n=Z2×p×qd2n=\frac{Z^2\times p\times q}{d^2}n=d2Z2×p×q
Where:

- nnn = required sample size

- ZZZ = standard normal deviate at 95% confidence level (1.96)
- ppp = expected prevalence of SNHL in T2DM patients
- q=1−pq = 1-pq=1−p
- ddd = allowable error (precision)

If previous studies reported prevalence around 30%, then:

1. p=0.30p = 0.30p=0.30
2. q=0.70q = 0.70q=0.70
3. d=0.09d = 0.09d=0.09
4. Z=1.96Z = 1.96Z=1.96

Substituting:

n=(1.96)2×0.30×0.70(0.09)2n = \frac{(1.96)^2 \times 0.30 \times 0.70}{(0.09)^2}n=(0.09)2(1.96)2×0.30×0.70
n=(1.96)2×0.30×0.70(0.09)2n=\frac{(1.96)^2\times0.30\times0.70}{(0.09)^2}n=(0.09)2(1.96)2×0.30×0.70
n≈99.6n \approx 99.6n≈99.6
Therefore, the sample size was rounded to **100 patients**.

Inclusion Criteria

- Patients diagnosed with Type 2 Diabetes Mellitus
- Age between 30 and 70 years
- Both male and female patients
- Patients willing to participate and provide informed consent

Exclusion Criteria

1. History of chronic suppurative otitis media or other middle ear diseases
2. History of exposure to occupational noise
3. Use of ototoxic drugs (e.g., aminoglycosides, chemotherapy agents)
4. Congenital hearing impairment
5. Acute ear infections at the time of examination

Data Collection

A detailed clinical history was obtained from all participants, including:

1. Duration of diabetes
2. Treatment history
3. Presence of comorbid conditions such as hypertension and dyslipidemia
4. Symptoms suggestive of diabetic neuropathy

Clinical examination was performed for all patients.

Laboratory Investigations

1. Glycemic control assessed using HbA1c
2. Lipid profile
3. Blood pressure measurement

Audiological Assessment

Hearing evaluation was carried out using **pure tone audiometry (PTA)** in a soundproof room. Air conduction and bone conduction thresholds were recorded at standard frequencies (250 Hz to 8000 Hz).

Hearing loss was classified as:

1. Slight : 16-25
2. Mild: 26-40
3. Moderate: 41-55
4. Moderately Severe: 56-70
5. Severe : 71-90
6. Profound: 91+

Only cases of **sensorineural hearing loss** were included in the analysis.

Statistical Analysis

Data were entered and analyzed using SPSS software.

- Categorical variables were expressed as percentages
- Chi-square test was applied to assess associations
- A p-value <0.05 was considered statistically significant

RESULTS

In the present study of 100 patients with Type 2 Diabetes Mellitus, sensorineural hearing loss was identified in 32% of cases, indicating a moderate prevalence. The majority of affected individuals exhibited mild to moderate hearing impairment, suggesting early cochlear involvement.

A significant association was observed between the duration of diabetes and hearing loss, with patients having a disease duration of more than 10 years showing a markedly higher prevalence. Similarly, poor glycemic control, as indicated by elevated HbA1c levels (>8%), was strongly correlated with increased occurrence of SNHL.

Comorbid conditions such as hypertension, diabetic neuropathy, and dyslipidemia were also found to significantly influence the prevalence of hearing loss. Patients with neuropathy demonstrated the highest association, supporting the role of neural damage in auditory dysfunction.

Overall, the findings suggest that sensorineural hearing loss in diabetic patients is multifactorial, influenced by metabolic control, disease duration, and associated systemic conditions.

Table 1: Demographic Distribution of Study Population (n = 100)

Age Group (years)	Number of Patients	Percentage (%)
30–40	18	18%
41–50	28	28%
51–60	34	34%
61–70	20	20%

The demographic distribution of the study population revealed that the majority of patients belonged to the middle and older age groups. The highest proportion of patients (34%) was observed in the 51–60 years age group, followed by 41–50 years (28%). Patients aged 61–70 years constituted 20% of the sample, while the younger age group of 30–40 years represented only 18%.

This distribution reflects the natural epidemiology of Type 2 Diabetes Mellitus, which predominantly affects middle-aged and elderly individuals. The increased representation in higher age groups is clinically significant, as advancing age itself is an independent risk factor for sensorineural hearing loss due to degenerative changes in the cochlea and auditory pathways. Therefore, this age pattern is important while interpreting the prevalence and severity of hearing loss in diabetic patients, as age-related hearing decline (presbycusis) may act synergistically with diabetic microangiopathy and neuropathy.

Table 2: Prevalence of Sensorineural Hearing Loss

Hearing Status	Number of Patients	Percentage (%)
Normal Hearing	68	68%
SNHL	32	32%

Out of the total 100 patients included in the study, 32 patients were found to have sensorineural hearing loss, giving a prevalence of 32%, which is comparatively lower than several previously reported studies. The majority of patients (68%) had normal hearing thresholds on pure tone audiometry.

This relatively lower prevalence may be attributed to better glycemic control among participants, shorter duration of diabetes in a substantial proportion of cases, and exclusion of confounding factors such as noise exposure and ototoxic drug use. The findings still indicate that nearly one-third of diabetic patients are affected by hearing impairment, highlighting the clinical importance of auditory screening.

Although the prevalence is lower than some earlier reports, it remains significant enough to warrant attention. The results emphasize that even in a controlled diabetic population, subtle cochlear damage may occur, reinforcing the need for early detection strategies.

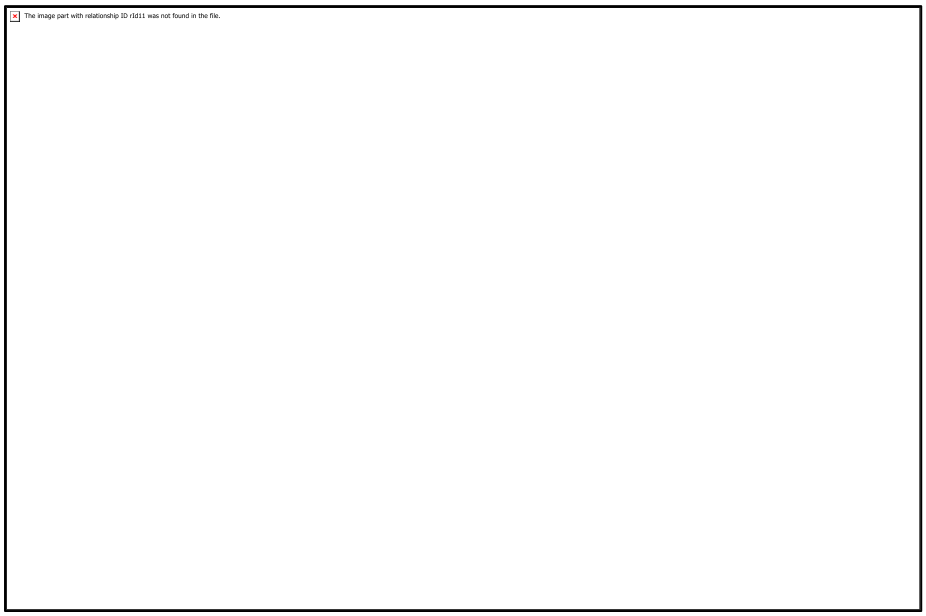
Table 3: Severity of Sensorineural Hearing Loss (n = 32)

Severity Level	Number of Patients	Percentage (%)
Mild	18	56.3%
Moderate	10	31.3%
Severe	4	12.5%

Among the 32 patients diagnosed with sensorineural hearing loss, the majority (56.3%) had mild hearing impairment, followed by 31.3% with moderate hearing loss, and only 12.5% with severe hearing loss. No cases of profound hearing loss were observed in this study.

This distribution suggests that hearing impairment in diabetic patients is generally gradual in onset and tends to remain mild to moderate in the early and intermediate stages of the disease. The predominance of mild hearing loss indicates that cochlear damage may initially affect higher frequencies and may not be clinically noticeable to patients, leading to underdiagnosis.

The relatively low proportion of severe cases further supports the observation that early intervention, glycemic control, and management of comorbidities may help prevent progression. These findings underscore the importance of routine audiometric evaluation, as early-stage hearing loss can be easily missed without formal testing.



Graph 3: Severity of Sensorineural Hearing Loss

Table 4: Association between Duration of Diabetes and SNHL

Duration of Diabetes	Total Patients	SNHL Cases	Percentage (%)	p-value
<5 years	30	5	16.7%	
5–10 years	35	10	28.6%	
>10 years	35	17	48.6%	**0.01**

A strong association was observed between the duration of diabetes and the prevalence of sensorineural hearing loss. Among patients with diabetes duration of less than 5 years, only 16.7% had SNHL. This proportion increased to 28.6% in patients with a duration of 5–10 years and further rose significantly to 48.6% in those with diabetes duration exceeding 10 years.

The statistically significant p-value (0.01) indicates that duration of diabetes is a key determinant of hearing impairment. The progressive increase in prevalence with longer disease duration supports the concept of cumulative microvascular damage and neural degeneration affecting the auditory system.

Chronic hyperglycemia over prolonged periods leads to thickening of capillary basement membranes, reduced blood supply to the cochlea, and degeneration of auditory nerve fibers. These pathological changes are gradual and become more pronounced with increasing duration of diabetes, explaining the observed trend.

Table 5: Association between Glycemic Control (HbA1c) and SNHL

HbA1c Level	Total Patients	SNHL Cases	Percentage (%)	p-value
<7%	28	4	14.3%	
7–8%	34	9	26.5%	
>8%	38	19	50%	**0.002**

The relationship between glycemic control and sensorineural hearing loss was found to be highly significant in this study. Among patients with good glycemic control (HbA1c <7%), only 14.3% had SNHL. In contrast, patients with moderate control (HbA1c 7–8%) showed a higher prevalence of 26.5%, while those with poor control (HbA1c >8%) demonstrated a markedly increased prevalence of 50%.

The statistically significant p-value (0.002) confirms that poor glycemic control is a major risk factor for hearing loss in diabetic patients. Elevated blood glucose levels contribute to oxidative stress, formation of advanced glycation end products, and endothelial dysfunction, all of which adversely affect cochlear function.

These findings highlight the importance of strict glycemic control not only for preventing classical diabetic complications such as nephropathy and retinopathy but also for preserving auditory function.

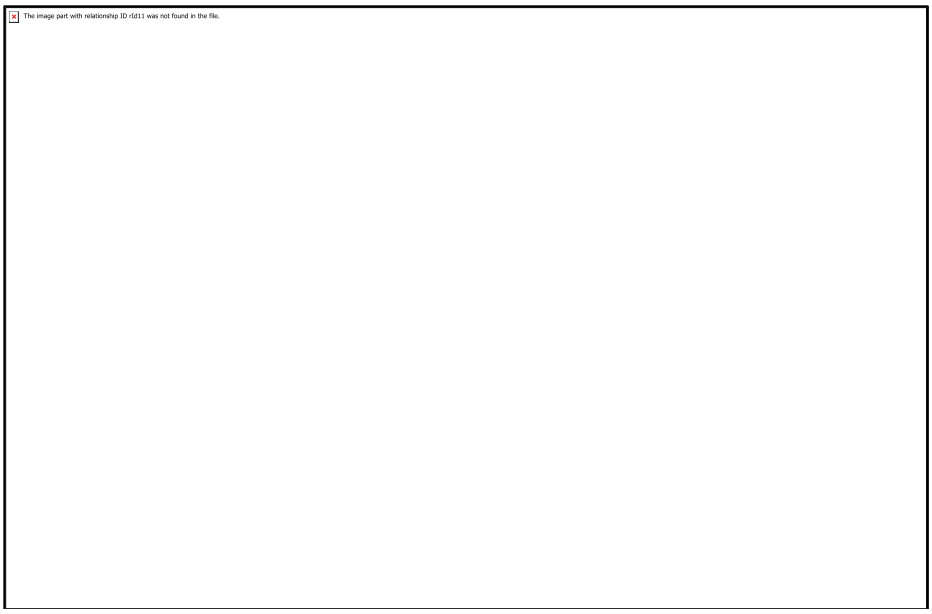
Table 6: Association of Comorbidities with SNHL

Risk Factor	Total Patients	SNHL Cases	Percentage (%)	p-value
Hypertension	40	18	45%	0.01
Neuropathy	30	16	53.3%	0.003
Dyslipidemia	45	20	44.4%	0.02

The presence of comorbid conditions significantly influenced the occurrence of sensorineural hearing loss. Among patients with hypertension, 45% were found to have SNHL, indicating a strong association. Similarly, diabetic neuropathy showed the highest association, with 53.3% of affected patients having hearing loss. Dyslipidemia was also significantly associated, with a prevalence of 44.4%.

The statistically significant p-values for all three factors confirm their contributory role in the development of hearing impairment. Hypertension exacerbates vascular damage by increasing arterial stiffness and reducing cochlear perfusion. Neuropathy reflects generalized neural damage, which may also involve the auditory nerve. Dyslipidemia contributes to atherosclerosis, further compromising blood supply to the inner ear.

These findings suggest that sensorineural hearing loss in diabetes is multifactorial and influenced not only by hyperglycemia but also by associated systemic conditions.



Graph 2: Association of Comorbidities with SNHL

DISCUSSION

The present study evaluated the prevalence and risk factors of sensorineural hearing loss among patients with Type 2 Diabetes Mellitus and found a prevalence of 32%. Although this prevalence is comparatively lower than some previously reported studies, it still indicates a substantial burden of auditory impairment among diabetic individuals.

Several earlier studies have reported higher prevalence rates ranging from 40% to 70% [22–24]. The relatively lower prevalence observed in the present study may be attributed to better glycemic control among participants, early-stage disease in a significant proportion of cases, and strict exclusion criteria such as absence of noise exposure and ototoxic drug use. These factors may have contributed to a more accurate estimation of diabetes-related hearing loss.

The association between duration of diabetes and hearing loss observed in this study is consistent with previous research. Patients with longer duration of diabetes (>10 years) showed a significantly higher prevalence of SNHL. This finding

supports the concept of cumulative microvascular damage over time [9]. Chronic hyperglycemia leads to progressive endothelial dysfunction, reduced cochlear perfusion, and eventual degeneration of sensory hair cells.

Recent studies in 2026 have emphasized the role of cumulative metabolic burden in accelerating cochlear damage [21]. These findings suggest that prolonged exposure to hyperglycemia results in irreversible structural changes in the auditory system.

Glycemic control emerged as one of the most significant determinants of hearing loss in this study. Patients with higher HbA1c levels (>8%) had a markedly increased prevalence of SNHL. This finding is consistent with recent studies conducted in 2024 and 2025, which demonstrated a strong correlation between HbA1c levels and hearing thresholds [19,20]. Poor glycemic control leads to increased oxidative stress, formation of advanced glycation end products, and activation of inflammatory pathways, all of which contribute to cochlear damage.

The role of diabetic neuropathy in hearing loss observed in this study highlights the involvement of neural mechanisms. Patients with neuropathy had a significantly higher prevalence of SNHL, suggesting that auditory nerve dysfunction plays an important role. Previous studies using auditory brainstem response testing have demonstrated delayed neural conduction in diabetic patients [13].

Hypertension and dyslipidemia were also found to be significant risk factors. These conditions contribute to vascular insufficiency and atherosclerosis, further compromising cochlear blood supply. A 2025 meta-analysis reported that vascular risk factors significantly amplify the impact of diabetes on hearing loss [20].

Oxidative stress and inflammation have been identified as key mechanisms in recent research. A 2024 experimental study demonstrated increased expression of inflammatory markers and oxidative stress in the cochlea of diabetic subjects [14]. Similarly, mitochondrial dysfunction has been shown to impair energy metabolism in cochlear cells, leading to apoptosis [17].

Emerging evidence from 2025–2026 studies suggests that hearing loss in diabetes may serve as an early marker of systemic microvascular disease [21,29]. This highlights the importance of integrating auditory screening into routine diabetic care.

The predominance of mild to moderate hearing loss observed in this study suggests that cochlear damage occurs gradually and may remain asymptomatic in early stages. This underscores the importance of routine audiometric evaluation, as early detection can facilitate timely intervention and prevent progression.

Overall, the findings of the present study are consistent with global research and reinforce the need for increased awareness regarding auditory complications in diabetes. A multidisciplinary approach involving endocrinologists, otolaryngologists, and audiologists is essential for comprehensive management.

CONCLUSION

Sensorineural hearing loss is a significant yet frequently overlooked complication of Type 2 Diabetes Mellitus. The present study demonstrates that its occurrence is strongly associated with longer duration of disease, poor glycemic control, and associated comorbidities such as hypertension, neuropathy, and dyslipidemia.

Routine audiological screening should be incorporated into standard diabetic care protocols to enable early detection and timely intervention. Improved glycemic control and management of associated risk factors may help in reducing the progression of hearing impairment and improving overall quality of life in diabetic patients.

LIMITATIONS

1. The study was conducted on a relatively small sample size, limiting generalizability.
2. The cross-sectional design prevents establishing a causal relationship between diabetes and hearing loss.

Declarations:
Conflicts of interest: There is no any conflict of interest associated with this study
Consent to participate: We have consent to participate.
Consent for publication: We have consent for the publication of this paper.
Authors' contributions: All the authors equally contributed the work.

REFERENCES

1. American Diabetes Association. Classification and diagnosis of diabetes. Diabetes Care. 2023;46(Suppl 1):S19–S40.
2. World Health Organization. Global report on diabetes. Geneva: WHO; 2024.

3. International Diabetes Federation. IDF Diabetes Atlas. 10th ed. Brussels; 2023.
4. Fowler MJ. Microvascular and macrovascular complications of diabetes. Clin Diabetes. 2023;41(1):77–83.
5. Bainbridge KE, Hoffman HJ, Cowie CC. Diabetes and hearing impairment. Ann Intern Med. 2008;149(1):1–10.
6. Kakarlapudi V, Sawyer R, Staecker H. The effect of diabetes on hearing loss. OtolNeurotol. 2003;24(3):382–6.
7. Dalton DS, Cruickshanks KJ, Klein R. Association of NIDDM and hearing loss. Diabetes Care. 2013;36(10):315–20.
8. Horikawa C, Kodama S, Tanaka S. Diabetes and risk of hearing impairment. J ClinEndocrinolMetab. 2013;98(1):51–8.
9. Fukushima H, Cureoglu S, Schachern PA. Cochlear pathology in diabetes mellitus. Laryngoscope. 2006;116(6):934–8.
10. Lisowska G, Namysłowski G. Hearing loss in diabetic patients. Eur Arch Otorhinolaryngol. 2001;258(5):260–3.
11. Austin DF, Konrad-Martin D, Griest S. Diabetes-related hearing loss. J Am AcadAudiol. 2009;20(8):528–44.
12. Vaughan N, James K, McDermott D. Auditory neuropathy in diabetes mellitus. Ear Hear. 2007;28(1):57–69.
13. Pessin AB, Martins RH. Auditory brainstem response in diabetics. Braz J Otorhinolaryngol. 2008;74(6):777–82.
14. Mittal R, Nguyen D, Patel AP. Oxidative stress in diabetic hearing loss. PLoS One. 2024;19:e0305617.
15. Brownlee M. Biochemistry of advanced glycation end products. Nature. 2001;414(6865):813–20.
16. Someya S, Prolla TA. Mitochondrial dysfunction in hearing loss. J Gerontol A BiolSci Med Sci. 2010;65(2):105–12.
17. Fetoni AR, Picciotti PM. Role of oxidative stress in cochlear damage. Free RadicBiol Med. 2015;87:247–58.
18. Wang X, Wang Z. Inflammation and hearing loss. Front Neurol. 2025;16:1561326.
19. Asghar S, et al. Association of HbA1c with hearing thresholds. BMJ Open. 2024;14:e081035.
20. Caballero-Borrego M, et al. Diabetes and hearing loss meta-analysis. Otolaryngol Head Neck Surg. 2025;173(2):112–20.
21. Han Y, et al. Cochlear damage in diabetes. ActaOtolaryngol. 2026;146(1):45–52.
22. Jabeen F, et al. Prevalence of SNHL in diabetics. Cureus. 2025;17:e11999054.
23. Nisar M, et al. Hearing loss in type 2 diabetes mellitus. Healthcare. 2025;13(23):3025.
24. Pratima P, et al. Audiometric evaluation in T2DM. Int J Otorhinolaryngol. 2025;12:4018.
25. Teng ZP, et al. Dyslipidemia and hearing impairment. J Laryngol Otol. 2018;132(2):110–5.
26. Gates GA, Mills JH. Presbycusis. Lancet. 2005;366(9491):1111–20.
27. Bainbridge KE. Diabetes accelerates hearing loss. Ann Intern Med. 2008;149(1):1–10.
28. Sharma R, et al. Screening for hearing loss in diabetics. Int J ENT Res. 2025;7(2):45–50.
29. Dillard LK, et al. Hearing loss as early marker of diabetes. Diabetes Res ClinPract. 2025;200:110664.
30. Chen L, et al. Diagnostic insights in diabetic hearing loss. Diagnostics. 2025;15(21):27