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Original Research Article

Study of Sensorineural Hearing Loss among Type-2 Diabetes Mellitus Patients in a Tertiary Care Teaching Hospital in the Western Region of India

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Conflict of interest: Nil

Abstract

Background: Hearing loss impairs daily functioning. Diabetes mellitus may contribute to sensorineural hearing loss (SNHL) via cochlear microangiopathy and neuropathy. Evidence remains mixed, particularly for type 2 diabetes mellitus (T2DM).

Objective: To compare the frequency and severity of SNHL in adults with T2DM versus non-diabetic controls and to examine associations with age, sex, duration of diabetes, and glycaemic control [i.e. HbA1c, fasting blood sugar (FBS), and 2-hour post-prandial blood sugar (PP2BS)].

Methods: We conducted a hospital-based comparative study including 180 participants aged ≤60 years (T2DM n=90; non-diabetic controls n=90). Pure-tone audiometry classified hearing as normal or SNHL and graded severity. Glycaemic indices were grouped as prespecified categories (HbA1c 6–7, 7–8, 8–9, 9–10, >10%; FBS 80–100, 101–125, ≥126 mg/dL; PP2BS <140, 140–199, ≥200 mg/dL). Diabetes duration was stratified as <10 vs ≥10 years. Group differences and trends were tested using chi-square; significance was set at $\alpha=0.05$.

Results: SNHL was more prevalent in T2DM than controls [80.0% (72/90) vs 41.1% (37/90); $\chi^2=28.49$, $p<0.001$]. Severity distributions were shifted toward moderate–profound loss in T2DM. Poorer glycaemic control correlated with greater severity: HbA1c ($\chi^2=40.28$, $p=0.004$), FBS ($\chi^2=18.65$, $p=0.04$), and PP2BS ($\chi^2=34.45$, $p=0.0001$). Longer diabetes duration (≥10 years) showed predominantly moderate–profound loss compared with <10 years. Age increased prevalence, while sex showed no significant association.

Conclusion: Sensorineural hearing loss was significantly more common and severe in type 2 diabetes patients than in non-diabetics, correlating with poor glycaemic control and longer disease duration. Regular hearing evaluation and good diabetes management may help prevent or limit auditory damage.

Keywords: Pure tone audiometry, Fasting blood glucose, Glycated haemoglobin (HbA1c), Sensorineural (SN) hearing loss, Diabetes type 2.

Introduction

Hearing is central to human communication and psychosocial well-being. Diabetes mellitus (DM) has long been suspected to affect auditory function; as early as 1857, Jordao reported hearing loss in a patient with incipient diabetic coma [1]. India bears a substantial and growing burden of type 2 diabetes mellitus (T2DM), 77 million affected in 2019, projected to exceed 134 million by 2045, making potential diabetes-related auditory morbidity a relevant public-health concern [2]. DM is characterized by chronic hyperglycaemia with disturbances of carbohydrate, fat, and protein metabolism [3]. Diabetic microangiopathy and neuropathy can affect the cochlea and auditory nerve, reduce cochlear perfusion and injure neural elements with loss of outer hair cells; clinically, hearing loss is typically progressive, bilateral, and high-frequency predominant, overlapping with presbycusis [4,5]. Pathological and mechanistic data support a diabetic contribution to SNHL: temporal bone studies show PAS positive thickening of capillary walls in the stria vascularis with luminal narrowing, spiral ganglion atrophy, and demyelination, consistent with microangiopathy and neurodegeneration [7,9]. Hyperglycaemia-related mitochondrial dysfunction may impair oxidative phosphorylation and ATP generation in energy-intensive tissues such as the stria vascularis, further compromising auditory function [9–11]. Clinically, India has an estimated 63 million people with auditory impairment; early identification enables timely amplification and rehabilitation, while improved glycaemic control may help prevent or slow progression [1].

However, epidemiological findings are mixed: several studies report higher prevalence and greater severity of SNHL in T2DM, with links to poorer glycaemic control and longer duration of diabetes, whereas others find weaker or no associations after adjustment for age related loss [4,5]. To address these uncertainties in an Indian tertiary care setting, we sought to determine whether T2DM is associated with increased frequency and severity of SNHL compared with non-diabetic controls, and to examine how age, sex, duration of diabetes, and glycaemic indices (HbA1c, fasting blood glucose, and two hour post prandial glucose) relate to the presence and severity of SNHL.

Patients and Methods

Study aim, design, and setting: We conducted a hospital-based observational study to assess whether type 2 diabetes mellitus (T2DM) is associated with greater frequency and severity of sensorineural hearing loss (SNHL) compared with non-diabetic controls, and to examine relationships between SNHL and age, sex, diabetes duration, and glycaemic indices. The study was carried out at tertiary teaching hospital in Surendranagar, Gujarat, India.

Participants

Eligibility

Inclusion: adults ≤60 years, with or without T2DM; intact tympanic membranes.

Exclusion: any conductive or mixed hearing loss (e.g., chronic suppurative otitis media, secretory otitis media, otosclerosis), history of ototoxic drug exposure, significant noise exposure, prior ear surgery, congenital hearing loss, or recent head injury/road-traffic accident.

Recruitment and groups: A total of 180 participants were enrolled: 90 with T2DM and 90 without diabetes (controls), selected consecutively from outpatient services.

Variables and measurements

Exposure (diabetes-related): diabetes status (yes/no), duration of T2DM (<10 years, ≥10 years), glycaemic indices [glycated haemoglobin (HbA1c), fasting blood glucose (FBS), and 2-hour post-prandial blood sugar (PP2BS)].

Primary outcome: prevalence of SNHL in T2DM vs controls.

Secondary outcomes: distribution of SNHL severity across age and sex strata; associations of SNHL severity with diabetes duration, HbA1c, FBS, and PP2BS.

Clinical and audiological procedures: All participants underwent focused ear–nose–throat examination including otoscopy and tuning-fork tests, followed by pure-tone audiometry (PTA) in a sound-treated room. PTA thresholds were obtained at 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz, and 8 kHz. Thresholds were determined using the modified Hughson–Westlake (5-up/10-down) method, with stimulus presentations of ~1–3 seconds and ≥50% response criterion.

Classification of hearing level (dB HL): Normal 10–15; Minimal 16–25; Mild 26–40; Moderate 41–55; Moderately severe 56–70; Severe 71–90; Profound >91 (per Clark, 1981 [12]). SNHL was defined by elevated air- and bone-conduction thresholds with no air-bone gap and normal otoscopy.

Data collection: Demographics, clinical history, diabetes duration, and laboratory indices (HbA1c, FBS, PP2BS) were recorded on a structured case-record form. An ophthalmic examination was performed as part of systemic assessment.

Statistical analysis: Data were summarized as counts and percentages. Group comparisons (T2DM vs controls) and trend across ordered categories (e.g., HbA1c bands; FBS and PP2BS strata; duration <10 vs ≥10 years) were evaluated using chi-square tests. Significance was set at $p<0.05$ (two-sided). No a priori power calculation was performed; the sample size (n=180) reflected feasibility within the study period. Analyses were conducted using standard statistical software.

Ethics: The protocol was approved by the Institutional Ethics Committee–Human Research (CUSMC/IEC (HR)/DI/7/2021/Final

Approval/36/2022). Written informed consent was obtained from all participants.

Results

A total of 180 participants were enrolled, including 90 diabetic and 90 non-diabetic patients, all below 60 years of age. In the diabetic group, there were 48 males and 42 females, while in the non-diabetic group, there were 50 males and 40 females.

Comparisons were made between the two groups for the occurrence and severity of sensorineural hearing loss (SNHL).

a. Correlation between Severity of Sensorineural Hearing Loss and Age: Among diabetics, increasing age correlated with higher grades of SNHL. In those aged 51–60 years, most had mild–moderate loss (25/40, 62.5%); 9/40 (22.5%) had moderately severe–severe loss and 3/40 (7.5%) had profound loss. In non-diabetics, most had normal hearing across age bands; mild–moderate loss increased slightly with age, while severe/profound loss was uncommon.

Table 1: Age-wise distribution of hearing status among diabetics

Age (years)	No HL	Mild HL	Moderate HL	Mod. Severe HL	Severe HL	Profound HL	Total
21–30	3	2	0	0	0	0	5
31–40	6	6	1	0	0	0	13
41–50	6	12	9	3	2	0	32
51–60	3	13	12	5	4	3	40
Total	**18**	**33**	**22**	**8**	**6**	**3**	**90**

Table 2: Age-wise distribution among non-diabetics

Age (years)	No HL	Mild HL	Moderate HL	Mod. Severe HL	Severe HL	Profound HL	Total
21–30	11	0	0	0	0	0	11
31–40	21	6	1	0	0	0	28
41–50	10	7	5	0	2	0	24
51–60	11	9	6	1	0	0	27
Total	**53**	**22**	**12**	**1**	**2**	**0**	**90**

b. Hearing loss by sex and diabetes status: Among diabetics, 39/48 males and 33/42 females had SNHL. Among non-diabetics, 21/50 males and 16/40 females had SNHL. Overall, 61.22% of males and 74.24% of females had hearing loss. The difference was not statistically significant ($p = 0.102$).

Table 3: Hearing loss by sex and diabetes status: counts across severity levels for males and females in diabetic vs non-diabetic groups

Severity	M (Diabetic)	F (Diabetic)	M (Non-Diabetic)	F (Non-Diabetic)	Total
No HL	9	9	29	24	71
Mild HL	15	18	11	11	55
Moderate HL	15	7	8	4	34
Mod. Severe HL	4	3	1	0	8
Severe HL	3	4	1	1	9
Profound HL	2	1	0	0	3
Total	**48**	**42**	**50**	**40**	**180**

c. Comparison between Diabetic and Non-Diabetic Patients: SNHL was far more common in diabetics than non-diabetics (80.0% vs 41.1%; χ^2=28.49, $p<0.001$). Severity also skewed worse in diabetics: moderate-to-profound loss occurred in 43.3% vs 16.7% of non-diabetics. Overall, diabetics made up two-thirds of all SNHL cases (72/109).

Table 4: Severity distribution by group (diabetic vs non-diabetic)

Group	No HL	Mild HL	Moderate HL	Mod. Severe HL	Severe HL	Profound HL	Total
Diabetic	18	33	22	7	7	3	90
Non-Diabetic	53	22	12	1	2	0	90
Total	**71**	**55**	**34**	**8**	**9**	**3**	**180**

Table 5: Type of hearing loss by group

Group	Normal Hearing	SNHL	% SNHL
Diabetic (n = 90)	18	72	80.0%
Non-Diabetic (n = 90)	53	37	41.1%
χ^2 = 28.49; p = 0.0001 (Significant)			

d. SNHL and Duration of Diabetes Mellitus: Longer diabetes duration was linked to markedly worse hearing. Patients with ≥10 years of diabetes had far more moderate–profound loss than those <10 years (80.0% vs 31.4%); severe–profound alone was 30.0% vs 4.3%. Normal hearing was uncommon with longer duration (5.0% vs 24.3%). Collapsing to ≥moderate vs <moderate, the odds of significant loss were ~8.7× higher with ≥10 years (χ^2=15.0, p≈0.0001).

Table 6: Hearing loss by duration of diabetes (diabetics only): <10 years vs ≥10 years

Hearing Loss	< 10 years (n=70)	> 10 years (n=20)	Total (n=90)
No HL	17 (24.3%)	1 (5.0%)	18 (20%)
Mild HL	30 (42.8%)	3 (10.0%)	33 (36.7%)
Moderate HL	15 (21.4%)	7 (30.0%)	22 (24.4%)
Moderate Severe HL	4 (5.7%)	3 (15.0%)	8 (8.9%)
Severe HL	2 (2.8%)	4 (20.0%)	6 (6.7%)
Profound HL	1 (1.4%)	2 (10.0%)	3 (3.3%)
Total	**70 (100%)**	**20 (100%)**	**90 (100%)**

e. SNHL and HbA1c Levels: Higher glycaemia tracked with worse hearing. The share with ≥moderate loss rose from 5.6% at HbA1c 6–7% to 36.4% (7–8%), 71.4% (8–9%), dipped to 44.4% (9–10%), and was 59.3% at >10%. Normal hearing fell sharply beyond 7% (66.7% at 6–7% vs 9–11% thereafter). Overall trend was significant (χ^2=40.28, p=0.004).

Table 7: Hearing loss by HbA1c category (diabetics only)

HbA1c (%)	No HL	Mild HL	Moderate HL	Mod. Severe HL	Severe HL	Profound HL	Total
6–7	12	5	0	0	1	0	18
7–8	2	12	7	1	0	0	22
8–9	0	4	8	0	2	0	14
9–10	1	4	1	1	2	0	9
> 10	3	8	6	5	2	3	27
χ^2 = 40.28; p = 0.004 (Significant)							

f. SNHL and Fasting Blood Sugar (FBS)

Rising fasting glucose levels were associated with progressively worse hearing. Among diabetics with FBS ≥126 mg/dL, 54/90 (60%) had higher rates of moderate-to-profound loss (54.9%) compared to only 35.7% in those with FBS ≤125 mg/dL. Normal hearing was most frequent at FBS ≤125 mg/dL (32.4%) and least at ≥126 mg/dL (13%). The trend was statistically significant (χ^2 = 18.65; p = 0.04), confirming that poorer glycaemic control correlates with greater SNHL severity.

Table 8: Hearing loss by fasting blood sugar (diabetics only):

FBS (mg/dL)	No HL	Mild HL	Moderate HL	Mod. Severe HL	Severe HL	Profound HL	Total
80–100	2	5	1	0	0	0	8
101–125	9	10	9	0	0	0	28
≥ 126	7	18	11	8	7	3	54
χ^2 = 18.65; p = 0.04 (Significant)							

g. SNHL and Post-Prandial Blood Sugar (PP2BS): Higher PP2BS strongly tracked with worse hearing. At ≥200 mg/dL, ≥moderate loss affected 68.8% and severe–profound 33.3%, versus 30.0% and 10.0% at <140 mg/dL, and just 9.4% and 0% at 140–199 mg/dL. Normal hearing was least common at ≥200 mg/dL (8.3%). Association was highly significant (χ^2=34.45, p=0.0001).

Table 9: Hearing loss by 2-hour post-prandial blood sugar (diabetics only)

PP2BS (mg/dL)	No HL	Mild HL	Moderate HL	Mod. Severe HL	Severe HL	Profound HL	Total
< 140	4	3	2	0	1	0	10
140–199	10	19	3	0	0	0	32
≥ 200	4	11	17	8	5	3	48
χ^2 = 34.45; p = 0.0001 (Highly Significant)							

Discussion

Age: A review of the literature shows that there is no correlation between the age of the patient and occurrences of SNHL among Diabetes mellitus patients. In our study, out of 90 diabetic patients, 37 (41.11%) were between 51 and 60 years, and 26 patients were between 41 and 50 years. Our study shows an increased prevalence of sensorial hearing loss in diabetics in the older age group of 50-60 years. The prevalence of Sensorineural hearing loss in this age group is 51.38% showing a strong association between old age and sensorineural hearing loss. It shows hearing loss due to diabetes is in addition to that due to age alone.

These results are in contrast with studies carried out by Cullen et al. [5]. Axelsson et al. showed that the incidence of pure tone hearing loss increases with age in patients with diabetes, even after correction for senile deafness [13]. In a study conducted by Rajendran S. et al. showed maximum incidence of hearing loss between 40-50 years of age [14]. Usually, age-related sensorineural hearing loss is more common in people above 60 years of age. Greater hearing loss in diabetic patients of 60 years of age and younger was observed in 5 5-year prospective study of Nancy Vaughan et al [15].

Sex: In our study, 39 (43.33%) males and 33(36.66%) females had sensorineural hearing loss out of 90 diabetics. Out of 39 males, 15 had mild sensorineural hearing loss, and 15 had moderate sensorineural hearing loss. Out of 33 females, 18 had mild sensorineural hearing loss. There is no significance between hearing loss among Diabetes mellitus patients and sex.

Taylor and Irwin (1978), in their study noted that diabetic females had a higher hearing loss compared to diabetic males [16]. But according to Cullen and Cinnamond (1993), diabetic male patients had sensorineural hearing worse than diabetic females [5]. There is no statistical significance between sex and sensorineural hearing loss among diabetics in our study.

Correlation between sensorial hearing loss among diabetics and non-diabetics: 72 diabetic patients (80%) had sensorineural hearing loss compared to 37 (41.11%) non-diabetic patients had sensorineural hearing loss. It's statistically significant that diabetics are more prone to sensorial hearing loss than non-diabetics, with a χ^2 = 28.49; p = 0.0001. Malucelli et al. found the prevalence to be 76% [17], Rajendran et al. found it to be 73.3% [14], and Krishnappa et al. [18] found the prevalence of SNHL among type-2 diabetic patients to be 73%.

Duration of disease and sensorineural hearing loss: Out of 70 patients having diabetes for less than 10 years, 63 patients (75.72%) have sensorineural hearing loss. Out of 20 patients having diabetes for more than 10 years, 19 patients (95%) have sensorineural hearing loss, which is similar to the study findings of Zelenka et al [19]. They stated that the hearing threshold increases with an increase in the duration of diabetes mellitus. Srinivas CV et al., Shyamala V. et al. and Shiva Kumar BR et al. [20] found a positive relationship between the duration of diabetes and sensorineural hearing loss. Jorgensen et al. [21], Axelson et al. [13], and Kurien et al. [22] did not find any relation between duration and sensorineural hearing loss. Cullen et al. [5] and Kurien et al. [22] stated no relation between hearing loss and diabetes mellitus.

Correlation between HbA1C & severity of sensorineural hearing loss: Out of 90 patients, 18 had HbA1C values of 6-7, and only 6 among these 18 patients had sensorineural hearing loss. Out of 90 patients, 62 had an HbA1C value of more than 7. Only 56 among 62 patients had sensorineural hearing loss. In our study, the prevalence of sensorineural hearing loss among poorly controlled patients is 90.32% whereas it is 33.33% among patients in control, which is highly significant. The clinical study of Lasisi et al. shows that poorly controlled diabetics have a significant hearing loss, while disagreeing with M. Mozaffari et al [23]. Uncontrolled diabetic patients with high blood sugar levels (88%, 44/50) had a higher rate of sensorineural hearing loss when compared to that of controlled diabetic patients with normal blood sugar levels (60%, 30/50). This difference is highly statistically significant showed by Harkare et al. [24]

Control of diabetes: The occurrence of sensorial hearing loss in diabetics depends upon the control of the disease. Most studies have stated that diabetic-related complications, such as SNHL, can be prevented or delayed in their onset by controlling DM. Reduction in blood glucose or HbA1C concentrations through glycemic control in diabetes reduces the rate of progression of sensorial hearing loss.

Correlation between FBS & severity of sensorineural hearing loss: Out of 90 patients, 8 had FBS values of 80-100 mg/dl, 28 had FBS values of 101-125mg/dl, and 54 had FBS values of ≥126mg/dl. Out of 8 patients having FBS (80-100 mg/dl), 6(75%) had sensorial hearing loss. Among these 6, 5 had mild sensorial hearing loss (83.33%). 19 out of 28 having FBS (101-125 mg/dl) had sensorial hearing loss. (67.85%).

Among these 19 patients, 10 patients (52.63%) had mild Sensorineural hearing loss, and 9 patients (47.36%) had moderate Sensorineural hearing loss. 47 out of 54 patients having FBS (≥126 mg/dl) had Sensorineural hearing loss (87.03%). Out of these 47, 18 patients (38.29%) had SNHL, and 29 patients (61.70%) had moderate to profound sensorial hearing loss. So, in our study, there is an increase in the severity of sensorial hearing loss in patients with higher FBS values. ($p = 0.001$). Similar results were seen in a study done by Asma et al [25]. However, Kurien et al. [22] concluded that good control of diabetes reduces the incidence of sensorineural hearing loss.

Correlation between PP2BS & severity of sensorineural hearing loss: Out of 90 patients, 10 had PP2BS of value <140 mg/dl, 32 had PP2BS of value 140-199 mg/dl and 48 had PP2BS value of ≥200 mg/dl. Out of 10 patients having PP2BS <140 mg/dl, 6 (60%) had Sensorineural hearing loss. Among these 6, 3 (50%) had mild sensorial hearing loss. 22 (68.75%) out of 32 having PP2BS (140-199 mg/dl) had sensorial hearing loss. Among these 22 patients, 19 patients (86.36%) had mild sensorial hearing loss. 44 (91.66%) out of 48 patients having PP2BS (≥200 mg/dl) had sensorial hearing loss. Out of these 44, 11 patients (25.00%) had mild sensorineural hearing loss, and 33 patients (75.00%) had moderate to profound sensorineural hearing loss.

So, in our study, there is an increase in the severity of sensorial hearing loss in patients with higher PP2BS values ($p = 0.001$). Similar results were seen in a study done by Krishnappa and Naseeruddin [18].

Limitations and future directions: This study was a single centric observational analysis with a hospital-based sample, which raises the possibility of selection bias and limits generalisability to the wider community. Residual confounding is possible, particularly by age, despite analytic adjustment. Audiological assessment relied solely on conventional pure tone audiometry, so sensitivity for early or high frequency changes may be limited because distortion product otoacoustic emissions (OAE) and high frequency audiometry were not performed. Glycaemic indices and hearing were assessed cross sectionally, which constrains causal inference, and some subgroup comparisons may be underpowered given the modest sample size. Future work should include multicentric community-based cohorts with age matched controls, longitudinal follow up to evaluate incidence and progression and to test the impact of improved glycaemic control, and an expanded audiologic battery that incorporates distortion product otoacoustic emissions, high frequency audiometry, speech in noise testing, and auditory brainstem responses. Rigorous multivariable adjustment for confounders such as noise exposure, ototoxic medications, hypertension, and dyslipidaemia is needed, alongside stratified analyses by duration of diabetes, microvascular complications, and treatment class, and interventional studies. Mechanistic studies integrating biomarkers of microangiopathy and neurodegeneration would help link metabolic control to cochlear pathology and clarify targets for prevention.

Conclusions

A statistically significant correlation was found between sensorial hearing loss and type 2 diabetes mellitus. Sensorineural hearing loss increases with the increase in the level of HbA1C among type 2 diabetes mellitus. Sensorineural hearing loss is also increased with the prolonged duration of uncontrolled type 2 diabetes mellitus.

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