



## RELATIONSHIP BETWEEN HEARING LOSS AND HbA1c LEVELS IN DIABETIC PATIENTS: A TERTIARY CARE HOSPITAL-BASED STUDY

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### ABSTRACT:

**Background:** Diabetes mellitus (DM) is increasingly recognized as a risk factor for sensorineural hearing loss (SNHL). Elevated glycosylated hemoglobin (HbA1c) levels may be associated with cochlear microangiopathy, leading to auditory dysfunction. This study examined the relationship between hearing loss and HbA1c levels among diabetic patients attending a tertiary care hospital, and evaluated the influence of demographics, subjective symptom severity, audiometric parameters, associated symptoms (tinnitus, vertigo), and diabetes treatment regimens on hearing outcomes. **Methods:** In this hospital-based cross-sectional observational study, 236 patients with type 2 diabetes mellitus aged 18–75 years attending the ENT and Endocrinology outpatient departments between 2023 and 2025 were evaluated for hearing impairment. Demographic data including age and gender were recorded. Clinical history focused on subjectively perceived hearing loss graded as mild, moderate, or severe, along with associated tinnitus and vertigo. Pure Tone Audiometry (PTA) was performed at frequencies of 0.5–4 kHz, and hearing loss was categorized as 20–30 dB, 30–40 dB, and 40–50 dB. Air–Bone Gap (ABG) was documented in ranges of 10–20 dB, 20–30 dB, and 30–40 dB. Glycemic control was assessed using HbA1c levels, grouped as 5–6%, 6–7%, and  $\geq 7\%$ . Diabetes treatment modalities (diet control, oral hypoglycemic agents, and insulin therapy) were noted. Hearing aid prescription and subjective post-intervention improvement using functional hearing assessment were also evaluated. Statistical analysis included chi-square test and Pearson correlation, with  $p < 0.05$  considered statistically significant.

**Results:** A total of 236 patients were included, with a mean age of  $47.6 \pm 9.8$  years. The study population comprised 138 males (58.5%) and 98 females (41.5%). Subjective hearing loss was reported as mild in 98 patients (41.5%), moderate in 86 (36.4%), and severe in 52 (22.1%). Pure tone audiometry revealed hearing thresholds of 30–40 dB in 88 patients (37.3%), followed by 40–50 dB in 76 patients (32.2%) and 20–30 dB in 72 patients (30.5%), with a mean PTA of  $34.9 \pm 8.2$  dB. ABG values of 20–30 dB were most prevalent (40.7%), particularly among patients with poorer glycemic control. HbA1c levels  $\geq 7\%$  were observed in 90 patients (38.1%) and were significantly associated with worsening PTA and ABG values compared to patients with HbA1c  $\leq 6\%$  ( $p < 0.001$ ). Tinnitus was present in 98 patients (41.5%) and vertigo in 64 patients (27.1%), with higher prevalence among

those with moderate to severe hearing loss. Among treatment groups, subjective hearing improvement was noted in 71.4% of patients on diet control alone, 69.2% on oral hypoglycemics, and 51.1% on insulin therapy. Hearing aids were prescribed to 76 patients (32.2%), predominantly among those with moderate to severe hearing loss. A significant positive correlation was observed between increasing HbA1c levels and severity of hearing loss ( $p < 0.01$ ).

**Conclusion:** This study provides compelling evidence that hearing loss in diabetic patients is strongly and positively associated with poor glycaemic control, as reflected by elevated HbA1c levels. The use of objective audiological parameters—such as PTA thresholds, air–bone gap measurements, and associated symptoms like tinnitus and vertigo—strengthens the validity of the findings. Patients with HbA1c values  $\geq 7\%$  consistently demonstrated higher degrees of hearing impairment, greater subjective disability, and increased need for audiological rehabilitation.

## INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by sustained hyperglycaemia and is associated with multiple systemic complications involving the microvascular and neural tissues. While complications such as retinopathy, nephropathy, and peripheral neuropathy are well documented, auditory dysfunction is increasingly being recognized as an important yet underdiagnosed complication of diabetes [1,2]. Recent epidemiological studies have demonstrated a significantly higher prevalence of hearing impairment among individuals with diabetes compared to non-diabetic populations [3].

The pathophysiology of diabetes-related hearing loss is multifactorial. Chronic hyperglycaemia leads to cochlear microangiopathy, thickening of capillary basement membranes, oxidative stress, and degeneration of the spiral ganglion cells, ultimately affecting cochlear and retrocochlear function [4–6]. Histopathological studies and clinical audiological evaluations have shown predominant involvement of the basal turn of the cochlea, explaining the frequent high-frequency sensorineural hearing loss observed in diabetic patients [7].

Pure tone audiometry (PTA) remains the gold standard for assessing hearing thresholds and has been widely used in studies evaluating auditory dysfunction in diabetes [8,9]. Several hospital-based studies conducted between 2020 and 2025 have demonstrated significantly elevated PTA thresholds in diabetic patients, particularly those with poor glycaemic control [10,11]. Air–bone gap (ABG) abnormalities, although less common, have also been reported, suggesting combined cochlear and middle-ear involvement in a subset of patients [12].

Glycated hemoglobin (HbA1c) is a reliable indicator of long-term glycaemic control and has been extensively studied in relation to diabetic complications. Multiple contemporary studies have reported a positive correlation between elevated HbA1c levels ( $\geq 7\%$ ) and the severity of hearing loss, supporting the role of chronic hyperglycaemia in auditory damage [13–15]. Horikawa et al. demonstrated a dose-dependent relationship between HbA1c levels and hearing thresholds, reinforcing the clinical relevance of glycaemic control in auditory health [16].

In addition to hearing loss, associated otological symptoms such as tinnitus and vertigo have been frequently reported in diabetic patients, indicating vestibulocochlear involvement [17,18]. These symptoms have been shown to correlate with worse audiometric outcomes and longer disease duration [19]. Treatment modality for diabetes also appears to influence auditory outcomes, with insulin-dependent patients often demonstrating more severe hearing impairment, possibly reflecting longer disease duration and poorer metabolic control [20,21].

Despite increasing evidence linking diabetes and hearing loss, routine auditory screening is not universally incorporated into diabetic care protocols, particularly in developing countries [22]. Early identification of hearing impairment allows timely intervention through improved glycaemic control, hearing rehabilitation, and use of hearing aids, which has been shown to significantly improve subjective hearing outcomes and quality of life [23,24].

The present tertiary care hospital-based study was undertaken to evaluate the relationship between hearing loss and HbA1c levels in diabetic patients, with special emphasis on demographic variables,

subjective hearing loss severity, audiometric findings, associated tinnitus and vertigo, diabetes treatment modalities, and final hearing outcomes.

**KEY WORDS:** Tinnitus, Loss of Hearing, HbA1c, Diabetes Mellitus, PTA and vertigo.

## OBJECTIVES

1. To assess the prevalence and severity of hearing loss in diabetic patients.
2. To evaluate the relationship between HbA1c levels and audiological parameters (PTA and ABG).
3. To analyze the association of tinnitus, vertigo, and diabetes treatment modalities with hearing outcomes.
4. To assess subjective improvement and hearing aid utilization.

## METHODS

A hospital-based cross-sectional observational study was conducted on **236 patients with type 2 diabetes mellitus** attending the Departments of **Otorhinolaryngology and Endocrinology** of a tertiary care teaching hospital between **January 2023 and December 2025**. Adult patients aged **18 years and above** with a confirmed diagnosis of type 2 diabetes mellitus were included in the study. Patients with a history of chronic otitis media, ototoxic drug exposure, occupational noise exposure, prior ear surgery, congenital hearing loss, or neurological disorders affecting hearing were excluded. Demographic variables including **age and gender** were recorded. Subjective hearing impairment was assessed and graded as **mild, moderate, or severe** based on patient self-report. Associated otological symptoms such as **tinnitus and vertigo** were documented. Functional impact of hearing loss was evaluated using the **Hearing Handicap Inventory for Adults (HHIA)**, with scores categorized as no handicap (0–16), mild to moderate handicap (18–42), and significant handicap (>42). Tinnitus severity, where present, was assessed using the **Tinnitus Handicap Inventory (THI)**.

Audiological evaluation was performed using **pure tone audiometry (PTA)** at frequencies of **0.5, 1, 2, and 4 kHz**, and average thresholds were recorded. Hearing loss was categorized based on PTA thresholds into **20–30 dB, 30–40 dB, and 40–50 dB**. **Air–bone gap (ABG)** was calculated and grouped into **10–20 dB, 20–30 dB, and 30–40 dB**. Tympanometry was performed where indicated to assess middle ear status.

Glycaemic control was assessed using **glycated hemoglobin (HbA1c)** levels, categorized as **5–6%, 6–7%, and ≥7%**. Details of diabetic management, including **dietary control, oral hypoglycaemic agents, and insulin therapy**, were documented. Improvement in hearing following optimization of diabetic treatment was assessed subjectively and functionally using post-intervention HHIA scores. The need for and prescription of **hearing aids** were also recorded.

Statistical analysis was performed using appropriate software. **Chi-square test** was used for categorical variables and **Pearson correlation coefficient** for continuous variables. A **p-value < 0.05** was considered statistically significant.

## RESULTS

Table 1 presents the **demographic and baseline clinical characteristics** of the study population comprising 236 patients with type 2 diabetes mellitus. The age distribution demonstrates a predominance of patients in the fourth and fifth decades of life, reflecting the typical age group affected by long-standing diabetes-related complications. Gender distribution shows a male predominance. The duration of diabetes is also detailed, as chronicity of the disease is an important determinant of microvascular and neurological complications, including auditory dysfunction.

**Table 1: Demographic and Clinical Profile of the Study Population (n = 236)**

| Variable    | Category Number (n) Percentage (%) |    |      |
|-------------|------------------------------------|----|------|
| Age (years) | 18–30                              | 32 | 13.6 |

| Variable             | Category   | Number (n) | Percentage (%) |
|----------------------|------------|------------|----------------|
| Mean age (years)     | 31–40      | 54         | 22.9           |
|                      | 41–50      | 68         | 28.8           |
|                      | 51–60      | 56         | 23.7           |
|                      | >60        | 26         | 11.0           |
|                      | —          | 47.6 ± 9.8 | —              |
| Gender               | Male       | 138        | 58.5           |
|                      | Female     | 98         | 41.5           |
| Duration of diabetes | <5 years   | 88         | 37.3           |
|                      | 5–10 years | 92         | 39.0           |
|                      | >10 years  | 56         | 23.7           |

Table 2 summarizes the **subjective assessment of hearing loss severity** as reported by the participants, along with commonly associated otological symptoms such as tinnitus and vertigo. Subjective grading provides insight into patient-perceived disability and symptom burden, which is clinically relevant when correlating audiological findings with quality-of-life measures. The presence of tinnitus and vertigo highlights possible cochleo-vestibular involvement in diabetic patients.

**Table 2: Distribution of Subjective Hearing Loss Severity and Associated Symptoms (n = 236)**

| Variable                | Category | Number (n) | Percentage (%) |
|-------------------------|----------|------------|----------------|
| Subjective hearing loss | Mild     | 98         | 41.5           |
|                         | Moderate | 86         | 36.4           |
|                         | Severe   | 52         | 22.1           |
| Associated tinnitus     | Present  | 98         | 41.5           |
|                         | Absent   | 138        | 58.5           |
| Associated vertigo      | Present  | 64         | 27.1           |
|                         | Absent   | 172        | 72.9           |

Table 3 depicts the **pure tone audiometry (PTA) findings**, categorizing the degree of hearing loss based on standard decibel thresholds. PTA serves as the primary objective measure of auditory sensitivity and allows quantification of hearing impairment. The distribution across mild, moderate, and moderately severe hearing loss categories reflects the spectrum of sensorineural involvement observed in diabetic patients.

**Table 3: Pure Tone Audiometry (PTA) Findings in the Study Population (n = 236)**

| PTA Range (dB HL) | Degree of Hearing Loss | Number (n) | Percentage (%) |
|-------------------|------------------------|------------|----------------|
| 20–30             | Mild                   | 72         | 30.5           |
| 30–40             | Moderate               | 88         | 37.3           |
| 40–50             | Moderately severe      | 76         | 32.2           |
| Mean PTA (dB HL)  | —                      | 34.9 ± 8.2 | —              |

Table 4 illustrates the **distribution of air–bone gap (ABG)** values among the study participants. ABG analysis helps identify the presence and extent of a conductive component contributing to hearing impairment. The table demonstrates varying degrees of ABG, indicating that, in addition to sensorineural pathology, a subset of patients exhibited mixed hearing loss patterns.

**Table 4: Distribution of Air–Bone Gap (ABG) Among Study Participants (n = 236)**

| ABG Range (dB)       | Conductive Component | Number (n) | Percentage (%) |
|----------------------|----------------------|------------|----------------|
| 10–20                | Mild                 | 82         | 34.7           |
| 20–30                | Moderate             | 96         | 40.7           |
| 30–40                | Severe               | 58         | 24.6           |
| <b>Mean ABG (dB)</b> | —                    | 23.8 ± 7.1 | —              |

Table 5 outlines the **glycemic control status based on HbA1c levels** and the **diabetes treatment modalities** adopted by the study population. HbA1c serves as an indicator of long-term glycemic control and is essential for assessing the metabolic severity of diabetes. Documentation of treatment modalities allows evaluation of their potential influence on auditory outcomes.

**Table 5: Glycemic Control (HbA1c Levels) and Diabetes Treatment Modalities (n = 236)**

| Variable                  | Category           | Number (n) | Percentage (%) |
|---------------------------|--------------------|------------|----------------|
| <b>HbA1c (%)</b>          | 5–6                | 64         | 27.1           |
|                           | 6–7                | 82         | 34.7           |
|                           | ≥7                 | 90         | 38.1           |
| <b>Treatment modality</b> | Diet control alone | 42         | 17.8           |
|                           | Oral hypoglycemics | 104        | 44.1           |
|                           | Insulin therapy    | 90         | 38.1           |

Table 6 demonstrates the relationship between **subjective hearing loss severity and functional impairment**, assessed using the Hearing Handicap Inventory for Adults (HHIA). The HHIA scores provide a validated measure of social and emotional handicap due to hearing loss. Increasing HHIA scores with worsening hearing severity highlight the functional impact of auditory impairment in diabetic individuals.

**Table 6: Distribution of Subjective Hearing Loss Severity and Functional Handicap (HHIA Scores) (n = 236)**

| Subjective Hearing Loss | Number (n) | Percentage (%) | Mean HHIA Score (± SD) | Functional Handicap Category |
|-------------------------|------------|----------------|------------------------|------------------------------|
| Mild                    | 98         | 41.53          | 18.6 ± 6.4             | Mild–moderate handicap       |
| Moderate                | 86         | 36.44          | 34.2 ± 8.1             | Moderate handicap            |
| Severe                  | 52         | 22.03          | 48.7 ± 9.6             | Significant handicap         |
| <b>Total</b>            | <b>236</b> | <b>100</b>     | —                      | —                            |

Table 7 examines the **association between HbA1c levels and audiological parameters**, specifically PTA and ABG values. This table highlights the correlation between poor glycemic control and worsening auditory thresholds. Statistical significance indicates a progressive deterioration in hearing sensitivity and conductive involvement with increasing HbA1c levels.

**Table 7: Association Between HbA1c Levels and Audiological Parameters (PTA and ABG) (n = 236)**

| HbA1c Category (%) | Number (n) | Mean PTA (dB $\pm$ SD) | PTA Category (dB) | Mean ABG (dB $\pm$ SD) | p value |
|--------------------|------------|------------------------|-------------------|------------------------|---------|
| 5–6                | 64         | 24.8 $\pm$ 5.2         | 20–30             | 14.6 $\pm$ 4.1         | —       |
| 6–7                | 82         | 32.5 $\pm$ 6.8         | 30–40             | 22.3 $\pm$ 5.6         | <0.01   |
| $\geq 7$           | 90         | 41.7 $\pm$ 7.4         | 40–50             | 31.2 $\pm$ 6.9         | <0.001  |

*Higher HbA1c levels showed significant association with worsening PTA and ABG.*

Table 8 presents the **distribution of associated otological symptoms**—tinnitus and vertigo—across varying degrees of hearing loss severity. This stratification emphasizes that the prevalence and combination of cochleo-vestibular symptoms increase with worsening auditory impairment, suggesting more extensive inner ear involvement in severe cases.

**Table 8: Distribution of Associated Otological Symptoms across Hearing Loss Severity (n = 236)**

| Hearing Loss Severity | Tinnitus n (%)   | Vertigo n (%)    | Both Symptoms n (%) | No Associated Symptoms n (%) |
|-----------------------|------------------|------------------|---------------------|------------------------------|
| Mild (n = 98)         | 26 (26.5)        | 14 (14.3)        | 8 (8.2)             | 50 (51.0)                    |
| Moderate (n = 86)     | 38 (44.2)        | 22 (25.6)        | 16 (18.6)           | 10 (11.6)                    |
| Severe (n = 52)       | 34 (65.4)        | 28 (53.8)        | 20 (38.5)           | 2 (3.8)                      |
| <b>Total</b>          | <b>98 (41.5)</b> | <b>64 (27.1)</b> | <b>44 (18.6)</b>    | <b>62 (26.3)</b>             |

Table 9 evaluates the **effect of different diabetes treatment modalities on hearing outcomes**, functional improvement (as reflected by reduction in HHIA scores), and the requirement for hearing aids. The table demonstrates differential auditory outcomes based on treatment approach and underscores the potential influence of metabolic control on hearing rehabilitation and assistive device dependency.

**Table 9: Effect of Diabetes Treatment Modality on Hearing Outcome and Hearing Aid Requirement (n = 236)**

| Treatment Modality | Number (n) | Improvement in Hearing (HHIA $\downarrow$ ) n (%) | No Improvement n (%) | Hearing Aid Prescribed n (%) |
|--------------------|------------|---------------------------------------------------|----------------------|------------------------------|
| Diet control alone | 42         | 30 (71.4)                                         | 12 (28.6)            | 6 (14.3)                     |
| Oral hypoglycemics | 104        | 72 (69.2)                                         | 32 (30.8)            | 28 (26.9)                    |
| Insulin therapy    | 90         | 46 (51.1)                                         | 44 (48.9)            | 42 (46.7)                    |
| <b>Total</b>       | <b>236</b> | <b>148 (62.7)</b>                                 | <b>88 (37.3)</b>     | <b>76 (32.2)</b>             |

## DISCUSSION

The present tertiary care hospital-based study evaluated the relationship between hearing loss and glycaemic control as measured by HbA1c levels among diabetic patients, using objective audiological parameters and clinically relevant outcome measures. With a study population of 236 patients, this work provides substantial evidence that diabetes mellitus, particularly when poorly controlled, is significantly associated with measurable auditory dysfunction. The findings reinforce the growing consensus that hearing loss should be recognized as an important microvascular complication of diabetes, alongside retinopathy, nephropathy, and neuropathy.

## Age, Gender, and Hearing Loss Distribution

In the present study, hearing loss was more prevalent in patients above the fourth decade of life, which aligns with existing literature suggesting an additive effect of aging and diabetes on cochlear degeneration. While presbycusis remains a confounding factor, multiple authors have demonstrated that diabetic individuals exhibit earlier onset and greater severity of hearing loss compared to age-matched non-diabetic controls (Alzahrani et al., 2021; Kim et al., 2023), (25 and 26). The male predominance observed in the study mirrors reports by Prabhu et al. (2022), (27) and Chen et al. (2024), (28), who attributed this trend to higher exposure to occupational noise, smoking, and poorer glycaemic control among males. However, gender itself did not independently predict severity of hearing loss, suggesting that metabolic factors play a more dominant role.

### **Subjective Hearing Loss and Audiological Correlation**

A notable strength of this study is the correlation between subjective hearing impairment (graded as mild, moderate, and severe) and objective PTA thresholds. Patients who reported moderate to severe subjective hearing loss predominantly exhibited PTA thresholds in the 30–50 dB range, indicating good concordance between patient-reported outcomes and audiometric findings. Similar correlations have been reported by Singh et al. (2021), (29) and Morales-Angulo et al. (2022), (30), emphasizing the importance of incorporating patient perception into routine diabetic evaluation. This finding supports the feasibility of early screening using targeted history-taking in resource-limited settings.

### **Pure Tone Audiometry and Air–Bone Gap Findings**

The PTA results demonstrated a progressive increase in hearing thresholds with rising HbA1c levels, particularly in patients with HbA1c  $\geq 7\%$ . This dose-response relationship strongly suggests a causal association between chronic hyperglycaemia and cochlear dysfunction. Studies by Hong et al. (2020), (31) and Elamin et al. (2023), (32) have reported similar threshold shifts, especially at higher frequencies, attributing these changes to microangiopathy of the stria vascularis and spiral ganglion neuron degeneration.

Although sensorineural hearing loss predominated, a subset of patients exhibited mild to moderate air–bone gaps (10–40 dB), indicating coexisting middle ear pathology. Diabetes-related immune dysfunction and altered Eustachian tube function have been proposed as contributing factors (Raghunandhan et al., 2021), (33). The presence of an air–bone gap also influenced treatment decisions and audiological rehabilitation outcomes, highlighting the importance of comprehensive audiological assessment rather than reliance on PTA alone.

### **HbA1c Levels as a Predictor of Hearing Loss**

HbA1c emerged as one of the strongest predictors of hearing impairment in this study. Patients with HbA1c levels above 7% consistently showed worse PTA thresholds, higher prevalence of tinnitus, and greater functional impairment. These findings are consistent with large population-based studies by Bainbridge et al. (2020), (34) and Lee et al. (2024), (35), which identified poor glycaemic control as an independent risk factor for hearing loss even after adjusting for age and cardiovascular comorbidities.

The pathophysiological basis for this association lies in chronic hyperglycaemia-induced oxidative stress, microvascular ischemia, and advanced glycation end-product deposition within cochlear structures. Recent histopathological studies have demonstrated thickening of capillary basement membranes and reduced cochlear blood flow in diabetic patients (Zhang et al., 2023), (36), lending biological plausibility to the observed clinical findings.

### **Associated Tinnitus and Vertigo**

Tinnitus was significantly more common among patients with higher PTA thresholds and elevated HbA1c levels. This association supports the hypothesis that metabolic dysregulation affects both auditory perception and neural processing. Similar observations were made by Kariya et al. (2021), (37) and Al-Muhaimmed et al. (2022), (38), who reported higher tinnitus prevalence among diabetics with poor metabolic control. Vertigo, although less common, was observed predominantly in patients

with long-standing diabetes, suggesting vestibular involvement due to shared microvascular pathology.

### **Impact of Treatment Modality on Hearing Outcomes**

An important and clinically relevant finding of this study is the positive influence of optimized diabetic management on hearing outcomes. Patients on structured treatment regimens including dietary modification, oral hypoglycaemics, and insulin therapy demonstrated subjective improvement in hearing and stabilization of PTA thresholds. Those achieving better glycaemic controls over time reported reduced tinnitus severity and improved communication ability. This aligns with interventional studies by Fukui et al. (2022), (39) and Meena et al. (2024), (40), which emphasized that strict metabolic control may slow the progression of diabetes-related auditory damage.

The requirement for hearing aids was higher among patients with long-standing poorly controlled diabetes, underscoring the irreversible nature of advanced cochlear damage. However, early identification and timely audiological rehabilitation significantly improved quality of life, reinforcing the need for integrated ENT and diabetic care.

### **Clinical and Public Health Implications**

The findings of this study have significant implications for clinical practice. Hearing assessment should be incorporated into routine diabetic evaluation, particularly for patients with HbA1c levels above recommended targets. Early screening, patient education, and interdisciplinary collaboration can reduce functional disability and improve long-term outcomes. Given the high prevalence of diabetes in India, these findings assume considerable public health importance.

### **CONCLUSION**

This study provides compelling evidence that hearing loss in diabetic patients is strongly and positively associated with poor glycaemic control, as reflected by elevated HbA1c levels. The use of objective audiological parameters—such as PTA thresholds, air–bone gap measurements, and associated symptoms like tinnitus and vertigo—strengthens the validity of the findings. Patients with HbA1c values  $\geq 7\%$  consistently demonstrated higher degrees of hearing impairment, greater subjective disability, and increased need for audiological rehabilitation.

Importantly, the study highlights modifiable variables that support improved outcomes. Early diagnosis of diabetes, strict metabolic control through diet, oral hypoglycaemics, and insulin therapy, and timely ENT referral were associated with stabilization of hearing thresholds and subjective improvement in auditory function. These positive associations reinforce the concept that hearing loss in diabetes is not merely an inevitable consequence but a potentially preventable and manageable complication when addressed early.

The findings advocate for the inclusion of routine hearing assessment in diabetic care protocols, particularly in tertiary care settings. Integrating audiological screening into standard diabetes management can facilitate early intervention, improve quality of life, and reduce long-term disability. Given the rising burden of diabetes in India and globally, this study underscores the need for multidisciplinary strategies to address the full spectrum of diabetic complications, including auditory dysfunction.

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