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Audiological Profile In Type 2 Diabetes Mellitus Patients And Its Correlation With Glycemic Control: A Cross-Sectional Study

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Abstract

Background: Type 2 Diabetes Mellitus (T2DM) is associated with microvascular and neuropathic complications that may affect the cochlea, leading to sensorineural hearing loss (SNHL). Despite growing evidence, routine audiological screening is not commonly practiced in diabetic care. This study aimed to evaluate the audiological profile of T2DM patients and determine its association with glycemic control and disease duration. ***Methods:***A hospital-based cross-sectional study was conducted jointly by the Departments of Otorhinolaryngology and General Medicine at a tertiary care teaching hospital. A total of 100 patients aged 30–65 years with confirmed T2DM were enrolled. Patients with conductive hearing loss, chronic otitis media, history of ototoxic drug use, significant noise exposure, or previous ear surgery were excluded. All participants underwent detailed clinical evaluation, HbA1c estimation, fasting and postprandial blood glucose testing, and Pure Tone Audiometry (PTA) across frequencies 250 Hz to 8 kHz. Hearing loss was classified according to WHO grading. Statistical analysis included Pearson's correlation, independent t-test, and multivariate regression analysis. A p-value <0.05 was considered statistically significant. ***Results:***Among the 100 participants (mean age 52.4 ± 8.6 years; 58% males), 38% demonstrated sensorineural hearing loss. High-frequency SNHL was the predominant pattern (71% of affected cases). Patients with HbA1c ≥8% had significantly higher mean hearing thresholds compared to those with HbA1c <8% (p=0.002). A moderate positive correlation was observed between HbA1c levels and hearing thresholds (r=0.41, p<0.001). Duration of diabetes >10 years was significantly associated with greater hearing impairment (p=0.01). Additionally, patients with diabetic neuropathy and retinopathy showed higher prevalence of SNHL (p=0.03). ***Conclusion:*** Sensorineural hearing loss, particularly at higher frequencies, is significantly associated with poor glycemic control and longer duration of T2DM. These findings suggest that periodic audiological evaluation may be beneficial in diabetic patients, especially those with uncontrolled disease and microvascular complications.

Keywords: Type 2 Diabetes Mellitus; Sensorineural Hearing Loss; HbA1c; Glycemic Control; Pure Tone Audiometry; Microangiopathy.r.

INTRODUCTION

Diabetes mellitus (DM) is one of the most significant global public health challenges of the 21st century. It is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from defects in insulin secretion, insulin action, or both. Among the various forms of diabetes, Type 2 Diabetes Mellitus (T2DM) accounts for approximately 90–95% of all cases worldwide and is associated with substantial morbidity, mortality, and economic burden.[1] The increasing prevalence of T2DM is primarily driven by rapid urbanization, sedentary lifestyles, population aging, unhealthy dietary habits, and the growing prevalence of obesity. According to the International Diabetes Federation (IDF) Diabetes Atlas 2025, approximately 589 million adults aged 20–79 years are living with diabetes globally, and this number is projected to increase to 853 million by 2050.[2]

India is recognized as the "diabetes capital of the world" because of its rapidly expanding diabetic population. Recent estimates indicate that India has more than 101 million individuals living with diabetes and an additional 136 million individuals with prediabetes.[3] The burden of T2DM in India has increased substantially over the past two decades due to socioeconomic transition, changes in lifestyle patterns, reduced physical activity, and increasing life expectancy. The rising prevalence of diabetes poses significant challenges to the healthcare system because of its associated chronic complications and the resulting impact on quality of life.

The long-term complications of T2DM are broadly categorized into macrovascular and microvascular complications. While diabetic retinopathy, nephropathy, and peripheral neuropathy are well-established microvascular complications routinely screened in clinical practice, auditory dysfunction remains an underrecognized and underdiagnosed manifestation. [4] Emerging evidence suggests that the auditory system, particularly the cochlea and auditory neural pathways, may be vulnerable to chronic hyperglycaemia and diabetes-related microvascular damage.

Several pathophysiological mechanisms have been proposed to explain the relationship between T2DM and hearing impairment. Chronic hyperglycemia results in endothelial dysfunction, thickening of the capillary basement membrane, reduced cochlear blood flow, oxidative stress, and accumulation of advanced glycation end products (AGEs). These changes may lead to microangiopathy of the stria vascularis, degeneration of outer hair cells, spiral ganglion neuron damage, and demyelination of the eighth cranial nerve.[5] Histopathological studies have demonstrated atrophy of the spiral ganglion cells, narrowing of the internal auditory artery, and degeneration of the cochlear structures in patients with diabetes, supporting the biological plausibility of diabetes-associated sensorineural hearing loss (SNHL).[6]

Hearing loss associated with T2DM is predominantly sensorineural in nature and typically affects higher frequencies initially. The prevalence of hearing impairment among individuals with diabetes has been reported to range from 20% to 45%, depending on the study population, diagnostic criteria, and audiological assessment methods.[7] A comprehensive meta-analysis demonstrated that adults with diabetes have a significantly higher risk of developing hearing impairment compared to non-diabetic individuals.[8] Moreover, poor glycemic control, longer duration of diabetes, and the presence of microvascular complications such as diabetic retinopathy and neuropathy have been identified as important predictors of hearing loss.

Despite increasing evidence linking T2DM with hearing impairment, routine audiological screening is not included in standard diabetic care protocols. Hearing loss often develops insidiously and may remain undetected until it significantly affects communication, social interactions, cognitive function, and overall quality of life. Early identification of hearing impairment through audiological evaluation may facilitate timely intervention and improve patient outcomes.

In the Indian context, limited studies have explored the association between glycemic control and hearing loss among patients with T2DM. Variations in ethnicity, environmental exposures, healthcare accessibility, and disease characteristics necessitate region-specific data to better understand the burden of diabetes-related auditory dysfunction. Furthermore, there remains a paucity of evidence examining the relationship between hearing thresholds, glycaemic control, disease duration, and diabetic microvascular complications in the Indian population.

Pure Tone Audiometry (PTA) is a reliable, non-invasive, and cost-effective tool for detecting early auditory dysfunction across different frequencies. Assessing the audiological profile of patients with T2DM and correlating hearing thresholds with glycaemic status may provide valuable insights into the role of chronic hyperglycaemia in cochlear dysfunction and support the incorporation of audiological assessment into comprehensive diabetes management strategies.

Therefore, the present study was undertaken to evaluate the audiological profile of patients with Type 2 Diabetes Mellitus and to determine its correlation with glycemic control, duration of diabetes, and the presence of microvascular complications.

OBJECTIVES

1. To determine the prevalence and pattern of hearing loss in patients with T2DM.
2. To correlate hearing thresholds with HbA1c levels.
3. To assess the association between duration of diabetes and hearing impairment.
4. To evaluate the relationship between diabetic microvascular complications and SNHL.

MATERIALS AND METHODS

Study Design

Hospital-based cross-sectional observational study.

Study Setting

Department of Otorhinolaryngology and Department of General Medicine, Subbaiah institute of medical sciences.

Study Duration

12 months.

Sample Size Calculation
Sample size was calculated using the formula:

$n=Z2\ P(1-P)/d2$

Assuming
- Expected prevalence (P) of SNHL in diabetics = 35% (based on previous literature)
- Z = 1.96 (95% confidence interval)
- Margin of error (d) = 9%

Calculated minimum sample size ≈ 97
Final sample size considered = 100 patients

Inclusion Criteria
- Diagnosed T2DM patients
- Age 30–65 years
- Willing to provide informed consent

Exclusion Criteria
- Conductive hearing loss
- Chronic otitis media
- History of ear surgery
- Ototoxic drug intake
- Significant occupational noise exposure
- Known congenital hearing impairment

Study Procedure
All participants underwent
- Detailed history and clinical ENT examination
- Fasting & postprandial blood glucose
- HbA1c estimation
- Screening for diabetic neuropathy & retinopathy
- Pure Tone Audiometry (250 Hz – 8 kHz)

Hearing loss is graded according to the WHO classification.

Statistical Analysis
Data analyzed using IBM SPSS Statistics for Windows, Version 25.0 (IBM SPSS Statistics; IBM Corp., Armonk, NY, USA). Continuous variables: Mean ± SD. Categorical variables: Frequency & percentage. Pearson correlation for HbA1c vs hearing thresholds. Independent t-test for group comparison. Multivariate regression for predictors. $p < 0.05$ considered statistically significant.

RESULTS

Table 1: Demographic Characteristics (n = 100)

Variable	Value
Mean Age	52.4 ± 8.6 years
Male	58%
Female	42%
Mean Duration of DM	9.2 ± 4.8 years
Mean HbA1c	8.4 ± 1.3%

Table 2: Prevalence & Pattern of Hearing Loss

Finding	Percentage
Normal Hearing	62%
SNHL	38%
High-frequency SNHL	27%
Bilateral involvement	31%

Table 3: Correlation Analysis

Variable	Correlation Coefficient (r)	p-value
HbA1c vs Hearing Threshold	0.41	<0.001
Duration vs Hearing Threshold	0.32	0.01

Patients with an HbA1c level of ≥8% had significantly higher mean hearing thresholds compared to those with an HbA1c level of <8% (p = 0.002). The presence of diabetic neuropathy and retinopathy showed a significant association with SNHL (p = 0.03).

DISCUSSION

The present hospital-based cross-sectional study evaluated the audiological profile of 100 patients with Type 2 Diabetes Mellitus (T2DM) and examined its association with glycemic control, duration of disease, and microvascular complications.

In the present study, 38% of patients demonstrated sensorineural hearing loss (SNHL). This prevalence is consistent with previous reports, which have documented hearing impairment among 30–45% of patients with T2DM.[9–11] The variation in prevalence across studies may be attributed to differences in study populations, age distribution, duration of diabetes, glycemic status, and audiometric assessment methods.

High-frequency SNHL was the predominant audiological pattern observed, accounting for 71% of affected cases. Similar findings have been reported by Panchu, who demonstrated significantly elevated hearing thresholds at higher frequencies among diabetic patients compared with non-diabetic individuals.[16] Austin et al. also observed early high-frequency hearing impairment in diabetic patients, suggesting increased vulnerability of the basal turn of the cochlea to metabolic and vascular injury.[15] The preferential involvement of higher frequencies may result from microangiopathy affecting the stria vascularis and degeneration of outer hair cells.

A significant positive correlation was observed between HbA1c levels and hearing thresholds (r = 0.41, p < 0.001). Furthermore, patients with HbA1c levels ≥8% had significantly higher hearing thresholds than those with HbA1c levels <8% (p = 0.002). These findings indicate that poor glycemic control is associated with worsening auditory function. Similar observations have been reported by Srinivas et al., who demonstrated a significant association between elevated HbA1c levels and SNHL severity in patients with T2DM.[13] Elamin et al. also identified poor glycemic control as an independent predictor of hearing impairment. [10] Chronic hyperglycemia may induce cochlear dysfunction through microvascular damage, oxidative stress, accumulation of advanced glycation end products, and neural degeneration.[12].

The present study further demonstrated a significant association between duration of diabetes and hearing impairment. Patients with disease duration greater than 10 years had significantly greater hearing thresholds, and a moderate positive correlation was observed between duration of diabetes and hearing thresholds (r = 0.32, p = 0.01). These findings suggest that prolonged exposure to hyperglycemia contributes to progressive cochlear damage. Similar results have been reported by Agrawal et al., who observed a higher prevalence of hearing loss among individuals with longer disease duration. [9] Kakarlapudi et al. also reported increasing severity of hearing loss with longer duration of diabetes.[14]

An important finding of the present study was the significant association between diabetic microvascular complications and SNHL. Patients with diabetic neuropathy and retinopathy exhibited a higher prevalence of hearing impairment (p = 0.03). This observation supports the concept that hearing loss may represent an additional microvascular complication of diabetes. Felício et al. demonstrated that cochlear dysfunction is more common among diabetic patients with established microvascular complications. [12] Similar findings have been reported by Dalton et al., who suggested that cochlear microangiopathy parallels vascular changes observed in the retina and peripheral nerves.[17].

The pathophysiological mechanisms underlying diabetes-associated hearing loss are multifactorial. Histopathological studies have demonstrated thickening of capillary basement membranes within the stria vascularis, atrophy of the organ of Corti, degeneration of spiral ganglion neurons, and reduced cochlear blood flow in diabetic patients. [14,18] Oxidative stress and chronic inflammation further contribute to vascular and neural injury within the auditory pathway.

The findings of the present study highlight the importance of incorporating periodic audiological assessment into routine diabetic care, particularly for patients with poor glycemic control, longer disease duration, and established microvascular complications. Early detection through Pure Tone Audiometry may facilitate timely intervention and improve quality of life.

CONCLUSION

This hospital-based cross-sectional study demonstrated that sensorineural hearing loss (SNHL) is a common yet underrecognized complication among patients with Type 2 Diabetes Mellitus (T2DM), with an overall prevalence of 38%. High-frequency SNHL was the predominant pattern observed, and bilateral involvement was present in a substantial proportion of affected individuals.

Poor glycemic control, as indicated by higher HbA1c levels, showed a significant positive correlation with increased hearing thresholds. Additionally, longer duration of diabetes was associated with greater hearing impairment. The presence of diabetic microvascular complications, particularly neuropathy and retinopathy, was also significantly associated with a higher prevalence of SNHL.

These findings suggest that chronic hyperglycemia and cumulative microvascular damage may contribute to progressive cochlear dysfunction in patients with T2DM. Therefore, periodic audiological assessment using Pure Tone Audiometry should be considered as part of comprehensive diabetes care, especially for patients with poor glycemic control, longer disease duration, and established microvascular complications. Early detection and timely intervention may help reduce the impact of hearing impairment and improve the overall quality of life of diabetic patients.

REFERENCES

1. American Diabetes Association Professional Practice Committee. Classification and diagnosis of diabetes: Standards of care in diabetes—2024. Diabetes Care. 2024;47(Suppl 1): S20-S42. doi:10.2337/dc24-S002
2. International Diabetes Federation. IDF Diabetes Atlas. 11th ed. Brussels, Belgium: International Diabetes Federation; 2025.
3. Indian Council of Medical Research, Madras Diabetes Research Foundation. Diabetes in India: Estimates from the INDIAB study. Lancet Diabetes Endocrinol. 2023;11(7):474-489. doi:10.1016/S2213-8587(23)00123-4
4. Bainbridge KE, Hoffman HJ, Cowie CC. Diabetes and hearing impairment in the United States: Audiometric evidence from the National Health and Nutrition Examination Survey, 1999–2004. Ann Intern Med. 2008;149(1):1-10. doi:10.7326/0003-4819-149-1-200807010-00231
5. Frisina ST, Mapes F, Kim S, Frisina DR, Frisina RD. Characterization of hearing loss in aged type II diabetics. Hear Res. 2006;211(1-2):103-113. doi: 10.1016/j.heares.2005.09.002
6. Fukushima H, Cureoglu S, Schachern PA, Paparella MM, Harada T, Oktay MF. Cochlear changes in patients with type 2 diabetes mellitus. Otol Neurotol. 2006;27(8):1091-1095. doi: 10.1097/01.mao.0000244354.85838.6f
7. Kakarlapudi V, Sawyer R, Staecker H. The effect of diabetes on sensorineural hearing loss. Otol Neurotol. 2003;24(3):382-386. doi:10.1097/00129492-200305000-00006
8. Horikawa C, Kodama S, Tanaka S, Fujihara K, Hirasawa R, Yachi Y, Shimano H, et al. Diabetes and risk of hearing impairment in adults: A meta-analysis. J Clin Endocrinol Metab. 2013;98(1):51-58. doi:10.1210/jc.2012-21.
9. Agrawal Y, Platz EA, Niparko JK. Prevalence of hearing loss and differences by diabetes status in the United States. Otol Neurotol. 2009;30(7):819-826. doi:10.1097/MAO.0b013e3181b76f90.
10. Nagahama S, Kashino I, Hu H, Nanri A, Kurotani K, Kuwahara K, et al. Haemoglobin A1c and hearing impairment: longitudinal analysis using a large occupational health check-up data of Japan. BMJ Open. 2018;8(9): e023220. doi:10.1136/bmjopen-2018-023220.
11. Horikawa C, Kodama S, Tanaka S, Fujihara K, Hirasawa R, Yachi Y, et al. Diabetes and risk of hearing impairment in adults: a meta-analysis. J Clin Endocrinol Metab. 2013;98(1):51-58. doi:10.1210/jc.2012-2119.
12. Felício JS, de Souza ICS, de Andrade LO, Ribeiro GS, de Carvalho CT, de Lemos LL, et al. Cochlear dysfunction and microvascular complications in patients with type 1 diabetes mellitus. Braz J Otorhinolaryngol. 2018;84(5):567-574. doi: 10.1016/j.bjorl.2017.06.009.
13. Srinivas CV, Shyamala V, Shiva Kumar BR. Sensorineural hearing loss in type 2 diabetes mellitus and its correlation with glycemic control. Indian J Otolaryngol Head Neck Surg. 2016;68(2):191-195. doi:10.1007/s12070-015-0929-7.
14. Kakarlapudi V, Sawyer R, Staecker H. The effect of diabetes on sensorineural hearing loss. Otol Neurotol. 2003;24(3):382-386. doi:10.1097/00129492-200305000-00006.
15. Austin DF, Konrad-Martin D, Griest S, McMillan GP, McDermott D, Fausti SA. Diabetes-related changes in hearing. Laryngoscope. 2009;119(9):1788-1796. doi:10.1002/lary.20523.
16. Panchu P. Auditory acuity in type 2 diabetes mellitus. Int J Diabetes Dev Ctries. 2008;28(4):114-120.
17. Dalton DS, Cruickshanks KJ, Klein R, Klein BEK, Wiley TL. Association of NIDDM and hearing loss. Diabetes Care. 1998;21(9):1540-1544. doi:10.2337/diacare.21.9.1540.
18. Vaughan N, James K, McDermott D, Griest S, Fausti S. A 5-year prospective study of diabetes and hearing loss in a veteran population. Otol Neurotol. 2006;27(1):37-43. doi: 10.1097/01.mao.0000188655.01738.6a.