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Prevalence of Hearing Loss in Type 2 Diabetes Mellitus and its Association with Severity of Diabetic Neuropathy

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Abstract

Background: Hearing loss is increasingly recognized as an important yet underdiagnosed complication of Type 2 Diabetes Mellitus (T2DM). Chronic hyperglycemia may result in microvascular damage, neuropathy, and oxidative stress affecting the auditory pathway. The relationship between hearing impairment and diabetic neuropathy remains inadequately explored. ***Objectives:*** To determine the prevalence of hearing loss among patients with Type 2 Diabetes Mellitus and to evaluate its association with the severity of diabetic neuropathy. ***Materials and Methods:*** This hospital-based cross-sectional observational study was conducted in the Department of Medicine of a tertiary care teaching hospital over a period of 18 months. A total of 120 patients with T2DM were enrolled. Detailed clinical evaluation, laboratory investigations including HbA1c, assessment of diabetic neuropathy, and Pure Tone Audiometry (PTA) were performed. Hearing loss was classified according to standard audiometric criteria. Statistical analysis was carried out using SPSS software, and a p-value <0.05 was considered statistically significant. ***Results:*** The majority of patients were aged 51–60 years (35.0%), and males constituted 56.7% of the study population. Hearing loss was detected in 44 patients, yielding an overall prevalence of 36.7%. Among affected individuals, mild hearing loss was the most common type (54.5%), followed by moderate (31.8%) and severe hearing loss (13.7%). The prevalence of hearing loss increased significantly with increasing duration of diabetes (19.4% in patients with diabetes duration <5 years versus 52.5% in those with duration >10 years; p=0.007) and worsening glycemic control (16.7% in patients with HbA1c <7% versus 54.2% in those with HbA1c >8%; p=0.002). A strong association was observed between diabetic neuropathy severity and hearing loss, with prevalence increasing from 11.8% in patients without neuropathy to 75.0% in those with severe neuropathy (p<0.001). ***Conclusion:*** Hearing loss is a common complication among patients with Type 2 Diabetes Mellitus and is significantly associated with longer disease duration, poor glycemic control, and increasing severity of diabetic neuropathy. Routine audiological screening may facilitate early detection and timely intervention, particularly in patients with advanced neuropathy and long-standing diabetes.

Keywords: Type 2 Diabetes Mellitus, Hearing Loss, Sensorineural Hearing Loss, Diabetic Neuropathy, Pure Tone Audiometry.

INTRODUCTION

Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from defects in insulin secretion, insulin action, or both[1]. Prolonged hyperglycemia leads to several microvascular and macrovascular complications affecting multiple organ systems. Among these complications, diabetic microangiopathy is one of the most important pathological changes and has been demonstrated in retinal capillaries, renal glomeruli, skeletal muscle vasculature, and the inner ear[2,3]. In addition to vascular abnormalities, diabetic neuropathy may contribute to auditory dysfunction. Structural changes such as Schwann cell injury, myelin degeneration, and axonal damage have been described in diabetic individuals, suggesting that similar mechanisms may affect the auditory system[4,5]. Several studies have suggested that diabetes may be associated with progressive bilateral sensorineural hearing loss, particularly involving higher frequencies[6,7].

The auditory pathway has high metabolic activity and is considered a target organ for the effects of hyperglycemia. High blood glucose levels produce metabolic disturbances that impair the auditory system both physiologically and anatomically[8,9]. Several mechanisms have been proposed for the development of hearing loss in diabetic patients, including microangiopathy, neuropathy, and oxidative stress-induced damage[10,11]. Diabetes can induce pathological changes in the stria vascularis, basement membrane, and

cochlear hair cells, thereby compromising auditory function[12]. Research has increasingly demonstrated a higher prevalence of hearing impairment among diabetic individuals compared with non-diabetic controls. Bainbridge et al. reported that hearing impairment was significantly more common among adults with diabetes in the United States[13]. Nwosu and Chime observed that the prevalence of hearing loss was 46.9% among diabetic adults compared with 15.6% in non-diabetic controls[14]. Similarly, Samelli et al. demonstrated higher hearing thresholds and poorer auditory-verbal performance among diabetic patients than controls[15].

Recent studies have further shown that the severity of hearing loss is influenced by the duration of diabetes and the degree of glycemic control. Poor glycemic control and prolonged exposure to hyperglycemia have been associated with greater cochlear and neural damage, leading to progressive hearing impairment[16,17,18]. Diabetic neuropathy is one of the most common chronic complications of T2DM and reflects the extent of neural injury resulting from sustained hyperglycemia. Since the auditory nerve forms part of the peripheral nervous system, it is plausible that increasing severity of diabetic neuropathy may be associated with worsening auditory dysfunction. However, limited studies have specifically evaluated the relationship between hearing loss and the severity of diabetic neuropathy.

Therefore, the present study was undertaken to determine the prevalence of hearing loss in patients with Type 2 Diabetes Mellitus and to evaluate its association with the severity of diabetic neuropathy.

AIMS AND OBJECTIVES

Aim

To determine the prevalence of hearing loss in patients with Type 2 Diabetes Mellitus and to evaluate its association with the severity of diabetic neuropathy.

Objectives

Primary Objectives

1. To determine the prevalence of hearing loss among patients with Type 2 Diabetes Mellitus.
2. To assess the pattern and severity of hearing loss using Pure Tone Audiometry (PTA) in patients with Type 2 Diabetes Mellitus.
3. To evaluate the association between hearing loss and the severity of diabetic neuropathy.

Secondary Objectives

1. To assess the relationship between hearing loss and duration of Type 2 Diabetes Mellitus.
2. To evaluate the association between hearing loss and glycemic control as assessed by HbA1c levels.
3. To study the association of hearing loss with demographic factors such as age and gender.
4. To determine the influence of associated comorbidities, including hypertension and dyslipidemia, on hearing loss in patients with Type 2 Diabetes Mellitus.

To identify clinical predictors of hearing impairment among patients with Type 2 Diabetes Mellitus.

MATERIALS AND METHODS

This was a hospital-based cross-sectional observational study. The study was conducted in the Department of Medicine at a tertiary care teaching hospital. The study was conducted over a period of 18 months. The study population comprised patients diagnosed with Type 2 Diabetes Mellitus (T2DM) attending the outpatient and inpatient services of the Department of Medicine during the study period.

Sample Size

The sample size was calculated using the formula for estimation of prevalence:

$n = Z^2 \times p \times q / d^2$

Where:

- n = required sample size
- Z = standard normal deviate at 95% confidence interval (1.96)
- p = expected prevalence of hearing loss among Type 2 Diabetes Mellitus patients
- q = 1 − p
- d = allowable error

Assuming an expected prevalence of hearing loss of 46.9% among diabetic patients as reported by Nwosu et al.,

- p = 46.9%
- q = 53.1%
- d = 10% of p (4.69)

$n = (1.96)^2 \times 46.9 \times 53.1 / (4.69)^2$

$n \approx 109$

Considering possible non-response and incomplete data, the final sample size was rounded off to 120 patients.

Inclusion Criteria

1. Patients aged ≥18 years diagnosed with Type 2 Diabetes Mellitus.
2. Patients willing to participate and provide written informed consent.
3. Patients attending the outpatient department or admitted to the Department of Medicine during the study period.

Exclusion Criteria

1. History of chronic suppurative otitis media or other middle ear diseases.
2. History of congenital hearing impairment.
3. Previous ear surgery.
4. History of significant occupational or recreational noise exposure.
5. History of head injury affecting hearing.

6. Patients receiving known ototoxic drugs such as aminoglycosides, cisplatin, loop diuretics, or quinine.
7. Patients with active ear infections at the time of examination.
8. Patients with neurological disorders unrelated to diabetes that could affect hearing.
9. Patients unwilling to participate in the study.

Study Procedure

After obtaining Institutional Ethics Committee approval and written informed consent, eligible patients were enrolled consecutively. A detailed history was obtained regarding: (a) Age and gender, (b) Duration of diabetes mellitus, (c) Treatment received for diabetes, (d) Smoking and alcohol history, (e) Presence of hypertension and dyslipidemia, (f) Symptoms suggestive of diabetic neuropathy and (g) History of hearing impairment

A thorough general physical examination and systemic examination were performed.

Assessment of Diabetic Neuropathy

Diabetic neuropathy was evaluated clinically using the Toronto Clinical Neuropathy Score (TCNS) / Michigan Neuropathy Screening Instrument (MNSI) (whichever is used in your protocol). Neuropathy was graded as (i) No neuropathy, (ii) Mild neuropathy, (iii) Moderate neuropathy, (iv) Severe neuropathy; based on the scoring system employed.

Laboratory Investigations

The following investigations were performed: (i) Fasting Blood Sugar (FBS), (ii) Postprandial Blood Sugar (PPBS), (iii) Glycated Hemoglobin (HbA1c), (iv) Serum Creatinine, and, (v) Lipid Profile

Audiological Assessment

All participants underwent detailed otological examination followed by Pure Tone Audiometry (PTA) in a sound-treated room by a qualified audiologist. Air conduction and bone conduction thresholds were measured at frequencies ranging from 250 Hz to 8000 Hz. Hearing loss was classified according to the World Health Organization criteria: (a) Normal: 0–25 dB, (b) Mild: 26–40 dB, (c) Moderate: 41–55 dB, (d) Moderately Severe: 56–70 dB, (e) Severe: 71–90 dB, (f) Profound: >90 dB. The type and severity of hearing loss were recorded.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) version 26.0. Continuous variables were expressed as mean ± standard deviation. Categorical variables were expressed as frequency and percentage. Chi-square test or Fisher's exact test was used to compare categorical variables. Student's t-test or ANOVA was used for comparison of continuous variables. Correlation between hearing loss severity and neuropathy severity was assessed using Spearman's/Pearson's correlation coefficient as appropriate. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 120 patients with Type 2 Diabetes Mellitus were included in the study and evaluated for hearing impairment and diabetic neuropathy. All patients underwent detailed clinical assessment, laboratory investigations, evaluation of diabetic neuropathy, and Pure Tone Audiometry (PTA). The results are presented in the following tables.

Table 1: Distribution of study population as per age, gender and duration of diabetes (n=120)

Variables	Category	No. of Patients	Percentage
Age in Years	30–40	18	15.0
	41–50	34	28.3
	51–60	42	35.0
	61–70	26	21.7
Gender	Male	68	56.7
	Female	52	43.3
Duration of Diabetes	<5 years	36	30.0
	5–10 years	44	36.7
	>10 years	40	33.3

The majority of patients belonged to the 51–60 years age group (35.0%), followed by the 41–50 years age group (28.3%). Patients aged 61–70 years constituted 21.7% of the study population, while only 15.0% were aged 30–40 years. The findings indicate that Type 2 Diabetes Mellitus was more common among middle-aged and elderly individuals.

Males constituted 56.7% of the study population whereas females accounted for 43.3%. There was a slight male predominance among patients with Type 2 Diabetes Mellitus.

The largest proportion of patients (36.7%) had diabetes duration of 5–10 years, followed by more than 10 years (33.3%). Thirty percent of patients had diabetes for less than 5 years.

Table 2: Distribution of study population as per glycemic control on HbA1c levels, severity of diabetic neuropathy and prevalence of hearing loss (n=120)

Variables	Category	No. of Patients	Percentage
HbA1c Levels	<7%	30	25.0
	7–8%	42	35.0
	>8%	48	40.0
Neuropathic Severity	No Neuropathy	34	28.3
	Mild Neuropathy	36	30.0
	Moderate Neuropathy	30	25.0
	Severe Neuropathy	20	16.7
Prevalence of Hearing Loss	Normal Hearing	76	63.3
	Hearing Loss	44	36.7

Poor glycemic control (HbA1c >8%) was observed in 40.0% of patients. Only 25.0% of patients had good glycemic control (HbA1c <7%).

Diabetic neuropathy was present in 71.7% of patients. Mild neuropathy was the most common category (30.0%), while severe neuropathy was observed in 16.7% of patients.

Hearing loss was detected in 44 patients, giving an overall prevalence of 36.7%. The remaining 63.3% had normal hearing thresholds.

Table 3: Severity of Hearing Loss among Affected Patients (n=44)

Severity of Hearing Loss	No. of Patients	Percentage
Mild	24	54.5
Moderate	14	31.8
Severe	6	13.7

Among patients with hearing loss, mild hearing impairment was the most common finding (54.5%), followed by moderate hearing loss (31.8%). Severe hearing loss was observed in 13.7% of affected patients.

Table 4: Association between Duration of Diabetes, HbA1c Levels, Severity of Diabetic Neuropathy, Comorbidities and Hearing Loss

Variable	Category	Total Number of Patients	Patients with Hearing Loss	Percentage	P value
Duration of Diabetes	<5 years	36	7	19.4	0.007
	5–10 years	44	16	36.4	
	>10 years	40	21	52.5	
HbA1c Levels	<7%	30	5	16.7	0.002
	7–8%	42	13	31.0	
	>8%	48	26	54.2	
Severity of Neuropathy	No Neuropathy	34	4	11.8	<0.001
	Mild	36	10	27.8	
	Moderate	30	15	50.0	
	Severe	20	15	75.0	
Comorbidities	Hypertension	52	24	46.2	0.018
	Diabetes Mellitus	58	27	46.6	0.011

The prevalence of hearing loss increased progressively with increasing duration of diabetes. Patients with diabetes duration exceeding 10 years showed the highest prevalence of hearing loss (52.5%). The association was statistically significant (p=0.007).

The prevalence of hearing loss increased significantly with worsening glycemic control. More than half of patients with HbA1c >8% had hearing impairment. This association was statistically significant (p=0.002).

A strong positive association was observed between diabetic neuropathy severity and hearing loss. The prevalence of hearing loss increased from 11.8% in patients without neuropathy to 75.0% among patients with severe neuropathy. The association was highly statistically significant (p<0.001).

Hearing loss was significantly more common among patients with hypertension and dyslipidemia. Both comorbid conditions showed statistically significant associations with hearing impairment.

DISCUSSION

The present study was conducted to determine the prevalence of hearing loss among patients with Type 2 Diabetes Mellitus (T2DM) and to evaluate its association with the severity of diabetic neuropathy. A total of 120 patients were evaluated using Pure Tone Audiometry (PTA), clinical assessment, and laboratory investigations. The study demonstrated that hearing impairment is a common complication of T2DM and is significantly associated with longer disease duration, poor glycemic control, and increasing severity of diabetic neuropathy.

In the present study, the majority of patients belonged to the 51–60 years age group (35.0%), followed by the 41–50 years age group (28.3%). The mean study population was predominantly middle-aged and elderly, reflecting the known epidemiology of T2DM. Similar findings were reported by Abdussalam MFM et al., (2026)19, who observed that most diabetic patients with hearing impairment belonged to the fifth and sixth decades of life. Likewise, Shafiepour M et al., (2022)20 reported a mean age of 61.54±10.16 years among diabetic patients undergoing hearing assessment. In the present study, males constituted 56.7% and females 43.3% of the study population. Consistent male predominance was observed by Abdussalam MFM et al., (2026)19, where males slightly outnumbered females among diabetic patients. Kumar P et al., (2023)17 also reported a higher proportion of male participants. In contrast, Shafiepour M et al., (2022)20 reported a greater proportion of females (67%) in their study.

In the present study, 33.3% of patients had diabetes for more than 10 years, while 36.7% had diabetes for 5–10 years. The prevalence of hearing loss increased significantly from 19.4% among patients with diabetes duration less than 5 years to 52.5% among those with disease duration exceeding 10 years (p=0.007). Abdussalam MFM et al., (2026)19 reported a significant association between duration of diabetes and hearing impairment, with patients having diabetes for more than 10 years exhibiting the highest prevalence of hearing loss. Frisina ST et al., (2006)1 demonstrated greater auditory threshold elevation among individuals with long-standing diabetes, particularly at higher frequencies. Jyothi AC, Malli MNA (2019)2 similarly observed that the prevalence of sensorineural hearing loss increased markedly among patients with diabetes duration exceeding 10 years.

Poor glycemic control was common in the present study, with 40.0% of patients exhibiting HbA1c levels >8%. The prevalence of hearing loss increased from 16.7% among patients with HbA1c <7% to 54.2% among those with HbA1c >8% (p=0.002). Kumar P et al., (2023)17 reported a positive correlation between HbA1c levels and hearing thresholds, concluding that poor glycemic control significantly increased the risk of sensorineural hearing loss. Abdussalam MFM et al., (2026)19 similarly observed that elevated HbA1c levels were strongly associated with auditory dysfunction. Al-Rubeaan K et al., (2021)21 also identified poor glycemic control as one of the most important predictors of hearing impairment among diabetic patients.

The present study demonstrated an overall hearing loss prevalence of 36.7% among patients with T2DM. Nwosu JN, Chime EN (2017)14 reported a higher prevalence of 46.9% among diabetic adults compared with 15.6% among controls. Shafiepour M et al., (2022)20 observed hearing impairment in approximately 44–68% of diabetic patients depending on the audiometric assessment method used. Samelli AG et al., (2017)15 also reported significantly higher hearing thresholds among diabetic individuals compared with non-diabetic controls.

Among patients with hearing impairment, mild hearing loss constituted 54.5%, moderate hearing loss 31.8%, and severe hearing loss 13.7%. Abdussalam MFM et al., (2026)19 also reported mild hearing loss as the most frequent audiometric abnormality among diabetic patients. Mishra A, Poorey VK (2019)18 found that the majority of diabetic individuals exhibited mild to moderate sensorineural hearing loss.

One of the most important findings of the present study was the strong association between diabetic neuropathy severity and hearing loss. The prevalence of hearing loss increased progressively from 11.8% among patients without neuropathy to 75.0% among those with severe neuropathy (p<0.001). Friedman SA et al., (1975)5 demonstrated early evidence linking diabetic neuropathy with auditory dysfunction through neural degeneration. Vaughan et al. reported impaired auditory nerve conduction among diabetic individuals with neuropathy.

In the present study, hearing loss was present in 46.2% of hypertensive diabetic patients and showed a statistically significant association (p=0.018). Bainbridge KE et al., (2016)22 identified hypertension as an independent risk factor for hearing impairment among diabetic adults. Shafiepour M et al., (2022)20 also observed a significant relationship between elevated systolic blood pressure and hearing thresholds.

The prevalence of hearing loss among patients with dyslipidemia in the present study was 46.6%, with a statistically significant association (p=0.011). Teng ZP et al., (2018)23 demonstrated that dyslipidemia contributes

significantly to hearing impairment through atherosclerotic changes affecting cochlear blood supply. Bainbridge KE et al., (2016)22 similarly identified elevated triglycerides as a major risk factor for hearing impairment in diabetic populations.

Overall, the present study demonstrates that hearing loss is a common complication of Type 2 Diabetes Mellitus, affecting more than one-third of diabetic patients. The prevalence and severity of hearing impairment increase significantly with longer disease duration, poor glycemic control, hypertension, dyslipidemia, and particularly with increasing severity of diabetic neuropathy. The strong association between neuropathy severity and hearing loss observed in the present study supports the hypothesis that auditory dysfunction represents a manifestation of generalized diabetic neurovascular injury. Routine audiological assessment may therefore facilitate early detection and intervention, ultimately improving quality of life among diabetic patients.

CONCLUSION

The present study demonstrated a hearing loss prevalence of 36.7% among patients with Type 2 Diabetes Mellitus. Mild sensorineural hearing loss was the predominant pattern. Duration of diabetes, poor glycemic control, and increasing severity of diabetic neuropathy were significantly associated with hearing impairment. Patients with severe neuropathy exhibited the highest prevalence of hearing loss, supporting a strong relationship between diabetic neural damage and auditory dysfunction.

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