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Clinical evaluation of hearing loss in type 2 diabetes mellitus: A prospective observational study

Abishesh Shakya[1], Sangita Regmi Chalise[2], Suman Simkhada[1], Jeegyasha Thapa[1], Subash Khadka[3], Rishi Bhatta[4], Ashish Khadgi[1], Binay Kumar[5], Ramesh Parajuli[6], Sujyoti Shakya[7]

[1]Lecturer, Department of ENT-HNS, KISTMCTH, Lalitpur, Nepal
[2]Professor, Department of ENT-HNS, KISTMCTH, Lalitpur, Nepal
[3]Consultant, Everest Hospital, Kathmandu, Nepal
[4]Assoc Professor, Department of ENT-HNS KISTMCTH, Nepal
[5]Audiologist, Department of ENT-HNS, KISTMCTH, Lalitpur, Nepal
[6]Assoc Professor, Department of ENT-HNS, CMCTH, Bharatpur, Nepal
[7]Pharmacist, Department of Pharmaceutical and Health Service Research, Nepal Health Research and Innovation Foundation, Nepal

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Abstract:

Background: Diabetes mellitus (DM) is associated with many consequences because of chronic hyperglycemia, including hearing impairment due to damage to small blood vessels and nerves in the auditory system. This study aims to assess the grade of hearing loss in patients with Type 2 DM.

Method: A prospective observational study was conducted at KISTMCTH from Dec 2022 to Jun 2023. Ninety-five patients with Type 2 DM who consented were included. Ethical approval was obtained. Patients with mental illness, family deafness history, noise exposure, and ototoxic medication were excluded. Routine ENT examinations, audiological and blood sugar evaluations were done. Hearing loss was classified according to WHO grading. Data analysis was done using SPSS, Pearson's correlation and Fischer's exact test to assess links between diabetes duration, glycaemic control, and hearing loss ($p<0.05$).

Result: Out of 95 DM 2 patients, mean age 52.5±9.6 years, most were of 51–60 years (35.8%), mainly females (58.9%). Hearing loss was observed in 63(66.3%). Hearing loss increased with duration of DM. Sensorineural Hearing loss (85.3%) was observed in patients with DM of >10 years. Hearing loss (91%) was observed in patients with poor glycaemic control (HbA1c >7). A significant correlation between hearing loss, glycaemic control, and duration of DM was found ($p<0.001$).

Conclusion: The study showed that patients with DM had hearing loss which was mainly of SNHL. The severity of hearing loss was associated with duration and glycaemic control of DM.

Keywords: Diabetes mellitus, Glycaemic control, Hearing loss, Pure tone audiometry

How to cite

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Correspondence

Abishesh Shakya, Lecturer, Department of ENT-HNS, KISTMCTH, Lalitpur, Nepal. Email: abishesh.shakya1234511@gmail.com, Telephone: +977 9841340516

Introduction

Diabetes mellitus (DM) is a metabolic disorder characterized by insulin deficiency, leading to elevated blood sugar levels and long-term complications affecting long-term vascular and neurological complications including the auditory system. Approximately 422 million people globally are suffering from DM.[1,2] In Nepal, 3.2% of the population suffer from DM.[3]

Hearing loss is a significant but sometimes ignored consequence of Type 2 diabetes. It can manifest as sensorineural, conductive, or mixed hearing loss. Sensorineural hearing loss (SNHL) is particularly common among diabetic patients. Researches indicate that individuals with diabetes have a higher prevalence of hearing impairment compared to the general population, with gradual, bilateral SNHL frequently affecting higher frequencies.[4,5]

The mechanism behind diabetes-related hearing loss is not fully understood, but possible causes are inner ear microangiopathy, cochlear nerve neuropathy, dysfunction of outer hair cells, and disturbances in endolymphatic potential. The risk of hearing loss may also be increased by other variables, including age, the duration of diabetes, and concomitant illnesses.[6,7]

A comprehensive audiological evaluation, including pure tone audiometry, tympanometry, and speech discrimination tests are essential for diagnosing hearing impairment in diabetic patients. Pure tone audiometry (PTA) is a vital test that assesses an individual's hearing threshold levels, helping to evaluate the degree, type, and pattern of hearing loss.[8]

This study aims to assess the degree and type of hearing loss in patients with Type 2 DM and its association with the duration of diabetes and glycemic control, so we can avoid complications of DM and develop targeted interventions.

Method

A prospective, observational, and hospital-based study was conducted from 01 Dec 2022 to 30 Jun 2023, for six months in the Department of Ear, Nose Throat – Head and Neck Surgery (ENT-HNS), KIST Medical College and Teaching Hospital, Lalitpur (KISTMCTH), Nepal. Patients having type 2 DM presenting to KISTMCTH Medicine and ENT outpatient department (OPD) during this period were included. Whereas, patients with mental illness, family history of deafness, history of prolonged exposure to noise, use of ototoxic medications and patients having a history of ear disease, ear surgery, head or ear trauma, patients with a family history of deafness, history of suggestive of noise-induced hearing loss were excluded. Before the collection of the data, the participants were informed about the purpose and objective of the study, and written consent was obtained from each of them. A consecutive sampling method was used to select study participants.

The sample size was calculated using formula (n): $z^2P(1-P)/d^2$ where, n= total number of samples, z=95% confidence interval, i.e. 1.96 p= Prevalence, q=1-p, and d= Precision i.e. 5%. We considered p=6.4%,[9] which is world prevalence of diabetes among adults. The precision of ±5% and level of confidence 95% was taken. Based on these parameters, the minimum required sample size was 93. But we included all 95 patients in the study. Approval from the institutional ethical committee was obtained before the beginning of the study in KISTMCTH (Ref. 2079/80/70).

Based on the inclusion criteria, the total sample included during the study period comprised 95 patients. After detailed history taking, all the subjects underwent general physical examination and complete ENT examination including tuning fork tests. After that, all subjects underwent fasting blood sugar (FBS), postprandial blood sugar (PPBS) estimation and duration of diabetes, and glycemic control measured by glycated hemoglobin (HbA1c) level estimation was done for diabetic patients. The good glycemic control group was labeled if HbA1c<7, and the poor control group if HbA1c >7.[10]

Hearing assessments were conducted by licensed audiologists using standard protocols

using Pure Tone Audiometry. Air and bone conduction thresholds were measured using a calibrated audiometer (Model: MAICO-MA 42) across frequencies of 250 Hz to 8000 Hz.

The grading of hearing loss was done using the World Health Organization (WHO) grades of hearing impairment.[11] These findings were recorded in the standard proforma. Then the data was compiled and analyzed. Data were analyzed using statistical software (e.g., SPSS version 26). Descriptive statistics were computed for demographic variables, and Pearson's correlation coefficient was calculated to assess the relationship between the duration of diabetes and the degree of hearing loss. Fischer's exact test was used to assess the relationship between glycemic control and the degree of hearing loss. A p-value of <0.05 was considered statistically significant.

Table 1. WHO grading of hearing impairment[11]

Grade of hearing impairment	Corresponding audiometric ISO value
0 - No impairment	25 dB or better
1 - Slight impairment	26-40 dB
2 - Moderate impairment	41-60 dB
3 - Severe impairment	61-80 dB
4 - Profound impairment including deafness	81 dB or greater

Note: dB= decibel, Hz: Hertz, ISO: International Organization for Standardization, m: meter

Result

Out of total 95 patients with Type 2 DM included in this study, majority of participants, 63 individuals (66.3%), were found to have some degree of hearing loss. The mean age was 52.48±9.64 years, with a maximum number of cases in the age group of 51-60 years 34(35.8%) followed by 61-70 years, 24 patients (25.3%), Table 2. Gender-wise, 39(41.1%) were males and 56(58.9%) females. The ratio of male:female was 0.69:1, Figure 1.

Sixty-three (66.3%) participants had a hearing loss, Figure 2. The results showed increasing sensorineural hearing loss with duration of diabetes. The percentage of participants with normal hearing declined sharply as the duration of diabetes increased from 65.4% in those with diabetes for less than five years to just 2.9% in those with diabetes for more than ten years, Table 3, Table 4.

There was a statistically significant association between glycemic control and the degree of hearing loss, Table 5.

Table 2. Age distribution of patients with Type 2 Diabetes Mellitus, n=95

Age, (mean 52.48±9.64 y)	n	%
30-40	14	14.7
41-50	23	24.2
51-60	34	35.8
61-70	24	25.3

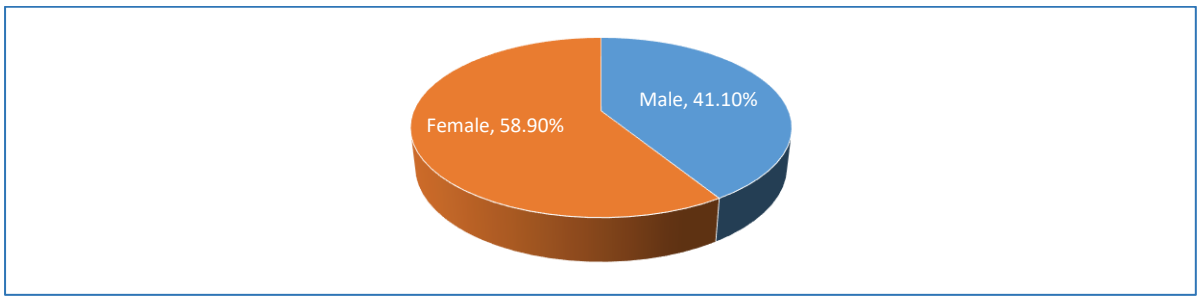

Figure 1. Distribution of Type 2 Diabetes Mellitus patients according to gender, n=95

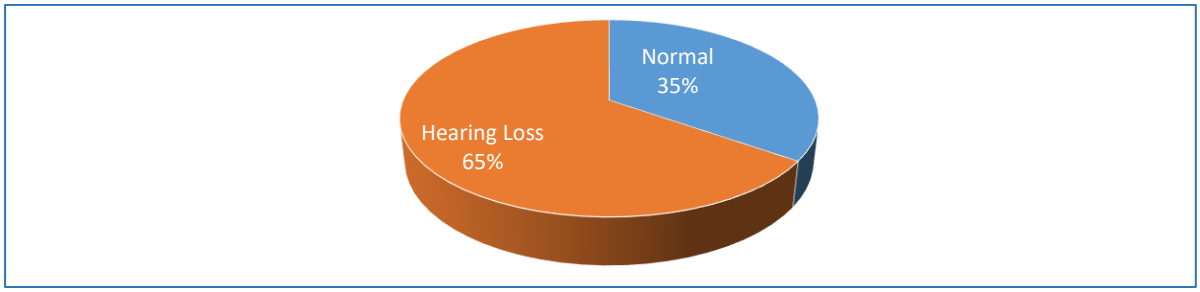

Figure 2. Distribution of Type 2 Diabetes Mellitus patients according to hearing loss, n=95

Table 3. Duration of diabetes and type of hearing loss in Type 2 Diabetes Mellitus patients (n=95)

Duration	n	Type of hearing loss n(%)			
DM (y)		Sensorineural	Conductive	Mixed	Normal
<5	26	8(30.8)	1(3.8)	0	17(65.4)
5-10	35	21(60)	0	0	14(40.0)
>10	34	29(85.3)	2(5.9)	2(5.9)	1(2.9)
Total	95	58(61)	3(3.2)	2(2.1)	32(33.7)

Table 4. Duration of Diabetes and degree of hearing loss in Type 2 Diabetes Mellitus patients, n=95

Duration	n	Degree of hearing loss, n(%)					r	p
DM (y)		No	Slight	Moderate	Severe	Profound		
<5	26	18(69.2)	8(30.8)	0	0	0	0.521	<0.001
5-10	35	13(37.1)	18(51.4)	3(8.6)	1(2.9)	0		
>10	34	1(2.9)	20(58.8)	6(17.6)	3(8.8)	4(11.8)		
Total		32(33.7)	46(48.4)	9(9.5)	4(4.2)	4(4.2)		

r= Pearson's correlation coefficient

Table 5. Glycemic control group and degree of hearing loss in Type 2 Diabetes Mellitus patients, n=95

DM control	n	Degree of hearing loss, n(%)					r	p
HbA1c		No	Slight	Moderate	Severe	Profound		
Good control	39	27(69.2)	12(30.8)	0	0	0	0.521	<0.001
Poor control	56	5(8.9)	34(60.7)	9(16.1)	4(7.1)	4(7.1)		
Total		32(33.7)	46(48.4)	9(9.5)	4(4.2)	4(4.2)		

Discussion

The findings of this study show mean age of participants was 52.48±9.64 years, with the greatest prevalence in the 51–60 age group (35.8%). The is in line with results from a study conducted in India, which found a mean age of 55.52±7.47 and more patients in the age group

of 50-60.[6] The gender distribution in this study shows a higher prevalence of diabetes among females (58.9%) compared to males (41.1%). This is consistent with the findings of a study from Nigeria, which reported a similar ratio in their group of people with diabetes, 57.6% females and 42.4% males.[12]

According to a study from India, 52.8% of patients were male, and 47.2% of patients were female which is contrary to the present study. This disparity may be due to hormonal differences, lifestyle factors, and varying healthcare access between genders. Understanding these factors is crucial for developing gender-specific healthcare strategies.[6]

The high prevalence of hearing loss, with 66.3% of participants affected, is similar to findings from a study done in Nigeria in which, 71.8% of type 2 DM participants had some degree of hearing loss. This pattern suggests a strong association between diabetes and auditory health.[12]

This study showed a prevalence of sensorineural hearing loss of 61%. These findings were similar to the study from India in which it was 64.86% of people with sensorineural hearing loss, progressive and of gradual onset.[13] Other studies from India (58%) and Iran (45%) have also reported similar rates of prevalence of SNHL.[14,15]

The findings were comparable to those of studies carried out in the USA (55.0%), and India (67.44%).[5,16] The SNHL typically progresses gradually. However, another study conducted in Taiwan published a series of 68% cases of sudden onset of SNHL in diabetes in 2005, which runs counter to our findings.[17] A study, conducted in India found a higher prevalence of sensorineural hearing loss at 76.8%.[6] A similar higher prevalence was noted in the study done in Nepal which was reported to be 72.5% and a very high prevalence was observed in a study conducted in Poland (95%) among diabetic patients which is in contrast to our study.[18,19] Such differences between our study and those of other authors can be attributed to the heterogeneity of the study populations, differences in the inclusion and exclusion criteria, and variations in the study period.

The study reveals a significant association between the duration of diabetes and the type of hearing loss, with sensorineural loss increasing from 30.8% in those with less than 5 of diabetes to 85.3% in those with more than 10 . This progressive trend was corroborated in a study conducted in India, in which subjects with diabetes for more than 10 showed significant SNHL in comparison to subjects with diabetes for less than 5 years.[20] According to another study from India, there is a significant association between the duration of diabetes mellitus and SNHL. Patients with diabetes for more than ten have the highest prevalence of hearing loss compared to those with diabetes for fewer years.[5] Other studies from India and Australia showed a positive correlation when extrapolating the severity of the SNHL with the duration of DM.[6,21] It is seen that as the duration of diabetes increases, the predisposition to SNHL also increases. The tendency for hearing loss to deteriorate as the disease progresses aligns with the understanding that patients experiencing prolonged exposure to the underlying pathological mechanisms causing SNHL (such as microangiopathy and neuropathy) are at greater risk.

Present study shows a Pearson's correlation coefficients ($r=0.521$) with a $p<0.001$, a significant positive relationship between the duration of diabetes and the severity of hearing loss. This further confirms that longer diabetes duration is associated with more severe auditory impairment. This insight underscores the importance of monitoring auditory health in diabetic patients, particularly as they age. This result was similar to the findings from a study done in India in which the correlation of hearing loss with a duration of disease was found to be highly significant ($p<0.0001$, Pearson's *r* coefficient = 0.3668).[6]

The findings from present study demonstrate a significant relationship between glycemic control, as measured by HbA1c levels, and the degree of hearing loss in both ears of diabetic patients. According to the data, people with

good glycemic control (measured by their HbA1c levels) have significantly less hearing impairment than people with poor control. In 69.2% of patients with good glycemic control around had no hearing impairment, whereas only 8.9% of those with poor control maintained normal hearing.

These results align with previous research that has established a link between diabetes and hearing loss, particularly to glycemic control. For instance, a study conducted in India showed that diabetic patients with poor control of the disease had an increased presence of SNHL when compared with diabetics with good control.[5] Another study done in China found that HbA1c levels were found to be positively correlated with the incidence of hearing loss in both T1DM and T2DM patients.[22]

Similarly, a study carried out in Saudi Arabia showed that patients with poor glycemic control (HbA1c ≥8%) had a higher rate of hearing loss than those with good glycemic control (HbA1c <8%) (62.9% vs. 48.3%) echoing the current study's findings of a greater degree of hearing loss in patients with poor glycemic control.[23]

Present study was a hospital-based study with a limited sample size so it may not be representative of the Nepalese community. A greater sample size and a wider geographic scope are required for a more thorough investigation. Second, the patient's response, a subjective test determines the results of pure tone audiometry, which was used to identify the hearing loss. Since subclinical hearing impairment cannot be ruled out, we were unable to explain this subjective test. In this study, we did not do in-depth analysis whether the patients were under or over-managed with medication.

Conclusion

The study found an association of hearing loss and Type-2 Diabetes Mellitus. Hearing impairment was mainly in the form of sensorineural hearing loss associated with diabetic control. The severity of hearing loss increased with duration of the diabetes. Multidisciplinary strategy with routine hearing tests and efficient glycemic control seems impairment to preserve hearing loss.

Author contribution

Concept and design: AS, SS, SRC, SK, JT; Data collection and analysis: AS, RB, AK, BK, SSh; Draft: AS, SRC, RB, RP, AK, SSh; Revision: AS, SRC, SS, RB, JT, SK, AK, RP, BK, SSh; Accountability- all authors have read and approved the final manuscript

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Conflict of interest

None

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None

Supplementary material

The data and supplementary material that support the findings of this study are available from the corresponding author upon reasonable request.

References

1. World Health Organization. World Health Organization Global Report on diabetes. Geneva: World Health Organization; 2016. Google Scholar Full Text
2. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes care. 2010;33(Supplement_1):S62-9. DOI PubMed Google Scholar Full Text
3. Pandey AR, Aryal KK, Shrestha N, Sharma D, Maskey J, Dhimal M. Burden of Diabetes mellitus in Nepal: An Analysis of Global Burden of Disease Study 2019. J Diabetes Res.

2022;2022(1):4701796. DOI PubMed Google Scholar Full Text

4. Maia CA, Campos CA. Diabetes mellitus as etiological factor of hearing loss. Braz J Otorrinolaringol. 2005;71:208-14. DOI PubMed Google Scholar Full Text
5. Chavadaki J.A, Malli MNA. Prevalence of sensorineural hearing loss in type 2 diabetes mellitus. Int J Otorhinolaryngol Head Neck Surg. 2019. 5(5):1227-33. DOI Google Scholar Full Text
6. Tiwari A, Mudhol RS. Prevalence of sensorineural hearing loss among type-II diabetes mellitus patients attending KLES Dr. Prabhakar Kore Hospital and MRC: A cross-sectional study. Indian Journal of Health Sciences and Biomedical Research kleu. 2018; 11(2):165-9. DOI Google Scholar Full Text
7. Austin DF, Konrad-Martin D, Griest S, McMillan GP, McDermott D, Fausti S. Diabetes-related changes in hearing. The Laryngoscope. 2009;119(9):1788-96. DOI PubMed Google Scholar Full Text
8. Lin HY, Shih SC, Chuang CK, Lee KS, Chen MR, Lin HC, et al. Assessment of hearing loss by pure-tone audiometry in patients with mucopolysaccharidoses. Mol Genet Metab. 2014 ;111(4):533-8. DOI PubMed Google Scholar Full Text
9. Shaw JE, Sicree RA, Zimmet PZ. Global estimates of the prevalence of diabetes for 2010 and 2030. Diabetes Res Clin Prac. 2010;87(1):4-14. DOI PubMed Google Scholar Full Text
10. Afroz A, Ali L, Karim MN, Alramadan MJ, Alam K, Magliano DJ, et al. Glycaemic Control for People with Type 2 Diabetes Mellitus in Bangladesh - An urgent need for optimization of management plan. Sci Rep. 2019;9(1):10248. DOI PubMed Google Scholar Full Text
11. Olusanya BO, Davis AC, Hoffman HJ. Hearing loss grades and the International classification of functioning, disability and health. Bull World Health Organ. 2019 ;97(10):725-28 DOI PubMed Google Scholar Full Text
12. Yikawe SS, Iseh KR, Sabir AA, Solomon JH, Manya C, Aliyu N. Effect of duration of diabetes mellitus on hearing threshold among type 2 diabetics. Indian Journal of Otology. 2017;23(2):113-6. DOI Google Scholar Full Text
13. Agarwal MK, Jha AK, Singh SK. Otorhinolaryngological studies in diabetics. Indian J Otolaryngol Head & Neck Surg. 1998;50:116-21. DOI PubMed Google Scholar Full Text
14. Meena R, Sonkhya D, Sonkhya N. Evaluation of hearing loss in patients with type 2 diabetes mellitus. Int J Res Med Sci. 2016;4(06):2281-7. DOI Google Scholar Full Text
15. Mozaffari M, Tajik A, Ariaei N, Ali-Ehyaii F, Behnam H. Diabetes mellitus and sensorineural hearing loss among non-elderly people. East Mediterr Health J. 2010;16(9),947-52. DOI PubMed Google Scholar Full Text
16. Friedman SA, Schulman RH, Weiss S. Hearing and diabetic neuropathy. Arch Intern Med. 1975;135(4):573-6. DOI PubMed Google Scholar Full Text
17. Weng SF, Chen YS, Hsu CJ, Tseng FY. Clinical features of sudden sensorineural hearing loss in diabetic patients. Laryngoscope. 2005;115(9):1676-80. DOI PubMed Google Scholar Full Text
18. Khakurel G, Mahato NB. Evaluation of Hearing loss by Pure Tone Audiometry in Type 2 Diabetes Mellitus. Nepalese Medical Journal. 2020;3(1):286-9. DOI Google Scholar Full Text
19. Rózańska-Kudelska M, Chodynicki S, Kinalska I, Kowalska I. Hearing loss in patients with diabetes mellitus type II. Otolaryngol Pol. 2002;56(5):607-10. PubMed Google Scholar Full Text
20. Srinivas CV, Shyamala V, Shiva Kumar BR. Clinical Study to Evaluate the Association Between Sensorineural Hearing Loss and Diabetes Mellitus in Poorly Controlled Patients whose HbA1c> 8. Indian J Otolaryngol Head Neck Surg. 2016;68:191-5. DOI PubMed Google Scholar Full Text
21. itchell P, Gopinath B, McMahon CM, Rochtchina E, Wang JJ, Boyages SC, et al. Relationship of Type 2 diabetes to the prevalence, incidence and progression of age-related hearing loss. Diabet Med. 2009;26(5):483-8. DOI PubMed Google Scholar Full Text

22. Deng Y, Chen S, Hu J. Diabetes mellitus and hearing loss. Mol Med. 2023 ;29(1):141. DOI PubMed Google Scholar Full Text
23. Al-Rubeaan K, AlMomani M, AlGethami AK, Darandari J, Alsalhi A, AlNaqeeb D, et al. Hearing loss among patients with type 2 diabetes mellitus: a cross-sectional study. Ann Saudi Med. 2021;41(3):171-8. DOI PubMed Google Scholar Full Text