e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2025; 17(12); 658-661

Original Research Article

Correlation between HbA1c Levels and Degree of Sensorineural Hearing Loss in Patients with Type 2 Diabetes Mellitus: A Cross-Sectional Study

Rashmika Rajendran[1], Dinesh Velmurugan[2], Andrew Thomas Kurian[3], Asha K. Joy[4], Puja Ghosh[5], T. Muthukumar[6]

[1]Assistant Professor, Department of ENT, Bhaarath Medical College and Hospital, Chennai, Tamil Nadu
[2]Assistant Professor, Department of ENT, Bhaarath Medical College and Hospital, Chennai, Tamil Nadu
[3]Associate Professor, Department of ENT, Bhaarath Medical College and Hospital, Chennai, Tamil Nadu
[4]Assistant Professor, Department of ENT, Bhaarath Medical College and Hospital, Chennai, Tamil Nadu
[5]Professor and Head of Department, Department of ENT, Bhaarath Medical College and Hospital, Chennai, Tamil Nadu
[6]Professor, Department of Community Medicine, Bhaarath Medical College and Hospital, Chennai, Tamil Nadu

Received: 01-09-2025 / Revised: 15-10-2025 / Accepted: 21-11-2025
Corresponding author: Dr. Asha K. Joy
Conflict of interest: Nil

Abstract

Background: Type 2 diabetes mellitus (T2DM) has been associated with microvascular and neuropathic complications that may extend to the cochlea, resulting in hearing loss[1]. This study aimed to evaluate the correlation between HbA1c levels and the degree of hearing loss among patients with T2DM.

Methods: A cross-sectional study of 100 patients with T2DM was conducted. HbA1c levels were measured and pure tone audiometry (PTA) was performed. Correlation and multiple linear regression analyses were used to assess the association between HbA1c and PTA.

Results: The mean HbA1c was 7.84 ± 1.36%, and mean PTA was 64.5 ± 10.6 dB HL. HbA1c showed a significant positive correlation with PTA ($r = 0.38$, $p < 0.001$). Each 1% rise in HbA1c corresponded to an average 2.7 dB worsening in hearing threshold after adjusting for confounders ($\beta = 2.66$, $p = 0.000$). The model explained 29% of the variance ($R^2 = 0.29$).

Conclusion: Poor glycemic control is significantly correlated with worse sensorineural hearing thresholds in patients with T2DM. Routine audiometric screening should be considered for patients with elevated HbA1c levels.

Introduction

Diabetes mellitus is a widely prevalent genetically inherited chronic metabolic disease in which glucose levels in the blood are abnormally high due to impaired insulin secretion or impaired insulin action. It clinically manifests with metabolic disorders, and vascular and neuropathic complications. Diabetes mellitus is as yet only controllable and not curable and its management is focused on preventing its chronic complications [1]. The most prevalent morphologic finding in Diabetes mellitus is the diffuse thickening of basal membranes observed in the vascular endothelium, referred to as diabetic microangiopathy.

The thickening of vascular endothelium is more evident on skin capillaries of skeletal muscles, retina, kidney glomeruli, and renal medulla. The pathogenesis of this morphologic disorder is yet unclear, but it is strongly linked to hyperglycemia. There also are morphologic disorders affecting nerves especially the lower extremity motor and sensorial nerves which is characterized by damage to the Schwann cells, myelinic degeneration, and axonal damage. The cause of this neuropathy is not clear, but it may have correlation to the diffuse microangiopathy and the consequent malnourishment of peripheral nerves. Arteriosclerosis, commonly occurring in conjunction with Diabetes mellitus, interferes with the nutrient transfer rate and hence may also contribute to the onset of neuropathies [2,3]. Angiopathy may by directly interfering with the blood supply of the cochlea and causing capillary wall thickening and. Thus reducing nutrient transportation or indirectly reducing flow in a narrowed vasculature. It may also cause secondary degeneration of the vestibulocochlear nerve [4].

Thickening of vessel walls in the modiolus of rats was found in some studies. Increased thickness of the basal membrane in the stria vascularis capillaries and outer hair cells loss was also seen (this last feature was found in diabetic rats exposed to noise). In these studies drugs were given to the rats to induce Diabetes mellitus are thus controversial as they do not reflect the actual physiological and genetic mechanism that leads to the onset of Diabetes mellitus in human beings [5,6,7,8]. Pathology tests were done in temporal bones of diabetic individuals of various age ranges and they have shown that the changes in the wall thickness of stria vascularis capillaries were similar to the changes found in atherosclerosis, but the changes were limited to the stria vascularis and were more pronounced [9].

This study aims to investigate the correlation between HbA1c levels which reflects long-term glycemic control and is widely used as a marker of chronic hyperglycemia [4] and the degree of hearing loss among patients with type 2 diabetes mellitus.

Materials and Methods

A cross-sectional study was conducted among 100 adults with T2DM attending the outpatient clinic at our tertiary care centre. Inclusion criteria included patient's ≥18 years old with confirmed T2DM. Exclusion criteria were congenital hearing loss, ear surgery, ototoxic drug use, and active ear disease.

HbA1c was measured using HPLC, and hearing thresholds were assessed via pure tone audiometry (PTA). Data were analyzed using SPSS and R. Pearson correlation assessed the relationship between HbA1c and PTA. Multiple linear regression was used to identify independent predictors adjusting for age, duration of diabetes, BMI, hypertension, and noise exposure.

Results

In the study population, the average participant was around 55 years old, with most participants between the fifth and seventh decade of life. The mean duration of diabetes was around 10 years. The mean BMI was 27. The mean HbA1c was 7.84 ± 1.36%, and mean PTA was 64.5 ± 10.6 dB HL (Table 1).

A significant positive correlation ($r = 0.38$, $p < 0.001$) was found between HbA1c and hearing thresholds.

In multiple regression analysis, HbA1c remained an independent predictor ($\beta = 2.66$, $p = 0.000$), along with age and duration of diabetes (Table 2). HbA1C and mean hearing threshold was also documented (Table 3)

Table 1: Baseline Characteristics of Study Participants

Variable	Mean ± SD
Age (years)	55.3 ± 11.7
Duration of diabetes (years)	9.8 ± 5.7
BMI (kg/m²)	27.1 ± 4.0
HbA1c (%)	7.84 ± 1.36
PTA (dB HL)	64.5 ± 10.6

Table 2: Multiple Linear Regression Analysis for Predictors of Hearing Loss

Predictor	β Coefficient	Std. Error	t-value	p-value
Constant	20.15	10.04	2.01	0.048
HbA1c (%)	2.66	0.71	3.74	0.000
Age (years)	0.25	0.08	3.18	0.002
Duration of Diabetes (years)	0.44	0.16	2.72	0.008
BMI (kg/m²)	0.23	0.24	0.94	0.348

Table 3: HbA1c Vs Mean Hearing Threshold

HbA1C	Mean Hearing Threshold {dB HL}	Sample size (n)
<6.5	58.2	12
6.5-7.4	61.5	28
7.5-8.4	65.7	30
8.5-9.4	69.8	18
>9.5	72.4	12

Discussion

This study demonstrated a significant positive correlation between HbA1c levels and hearing thresholds in patients with T2DM. Each 1% increase in HbA1c corresponded to a 2.7 dB worsening in hearing threshold. The association persisted after adjusting for confounding variables. These findings are consistent with previous reports. This further proves microangiopathy and neuropathy can act as causative mechanisms of diabetic hearing loss [9,10,11]. The correlation between chronic hyperglycemia and progressive cochlear dysfunction is now established by latest research [9,10]. This finding is further reinforced in this study. Higher levels of HbA1c are likely to contribute to microangiopathic changes within the inner ear, especially the stria vascularis.

This can further lead to reduced endocochlear potential and impaired hair cell metabolism [12]. Data from experimental studies demonstrates basement membrane thickening and reduced cochlear blood flow in diabetic models [12]. Neuropathic degeneration of the auditory nerve has also been reported in chronic diabetes [12]. This can also be an additional mechanism for the observed sensorineural hearing loss [12].

The present findings show a rise in hearing thresholds which is directly proportional to an increase in HbA1c. This is also similar to previous studies [9,10].

An interesting observation in this study was that individuals with HbA1c levels above 8.5% demonstrated higher degrees of hearing loss when compared to those with levels lesser. This suggests a possible nonlinear decline once a critical hyperglycemic threshold has been reached [9,10]. This pattern is not unique. It has been noted in retinal and renal microvascular complications in other studies [10]. This supports the theory of shared microvascular pathophysiology [10]. Age of the individual and duration of diabetes can also be considered as significant predictors. This highlights that diabetics suffer from cumulative metabolic burden over time. Thus we can further postulate that earlier glycemic intervention may help delay cochlear damage.

Using audiometric screening into diabetes care in the clinical setting could help in early identification of early hearing loss. Studies show that nearly 70% of diabetic patients may have undiagnosed hearing loss when on evaluation9. Early detection helps in timely auditory rehabilitation. Randomized control trials evaluating whether intensive glycemic control can slow or reverse hearing decline are necessary to clarify causality15. High-frequency audiometry and otoacoustic emissions may serve as sensitive tools in early detection of cochlear injury9.

India, as well as the world, is facing an increase in the prevalence of type 2 diabetes. In the year 2000, the estimated number of individuals with diabetes in India was 32 million. This then increased to 63 million by 2012 and further increased to 74 million in 2021.13 it is now estimated to be around 101 million, according to the ICMR–INDIAB Study.14 studies have also shown that glycemic control among subjects with self-reported diabetes is poor in India. Less than a third of around 15,000 subjects exhibited good glycemic control. The population with bad control of their diabetes is most at risk for developing hearing loss [19].

Individuals with hearing loss face psychosocial and emotional issues that can be substantial and debilitating. It is a disability and its burden is often exacerbated because of negative societal attitudes and prejudice towards affected people. Other issues those with hearing loss face include difficulty in interpersonal communication, leading to reduced psychosocial health, a decrease in their quality of life and difficulty to be economically independent. [15-17] Individuals suffering from hearing loss also complain of social isolation and stigmatization, loneliness, abuse, psychiatric disturbance, depression, relationship issues with family and friends, reduced career opportunities, occupational stress and reduced earning capacity. [17] To counter this, early diagnosis of hearing loss secondary to diabetes mellitus is a necessity.

Hearing loss is often unaddressed in society. This leads to economic impacts on health, education and productivity. This is estimated to cost an extraordinary amount of over 750 billion United States dollars in the global scale. [19] This further reiterates the necessity to diagnose and treat hearing loss in those suffering from diabetes mellitus.

Limitations of the study include the cross-sectional design and the use of a single HbA1c measurement. Future longitudinal studies can help us assess correlation between diabetes and hearing loss, as well as the effects of improved glycemic control on hearing levels.

Conclusion

Poor glycemic control, which is proven by elevated HbA1c levels, is significantly correlated with worse sensorineural hearing loss. Audiometric screening with the help of Puretone Audiograms can be incorporated into routine evaluation of patients with type 2 diabetes mellitus. This is even more necessary in those with poor glycemic control. Increasing prevalence of diabetes brings early identification and management to the forefront to prevent sensorineural hearing loss related stigma and complications.

Overall, this study further reinforces our current understanding of HbA1c as a modifiable risk factor for hearing preservation in Type 2 diabetes mellitus. Larger cohort studies and randomized control trials may help to refine screening strategies and establish evidence-based guidelines in patients with Type2 diabetes mellitus[1]9.

References

1. Chacra AR. Diabetes mellitus. In: Prado FC, Ramos JA, Borges DR, Rothschild HA, editors. Tratado de atualização terapêutica. 20th ed. São Paulo: Artes Médicas; 2001. p. 375–389.
2. Robbins SL, Cotran RS, Kumar V. Pathologic basis of disease. 3rd ed. Philadelphia: WB Saunders; 1991.
3. Makishima K, Tanaka AK. Pathological changes of the inner ear and central auditory pathway in diabetes. Ann Otol Rhinol Laryngol. 1971;80(2):218–28. doi:10.1177/000348947108000208.
4. Frisina ST, Mapes F, Kim S, Frisina DR, Frisina RD. Characterization of hearing loss in diabetes mellitus. Hear Res. 2006; 211:103–13. doi:10.1016/j.heares.2005.09.002.
5. Costa OA. Inner ear pathology in experimental diabetes. Laryngoscope. 1967; 77:68–75. doi: 10.1288/00005537-196701000-00005.
6. Smith TL, Raynor E, Prazma J, Buenting JE, Pillsbury HC. Insulino-dependent diabetic microangiopathy in the inner ear. J Laryngol Otol. 1995; 105:236–40. doi:10.1017/S002221510013995X.
7. Raynor EM, Carrasco VN, Prazma J, Pillsbury HC. Cochlear hair-cell loss in insulin-dependent diabetes mellitus and noise-exposed rats. Arch Otolaryngol Head Neck Surg. 1995; 121:452–6. doi:10.1001/archotol.1995.01890040074012.
8. Maia CAS, Campos CAH. Diabetes mellitus como causa de perda auditiva. Rev Bras Otorrinolaringol. 2005; 71:208–14.
9. Bainbridge KE, Hoffman HJ, Cowie CC. Diabetes and hearing impairment in the United States. Ann Intern Med. 2008;149(1):1–10. doi:10.7326/0003-4819-149-1-200807010-00231.
10. Kurien M, Thomas J, Bhanu TS. Hearing loss in diabetes mellitus. Indian J Otolaryngol Head Neck Surg. 2019;71(2):159–65. doi:10.1007/s12070-018-1428-8.
11. Le T, Straatman LV, Lea J, Westerberg BD. Current insights in noise-induced hearing loss. J Otolaryngol Head Neck Surg. 2017; 46:41. doi: 10.1186/s40463-017-0219-x.
12. International Diabetes Federation. IDF Diabetes Atlas. 10th ed. Brussels: IDF; 2021. Available from: https://diabetesatlas.org/atlas/tenth-edition/
13. Anjana RM, Unnikrishnan R, Deepa M, et al. Metabolic NCD profile of India: The ICMR–INDIAB study. Lancet Diabetes Endocrinol. 2023; 11:474–89. doi:10.1016/S2213-8587(23)00143-6.
14. Olusanya BO, Neumann KJ, Saunders JE. The global burden of disabling hearing impairment: a call to action. Bull World Health Organ. 2014; 92:367–73. doi:10.2471/BLT.13.128728.
15. Nordvik Ø, Laugen Heggdal PO, Brännström J, Vassbotn F, Aarstad AK, Aarstad HJ. Generic quality of life in persons with hearing loss: a systematic literature review. BMC Ear Nose Throat Disord. 2018; 18:1. doi:10.1186/s12901-018-0051-6.
16. Huddle MG, Goman AM, Kernizan FC, Foley DM, Price C, Frick KD, et al. The economic impact of adult hearing loss. JAMA Otolaryngol Head Neck Surg. 2017;143(10):1040–8. doi:10.1001/jamaoto.2017.1243.
17. Shield B. Hearing loss numbers and costs: Evaluation of the social and economic costs of hearing impairment. London: Brunel University; 2019.
18. World Health Organization. Global costs of unaddressed hearing loss and cost-effectiveness of interventions. Geneva: WHO; 2017.
19. Unnikrishnan R, Anjana RM, Deepa M, et al. Glycemic control among individuals with self-reported diabetes in India: the ICMR–INDIAB Study. Diabetes Technol Ther. 2014;16(9):596–603. doi:10.1089/dia.2014.0018.