

## ORIGINAL RESEARCH

### **Prevalence of Sensorineural hearing loss in Type -2 Diabetes Mellitus and its association with glycosylated haemoglobin (HbA1c)**

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#### **ABSTRACT**

**Background:** Hearing is a critical part of speech and enhances our day to day activities. It is an integral part of our personal, social and economic status and hence improves the quality of life. The study was conducted to find out the prevalence of sensori-neural hearing loss in Type -2 Diabetes Mellitus and the association between glycosylated haemoglobin and Sensori-neural hearing loss in these patients.

**Methodology:** This study was conducted as Cross-sectional observational study, based on 100 patients who presented to the ENT and Endocrine Out Patient Department of Peoples Medical College and Research Centre between 1<sup>st</sup> December 2020 to 31<sup>st</sup> March 2022. This study suggests that there is necessity of introducing routinely periodic assessment of auditory functions in patients of Type-2 diabetes mellitus for early detection and prevent further complications.

**Results:** This study was conducted on a total of 100 diabetic patients, showed, the association between age group and degree of hearing loss was statistically significant with a p-value of 0.03 by Pearson Chi-square test and Association between degree of SNHL and levels of HbA1C was statistically significant by Pearson Chi-square test. In our study, it was seen that as HbA1c level rises, degree of SNHL also rise.

**Conclusion:** Thus we would like to conclude that routine evaluation of the auditory system can help in the early diagnosis of sensorineural hearing loss in type 2 diabetes mellitus, good glycaemic control is key to prevent or delay occurrence of SNHL. We also suggest regular audiological evaluation of all diabetic patients to improve the quality of life.

**Keywords:** Glycosylated Haemoglobin (HbA1c), Sensorineural hearing loss (SNHL), Pure tone audiometry

#### **INTRODUCTION**

Hearing is an integral part of our day-to-day life and empowers us in interacting with people, which in turn, helps us to carry out our daily activities, work, as well as, earn our livelihood.

It also forms an integral part of our speech. Any impairment in hearing can disrupt the personal social and economic activities and impact the quality of life negatively.<sup>[1]</sup>

As per WHO, an estimated 2.5 billion people in the world will have some degree of loss of hearing and approximately 700 million people will be in need of rehabilitation, by 2050.<sup>[2]</sup>

Diabetes mellitus (DM), a chronic, non-communicable, metabolic disorder which is characterized by elevated blood glucose levels and has a systemic impact on almost every system in the body. It is caused due to relative or absolute deficiency of insulin which results in hyperglycemia. While type-I diabetes mellitus is caused by autoimmune destruction of beta cells of pancreas (which produce insulin), the type-II DM results from a combination of impaired function of pancreatic beta cells along with insulin resistance by the receptor cells of the body.<sup>[3]</sup> Among the two, type-II DM is most predominant, and thus, a major non-communicable global health issue.

The prevalence of diabetes has increased dramatically over the past three decades worldwide. According to WHO, approximately 422 million people in the world have diabetes, of which, a major proportion are residing in low and middle income countries. An estimated 1.5 million deaths are occurring due to diabetes every year. The numbers are continuing to rise.<sup>[5]</sup>

According to another report, the prevalence of diabetes is estimated to be 4.4% in the year 2030 all over the world. The total number of diabetic patients is expected to rise to 366 million in 2030. This rise in the number of diabetic patients has been termed a “diabetic epidemic”.<sup>[6]</sup> It has been estimated that the number of diabetes patients in India will reach 69.92 million by the year 2025.<sup>[1]</sup>

Since diabetes mellitus is a long term disorder which cannot be cured and can only be managed therapeutically, complications associated with it advance with time.<sup>[7]</sup> They affect all systems of the body depending upon the duration and metabolic control over the years. These complications lead to high morbidity and mortality among the diabetic patients.<sup>[4]</sup>

The long term complications can either be microvascular (such as retinopathy, neuropathy etc.) or macrovascular (such as coronary artery disease, nephropathy, peripheral vascular disease etc.). Hearing impairment is one such complication of diabetes.<sup>[3]</sup>

It has been proposed that microvascular abnormalities affect the auditory system and are responsible for the hearing impairment.<sup>[8]</sup>

Sensorineural hearing loss (SNHL) is one such type, caused by damage in inner ear, which involves the cochlea and hair cells.<sup>[8]</sup> One in every two individuals living with diabetes mellitus is unaware about this condition which results in under diagnosis of the hearing loss.<sup>[9]</sup>

The relationship between the hearing loss and diabetes mellitus has been addressed in various studies. It was first addressed by Jorhoa in 1857. However, discrepancies in literature are seen since. This may be due to confounding factors (age, gender, HbA1C, duration of diabetes etc.), inadequate self-reporting or incomplete medical history. There is limited research conducted on this topic in India.<sup>[9]</sup>

This study was done to study the prevalence of sensorineural hearing loss in type-II Diabetes Mellitus and its association with glycosylated haemoglobin (HbA1C).

## **MATERIALS AND METHODS**

The present study was based on 100 patients who presented to the ENT and Endocrine Out Patient Department of Peoples Medical College and Research Centre between 1<sup>st</sup> December 2020 to 31<sup>st</sup> March 2022. The study was conducted to find out the prevalence of Sensorineural hearing loss in Type-2 Diabetes Mellitus and the association between glycosylated haemoglobin and sensori-neural hearing loss in these patients.

## **STUDY DESIGN**

Cross-sectional observational study

## **STUDY DURATION**

1<sup>st</sup> December 2020 to 31<sup>st</sup> March 2022

## **STUDY SETTING**

ENT Department, Peoples Medical College and Research Centre

## **SAMPLE SIZE AND STUDY SUBJECTS**

100 patients with Diabetes Mellitus who presented to the ENT and Endocrine Out Patient Department of Peoples Medical College and Research Centre.

## **DATA COLLECTION**

By detailed history, clinical examination, blood investigations (HbA1C), otoscopic examination and audiometry of 100 patients with Diabetes Mellitus. Apparatus used is pure tone audiometer.

## **STUDY PROCESS**

- Patient of Diabetes Mellitus who gave consent and fulfilling the criteria were included.
- A detailed history was taken from these patients.
- Complete General and Ear examination was done.
- HbA1c and Pure tone audiometry was done.
- A clinical proforma was filled up for each patient incorporating details regarding particulars of the patient, history, clinical examination and investigations.

## **INCLUSION CRITERIA**

Patients having Type-2 Diabetes Mellitus in all age group and both genders.

## **EXCLUSION CRITERIA**

- History of any ear disease, ear surgery
- Head or ear trauma
- Family history of deafness
- History of noise induced hearing loss
- History of taking ototoxic drugs
- Patients with other systemic diseases including HIV, TB, renal disorder.
- Genetic disorders
- Pregnant patients and lactating mother
- Severely ill patients
- Using mobile phone >5 hours per day

## **DATA ANALYSIS**

- Data was collected, coded appropriately and compiled in MS Excel spreadsheet.
- Continuous data was expressed in mean and standard deviation.
- The descriptive representation of data was done in the form of frequencies and percentages, calculated in MS Excel.
- The graphical representation of data was done using figures and tables. Analytical part was done using appropriate tests of association. SPSS 25 (trial version) software was used.

## ETHICAL CONSIDERATIONS

- The study was approved by Institutional Review Board & Scientific Review Committee.
- Each study participant was informed about the objective of study and research.
- The study participant was assured of the confidentiality of their responses and all measures would be taken to protect their identity.

Informed consent was taken from the study subjects.

## OBSERVATION AND RESULT

The present study was based on 100 patients who presented to the ENT and Endocrine Out Patient Department of Peoples Medical College and Research Centre between 1<sup>st</sup> December 2020 to 31<sup>st</sup> March 2022. The study was conducted to find out the prevalence of sensori-neural hearing loss in type 2 Diabetes Mellitus and the association between glycosylated haemoglobin and sensori-neural hearing loss in these patients.

**Table 1: Distribution of study participants according to duration of type-II diabetes mellitus**

### DURATION OF TYPE 2 DIABETES MELLITUS

Duration of DM	No. of patients (N)	Percentage (%)
0-3 Years	37	37%
4-6 Years	51	51%
7-10 Years	12	12%
Total	100	100%

Table 1 shows the distribution of study participants according to duration of type-II diabetes mellitus.

It shows that most of the study subjects (51%) had diabetes for 4-6 years while 37% were known cases since 3 or less than 3 years. Only 12% of the participants had diabetes for 7-10 years.

**Table 2: SNHL in relation to duration of diabetes in the study participants**

Duration	SNHL		Normal	
	No. of patients	Percentage	No. of patients	Total
0-3 Years	5	18%	22	27
4-6 Years	22	38%	35	57
7-10 Years	9	56%	7	16
Total	36	100%	64	100
Pearson Chi-Square		.83a	P-value	0.03 significant

Table 2 shows the type of hearing in relation to duration of diabetes in the study participants. Participants with diabetes for 4-6 years constituted the major proportion (61%) among those with SNHL followed by those who had diabetes for 7-10 years (25%). Only 14% of the study subjects with SNHL had diabetes for  $\leq 3$  years. Among those with normal hearing, 55% were known cases of diabetes since 4-6 years while 34% were diabetic since  $\leq 3$  years, and 11% since 7-10 years. A statistically significant association ( $p$ -value $<0.05$ ) between duration of diabetes and hearing was seen on applying Pearson Chi-Square test. (Pearson Chi-Square value=0.83a;  $p$ -value=0.03 significant)

**Table 3: Distribution of study participants according to levels of HbA1C**

HbA1C	No. of patients (N)	Percentage (%)
<7	72	72.00%
7-8	13	13.00%
>8	15	15.00%

Total	100	100%
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**Table 3** shows the distribution of study participants according to levels of HbA1C which indicate the glycemic control over a long period of time in patients with diabetes.

As per the above table, on evaluating the HbA1C levels in patients, it was noted that a major proportion of the participants i.e. 72% had levels <7%, while 13% and 15% had elevated levels between 7-8% and >8% respectively, i.e. in total 28% of them had elevated HbA1C.

**Table 4: SNHL in relation to HbA1C levels in the study participants**  
**HbA1c LEVELS**

HbA1C	SNHL N (%)	Normal N (%)	Total N (%)	Percentage
<7	8 (22.20%)	64 (100.00%)	72 (72.00%)	11%
7-8	13 (36.10%)	0 (0.00%)	13 (13.00%)	100%
>8	15 (41.70%)	0 (0.00%)	15 (15.00%)	100%
Total	36 (100.00%)	64 (100.00%)	100 (100.00%)	
Pearson Chi-Square	69.136a	2	0.000 significant	

Table 4 shows the type of hearing in relation to HbA1C levels in the study participants. 41.7% of the study participants with SNHL had elevated levels of HbA1C (>8%), while 36.10% had levels between 7-8gm% and only 22.20% had <7gm%. None of the study subjects with normal hearing had elevated HbA1C. The association between HbA1C levels and auditory function was statistically significant (p-value<0.05) on applying Pearson Chi-Square test. (Pearson Chi-Square value=69.13a; p-value=0.000 highly significant).

**Table 5: Degree of hearing loss in relation to HbA1c levels in the study participants**

HbA1C	Degree of hearing loss					Total
	Normal	Mild	Moderate	Moderately severe	Severe	
<7	64 (100.00%)	3 (18.80%)	5 (50.00%)	0 (0.00%)	0 (0.00%)	72 (72.00%)
7-8	0 (0.00%)	6 (37.50%)	5 (50.00%)	1 (12.50%)	1 (50.00%)	13 (13.00%)
>8	0 (0.00%)	7 (43.80%)	0 (0.00%)	7 (87.50%)	1 (50.00%)	15 (15.00%)
<b>Total</b>	64 (100.00%)	16 (100.00%)	10 (100.00%)	8 (100.00%)	2 (100.00%)	100 (100.00%)
	<b>Pearson Chi-Square</b>	99.072a	<b>p-value</b>	0.000 significant		

Table 5 shows the degree of hearing loss in relation to HbA1c levels in the study participants. Participants with HbA1C levels less than 7 were found to have only mild or moderate degree of hearing loss. Among those with moderately severe degree of SNHL, 87.50% had elevated levels of HbA1C i.e. >8%. Among all participants with severe degree of loss of hearing, elevated HbA1C levels were noted. Association between degree of SNHL and levels of HbA1C was statistically significant with a p-value of 0.000 by Pearson Chi-square test.

## DISCUSSION

The Centre for Disease Control (CDC) reported Prevalence of diabetes in urban areas in India ranges between 10.9% to 14.2% and in rural areas 3.0% to 7.8%. Diabetes is a metabolic disorder. Early identification of diabetes and its good control may prevent complications of sensorineural hearing loss.<sup>1</sup>

Diabetes Mellitus is a metabolic disorder of impaired carbohydrate, fat, protein metabolism caused by either lack of insulin secretion (Type 1) or decreased sensitivity of tissues to insulin (Type 2). Long standing diabetes may be associated with hearing loss.<sup>2</sup>

The pathologic changes that accompany diabetes injure the vasculature of inner ear, resulting in sensorineural hearing impairment.<sup>3</sup>

The probable mechanism for hearing loss in diabetes is microangiopathy of inner ear resulting in thickened stria vascularis, hyperglycemia of cerebrospinal fluid or perilymph, secondary degeneration of eighth cranial nerve, neuropathy of outer hair cells dysfunctions and disruption of endolymphatic potentials.

In diabetes mellitus, the hearing impairment is predominantly bilateral SNHL, mainly affecting high-frequency tones with a gradual onset and progression.<sup>4</sup>

In few studies, higher HbA1c with longer duration of diabetes have been correlated although not significantly high. This study has not been conducted on the Indian population, hence it's important to find if there is a correlation in the Indian population.

With this background, the present study was undertaken to study the effect of Diabetes Mellitus on hearing and assess the relationship between hearing impairment, duration of diabetes and HbA1c.

### **HbA1C LEVELS**

When the HbA1C levels were evaluated in our study, it was noted that a 72% of the participants had levels <7%, while 13% and 15% had elevated levels between 7-8% and >8% respectively.

In our study, the association between HbA1C levels and auditory function was statistically significant (p value <0.05).

Findings of our study were supported by **Uju I et al (2021)** <sup>[12]</sup> observed that in majority of the study participants i.e. 57.4%, the HbA1C levels were elevated above 7%. **Krishna H (2020)** <sup>[14]</sup> reported that 45.28% of the diabetics had >8% HbA1C levels. Similarly, **Dosemane D et al. (2019)** <sup>[7]</sup> and **Srinivas CV et al. (2016)** <sup>[1]</sup> noted that majority had elevated HbA1C levels.

In our study, 41.7% of the study participants with SNHL had elevated levels of HbA1C (>8%), while 36.10% had levels between 7-8gm% and only 22.20% had <7gm%. None of the study subjects with normal hearing had elevated HbA1C.

Similarly, **Maran R et al. (2022)** <sup>[11]</sup> in their study found that 28 out of 42 diabetics had elevated levels (>8%) of HbA1C indicating poor control of blood glucose in majority leading to increased SNHL, while 8 had values <7% and 6 had values between 7-8%. **Dhasmana G et al. (2021)** <sup>[4]</sup> observed that 69.2% patients with poor glycaemic control (HbA1C>7.64) had hearing loss, while only 30% patients with good glycaemic control (HbA1C 5.97-6.80%) had hearing loss. **Tiwari A et al. (2018)** <sup>[3]</sup> reported that majority patients with HbA1C 8.1-10% had SNHL, while **Gutierrez J et al. (2016)** <sup>[8]</sup> reported elevated levels in 87% of the participants. **Shafeeq M et al. (2015)** <sup>[27]</sup> discussed that uncontrolled diabetes in patients was responsible for increased incidence of SNHL.

### **DURATION OF DIABETES**

It was found in our study that participants with diabetes for 4-6 years constituted a major proportion i.e. 61% among those with SNHL followed by those who had diabetes for 7-10 years (25%). Only 14% of the study subjects with SNHL had diabetes for ≤ 3 years. In patients with normal auditory function, 55% had diabetes for 4-6 years while 34% and 11% had diabetes for ≤ 3 years and 7-10 years respectively.

A statistically significant association (p-value<0.05) between duration of diabetes and hearing was seen.

Similar to our study, **Krishna H (2020)** <sup>[14]</sup> found a significant association between the duration and hearing loss with a SNHL prevalence of 70.9% in persons with diabetes for over 10 years. In the study by **Jyothi AC et al. (2019)** <sup>[10]</sup>, the percent of SNHL patients among patients with diabetes for >10 years was the highest followed by those with 6-10 years duration. **Ghosh U et al. (2019)** <sup>[18]</sup> found a significant association between the duration and hearing loss, and a major proportion with diabetes for >10 years had loss of hearing. **Tiwari A et al. (2018)** <sup>[3]</sup> observed findings similar to the present study where majority of the patients with SNHL had diabetes for 3-6 years followed by 6-9, 9-12 & >12 years; and a significant association between duration & hearing loss. **Dadhich S et al. (2018)** <sup>[20]</sup> discussed that majority SNHL patients had diabetes for >5 years, and the reason for SNHL being the long term effect of diabetes including microangiopathy and neuropathy. As per the study by **Rajamani S et al. (2018)** <sup>[21]</sup> and **Srinivas CV et al. (2016)** <sup>[1]</sup>, a significant association between the two did exist. **Shafeeq M et al. (2015)** <sup>[27]</sup> discussed that with the increase in duration of diabetes, the incidence of SNHL also increased.

In contrast to our study, **Dhasmana G et al. (2021)** <sup>[4]</sup> reported that, among patients with duration of diabetes <5 years, 46.6% had hearing loss, while among those with duration between 5-10 years, 57.7% had hearing loss. However, 21 patients had a duration between 11-15 years, of which 71.4% had loss of hearing. Nevertheless, no significant association between the duration and hearing loss was noted. Majority of the study participants (33.3%) had diabetes for more than 10 years in a study by **Uju I et al (2021)** <sup>[12]</sup>, however, no significant association was seen.

#### DEGREE OF SENSORINEURAL HEARING LOSS

In the present study, the degree of sensori-neural hearing loss was classified as mild, moderate, moderately severe and severe. Among the females with SNHL, majority i.e. 9 out of 21 had mild degree of hearing loss, while among the males with SNHL, mild degree of hearing loss was present in 7 out of 15 subjects. Only 1 male and 1 female had profound hearing loss.

In a similar study by **Maran R et al. (2022)** <sup>[11]</sup>, 24 out of 29 subjects had mild hearing loss while only 5 had moderate hearing loss. Similarly, **Dhasmana G et al. (2021)** <sup>[4]</sup> observed that 66.3% had mild hearing loss while only 2.7% had severe hearing loss. Mild degree of hearing loss was the most common (50%) followed by moderate degree in a study by **Uju I et al (2021)** <sup>[12]</sup>. **Krishna H (2020)** <sup>[14]</sup> observed that 48% had mild hearing loss constituting the majority. Similar findings were observed by **Khakurel G et al. (2020)** <sup>[15]</sup>. **Singh A (2020)** <sup>[16]</sup> reported 45% diabetics to have mild SNHL followed by moderate, moderately severe and severe hearing loss. **Ghosh U et al. (2019)** <sup>[18]</sup>, **Tiwari A et al. (2018)** <sup>[3]</sup>, **Ren H et al. (2018)** <sup>[23]</sup>, **Gutierrez J et al. (2016)** <sup>[8]</sup> also observed similar findings. **Meena R et al (2016)** <sup>[25]</sup> also reported mild hearing loss in majority.

In the present study, most of the study participants with moderate hearing loss (60%) were in the age group of 41-50 years, while moderately severe hearing loss was noted to be 50% in participants of 51-60 years of age. Mild to moderate hearing loss was noted in 40-50 years.

In our study, the association between age group and degree of hearing loss was statistically significant (p-value <0.05)

Similar to the present study by **Rajamani S et al. (2018)** <sup>[21]</sup>, and those above 50 years had severe loss. Severe degree of hearing loss was noted in participants of 61-70 years of age. **Jyothi AC et al. (2019)** <sup>[10]</sup> reported that diabetics in the age-group of 46-50 had mild hearing loss and constituted the majority followed by 56-60 and 51-55 year. The results of the present study were supported by **Rajamani S et al. (2018)** <sup>[21]</sup>.

However, In contrast to our study **Kumar V et al. (2021)** <sup>[13]</sup> found no such association between type & severity of hearing loss and age.

## DEGREE OF HEARING LOSS AND HbA1c LEVELS ASSOCIATION

The present study observed that association between degree of SNHL and levels of HbA1C was statistically significant ( $p$ -value $<0.05$ ). Participants with HbA1C levels less than 7 were found to have only mild or moderate degree of hearing loss. Among those with moderately severe degree of SNHL, 87.50% had elevated levels of HbA1C i.e.  $>8\%$ . Among all participants with severe degree of loss of hearing, elevated HbA1C levels were noted.

Similarly, **Singh A (2020)**<sup>[16]</sup> reported that 92% of the diabetic patients with SNHL had HbA1C levels of  $>8\text{gm}\%$ . Among these majority had either moderate or moderately severe SNHL. In the study by **Jyothi AC et al. (2019)**<sup>[10]</sup>, it was seen that moderate and moderately severe SNHL were present in more than 90% of the patients with HbA1C levels of  $>8\%$ , while mild degree of SNHL was present in only those with HbA1C levels  $<7\%$ . Similar to the present study, **Rajamani S et al. (2018)**<sup>[21]</sup> observed a statistically significant association between the two. Those with HbA1C between 7-10% had mild or moderate loss, while those with  $>10\%$  had severe loss, indicating that poor control of diabetes posed as a risk factor for SNHL.

Contrary to this, **Kumar V et al. (2021)**<sup>[13]</sup>, **Uju I et al (2021)**<sup>[12]</sup>, **Dosemane D et al. (2019)**<sup>[7]</sup>, **Ghosh U et al. (2019)**<sup>[18]</sup>, **Ren H et al. (2018)**<sup>[23]</sup> found no association between the type and severity of SNHL with glycaemic control.

Our study suggests that there is necessity of introducing routinely periodic assessment of auditory functions in patients of Type-2 diabetes mellitus for early detection and prevent further complications.

## CONCLUSION

Thus we would like to conclude that routine evaluation of the auditory system can help in the early diagnosis of sensorineural hearing loss in type 2 diabetes mellitus, good glycaemic control is key to prevent or delay occurrence of SNHL. We also suggest regular audiological evaluation of all diabetic patients to improve the quality of life

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