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**Original Research Article**

# Prevalence and factors influencing sensorineural hearing loss among type II diabetes mellitus patients

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## ABSTRACT

**Background:** The typical hearing loss described among diabetes patients is progressive, bilateral, sensorineural deafness of gradual onset that predominantly affects the higher frequencies. Although there is mounting evidence for a relationship between diabetes and hearing impairment the awareness of auditory organ involvement in the course of diabetes is still not widespread among healthcare providers involved in diabetes care. Objective of present study was to assess the prevalence and the factors influencing sensorineural deafness among the patients with type II diabetes mellitus.
**Methods:** A cross-sectional study was conducted at our hospital for a period of 6 months. All type II diabetes patients without any other major systemic illness (CVA, coronary artery disease, thyroid disorders) were included for the study. A total of 300 patients were included in our study and the informed consent was obtained from all the study participants. A detailed history related to hearing loss and diabetes status was elicited from all the patients. All basic blood investigations along with HbA1c was performed on all the patients. All the patients were subjected to pure tone audiometry and it was performed using a pure tone audiometer model AUL 12096 audiometer of Labat company in a sound proof room.
**Results:** The total prevalence of sensori-neural deafness among the study subjects was found to be 51.3% with majority of them having mild to moderate degree of sensori-neural deafness. Increase in age, female gender, longer duration of diabetes and higher HbA1C levels are the factors which had influenced the state of sensorineural deafness among the study subjects.
**Conclusions:** The use of audiological test at primary care level should be made mandate for screening all the diabetes patients for hearing loss such a way the quality of life can be improved for patients requiring therapeutic interventions for their hearing improvement.

**Keywords:** Prevalence, Pure tone audiometry, Sensorineural deafness, Type II diabetes mellitus

## INTRODUCTION

Diabetes mellitus is one of the most common non-communicable disease among the developed and developing countries in the world. It is usually associated with numerous complications and among that one of the lesser known complications of diabetes is auditory organ dysfunction and tinnitus, which leads to a decreased quality of life among those affected.[1,2] Globally, as of 2013, an estimated 382 million people have diabetes worldwide, with type 2 diabetes making up about 90% of the cases.[3,4] Diabetes mellitus has been implicated as an independent causative factor of sensorineural hearing loss.[5]

Hearing loss is defined as a pure tone average of the frequencies ranging between 250, 500, 1000, 2000, 4000, 6000, 8000 Hz when the hearing threshold is greater than

25 decibel in that ear. Hearing loss is impairment of hearing and its severity may vary from mild to severe or profound and in general hearing loss may be conductive, sensorineural or mixed.[6] The typical hearing impairment described in diabetics is a bilateral sensorineural hearing loss. A number of studies have shown that hearing loss among diabetics predominantly involves the high frequencies.[7,8] This is similar to presbyacusis, that affects higher frequencies first.[9,10] Sensory hair cell loss and cochlea neuron loss at the basal turns are thought to be responsible for presbyacusis.[11] Nakae et al made similar observations in an animal model of diabetes mellitus.[12] High frequency hearing impairment is associated with difficulties understanding speech and thus impacting negatively on ones life.[13]

The typical hearing loss described among diabetes patients is progressive, bilateral, sensorineural deafness of gradual onset that predominantly affects the higher frequencies.[14] However many authors disagree that diabetes mellitus can lead to a sensorineural hearing impairment.[15] The effects of different variables such as duration of diabetes, blood sugar control, and presence of end-organ damage on hearing loss have yet not been clarified despite several studies on this topic. Although there is mounting evidence for a relationship between diabetes and hearing impairment the awareness of auditory organ involvement in the course of diabetes is still not widespread among healthcare providers involved in diabetes care.[16] There are a number of physiologically plausible theories about the underlying mechanism responsible for hearing loss occurring with diabetes such as microangiopathic changes involving the coclea, advanced glycation end products leading onto vascular endothelial damage which further leads onto hearing loss, and reactive oxygen species/oxidative stress in basal hair cells leading to hearing loss.[17] As of today only very few Indian studies had been conducted to assess the deafness levels among diabetic patients and so this study was undertaken to assess the hearing loss among the type II diabetes mellitus patients.

Objective of present study was to assess the prevalence and the factors influencing sensorineural deafness among the patients with type II diabetes mellitus.

## METHODS

A cross-sectional study was conducted at our hospital for a period of 6 months between July 2017 and December 2017. All type II diabetes patients without any other major systemic illness (CVA, coronary artery disease, thyroid disorders) were included for the study.

Patients less than 30 years and more than 55 years of age, patients on dialysis, patients with history of hearing loss prior to onset of diabetes, history of ear discharge, patients with history of head trauma, radiotherapy, ototoxic drug intake, noise exposure were excluded from the study. The study was started after getting the clearance from the institutional ethical committee. A total of 300 patients were included in our study and the informed consent was obtained from all the study participants. A detailed history related to hearing loss and diabetes status was elicited from all the patients. All basic blood investigations along with HbA1c was performed on all the patients.

All the patients were subjected to pure tone audiometry and it was performed using a pure tone audiometer model AUL 12096 audiometer of Labat company in a sound proof room. Air conduction thresholds were measured for tones of 250, 500, 1000, 2000, 4000 6000 and 8000 Hertz. Bone conduction thresholds were measured for 250, 500, 1000, 2000, 4000 Hz. At each frequency, an initial stimulus of 10 dB was given and then the level of the tone was increased in steps of 5 dB, presenting one pulse at each level until a response was obtained. The level at which the subject gave a response after the raise of 5 dB was the threshold.

Hearing loss is defined as an unaided, measured, bilateral, pure-tone hearing loss at frequencies of 500, 1000, and 2000 hertz averaging 40 decibels (dB) or more in the better ear on the most recent audio logical evaluation conducted by a qualified professional {qualified professional is defined as a licensed or certified audiologist or qualified physician (otolaryngologist/ENT, otologist, neurologist). Hearing impairment was graded as slight (26-40 dB); moderate (41-60 dB); severe (61-80 dB) and profound (>81 dB).[18] Later to further confirm our diagnosis all patients were also tested for Auditory brainstem responses using the neuro-audio (v-2010) device manufactured by Neurosoft Company with click stimulus of 100 μs duration, a repetition rate of 19.1 Hz, an intensity of 80 dB, and a contralateral ear masking of 30 dB. Electrodes were placed on the forehead (positive), the ipsilateral mastoid (negative), and chin (ground). The latency times of wave I, III, V and the intervals between them were measured.

### *Statistical analysis*

All data were entered and analysed using SPSS version 21. Mean and standard deviation was derived for all the parametric variables and the association between the diabetes status and the hearing loss was assessed using Chi-square test considering $P < 0.05$ as statistically significant.

## RESULTS

Table 1 shows the age and gender wise distribution of the study subjects. It is seen from the table that the majority of the study subjects are in the age group 46 and 50 years among both males and females and the mean age in both these group were 46.7 and 47.3 years respectively. The minimum age was 30 and the maximum age was 55 years. Female subjects were slightly more in number than the males with a male: female ratio of 0.89:1.

**Table 1: Age and gender wise distribution of the study subjects.**

| Age group | Male | Female | Total | P value |
|---|---|---|---|---|
| 30-35 | 14 (9.8%) | 10 (6.3%) | 24 (8%) | |
| 36-40 | 36 (25.3%) | 42 (26.5%) | 78 (26%) | |
| 41-45 | 28 (19.7%) | 34 (21.5%) | 62 (20.6%) | |
| 46-50 | 54 (38%) | 61 (38.6%) | 115 (38.3%) | 0.518 |
| 51-55 | 10 (7%) | 11 (6.9%) | 21 (7%) | |
| Total | 142 (100%) | 158 (100%) | 300 (100%) | |
| Mean±SD | 46.7±13.5 | 47.3±14.2 | | |

Based on the pure tone audiometry results sensori-neural deafness was graded as mild, moderate, severe and profound. The total prevalence of sensori-neural deafness among the study subjects was found to be 51.3% with majority of them having mild to moderate degree of sensori-neural deafness. It was shown in our study that mild and moderate grading of deafness were more common in the age group of 40 to 50 years whereas severe and profound grading of deafness was found to be more common among people aged more than 50 years and this difference was found to be statistically significant (p<0.05) (Table 2).

**Table 2: Prevalence of sensori-neural deafness according to age group.**

| Age group | Grading of sensori-neural deafness | | | | Total | P value |
|---|---|---|---|---|---|---|
| | Mild | Moderate | Severe | Profound | | |
| 30-35 (n=24) | 8 (33.3%) | 1 (4.1%) | 0 | 0 | 9 (37.5%) | |
| 36-40 (n=78) | 24 (30.7%) | 10 (12.8%) | 1 (1.2%) | 0 | 35 (44.8%) | |
| 41-45 (n=62) | 16 (25.8%) | 14 (22.5%) | 3 (4.8%) | 0 | 33 (53.2%) | |
| 46-50 (n=115) | 21 (18.2%) | 32 (27.8%) | 8 (6.9%) | 3 (2.6%) | 64 (55.6%) | <0.005 |
| 51-55 (n=21) | 0 | 3 (14.2%) | 6 (28.5%) | 4 (19%) | 13 (61.9%) | |
| Total (n=300) | 69 (23%) | 60 (20%) | 18 (6%) | 7 (2.3%) | 154 (51.3%) | |

Percentage indicates row percentage

**Table 3: Gender wise distribution of sensorineural deafness among the study subjects.**

| Gender | Grading of sensori-neural deafness | | | | Total | P value |
|---|---|---|---|---|---|---|
| | Mild | Moderate | Severe | Profound | | |
| Male (n=142) | 33 (23.2%) | 26 (18.3%) | 6 (4.2%) | 2 (1.4%) | 67 (47.1%) | |
| Female (n=158) | 36 (22.7%) | 34 (21.5%) | 12 (7.5%) | 5 (3.1%) | 87 (55%) | <0.005 |
| Total (n=300) | 69 (23%) | 60 (20%) | 18 (6%) | 7 (2.3%) | 154 (51.3%) | |

Percentage indicates row percentage

**Table 4: Association between the duration of diabetes and sensorineural deafness among the study subjects.**

| Duration of diabetes | Grading of sensori-neural deafness | | | | Total | P value |
|---|---|---|---|---|---|---|
| | Mild | Moderate | Severe | Profound | | |
| <5 years (n=38) | 12 (31.5%) | 0 | 0 | 0 | 12 (31.5%) | |
| 5-10 years (n=72) | 11 (15.2%) | 21 (29.1%) | 1 (1.3%) | 0 | 33 (45.8%) | |
| 10.1-15 years (n=178) | 44 (24.7%) | 35 (19.6%) | 12 (6.7%) | 6 (3.3%) | 97 (54.4%) | <0.005 |
| >15 years (n=12) | 2 (16.6%) | 4 (33.3%) | 5 (41.6%) | 1 (8.3%) | 12 (100%) | |
| Total | 69 (23%) | 60 (20%) | 18 (6%) | 7 (2.3%) | 154 (51.3%) | |

Percentage indicates row percentage

The overall prevalence of sensori-neural deafness among the males was 47% and among females it was 55% and we found the prevalence of sensorineural deafness was more among females than that of males and the difference was found to be statistically significant (p<0.05) and the severe and profound sensorineural deafness was more common among females than that of males (Table 3). The duration of diabetes showed a

statistically significant association with sensorineural deafness, as the duration of diabetes increases the prevalence in deafness also increased. In our study subjects majority of the patients with a history of diabetes of less than 15 years had mild to moderate grading of sensori-neural deafness whereas patients history of more than 15 years of diabetes had severe or profound grading of deafness (Table 4). The correlation between HbA1C levels and the grading of sensorineural deafness shows that there exists a statistically significant correlation between the two, that is as the HbA1C level increases the severity of sensorineural deafness also increases. In our subjects patients with A1C levels between 7 and 10 gm% had more of mild or moderate grade of deafness, whereas patients with A1C levels greater than 10 gm% had severe and profound grade of deafness. It proves that the poor control of diabetes is a major risk factor for developing sensorineural deafness (Table 5).

**Table 5: Pearson's correlation between the severity of diabetes (HbA1C) and sensorineural deafness among the study subjects.**

| HbA1C (gm%) | Grading of sensori-neural deafness | | | | Total | r value | P value |
|---|---|---|---|---|---|---|---|
| | Mild | Moderate | Severe | Profound | | | |
| <6.5 (n=53) | 8 (15%) | 0 | 0 | 0 | 8 (15%) | | |
| 6.5-7.5 (n=66) | 16 (24.2%) | 21 (31.8%) | 1 (1.5%) | 0 | 38 (57.5%) | | |
| 7.6-8.5 (n=104) | 33 (31.7%) | 29 (27.8%) | 2 (1.9%) | 0 | 64 (61.5%) | | |
| 8.6-9.5 (n=46) | 9 (19.5%) | 8 (17.3%) | 5 (10.8%) | 3 (6.5%) | 25 (54.3%) | 0.874 | <0.005 |
| 9.6-10.5 (n=21) | 3 (14.2%) | 2 (9.5%) | 5 (23.8%) | 2 (9.5%) | 12 (57.1%) | | |
| >10.5 (n=10) | 0 | 0 | 5 (50%) | 2 (20%) | 7 (70%) | | |
| Total | 69 (23%) | 60 (20%) | 18 (6%) | 7 (2.3%) | 154 (51.3%) | | |

Percentage indicates row percentage

## DISCUSSION

Diabetes mellitus is a common metabolic disease affecting almost all age groups which is frequently associated with hearing loss. The hearing loss associated with diabetes mellitus is characteristically bilaterally symmetrical, gradual in onset and progressive in nature. The relationship between diabetes mellitus and sensorineural hearing loss is complex and not well explained. The two factors that is found to affect hearing in diabetic patients are diabetic angiopathy and diabetic neuropathy.[19] In addition to increased formation of advanced glycation products in collagen, DNA also contributes to tissue damage leading to cellular hypertrophy and hyperplasia The present study had shown the prevalence of sensorineural deafness as 51.3% and in comparison with other studies conducted earlier the prevalence of Sensorineural hearing loss among the diabetes patients ranged between 13 and 95%. Our results are similar to those of Ramlakhan Meena (58%) Nagoshi Y et al (54%); Friedmann SA et al (55%); Boomsma LJ and Stolk RP (48%); Weng SF et al (44.8%) and Mozaffari M et al (45%).[20-25]

However, a higher prevalence of sensorineural hearing loss was noted in few studies conducted by Rajendran S et al (73.3%) and Harkare V et al (74%) and a very high prevalence was noted in a study done by Rózańska-Kudelska M et al (95%) among the diabetics patients.[26-28] Similarly a comparatively lower prevalence was observed in studies conducted by Somogyi A et al (34%) and Saini S et al (30%) and Kakarlapudi V et al (13.1%).[29-31] The variations observed in the prevalence might be due to the different study period, different inclusion and exclusion criteria and the heterogeneity of the study populations. Contradictory to our study, Harner SG and Schuknecht HF had denied any relationship between SNHL and diabetes.[32,33]

In present study authors found severe and profound grading of sensorineural hearing loss to be more common among patients aged more than 50 years which proves that increase in age among patients with diabetes are more prone for severe SNHL. Our results were further substantiated by the study conducted by Axelsson A et al where he showed that the incidence of pure tone hearing loss increases with age in patients with diabetes, even after correction for prebyacusis.[14] The impact of age on hearing function is well documented. The hearing threshold increases, predominantly at middle and high frequencies, whereas amplitude of OAE decreases, with age. Our findings are similar to other studies but contradictory to one study which does not report any correlation with age.[26,28]

The current study shows that female gender with diabetes has a strong association in developing sensorineural deafness than that of males and it is in par with the studies reported by Taylor IG and Irwin J etal.[34] As per the study of Cullen JR and Cinnamond MJ, male patients with diabetes had worse hearing than female patients with diabetes whereas few studies had shown no difference between gender and the severity of deafness.[16,26,27,30]

In present study authors report a statistically significant association between diabetes duration and the severity of SNHL, longer the duration higher the grading of deafness particularly among the patients with history of more than 15 years of diabetes the severity of hearing loss was high and most of the studies had also reported the same barring few others.[35,36]

Control of blood sugar levels and their association with sensorineural hearing loss has been debated since long and in this study glycosylated haemoglobin was taken into consideration for assessing the diabetes control and we found a statistically significant correlation between the HbA1C levels and the severity of sensorineural hearing loss and our results are in par with the studies done by Cullen R, Kurien M and Tay H L.[16,37,38]

## CONCLUSION

The prevalence of sensorineural hearing loss (51.3%) was found to be very high among the patients with diabetes with a siinficant association with age, gender, duration of diabetes and glycemic control in diabetes. The use of audiological test at primary care level should be made mandate for screening all the diabetes patients for hearing loss such a way the quality of life can be improved for patients requiring therapeutic interventions for their hearing improvement. Though for evaluating hearing loss associated with type 2 diabetes requires tests that evaluate the full auditory system, from the cochlea to the higher auditory pathways but there is no ‘‘gold standard’’ audiological-test protocol available for this purpose in regular clinical use so still the pure tone audiometry testing can be applied at a clinic level to diagnose the deafness early.

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