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*Original Research Article*

# A cross sectional study of prevalence of hearing impairment and tinnitus in type 2 diabetes mellitus patients

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**Abstract**

**Aims and Objective:** To assess prevalance of hearing loss and tinnitus among Diabetes mellitus type 2 patients in the cross-sectional study.

**Materials and Methods:** 120 patients were divided into groups based on their age, gender, the duration of their diabetes mellitus (10 years), and the types of diabetic medications they were using. In a soundproof room, thorough otoscopy examinations of their ears were performed, along with the tuning fork test, PTA, and other tests. A questionnaire was used to assess tinnitus.

**Results:** The total no.of diabetic patients considered for this study are 120. Out of which, 76 patients were identified with sensorineural hearing loss (SNHL). In these SHNL patients,48 were identified with mild SNHL(63.15%), 22 patients with moderate SNHL(28.94%), 2 with moderate severe SNHL(2.63%) and 4 patients with severe SNHL (5.26%).Tinnitus is seen in 35 patients (29.16%).The association of age (p=0.21) and sex (p=0.58) with Hearing loss (HL) and tinnitus were not statistically significant. Nevertheless, the duration of diabetes mellitus in relation to these ailments were statistically significant (p=0.07).

**Conclusion:** The patients with Diabetic mellitus were having higher degree of hearing threshold with B/L mild to moderate SNHL. Age and Gender of diabetic mellitus patients had no major correlation with HL and tinnitus. While the duration had major correlation with HL and tinnitus. These results infer that there is more prevalence of hearing impairment and tinnitus and develop at an earlier age in type 2 diabetes patients.

**Keywords:** Diabetes, hearing loss, tinnitus

## Introduction

Hearing is a special sensation in evolved animals including humans. Hearing is the integral part of speech and quality of life. HL is total or partial inability to hear. Tinnitus is defined as perception of sound in absence of a matching external acoustic stimulus [1]. Tinnitus may have various debilitating effects on the sufferer. Tinnitus is one of the three most significant otoneurological clinical manifestations besides sensorineural hearing impairment and vertigo.

The blood circulation's delivery of oxygen and glucose is essential for the inner ear's metabolism. Changes in glucose metabolism may affect how well the brain and inner ear work, which could diminish the ability to comprehend complex sounds like speech and increase the risk of developing tinnitus along with hearing loss. Tinnitus and hearing loss are signs of conditions that include metabolic changes, including diabetes mellitus, ototoxic medications, high insulin levels in the blood, loud noises, and barotrauma.

Diabetes mellitus is a common metabolic disorder that is not contagious and results in a

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number of systemic abnormalities. Hearing impairment, particularly hearing loss and tinnitus, is one of the known side effects of DM and lowers the quality of life for people who are affected [2]. The severity of hearing loss was shown to increase as diabetes duration increased [3].

The link between diabetes and hearing loss and tinnitus is well known, but the results are inconclusive because of inaccurate self-reporting, incomplete medical history collection (e.g., level and duration of noise exposure, use of ototoxic drugs), and confounding variables like age, sex, duration of diabetes, glycemic control, and smoking. Diabetes mellitus causes a high frequency threshold-related, progressive sensorineural hearing loss. With advancing years, ongoing diabetes, and high levels of HbA1c greater than 8%, hearing threshold also rises. The purpose of this study was to look at the connection between inner ear issues including hearing loss and tinnitus brought on by diabetes mellitus.

## Materials and Methods

A Cross Sectional Study was conducted in 120 patients (70 males and 50 females) with diabetic mellitus for 10 years, in Department of ENT, Katuri Medical College and Hospital, Guntur. Prior to the medical examination, patients have undergone through self-administered questionnaire on medical history and lifestyle like smoking habit, frequency of smoking (i.e, No. of cigarettes per day) and frequency of alcohol intake.

### Inclusion criteria

1. Patients with more blood sugar levels (fasting blood sugar, PPBS, random blood sugar).
2. Known case of Diabetic mellitus for at least 10 years.
3. Tympanic Membrane of both ears must be normal and intact.
4. Age 40–69 years.

### Exclusion criteria

1. Family h/o deafness
2. H/o chronic suppurative otitis media (CSOM), meningitis, head or ear trauma
3. H/O malaria, jaundice, typhoid.
4. Past h/o ear surgeries performed.
5. h/o radiotherapy, ototoxic drug intake, systemic diseases, and autoimmune diseases such as HTN, Cardiovascular diseases, renal failure and occupational exposure to noise levels.

Threshold determination is done for both bone conduction and air conduction using PTA. The random, FBS and PPBS levels, and HbA1c were estimated to find glycemic status. Detailed examinations of ear with an otoscope and the PTA were done in a sound proof room. To assess the degree of HL. Based on the PTA, WHO classification was done considering the average thresholds of hearing with frequencies of 500, 1000, and 2000. Degree of HL – mild: 26–40 dB, moderate: 41–55 dB, mod-severe: 56–70 dB, severe: 71–90 dB, and profound: more than 90 dB. Tinnitus was assessed using a questionnaire; Tinnitus Handicap Inventory [4]. The examined persons answered the question whether they experienced regular tinnitus and they are validated. The data was analysed in terms of audiometric findings for the presence of and tinnitus questionnaire.

**Tinnitus Handicap Inventory Questionnaire**

Patient Name:_____ Date:_____

| | | | |
|---|---|---|---|
| **Instructions:** The purpose of this questionnaire is to identify difficulties that you may be experiencing because of your tinnitus. Please answer every question. Please do not skip any questions. | | | |
| 1. Because of your tinnitus, is it difficult for you to concentrate? | Yes | Sometimes | No |
| 2. Does the loudness of your tinnitus couldn't to hear people? | Yes | Sometimes | No |

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| | | | |
|---|---|---|---|
| 3. Does your tinnitus cause you angry? | Yes | Sometimes | No |
| 4. Does your tinnitus confuse you? | Yes | Sometimes | No |
| 5. Does your tinnitus, make you desperate? | Yes | Sometimes | No |
| 6. Is there any complaint about your tinnitus? | Yes | Sometimes | No |
| 7. Are you able to fall asleep or not? Because of your tinnitus | Yes | Sometimes | No |
| 8. Do you think the problem of tinnitus cannot be solved? | Yes | Sometimes | No |
| 9. Does your tinnitus has any impact on your social activities? (Such as going out to dinner, to the movies)? | Yes | Sometimes | No |
| 10. Does your tinnitus make you feel frustrated? | Yes | Sometimes | No |
| 11. Do you think your tinnitus is a terrible disease? | Yes | Sometimes | No |
| 12. Were you able to enjoy your life though having tinnitus? | Yes | Sometimes | No |
| 13. Does your tinnitus impact with your job/ household responsibilities? | Yes | Sometimes | No |
| 14. Because of your tinnitus, Do you find that you are often irritable? | Yes | Sometimes | No |
| 15. Is your tinnitus making you difficult to read? | Yes | Sometimes | No |
| 16. Does your tinnitus make you upset? | Yes | Sometimes | No |
| 17. Do you feel that your tinnitus problem has placed stress on your relationships with your family members and friends? | Yes | Sometimes | No |
| 18. Do you find you are losing your attention because of tinnitus? | Yes | Sometimes | No |
| 19. Do you feel that you have no control over your tinnitus? | Yes | Sometimes | No |
| 20. Does your tinnitus often makes you feel irritated? | Yes | Sometimes | No |
| 21. Do you feel depressed? With your tinnitus? | Yes | Sometimes | No |
| 22. Does your tinnitus make you feel anxious? | Yes | Sometimes | No |
| 23. Do you feel that you can no longer cope with your tinnitus? | Yes | Sometimes | No |
| 24. Does your tinnitus get worse when you are under stress? | Yes | Sometimes | No |
| 25. Does your tinnitus make you feel insecure? | Yes | Sometimes | No |

## Results

120 diabetic patients participated in this study. Males outnumbered girls by a large margin. 50 (41.6%) women and 70 (58.3%) men participated in the study. The diabetic patients evaluated ranged in age from 40 to 69 years, with 91 patients (75.83%) making up the majority of that age group. Of 120 diabetic patients, sensorineural hearing loss affected 76 of them (SNHL). Of the 76 diabetic SNHL patients, 50 (or 46.05% of the total) are between the ages of 61 and 69, and 45 (or 44.73% of the total) are between the ages of 51 and 60.
Of 76 diabetics with SNHL, 48 have mild SNHL (63.15%), 22 have moderate SNHL (28.94%), two have mod severe SNHL (2.63%), and four have severe SNHL (5.26%). 35 patients (29.16%) experience tinnitus.

**Table 1:** Diabetic mellitus patient's age group and No. of patients

| Age group (years) | Number of patients (n=120) | Percentage (%) |
|---|---|---|
| 41-50 | 25 | 20.83% |
| 51-60 | 45 | 37.5% |
| 61-69 | 50 | 41.6% |

Table 1 shows that more number of diabetic patients 50 out of 120 (41.6%) are between 61-69 years.45(37.5%) of diabetic patients are of the age group of 51- 60 years, 25(20.83%) of them are in the age group of 41-50 years.

**Table 2:** SNHL and age distribution of diabetic patient

| Age (years) | Number of patient (n=120) | Number of SNHL patient (n=76) | Percentage of SNHL Patient (%) |
|---|---|---|---|
| 41-50 | 25 | 7 | 9.2% |
| 51-60 | 45 | 34 | 44.73% |
| 61-69 | 50 | 35 | 46.05% |

SNHL: Sensorineural hearing loss

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**Table 3:** Degree of SNHL in diabetic patient (n=76), SNHL: Sensorineural hearing loss

| Degree of SNHL | Number of patient (n=76) | Percentage of SNHL Patient (%) |
|---|---|---|
| Mild SNHL | 48 | 63.15% |
| Moderate SNHL | 22 | 28.94% |
| Moderate severe SNHL | 2 | 2.63% |
| Severe SNHL | 4 | 5.26% |

Table 3 explains that most diabetic patients have Moderate SNHL. There were 22 patients (28.94%) with moderate SNHL. Two patients (2.63%) had moderately severe SNHL. A total of 4 individuals (5.26%) had severe SNHL.

**Table 4:** Tinnitus and age distribution of diabetic patient

| Age (years) | Number of patient (n=120) | Number of patients with Tinnitus (n=35) | Percentage of Patients with Tinnitus (%) |
|---|---|---|---|
| 41-50 | 25 | 4 | 11.42% |
| 51-60 | 45 | 13 | 37.14% |
| 61-69 | 50 | 18 | 51.42% |

Table 4 explains that tinnitus is most common in elderly patients of age group 61 to 70 years. Out of 120 diabetic patients 35 patients showed tinnitus on Tinnitus handicap inventory questionnaire.

**Table 5:** No. of diabetic years and sensorineural hearing loss

| Number of diabetic year | Number of patient (n=120) | Number of patient having SNHL (n=76) | Percentage of SNHL patient in diabetic group |
|---|---|---|---|
| 1-3 | 78 | 34 | 43.58% |
| 4-7 | 27 | 27 | 100% |
| 8-10 | 15 | 15 | 100% |

SNHL: Sensorineural hearing loss

The correlation between the number of years with diabetes and SNHL is seen in Table 5. It has been found that patients' hearing, regardless of age group, is directly impacted by the length of their diabetes. Because to the long-term effects of diabetic microangiopathy and neuropathy, all patients with diabetes for more than 5 years have SNHL. 78 participants in this study had diabetes for 1-3 years; 34 of these 78 diabetic participants (43.58%) had SNHL.

In this study, it was shown that moderate and severe SNHL was more commonly identified in diabetes patients who had been on medication for 5 years or more, and that all diabetic individuals with SNHL had higher and midfrequency effects that were more severe. Age ($p=0.21$) and sex ($p=0.58$) did not statistically significantly correlate with HL and tinnitus. Nonetheless, there was a statistically significant relationship between the duration of diabetes and these conditions ($p=0.07$).

## Discussion

Diabetes mellitus is one of the most common metabolic disorders, which affects both the older as well younger individuals and is associated with hearing impairment.

In the normal physiology of glucose metabolism, insulin is secreted by the pancreatic beta cells which affects the metabolism and lowers the blood glucose levels. In persons suffering from diabetes, there occurs an absolute deficiency of insulin [5]. This may lead to the long term failure of the kidneys, peripheral neuropathy, cognitive degeneration and at times, the complete breakdown of the auditory-vestibular system [5].

It is challenging to determine whether hearing loss in diabetes is brought on by the natural

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ageing process or by the biochemical and vascular abnormalities linked to diabetes [6]. Diabetes essentially speeds up the senile changes in the cochlea, which raises the incidence of hearing loss in them. Thus, Dabrowski's phrase "diabetic otopathy" Their sensory organs are gradually harmed, resulting in irreversible diseases, in diabetes individuals as they present with persistent or recurrent disorders that can impair cochleovestibular function [7, 8].

Due to microvascular angiopathy, which causes the striavascularis capillaries to thicken more than usual, the hearing threshold has increased. Other veins supplying the auditory system may also experience these alterations [9]. Moreover, the ear's cochlear vessels are impacted by microangiopathy. This could result in a total loss of nutrition, cell deterioration, and atrophy. Both the eighth nerve and the cochlea exhibit signs of nerve cell degeneration [10]. Also possible is the atrophy of the outer hair cells in the corti organs.

Patients with diabetes who were older had a higher incidence of hearing loss and a severer grade of hearing loss. Virteniemi *et al*. [11] and Fangcha *et al*. [12] support this conclusion. The duration of diabetes and hearing loss, however, did not appear to be correlated in investigations by Kurien *et al*. [13] and Cullen *et al*. [14]. According to Kurien *et al*. research's [13], poorly managed diabetics suffer from severe hearing loss across the board. The cumulative effects of advanced glycation end products and their effects on the inner ear [15] may help to explain this.

Diabetes has a devastating effect from the periphery (cochlea) to the CNS, leading to neuropathy of the auditory nerve which may cause tinnitus. The co-morbidity of the occurrence of HL and tinnitus in diabetes makes this condition even more debilitating. One neurophine is equivalent to the nerve growth factor (NGF) essential for the development, survival and maintenance of the peripheral and CNS. A decrease in the NGF plays a significant role in causing diabetic neuropathy.

The presence of insulin receptors, glucose transporters, and insulin signaling components in the sensory receptors and supporting cells of the cochlea, stria vascularis, and spiral ligament indicate that hearing and balance are vulnerable to impairments of glucose utilization. The variable pathologies and times of onset associated with glucose processing abnormalities suggest multifactorial processes, and yet, diabetes remains as a definite risk factor for HL [16].

The Inner ear and its lateral wall are supplied by a well-known microvascular network. The blood supply and specialized cytoarchitecture of the stria vascularis are consistent with it having an active role in both fluid and electrolyte transport. A dense system of capillaries is found within the middle layer of stria vascularis. The stria itself is a highly specialized epithelium, interlinked on top and bottom by a network of cells tied together by tight junctions. Marginal cells of the stria form part of the lateral wall of the scala media and are crucial for maintaining the endocochlear potential and controlling movement of K+ into the perilymph. The energy demands for ion pumping are met by the high density of mitochondria in the fine cytoplasmic basolateral folds of the marginal cells and the Na+, K+-ATPase localized on the membranes of the folds. Anoxia rapidly depletes ATP, which accompanies the decline in endocochlear potential.

Certain types of hearing loss may be accompanied by diabetic micro-angiopathy in the ear, and both type 1 and type 2 diabetic patients have been shown to experience cochlear alterations. Diabetes resulted in much thicker vascular walls in the stria vascularis and basilar membrane compared to healthy people, as well as a loss of outer hair cells in the basal turns. The vestibulocochlear nerve's inner ear and cochlear portions are involved in pathophysiology. It can be argued that the cochlear portion of the 8th cranial nerve is unaffected because sensorineural hearing loss was only observed in higher frequency. The inner ear components may have a role in pathology. This suggests that the striavascularis, inner ear blood vessels, or hair cells may be involved [17].

Severe atrophy of the spiral ganglion of the basal and middle turns of the cochlea in diabetic patients with SNHL was reported and the VIIIth nerve was recorded to have signs of myelin degeneration, with fibrosis of the perineurium [18] — leading to hearing ailments. Most audiometric studies on hearing in pts with DM with a higher threshold of blood sugar showed a mild to moderately high frequency SNHL [19, 20]. A study demonstrated abnormalities of

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outer hair cell function and abnormal auditory brainstem response in diabetics [21]. There was partial degeneration of the vestibular nerves, which was interpreted to represent the pathological sequela of acute diabetic vestibular neuritis [22]. Endothelial dysfunction seems to play a role in the initiation of microvascular pathology that includes thickening of the basement membrane, pericyte degeneration, and endothelial cell hyperplasia.

In the future, screening for hearing loss among all diabetes patients participating in a multicentric longitudinal study may help to better understand the connection between diabetes, hearing loss, and tinnitus. To avoid hearing loss and tinnitus, diabetic patients might be counselled to maintain stable blood sugar levels.

## Conclusion

With bilateral mild to severe SNHL, the diabetic people had greater hearing thresholds. The hearing loss and tinnitus of diabetes patients were not significantly correlated with their gender or age. Hearing loss and tinnitus were significantly correlated with the length of diabetes. These findings imply that people with type 2 diabetes have a higher prevalence of hearing loss and tinnitus, which also appear earlier in life.

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