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RESEARCH ARTICLE

# Audiometric assessment of hearing loss and its association with oxidative stress in patients with type 2 diabetes mellitus

**Ashna Kallingal Akbar[1], Kamalakshi T V[1], Thulaseedharan N K[2], Muraleedharan Nampoothiri P[3]**

[1]Department of Physiology, Government Medical College, Kozhikode, Kerala, India, [2]Department of Medicine, Government Medical College, Kozhikode, Kerala, India, [3]Department of ENT, Government Medical College, Kozhikode, Kerala, India

**Correspondence to:** Kamalakshi T V, E-mail: amalasree1960@gmail.com

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## ABSTRACT

**Background:** Diabetes mellitus (DM) is a multifunctional metabolic disorder affecting almost all the systems of the body. There is a strong relationship between DM and hearing. Hearing loss in diabetes may be the result of neuronal degeneration and microangiopathy in the inner ear, deranged glucose metabolism, and hyperactivity of oxygen free radicals. **Aims and Objectives:** The aims and objective were to study the hearing loss in type 2 diabetic patients of age group 30–60 years by pure tone audiometry (PTA) and compare it with that in the healthy people. **Materials and Methods:** A total of 126 subjects were divided into two groups of 63 each (Group I – diabetics and Group II – healthy controls). Serum fasting blood glucose and random blood sugar were estimated by glucose oxidase–peroxidase method; HbA1C was estimated by ion exchange high performance liquid chromatography (HPLC). Hearing loss was assessed by PTA. All statistical analyses were done with SPSS software, version 18. **Results:** About 77.80% of diabetics had a higher prevalence of hearing loss which was characteristically progressive, bilateral, and sensorineural with gradual onset predominantly affecting the higher frequencies. **Conclusion:** Diabetic patients whose glycemic levels were not under control were more prone for sensorineural hearing loss. Early screening of diabetics by audiometry will help postpone hearing loss by good glycemic control so as to improve the quality of life.

**KEY WORDS:** Diabetes Mellitus; Hearing Loss; Neuronal Degeneration; Audiometry; Higher Frequency

## INTRODUCTION

Diabetes mellitus (DM) is one of the most common endocrinological disorders caused by an insufficiency of insulin.[1] It is a state of persistent hyperglycemia with derangements in the metabolism of carbohydrates, proteins, and fats associated with long-term neurological and vascular complications.[1] DM is classified into type 1 and type 2 on the basis of the morbific process that leads to elevated blood sugar levels. Type 2 diabetes is a variegated collection of disorders distinguished by varying degrees of proliferated glucose production, insulin resistance, and diminished insulin release. Due to industrialization, the ubiquity of type 2 diabetes is uptrending far more expeditiously due to advanced obesity and mitigated pursuit levels. The aggregate of people with diabetes is reckoned to hike from 135 million in 1995 to >350 million in 2030.[2]

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The present diagnostic criteria of DM points out that the fasting plasma glucose is the most expedient and authentic investigation in symptomless individuals (≥126 mg/dL). A random blood glucose ≥200 mg/dL coincided with typical manifestation of diabetes (polydipsia, polyuria, and weight loss) is adequate for the detection of DM.[2]

Diabetes itself has been insinuated as a self-sufficient causal factor for hearing loss. The stereotypical hearing disability

elucidated in diabetics is a bilateral sensorineural hearing loss.[3] The prevalence of hearing loss in type 2 diabetes is roughly 2-fold higher compared to people without diabetes.[4] Type 2 DM is closely related with microvascular impediments that may have an impact on hearing.[5] The researches appraising interrelation between hearing loss and diabetes had started years back.

Many corporeal mechanisms have been recommended to describe the relatedness between hearing loss and Type 2 diabetes. These incorporate vascular and neurological causes including effects of diabetes on brain and spinal cord, genetic causes, and mitochondrial idiosyncrasies.[6] Hearing relies on nerves and tiny blood conduits of the internal ear that are influenced by elevated glucose in the bloodstream of diabetic patients. Microscopic examination exhibits damage to the vessels and nerves of the internal ear in subjects with type 2 diabetes, feasibly entailing to nerve cell deterioration of the labyrinth.[4] The magnitude of affection of the ear in diabetics influences the auditory threshold to high frequencies.[7] For the complex signal procession of the auditory system, it is in need of blood sugar and high-potential usage. Thus, the target organ for the negative impacts of hyperglycemias is mainly cochlea.[8]

Hearing loss is expressed as the pure-tone mean of air-conduction hearing thresholds >25 decibels (dB) hearing level for the four frequencies (0.5, 1.0, 2.0, and 4.0 kHz) in the better ear.[9] The evaluation of hearing loss in diabetic patients is an essential advancement in treating and learning microvascular diseases of the internal ear. The extremity of hearing loss may alter from mild to severe. Normally hearing loss is classified as conductive, sensorineural, or mixed. Hearing loss is analyzed by pure-tone audiometry (PTA). PTA ascertains the threshold of hearing of the patient described as the lowest hearing level whereupon the patient acknowledges to at least 50% of auditory stimuli applied. The instrument used in the measurement of auditory threshold is known as the audiometer. The generated pure-tone audiogram is in common use as a fundamental interpretation of the degree of hearing loss. Audiogram is a plot that represents hearing threshold as a function of frequency. This procedure contemplates the entire auricular function, each its central and peripheral parts.[10] In this study, hearing loss in type 2 diabetic patients was compared with that of healthy people.

## MATERIALS AND METHODS

The present study was a cross-sectional comparative study which is done to study the hearing loss in diabetics and healthy controls. The study was done after obtaining approval from the institutional ethics committee. The study was conducted for a period of 1 year from July 2016 to June 2017. The study was conducted in Medicine OPD, Medicine wards and the Audiology clinic in the Department of ENT, Government Medical College, Kozhikode. Two study groups were selected according to inclusion and exclusion criteria. Before registering, an informed consent was taken and counseling was given to all patients. The sample size was calculated using basic sample size calculation formula. The study population [Figure 1] consisting of subjects between 30 and 60 years were divided into two groups.

- Group I: 63 diabetic patients
- Group II: 63 age- and sex-matched normal subjects.

### Inclusion Criteria

- Study group I – Subjects aged 30–60 years diagnosed with diabetes as per the American Diabetes Association diagnostic criteria.
- Study group II – Apparently healthy age and sex-matched subjects, not suffering from diabetes or any other illness.

### Exclusion Criteria

Patients with any history of the following criteria were excluded from the study:

- Persistent exposure to noise
- Ear discharge, ruptured tympanic membrane, or some longstanding aural illness
- Recent intake of medicines toxic to the ear
- Family history of hearing loss
- Intake of drugs that depress the activity of central nervous system
- Any injury to the ear

Subjects were briefed about the objectives and methods of the study, and an informed written consent was taken before the study. A detailed history was taken from all subjects. Relevant clinical examination was done. PTA was performed to evaluate the hearing loss. Blood samples were collected. Fasting blood sugar and random blood sugar values were estimated by glucose oxidase-peroxidase method.

## RESULTS

Statistical analysis was performed to determine the percentage of hearing loss in two groups. Data were analyzed using Microsoft Excel and Statistical Package for the Social Sciences [SPSS] version 18. Results were expressed as mean ± standard deviation. The significance of the difference of the mean of each parameter between the two groups was analyzed using the Student's *t*-test. The $p$ value < 0.05 was considered to be statistically significant.

There was a significant increase in the percentage of hearing loss in the diabetic group compared to the controls and $P$ value was considered to be statistically significant ($P = 0.000$).

The diabetic group had higher degrees of hearing loss when compared to the controls, and *P* value was considered to be statistically significant (*P* = 0.000).

## DISCUSSION

In the present study, the percentages of hearing loss in type 2 diabetics were 77.80% and in control group were 36.50%. The percentage of hearing loss in the diabetic group [Figure 2] was higher. The differences were statistically significant (*P* = 0.000). Nearly, all recent studies show the association of sensorineural hearing loss with diabetes. Among the cases, 4.80% had minimal (16–25 dB), 7.90% had mild (26–40 dB), 17.50% had moderate (41–55 dB), 38.10% had moderately severe (56–70 dB), and 9.50% had severe (71–90 dB) hearing loss, respectively. Of the 63 controls, majority had normal hearing (63.5%) and others had minimal (25.40%) and mild (11.10%) hearing loss [Figure 3]. In our study, the diabetic group had higher degrees of hearing loss, and this finding was significantly significant (*P* = 0.000). In the present study, hearing loss was characteristically progressive, bilateral, and sensorineural predominantly affecting the higher frequencies.

In studies conducted by Friedman *et al*.,[11] Agarwal *et al*.,[12] and Bhaskar *et al*.,[13] the percentage of hearing loss in the diabetic group was higher similar to our study. Hearing loss was characteristically progressive, bilateral, and sensorineural predominantly affecting the higher frequencies in the studies done by Sunkum *et al*.,[14] Taylor and Irwin,[15] and Kurien *et al*.[16] similar to our study. Weng *et al*. reported sudden onset SNHL in diabetes.[17] Diabetes is affiliated with neuropathic and microvascular complications affecting the peripheral nerves, retina, and kidney.[14] DM-associated sensorineural hearing loss may be due to cochlear microangiopathy or auditory neuropathy.[8] The pathophysiological changes in diabetes cause damage to the vasculature or the neuronal network of the internal ear, resulting in sensorineural hearing loss. Pathologic changes specific to the cochlea include considerable deprivation of outer hair cells in the lower basal turn and thickening of walls of the vessels of basilar membrane. Autopsy in diabetic patients has revealed authentication of commensurate pathology, including thickening of the internal auditory artery, atrophy of the spiral ganglion, and degeneration of the eighth cranial nerve.[4] As the basal region of cochlea is highly vascularized, hearing loss exists at higher frequencies. This also makes the basal region more susceptible to vascular damage and hyperglycemia. DM can thus cause a hardening of the capillary walls of the stria vascularis indispensable in the generation of ionic gradients and endocochlear potential, extravasation of blood from perilymph and endolymph, depletion of spiral fibers, degenerative changes in the organ of corti, and diminished amount of outer hair cells.[18] A modest association was observed in a population-based cohort study.[5]

### Strength and Limitations of the Study

As quantitative method was used, selection process was well-designed and sample was representative of study population, so data could be analyzed easily. As age is an important factor, both for diabetes and hearing loss, it would have been better to report hearing loss in diabetes in different age groups. If sample size was more, a more representative data would have been obtained.

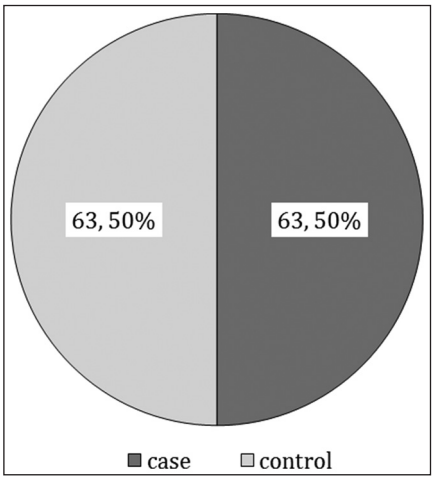


**Figure 1:** The study population

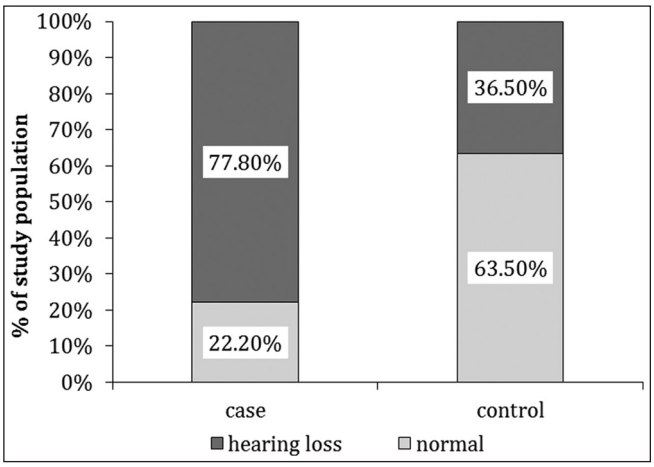


**Figure 2:** Percentage of hearing loss in the study population (*n* = 63)

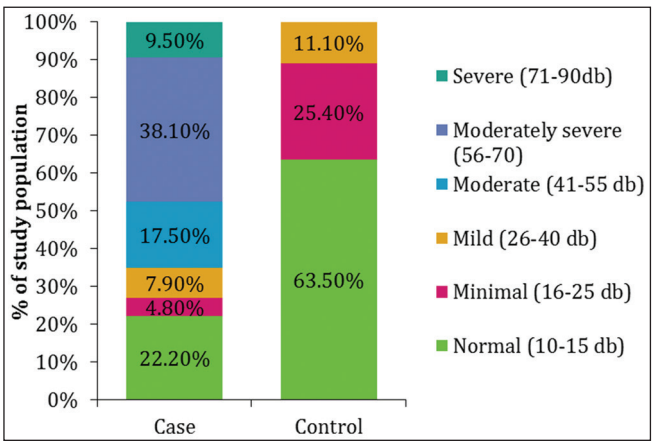


**Figure 3:** Degree of hearing loss in the study population (*n* = 63)

## CONCLUSION

From the observations and results of the present study, it can be concluded the diabetic subjects had significant hearing impairment than the normal healthy control group. The hearing impairment was predominant with higher frequencies due to which it commonly goes unnoticed and unrecorded. A clinical perspective to monitor hearing in diabetic patients is hence of paramount importance. Intercessions focused at supervising determinants that may bring about structural and functional variations in the cochlea are imperative in controlling the hearing loss in diabetic patients. Further research and evidence-based outcomes to identify hearing difficulties in the diabetes population and provide supportive biochemical marker for early diagnosis and therapeutic intervention may be necessary to revamp the standard of survival of patients.

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