

**Association between Diabetes Mellitus and Sensorineural Hearing Loss****Humera Abida<sup>1</sup>, Praneeth Kumar. K<sup>2</sup>, Feroz Basha Shaik<sup>3\*</sup>**<sup>1</sup>Assistant Professor, Department of Community Medicine, Mahavir Institute of Medical Sciences, Vikarabad,<sup>2</sup>Assistant Professor, Department of ENT, Govt. Medical College, Siddipet,<sup>3</sup>Assistant Professor, Department of ENT, Mahavir Institute of Medical Sciences, Vikarabad, Telangana, India.

Received: 16-08-2023 / Revised: 28-09-2023 / Accepted: 05-10-2023

Corresponding Author: Dr. Feroz Basha Shaik

Conflict of interest: Nil

**Abstract:****Introduction:** Diabetes (type 2) and sensorineural hearing loss are common health problems manifested with ageing. While both type 1 and type 2 diabetes have been associated with hearing loss, a causal link has been difficult to establish.**Aim and Objective:** To analyze the occurrence of sensorineural hearing loss among patients with DM and find a correlation between the degree of hearing loss and the duration and type of DM.**Materials and Method:** This was a hospital based cross sectional study conducted on 130 individuals with hearing-impairment, visited to the department of ENT in association with department of community medicine, Mahavir Institute of medical hospital and tertiary care centre, Vikarabad and for duration of 1 year, after approved by institutional ethical committee and consented by study participants after following inclusion and exclusion criteria.**Results:** In the study out of 130 individuals with type 2 diabetes, majority of patients were from age group of 51-70 years, predominantly male compared to female. Prevalence of Sensorineural hearing loss was observed 56.9% and almost 26.9% of the patients had duration of diabetes was more than equal to 10 years and association between type of hearing loss with age and duration of diabetes mellitus was statistically highly significant.**Conclusion:** Sensorineural hearing loss was more common in patients with diabetes (Type 2). The early detection of hearing loss in type 2 diabetes mellitus, using PTA, may help to avoid deafness and its further progression.**Keywords:** Diabetes Mellitus, Sensorineural hearing loss, Pure-Tone Audiometry, Hearing-Impairment etc.This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.**Introduction**

Worldwide, 422 million people are affected by diabetes mellitus (DM). Approximately 5% of the population suffers from DM in India. [1,2] The disease's long-term complications can be macrovascular or microvascular in nature. Hearing loss in DM may be bilateral sensorineural. [3] The microvascular complications of DM and diabetic neuropathy affect hearing in the diabetic population. [4,5]

Sensorineural hearing loss (SNHL) is a type of hearing loss, or deafness, in which the root cause lies in the inner ear (cochlea and associated structures), vestibulocochlear nerve (cranial nerve VIII), or central auditory processing centres of the brain. [3] Sudden sensorineural hearing loss (SSNHL) is defined as the sudden onset of unilateral sensorineural hearing loss of 30 dB over at least three contiguous audiometric frequencies [6]. Diabetes is a risk factor of SSNHL, possibly

due to microangiopathy [7,8]. Currently, the clinical studies of SSNHL rarely focus on diabetic patients. The correlations between biochemical data and hearing outcomes in SSNHL are seldom analyzed.

Studies on the possible relationship between DM and HL are often biased by noise exposure, ototoxic drug use, and confounding factors such as age, gender, duration of DM, glycemic control, smoking, and other metabolic and cardiovascular comorbidities [9]. DM is a chronic multisystem condition characterized by high levels of glucose in the blood and urine due to the inadequate production or use of insulin.

DM is a major cause of death and is associated with numerous comorbidities. Micro and macrovascular lesions can cause retinopathy, peripheral neuropathy, and nephropathy. Many patients also

have sensorineural HL (SNHL). Moreover, despite HL having been identified as a possible consequence of DM, hearing assessment is not included in the most recent protocol for the assessment of DM comorbidities [10].

*Pure-tone audiometry (PTA)* is described as the gold standard for assessment of a hearing loss. Hearing impairment is defined by the World Health Organisation (WHO) as a hearing loss in one or both ears. The results of PTA are a good indicator of hearing impairment. It can be used to differentiate between conductive hearing loss, sensorineural hearing loss, auditory and mixed hearing loss. Considering the above, we notice that the results from the audiological evaluation of patients with diabetes mellitus are conflicting, making it necessary to broaden the studies in this line of research. Thus present we have undertaken to analyze the occurrence of sensorineural hearing loss among patients with DM and find a correlation between the degree of hearing loss and the duration and type of DM.

#### Materials and Method

This was a hospital based cross sectional study conducted on 130 individuals with hearing-impairment, visited to the department of ENT in association with department of community medicine, Mahavir Institute of medical hospital and tertiary care centre, Vikarabad, for duration of 1 year, after approved by institutional ethical committee and consented by study participants, after following inclusion and exclusion criteria bellow.

#### Inclusion Criteria

- Age  $\geq 30$  Years.
- Any patient male or female with Type II Diabetes Mellitus with complaints of hearing loss and requiring assessment of hearing loss.
- Willing to participate in the study.
- All Known case of diabetes.

#### Exclusion Criteria

- Any person not willing to be included in the study.
- Patients with history of middle ear diseases or surgeries.
- Patients with conductive hearing loss.

- Patients with history of any chronic illness or any known neurological diseases other than diabetes mellitus.
- Patients on any ototoxic medications.
- Patients with occupational noise exposure.

#### Study Procedure

All the patients with Hearing Loss with Type II Diabetes Mellitus who have come to the ENT OPD and an informed consent will be obtained from those willing for the study. Data including age, sex, occupation, weight, history of smoking, alcoholism, diabetes, hypertension, and hypothyroidism history are noted Results regarding these investigations will be noted from the IP/OP chart of the patient.

Assessment of hearing loss in these patients is done using PTA. In this method, they are exposed to pure tones, the intensity of which can be increased or decreased in 5 dB steps. Air conduction thresholds are measured for tones of 125, 250, 500, 1000, 2000 and 4000 and 8000 Hz and bone conduction thresholds for 250, 500, 1000 and 2000 and 4000 Hz. The amount of intensity that has to be raised above the normal level is a measure of the degree of hearing impairment at that frequency. It is charted in the form of a graph called audiogram. The threshold of bone conduction is a measure of cochlear function. The difference in the thresholds of air and bone conduction (A-B gap) is a measure of the degree of conductive deafness. The audiometer is so calibrated that the hearing of a normal person, both for air and bone conduction, is at zero dB and there is no A-B gap.

#### Statistical Analysis :

Collected data were entered in the Microsoft Excel 2016, for further statistical analysis. Categorical data were expressed in terms of frequency and percentages, while quantitative data were expressed in terms of mean and standard deviation. Association between the variables were assessed by using chi-square test. P-value < 0.05 considered as statistically significant at 5% level of significance.

#### Observation and Results :

In the present study we have included 130 individuals, among that we have observed that, majority of patients were from 51-70 years followed by 21- 50 years and more than 70 years.

**Table 1: Demographic profile of study population**

Parameters	Frequency	Percentages
Age		
30 - 50 Years	48	36.9
50 - 70 Years	52	40
> 70 Years	30	23.1
Gender		
Male	74	56.9

Female	56	43.1
Duration of Diabetes		
< 10 Years	95	73.1
≥ 10 Years	35	26.9
Type of Hearing Loss		
Normal	43	33.1
SNHL	74	56.9
Mixed	13	10

Majority of individuals observed were male compared to female. Among all 26.9% of the patients had duration of diabetes was more than equal to 10 years and rest of patients had duration less than 10 years. Out of all the diabetic patients 56.9% of them observed with Sensorineural hearing loss and only 10% of the patients found with mixed SNHL and normal hearing loss shown in bellow table 1.

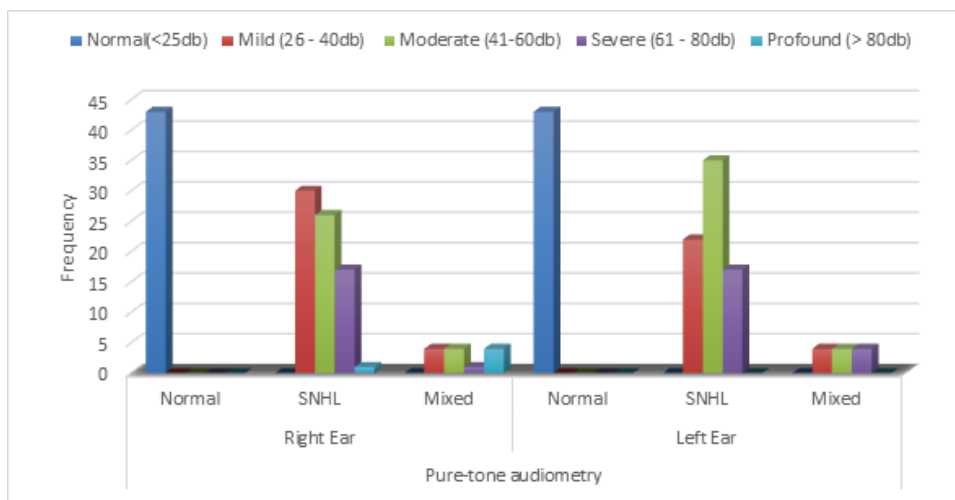
**Table 2: Association between type of hearing loss with age and duration of diabetes.**

Parameters	Type of Hearing Loss			Chi-square	P-value
	Normal	SNHL	Mixed		
<b>Age</b>					
30 - 50 Years	17(35.4%)	26(54.2%)	5(10.4%)	17.41	0.0016 (Significant)
50 - 70 Years	18(34.6%)	26(50.0%)	8(15.4%)		
> 70 Years	0(0%)	28(93.3%)	2(6.7%)		
<b>Gender</b>					
Male	20(27.0%)	46(62.2%)	8(10.8%)	0.7556	0.6853
Female	19(33.0%)	31(55.4%)	6(10.7%)		
<b>Duration of Diabetes</b>					
< 10 Years	43(45.3%)	39(41.1%)	13(13.7%)	24.25	<0.001 (Significant)
≥ 10 Years	1(2.9%)	31(88.6%)	3(8.6%)		

**Table 3: Levels of hearing loss between right and left ear using PTA**

Level of Hearing Loss	PTA	
	Right	Left
Normal(<25db)	43(33.08%)	43(33.08%)
Mild (26 - 40db)	35(26.92%)	26(20.0%)
Moderate (41-60db)	30(23.08%)	39(30.0%)
Severe (61 - 80db)	17(13.08%)	22(16.92%)
Profound (> 80db)	4(3.08%)	0(0%)
Total	130(100%)	130(100%)

It was observed that, association between type of hearing loss with age and duration of diabetes mellitus was statistically highly significant shown in above table 2. It was observed that patients having duration of diabetes mellitus more than or equal to 10 years observed with Sensorineural hearing loss compared to those were having duration less than 10 years.(Table 2)



**Figure 1 : Association of degree of hearing loss with Left PTA and Right PTA**

PTA tested degree of hearing loss against hearing loss type was statistically significant at 5% level of significance ( $P$ -value $<0.05$ ) with SNHL in left side as well as right side of ears, shown in above figure.

### Discussion

Association between diabetes mellitus and hearing loss has been debated since it was first reported by Jordao in 1857. [11] However, there is controversy regarding the etiopathogenesis of hearing loss, as some researchers support that it develops due to neuropathy, others say it is due to angiopathy, or even a combination of both. Yet, some researchers believe diabetes mellitus and hearing loss are part of a genetic syndrome. An extensive bibliographic review to determine whether there is cause-effect relationship between diabetes mellitus and hearing loss has been conducted by Maia and de Campos. [12] They concluded that there is still a great deal of controversy. The present case control study was designed to explore the association between hearing loss and diabetes mellitus to add to that endeavour.

In the present study we have included total 130 diabetic patients (Type 2) among which, prevalence of Sensorineural hearing loss was observed among 56.9% and 10% of the patients had mixed (Normal and SNHL) hearing loss. Study conducted by, Ren et al [13] and Kakarlaupadi et al [14] found that hearing loss in diabetics coincided with higher frequencies yielding to moderate degree of hearing loss. Celik o et al [15] compared age groups and gender similar to this study. Similarly, they also compared age groups with duration of diabetes and other diabetic related conditions, hence establishing relation of duration of diabetes with hearing loss. One more study conducted by Kumar and Purushotham et al [16] observed that, the prevalence of the diabetic SNHL population was 37.74% of a total of 7382 patients with hearing loss, which was less than our study. But also other study like Malucelli et al. [17] found the prevalence to be 76%, Rajendran et al. [18] as 73.3% and Krishnappa and Naseeruddin found the prevalence of SNHL among type-2 diabetic patients to be 73%. [19] were more compared to our study.

In the present study association of type of hearing loss mainly Sensorineural hearing loss, with age group and duration of diabetes mellitus found statistically significant ( $P$ -value $<0.05$ ). according to the study by Kumar and Purushotham et al, found that age of onset and duration of DM were associated with the occurrence of SNHL. Therefore, the role of DM progression and aging should be considered more carefully. [20, 21] in the same study the age of diabetic patients was associated with the severity of SNHL ( $P = .042$ ), suggesting that aging is a factor in SNHL patients with DM, and that the role of disease progression

should be investigated more precisely. All these factors allowed us to eliminate some possible confounding factors in the role of DM in SNHL development. Celik et al. [22] observed that as the duration of diabetes increased to 15 years, the incidence of hearing loss increased. After 15 years of diabetes, the influence on hearing loss was not significant.

In a study by Cullen and Cinnamon et al [23], male patients with diabetes had worse hearing than female patients with diabetes. They surmised that this may have been due to occupational noise exposure, which is similar observed in our study. Since many people worldwide are living in communities with a high rate of undiagnosed DM, and since hearing loss can be considered to be a consequence of diabetes, a metabolic assessment may be useful to the patients with hearing loss. [24] On the other hand, routine screening for hearing loss in diabetic patients may also be helpful to diminish comorbidities among these patients, with a consequent improvement in their quality of life.

### Conclusion

From overall observation and after discussion with other studies we can conclude that Sensorineural hearing loss is more common in diabetic individuals, mainly in type-2 diabetic patients, with an average age of forty to sixty years. It is more common in diabetes individuals who had longer duration of diabetes. The early detection of hearing loss in type 2 diabetes mellitus, using PTA, may help to avoid deafness and its further progression. In the study we can also conclude that, male patients with diabetes had worse hearing than female patients with diabetes.

**Acknowledgement:** None

**Funding:** None

### References

1. World Health Organization. Global Report on Diabetes. World Health Organization: Geneva; 2016.
2. Tiwari A, Mudhol RS. Prevalence of sensorineural hearing loss among type-II diabetes mellitus patients attending KLES Dr. Prabhakar Kore Hospital and MRC: a cross-sectional study. Indian J Health Sci Biomed Res. 2018;11(2):165-169.
3. Kumar V, Abbas KA, Aster JC. Robbins and Cotran Pathologic Basis of Disease. 9th ed. Elsevier Publications: Philadelphia; 2015
4. Horikawa C, Kodama S, Tanaka S, et al. Diabetes and risk of hearing impairment in adults: A meta-analysis. J Clin Endocrinol Metab. 2013;98(1):51-58.
5. Fukushima H, Cureoglu S, Schachern PA, et al. Effects of type 2 diabetes mellitus on coch-

- lear structure in humans. *Arch Otolaryngol Head Neck Surg.* 2006;132(9):934-938.
6. Weng SF, Chen YS, Hsu CJ, Tseng FY. Clinical features of sudden sensorineural hearing loss in diabetic patients. *The Laryngoscope.* 2005 Sep; 115(9):1676-80.
  7. Shikowitz MJ: Sudden sensorineural hearing loss. *Medical Clinics of North America* 75:1239-1250, 1991.
  8. Mozaffari M, Tajik A, Ariaei N, Ali-Ehyaii F, Behnam H. Diabetes mellitus and sensorineural hearing loss among non-elderly people. *East Mediterr Health J.* 2010 Sep;16(9):947-52.
  9. Samocha-Bonet, D.; Wu, B.; Ryugo, D.K. Diabetes mellitus and hearing loss: A review. *Ageing Res. Rev.* 2021; 71: 101423.
  10. American Diabetes Association. 3. Comprehensive Medical Evaluation and Assessment of Comorbidities. *Diabetes Care* 2017, 40(Suppl 1), S25–S32, Erratum in *Diabetes Care* 2017;40: 985.
  11. Nageris, B., Hadar, T., Feinmesser, M. and Elidan, J. Cochlear histopathologic analysis in diabetic rats. *The American Journal of Otolaryngology* 1998; 19:63-5.
  12. Maia, C. A. S. and de Campos, C. A. H. Diabetes Mellitus as etiological factor of hearing loss. *Rev Bras Otorrinolaryngol* 2005;71(2): 208–14.
  13. Ren J, Zhao P, Chen L, Xu A, Brown SN, Xiao X. Hearing loss in middle-aged subjects with type 2 diabetes mellitus. *Archives of medical research.* 2009 Jan 1;40(1):18-23.
  14. Venkata Kakarlapudi, Robert Sawyer, and Hinrich Staecker. The Effect of Diabetes on Sensorineural Hearing Loss. *Otology & Neurotology* 24:382–386 © 2003, Otology & Neurotology, Inc. / *Otology & Neurotology*: May 2003;24(3): 382-386.
  15. Çelik O, Çelebi H, Öztvrk A. Hearing loss in insulin-dependent diabetes mellitus. *Auris Nasus Larynx.* 1996 Jan 1; 23(1):127-32.
  16. Kumar VPR, Purushotham K. Role of diabetes mellitus on sensorineural hearing loss in patients attending a tertiary care health center: A clinical audit of four and a half years. *ENT Updates.* 2021;11(2):73-76.
  17. Malucelli DA, Malucelli FJ, Fonseca VR, et al. Hearing loss prevalence in patients with diabetes mellitus type 1. *Braz J Otorhinolaryngol.* 2012;78(3):105-115.
  18. Rajendran S, Anandhalakshmi S, Mythili B, Vishwanatha R. Evaluation of the incidence of sensorineural hearing loss in patients with type 2 diabetes mellitus. *Int J Biol Med Res.* 2011; 2:982-987.
  19. Krishnappa S, Naseeruddin K. A clinical study of age-related hearing loss among diabetes patients. *Indian J Otol.* 2014;20(4):160-165.
  20. Kakarlapudi V., Sawyer R., Staecker H. The effect of diabetes on sensorineural hearing loss. *Otol Neurotol.* 2003;24(3):382-386.
  21. Harrell RW. Pure tone evaluation. In: Katz J, ed. *Handbook of Clinical Audiology.* New York: Williams and Wilkins; 2002:82.
  22. Celik O, Yalcin S, Celebi H, et al. Hearing loss in insulin-dependent diabetes mellitus. *Auris Nasus Larynx* 1996; 23:127–32.
  23. Cullen JR, Cinnamon MJ. Hearing loss in diabetics. *J Laryngol Otol* 1993; 107:179–82.
  24. Cruickshanks KJ, Klein R, Klein BE, et al. Cigarette smoking and hearing loss: the epidemiology of hearing loss study. *JAMA.* 1998; 279(21):1715-1719.