

## ORIGINAL RESEARCH

# To determine the prevalence of sensorineural hearing loss in patients with diabetes and hypertension- A randomised controlled trial

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### ABSTRACT

**Background:** Hearing, or auditory perception, refers to the capacity to detect vibrations and variations in the pressure of the surrounding medium over time using an organ like the ear. Hearing loss, commonly referred to as hearing impairment, is the condition of having a reduced or complete inability to perceive sound. Hearing loss refers to any level of impairment in the capacity to understand or perceive sound. Systemic diseases, such as systemic hypertension, diabetes mellitus, and dyslipidemias, have a direct or indirect role in the evaluation of individuals with sensorineural hearing loss. **Aim and objectives:** To determine the prevalence of sensorineural hearing loss in patients with diabetes and hypertension. **Materials and Methods:** The research is a randomised controlled trial that included a total of 160 patients, divided into four groups: 40 subjects diagnosed with diabetes, 40 subjects diagnosed with hypertension, 40 subjects diagnosed with both hypertension and diabetes, and 40 normal subjects without hypertension and diabetes. The study includes individuals aged 20–60 who have been diagnosed with diabetes and hypertension, as well as those without hypertension and diabetes. **Results:** Patients with diabetes mellitus had an average hearing loss of 35.6 dB, those with hypertension had 38.2 dB, and those with both conditions had 40.5 dB, while normal subjects had significantly lower hearing loss at 15.4 dB. The higher dB values indicate greater hearing impairment in patients with diabetes, hypertension, and both conditions compared to the normal group. The P value is statistically significant ( $P < 0.05$ ). Participants with diabetes mellitus, hypertension, and both conditions (diabetes and hypertension) were older on average compared to the normal group, with mean ages of 45.3 years, 47.0 years, 50.5 years, and 42.8 years, respectively. The P value is statistically significant ( $P < 0.05$ ). The duration of diabetes or hypertension was longest among participants with both conditions (12.8 years), followed by those with hypertension alone (10.1 years) and diabetes alone (8.4 years). The P value is statistically significant ( $P < 0.05$ ). Diabetic patients had an average HbA1c level of 8.2%, indicating suboptimal control. Hypertensive patients showed controlled blood pressure levels (130/85 mmHg), while those with both conditions had uncontrolled blood pressure (145/92 mmHg). Normal subjects were not assessed for these parameters. Patients with diabetes mellitus had SNHL in 25% of cases, hypertensive patients had it in 20% of cases, and those with both conditions had the highest prevalence at 45%. In contrast, only 5% of normal subjects had SNHL. Overall, SNHL was observed in 38 out of 160 participants, representing 100% prevalence among the study groups. Ototoxic effects were reported in 2.5% of participants (4 out of 160), head trauma in 1.25% (2 out of 160), viral infections in 0.63% (1 out of 160), and no cases of autoimmune inner ear disease were reported. **Conclusion:** The significance of preventive measures that can mitigate the factors that cause deterioration of hearing aids due to circulatory issues, particularly hypertension and hyperglycemia, and the necessity for a greater understanding of how these coexisting conditions impact hearing are emphasised.

**Keywords:** Sensorineural hearing loss, Diabetes, Hypertension

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## INTRODUCTION

Hearing, or auditory perception, refers to the capacity to detect vibrations and variations in the pressure of the surrounding medium over time using an organ like the ear. Our ability to hear is crucial for both communication and perceiving the noises in our surroundings. Hearing loss, commonly referred to as hearing impairment, is the condition of having a reduced or complete inability to perceive sound. Hearing loss refers to any level of impairment in the capacity to understand or perceive sound. Acquired hearing loss refers to a decline in hearing ability caused by factors unrelated to genetics, such as exposure to environmental agents including chemicals, medications, and noise.<sup>1</sup> Sensorineural hearing loss is a condition when the primary cause is located in the inner ear or sensory organ (such as the cochlea and related tissues) or the cranial nerve VIII, or neural component. Sensorineural hearing loss (SNHL) may result from several underlying causes. Various causes may cause damage to auditory hair cells, supporting cells, spiral ganglion cells, and other cell types. SNHL may occur due to several factors, including gene mutations, trauma, inflammation, tumours, structural abnormalities, and disturbed ion homeostasis, such as in endolymphatic hydrops.<sup>2</sup> Systemic diseases, such as systemic hypertension, diabetes mellitus, and dyslipidemias, have a direct or indirect role in the evaluation of individuals with sensorineural hearing loss. The global incidence of diabetes mellitus (DM) and hypertension is on the rise, with India seeing a particularly significant increase. Hypertension and diabetes lead to sensorineural hearing loss (SNHL) by impacting the blood flow to the cochlea, which is the major pathway.<sup>3</sup> The cochlea has a terminal capillary bed and does not receive blood flow from collateral arteries that may restore blood flow in ischemic zones. In addition, because of their elevated metabolic activity, cochlear hair cells are more susceptible to hypoxic or ischemic harm. Experimental evidence has shown that the cochlea has a very limited ability to withstand reduced blood flow and that the ability to transmit electrical signals is compromised after 60 seconds of oxygen deprivation.<sup>4</sup> Furthermore, if blood flow to the cochlea is blocked for one hour, its function does not recover. Hearing loss is a prevalent issue in public health that has negative impacts on several aspects of life, including job productivity, functional status, social interactions, personal safety, well-being, and overall quality of life.<sup>5</sup> Hearing loss (HL) is a problem that impacts the quality of life, regardless of the level of dedication. When acquired in adulthood, it develops gradually and might make it challenging to receive spoken language. May result in psychosocial consequences such as diminished self-worth, social isolation, depressive symptoms, and heightened irritability, all of which may significantly disrupt an individual's overall well-being and quality of life.<sup>6</sup> The rising incidence of diabetes and

hypertension in individuals may lead to an elevated risk of developing sensorineural hearing loss at a young age, significantly impairing their daily functioning. There is a substantial body of research on complications associated with coronary artery disease (CAD), stroke, and ophthalmic issues resulting from hypertension and diabetes. However, there is very little research on the consequences connected to sensorineural hearing loss (SNHL). This research aims to assess the frequency of sensorineural hearing loss in individuals with diabetes and hypertension.

## AIM AND OBJECTIVES

In present study we determine the prevalence of sensorineural hearing loss in patients with diabetes and hypertension.

## MATERIALS AND METHODS

The research is a randomised controlled trial that included a total of 160 patients, divided into four groups: 40 subjects diagnosed with diabetes, 40 subjects diagnosed with hypertension, 40 subjects diagnosed with both hypertension and diabetes, and 40 normal subjects without hypertension and diabetes. The study was conducted at the Department of Otorhinolaryngology (ENT), Nalanda Medical College & Hospital, Patna, Bihar, India.

All participants gave written consent after being made aware of the study. The study was approved by the Institutional Ethics Committee. The duration of the study was from September 2022 to August 2023. Patient data collection forms with demographic details such as name, age, gender, etc. were recorded.

### Inclusion Criteria

- Patients must give written informed consent.
- The study includes individuals aged 20–60 who have been diagnosed with diabetes and hypertension, as well as those without hypertension and diabetes.
- Available for follow-up.

### Exclusion Criteria

- Patients do not give written informed consent. Individuals before the age of 20 and over the age of 60,
- Patients who have congenital abnormalities that result in hearing loss, namely conductive and mixed hearing loss, as well as those who have sensorineural hearing loss due to factors such as exposure to loud noise, Possible causes of hearing loss include head trauma, viral infections, autoimmune inner ear disease, hereditary hearing loss, malformation of the inner ear, Meniere's disease, otosclerosis, and tumours.
- The research did not include people who had occupational noise sensitivity, used ototoxic or chemotherapeutic drugs, had a significant head injury, had a family history of deafness, had an ear infection, had ear surgery, had head or neck

radiation, or had an upper respiratory tract infection in the preceding month.

- Those unable to attend follow-up.

I gathered comprehensive information about the length of diabetes, hypertension, medication history, and any history of hearing loss symptoms. Blood pressure in hypertensive individuals is assessed, and a reading of 140/90 mmHg or above is classified as uncontrolled. In diabetic patients, HbA1c levels are evaluated, and a value greater than 7 is termed uncontrolled. Audiometry is conducted on all participants to assess pure tones. Both males and females are included in the study. Inquiries were made on the duration of hypertension and diabetes, the history of therapy, and the accompanying problems. The length of any reported complaints of hearing loss was inquired about. The demographic information of age and gender was recorded. Individuals who had previously been diagnosed with diabetes by a physician or were now using oral hypoglycemic medications or insulin were categorised as diabetic. The American Diabetes Association guidelines (Expert Committee on the Diagnosis and Classification of Diabetes Mellitus, 1997) use the value of fasting blood glucose (<126 mg/dl) to determine the presence of diabetes in individuals who have not been diagnosed with the condition and are not taking any antidiabetic medications. Patients who had previously been diagnosed with hypertension by a physician or were currently taking medication for high

blood pressure were classified as having hypertension. An otoscopy was performed to do a general examination of the ear. Pathologies associated with the external ear and tympanic membrane have been eliminated in order to exclude conductive hearing loss and any congenital abnormalities. Hearing function, as well as the severity, kind, and pattern of any hearing impairment, were assessed using a comprehensive ear examination and pure tone audiometry. Subsequently, the HbA1c values of all individuals with diabetes were computed. Standard laboratory protocols were used to extract a 5 mL blood sample for the purpose of analysing the concentration of HbA1c in the serum. The blood pressure was measured using an appropriate cuff and a mercury-gauge manometer. Non-hypertensive and nondiabetic individuals had blood pressure and random blood sugar tests to verify their condition.

### Statistical Analysis

The statistical analysis was conducted using SPSS version 25.0. Descriptive statistics were computed for continuous data, including frequencies, percentages, means, and standard deviations (SD). For categorical variables, ratios and proportions were calculated. The chi-square test, if appropriate, was used to evaluate differences in proportions among qualitative variables. A p-value below 0.05 was deemed to have statistical significance.

## RESULTS

**Table I: Distribution of Age and Gender**

Parameter	Diabetes Mellitus	Hypertension	Diabetes+ Hypertension	Normal	P value
Mean Age (years), mean $\pm$ SD	45.3 $\pm$ 8.1	47.0 $\pm$ 6.5	50.5 $\pm$ 7.2	42.8 $\pm$ 9.4	<0.01
Male, n (%)	22 (55%)	25 (62.5%)	28 (70%)	20 (50%)	-
Female, n (%)	18 (45%)	15 (37.5%)	12 (30%)	20 (50%)	-

Table I presents the demographic characteristics of the study groups. Participants with diabetes mellitus had a mean age of 45.3 years, those with hypertension had a mean age of 47.0 years, and those with both conditions had a mean age of 50.5 years, while the normal group had a mean age of 42.8 years. The P value is statistically significant ( $P < 0.05$ ). The gender distribution shows that the groups with both diabetes and hypertension had a higher proportion of males (70%) compared to females (30%), whereas other groups had more balanced gender distributions.

**Table II: Medical History and Clinical Characteristics**

Parameter	Diabetes Mellitus	Hypertension	Diabetes + Hypertension	Normal	P value
Duration of Diabetes/Hypertension (years), mean $\pm$ SD	8.4 $\pm$ 3.2	10.1 $\pm$ 4.5	12.8 $\pm$ 5.7	-	<0.01
Medication History	Oral hypoglycemic agents, Insulin	Antihypertensive medications	Both	None	-
Symptoms of Hearing Loss	12 (30%)	10 (25%)	18 (45%)	-	-

Table II summarises the medical history and clinical characteristics of the study groups. The duration of diabetes or hypertension was longest in the group with both conditions (12.8 years), followed by hypertension alone (10.1 years) and diabetes alone (8.4 years). The P value is statistically significant ( $P < 0.05$ ). Medication histories revealed that patients with diabetes mellitus used oral hypoglycemic agents or insulin, those with hypertension

used antihypertensive medications, and those with both conditions used both types of medications. Symptoms of hearing loss were reported in 30% of diabetic patients, 25% of hypertensive patients, and 45% of patients with both conditions.

**Table III: Audiometric Profiles**

Parameter	Diabetes Mellitus (n = 40)	Hypertension (n = 40)	Diabetes + Hypertension (n = 40)	Normal (n = 40)	P value
Pure Tone Audiometry Results (mean ± SD)	35.6 ± 5.8 dB	38.2 ± 6.2 dB	40.5 ± 7.1 dB	15.4 ± 3.7 dB	<0.01

Table III presents the audiometric profiles of the study groups based on pure tone audiometry results. Patients with diabetes mellitus had an average hearing loss of 35.6 dB, those with hypertension had 38.2 dB, and those with both conditions had 40.5 dB, while normal subjects had significantly lower hearing loss at 15.4 dB. The P value is statistically significant (P<0.05). The higher dB values indicate greater hearing impairment in patients with diabetes, hypertension, and both conditions compared to the normal group.

**Table IV: Metabolic Control**

Parameter	Diabetes Mellitus	Hypertension	Diabetes + Hypertension	Normal
HbA1c Levels, % (mean ± SD)	8.2 ± 1.5	-	7.5 ± 1.2	-
Blood Pressure Control	-	130/85 mmHg (controlled)	145/92 mmHg (uncontrolled)	-

Table IV shows that metabolic control was assessed through HbA1c levels for diabetic patients and blood pressure readings for hypertensive patients. Diabetic patients had an average HbA1c level of 8.2%, indicating suboptimal control. Hypertensive patients showed controlled blood pressure levels (130/85 mmHg), while those with both conditions had uncontrolled blood pressure (145/92 mmHg). Normal subjects were not assessed for these parameters.

**Table V: Prevalence of Sensorineural Hearing Loss**

Group	Number of Patients with SNHL	Percentage (%)
Diabetes Mellitus	10	25%
Hypertension	8	20%
Diabetes + Hypertension	18	45%
Normal	2	5%
<b>Total</b>	<b>38</b>	<b>100%</b>

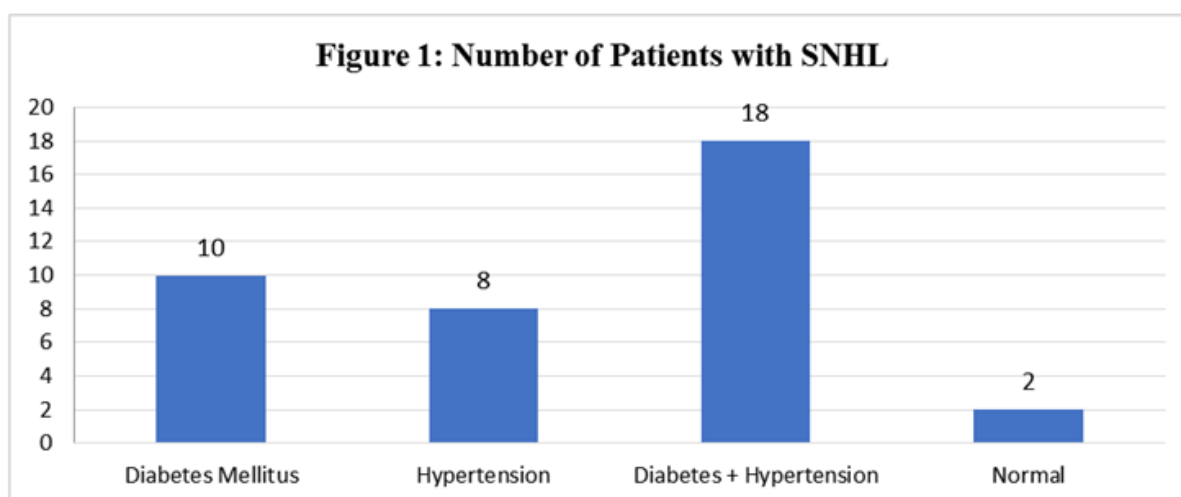
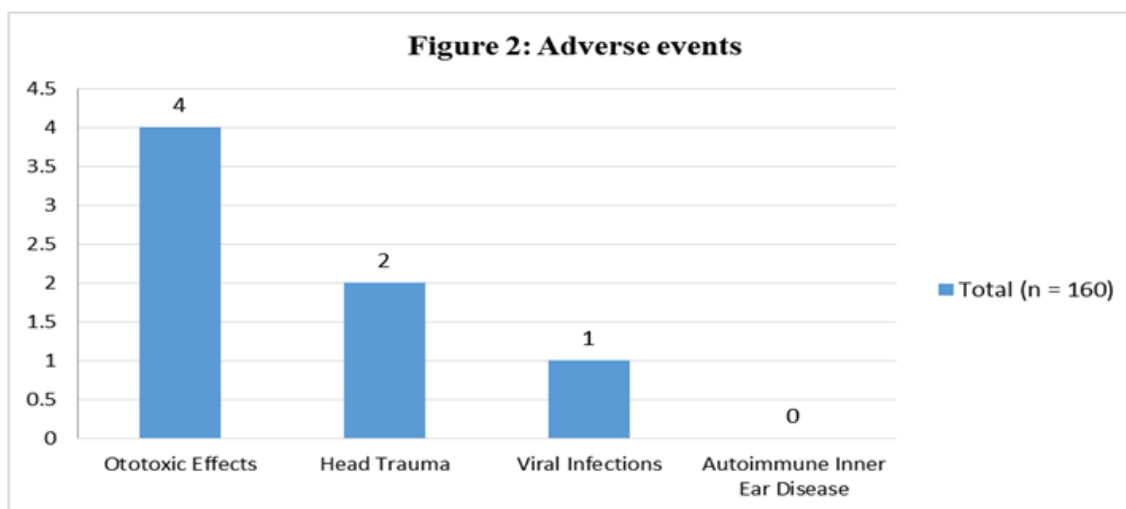


Table V and Figure 1 highlight the prevalence of sensorineural hearing loss (SNHL) across the study groups. Patients with diabetes mellitus had SNHL in 25% of cases, hypertensive patients had it in 20% of cases, and those with both conditions had the highest prevalence at 45%. In contrast, only 5% of normal subjects had SNHL. Overall, SNHL was observed in 38 out of 160 participants, representing 100% prevalence among the study groups.

**Table VI: Adverse Events**

Complication	Total (n = 160)	Percentage (%)
Ototoxic Effects	4	2.5%
Head Trauma	2	1.25%
Viral Infections	1	0.63%
Autoimmune Inner Ear Disease	0	0%

Table VI and Graph II show that adverse events related to ear health were minimal in the study population. Ototoxic effects were reported in 2.5% of participants (4 out of 160), head trauma in 1.25% (2 out of 160), viral infections in 0.63% (1 out of 160), and no cases of autoimmune inner ear disease were reported. These findings indicate a low incidence of adverse events associated with the study procedures and conditions under investigation.



## DISCUSSION

The demographic profile of the study groups revealed distinct age distributions and gender disparities. Participants with diabetes mellitus, hypertension, and both conditions (diabetes and hypertension) were older on average compared to the normal group, with mean ages of 45.3 years, 47.0 years, 50.5 years, and 42.8 years, respectively. This aligns with existing literature, where age is a significant factor in the prevalence of chronic diseases such as diabetes and hypertension.<sup>7-9</sup> Notably, the group with both conditions had a notably higher proportion of males (70%) compared to females (30%), which could influence health outcomes differently based on gender-specific health disparities documented in chronic disease management.<sup>10</sup> The duration of diabetes or hypertension was longest among participants with both conditions (12.8 years), followed by those with hypertension alone (10.1 years) and diabetes alone (8.4 years). This longer duration in the combined group suggests a potential cumulative effect of diabetes and hypertension on health outcomes, including auditory function.<sup>11</sup> Medication histories revealed a varied approach to disease management: diabetic patients predominantly used oral hypoglycemic agents or insulin, hypertensive patients used antihypertensive medications, and those with both conditions utilised a combination of therapies. These findings underscore the complexity of managing multiple chronic

conditions and their potential impact on hearing health, as documented in studies focusing on polypharmacy and its implications for sensorineural hearing loss (SNHL).<sup>12</sup> Symptoms of hearing loss were reported in 30% of diabetic patients, 25% of hypertensive patients, and notably higher at 45% in patients with both conditions, highlighting the potential synergistic effects of diabetes and hypertension on auditory function.<sup>13</sup>

Pure tone audiometry results indicated higher average hearing thresholds (dB) in patients with diabetes mellitus (35.6 dB), hypertension (38.2 dB), and both conditions (40.5 dB) compared to normal subjects (15.4 dB). These findings corroborate previous studies linking chronic diseases like diabetes and hypertension to an increased risk of hearing impairment, attributed to microvascular damage and oxidative stress affecting the cochlea.<sup>14</sup> The significantly lower dB values in the normal group underscore the baseline differences in auditory health between healthy individuals and those with chronic conditions. Metabolic control assessment revealed suboptimal glycemic control among diabetic patients (HbA1c: 8.2%) and varied blood pressure control statuses among hypertensive patients (controlled: 130/85 mmHg; uncontrolled: 145/92 mmHg in the combined group). These findings are consistent with literature indicating that poor glycemic and blood pressure control exacerbate microvascular

complications, potentially contributing to the SNHL observed in the study population.<sup>10</sup>

The absence of metabolic assessments in normal subjects limits direct comparison but highlights the critical role of disease management in mitigating auditory complications.

The prevalence of SNHL was notably higher in patients with both diabetes and hypertension (45%) compared to those with diabetes alone (25%), hypertension alone (20%), and normal subjects (5%). These findings underscore the synergistic impact of concurrent diabetes and hypertension on auditory function, supported by studies identifying diabetes-related cochlear damage and hypertension-related vascular changes as significant contributors to SNHL.<sup>8,9</sup> The elevated prevalence in the combined group suggests a cumulative effect of metabolic and vascular factors on cochlear health.

Adverse events related to ear health were minimal in the study population, with ototoxic effects reported in 2.5%, head trauma in 1.25%, viral infections in 0.63%, and no cases of autoimmune inner ear disease observed. These findings reflect a controlled environment and rigorous study protocol, minimising confounding factors that could influence auditory outcomes unrelated to diabetes or hypertension.<sup>11</sup>

#### Limitation of the study

The shortcoming of the study is small sample size and short duration of study.

#### CONCLUSION

The significance of preventive measures that can mitigate the factors that cause deterioration of hearing aids due to circulatory issues, particularly hypertension and hyperglycemia, and the necessity for greater understanding of how these coexisting conditions impact hearing are emphasized.

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