Pure Tone Audiometric Evaluation of Hearing Loss among Diabetic Patients in Azare: A Prospective Observational Study

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ABSTRACT

Background: The prevalence of diabetes mellitus (DM) and the burden of its complications have been increasing, particularly in low- and middle-income countries. These complications include blindness, chronic kidney disease, heart attacks, stroke, diabetic foot disease, and hearing loss. Of these complications, hearing loss is a hidden disability; it usually goes undetected for a long time until it is too late. Once the diagnosis is late, the hearing loss is irreversible. This emphasizes the importance of early screening and prevention of hearing loss among diabetic patients. The aim of this study was to evaluate the prevalence, severity, and type of hearing loss among diabetic patients attending the medical outpatient clinic of our institution.

Methods: This was a prospective observational study among adults diagnosed with DM. Ethical clearance and informed consent were obtained. Each participant had fasting blood sugar and pure tone audiometric tests performed. The severity of hearing loss was categorized according to WHO grading. The data was analyzed using Statistical Products and Service Solution (SPSS) version 26.

Results: There were 240 participants, with 131(54.6%) being males. The majority of the participants had type 2 DM 232(96.7%) with uncontrolled blood sugar levels of 176 (73.3%). The overall prevalence of hearing loss was 67.5%, of which 51.7% had asymptomatic hearing loss. The severity of hearing loss was 102(42.5%), 34(14.2%), 14(5.8%), and 4(1.7%) for mild, moderate, severe, and profound sensory neural hearing loss respectively. The most common type of hearing loss was sensorineural 154(64.2), other types were conductive hearing loss 6(2.5%), and mixed hearing loss 2(0.8%).

Conclusion: This study revealed high prevalence of hearing impairment among diabetic patients, of whom most had asymptomatic hearing impairment and were not aware of their hearing impairment. This emphasized the importance of routine pure tone audiometry for early detection of hearing loss among diabetic patients, a practice that could significantly improve the quality of life of the DM patient.

KEYWORDS: Diabetes mellitus, hearing loss, prevalence, early detection, pure tone audiometry

ARTICLE DETAILS

INTRODUCTION

Diabetes mellitus (DM) is a metabolic disorder characterized by chronic hyperglycemia due to insulin deficiency, resistance to insulin, or both.[1] Globally, the prevalence of DM has been increasing annually. In 2019, it was estimated that there were about 463 million adults living with DM globally.[2] The prevalence is expected to rise to about 700 million by the year 2045.[2] The cumulative healthcare expenditure of DM amounts to at least 727 billion US dollars annually.[3] The prevalence of DM and the burden of its complications have been increasing, particularly in low- and middle-income countries.[3] Furthermore, some studies have suggested that the prevalence and burden of DM in Sub-Saharan Africa and Nigeria are high and rising dramatically.[4]

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The overall pooled prevalence of DM in Nigeria is reported to be between 4.3% – 7.1%.[5] This accounts for more than 11 million Nigerians living with DM, of whom most have associated complications.[5] Early diagnosis of DM, and identification of signs of complications will play a considerable role in reducing the burden of DM, especially in sub-Saharan African countries like Nigeria.

Diabetes mellitus is a major cause of morbidities such as blindness, chronic kidney disease, heart attacks, stroke, diabetic foot disease, and hearing loss.[6,7,8] The relationship between DM and these complications has been well studied. However, there are still controversies regarding the relationship between DM and hearing loss.[9] Some studies have shown an association between DM and hearing loss.[10] But other authors have suggested that there is no relationship between hyperglycemia and hearing loss.[11] Few studies have investigated the relationship between hearing loss and DM in our environment.

Pure tone audiometry (PTA) is an important hearing test that evaluates the hearing thresholds among patients. The PTA test helps in determining the type, severity, and configuration of hearing loss. Therefore, the aim of this study was to determine the prevalence, severity, and type of hearing loss among diabetic patients using pure tone audiometry. We seek to contribute valuable insights that may inform clinical decision-making among diabetic patients, ultimately enhancing the quality of life of these patients.

METHODS

This was a prospective observational study of all adult diabetic patients attending the medical outpatient clinic of Federal Medical Centre, Azare, Nigeria. The hospital is a 500 bed capacity tertiary healthcare facility located at latitude 11.7°N and longitude 10.2°E. It serves a population of about 6.5 million people, mainly from Bauchi State. The hospital also receives patients referred from the neighboring states of Yobe, Gombe, and Jigawa States. Ethical approval to carry out the study was obtained from the Ethical Review Committee of the institution. Additionally, informed consent was obtained from each participant. The participants were informed about confidentiality. Their names were not used at any point in the study. We included adult patients, with a minimum age of 18 years or older, diagnosed with DM for at least 1 year, who presented during the study period. We excluded patients with ear surgery, ear tumors, head injuries, ear diseases, use of ototoxic/cytotoxic medications, sickle cell anemia or congenital ear anomalies. The participants were selected using simple random sample technique and the study period lasted for a year.

A profoma was used to collect information on sociodemographic variables, clinical history, and examinations (including blood pressure, weight, and height). Each participant had fasting blood sugar (FBS) tests performed. Those whose FBS value less than 126 mg/dl (7.0 mmol/L) were considered to have good DM control, while those with FBS value greater than 126 mg/dl (7.0 mmol/L) were considered to have poor DM control. The pure tone audiometry was carried out in our institution's audiology room, which is a sound isolated room that satisfied the International Standard Organization (ISO)-8253–1 criteria.[12] A digital diagnostic audiometer calibrated to the ISO standard was used to perform the pure tone audiometry. Both Air Conduction (AC) and Bone Conduction (BC) were measured. The hearing thresholds were measured using the modified Hughson-Westlake method.[13] The severity of hearing loss was categorized according to the WHO grading as follows: normal hearing ($\leq$ 25 dB), mild hearing loss (26-40 dB), moderate hearing loss (41-60 dB), severe hearing loss (61-80 dB), and profound hearing loss (>80 dB).[14] The type of hearing loss was determined from the tracings on the audiogram, and was classified as: Sensorineural Hearing Loss (SNHL) = both AC and BC thresholds were > 25 dB; Conductive Hearing Loss (CHL) = Air-Bone Gap (ABG) of 10 dB or more with the BC < 25 dB while AC > 25 dB. Mixed Hearing Loss (MHL) = both AC and BC thresholds were > 25 dB with an ABG of 10 dB or more.

The collected data were entered into a database and analyzed using SPSS software, version 26.0 for Windows (IBM Incorporated, Chicago, Illinois). A descriptive statistical analysis was employed to summarize the variables. The results were presented as frequencies and percentages for categorical variables, as well as range and mean for continuous variables. Tables, bars and pie chats were used to describe some of the variables.

RESULTS

There were 240 participants, with 131(54.6%) males and 109(45.4%) females, with a male-female ratio of 1:0.8. The ages of the participants range from 23–72 years, with a mean age of 45.5 ± 12.7 years. Most of the patients were Hausa tribe 125(52.1%), and majority obtained secondary school certificate as highest level of education 64(26.7%). Table 1 shows the sociodemographic variables of the participants. The majority of the participants had type 2 DM 232(96.7%), while the few remaining patients had type 1 DM (Figure 1). The duration of DM ranges from 1 - 11 years, with a mean of 3.5 ± 2.1 years. Fasting blood glucose ranged from 4.3 – 26.0 mmol/L, with a mean of 8.5 ± 2.4 mmol/L. Most of the patient had uncontrolled blood sugar levels of 176 (73.3%), indicating poor glycemic control. Figure 2 shows the level of glycemic control among the patients. Body Mass Index among the patients ranged from 17.2 – 43.1 Kg/m^2, with a mean of 25.3 ± 5.0 Kg/m^2. Most of the patients had normal blood pressure 181(75.4%), but the remaining had elevated blood pressure on examination during the study.

Some of the patients had history of hearing loss at presentation 38(15.8%). However, pure tone audiometry detected 162(67.5%) with hearing loss. Of which

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102(42.5%), 34(14.2%), 14(5.8%), and 4(1.7%) had mild, moderate, severe, and profound sensory neural hearing loss respectively. The most common type of hearing loss was sensorineural 154(64.2%), other types of hearing loss were conductive hearing loss 6(2.5%), and mixed hearing loss 2 (0.8%). Table 2 shows the types and severity of hearing loss among the participants. The overall prevalence of hearing impairment among diabetic patients detected using PTA was 67.5%, while the prevalence of symptomatic and asymptomatic h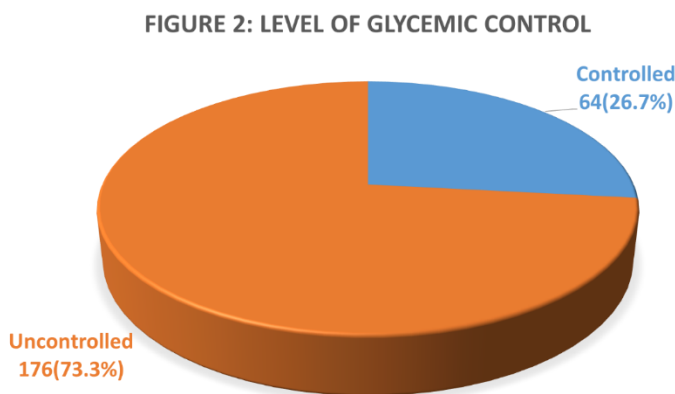earing loss was 15.8% and 51.7%, respectively. Figures 3 and 4 show the comparison of self-reported hearing loss and PTA detected hearing loss. There was increased detection of hearing loss when PTA was used for evaluation. The PTA detected a large number of cases of asymptomatic hearing loss among the diabetic patients. The pure tone average of the right ear ranged from 13.7 – 96.25 dB, with a mean of 32.5 ± 14.3 dB, while that of the left ear ranged from 12.5 – 90.0 dB, with a mean of 33.0 ± 14.4 dB.

Table 1: Distributions of socio-demographic variable of the participants

Variable	Frequency	Percentage (%)
Age group (Years)		
< 40	92	38.3
≥ 40	148	61.7
Gender		
Male	131	54.6
Female	109	45.4
Tribe		
Hausa	125	52.1
Kanuri	21	8.8
Fulani	69	28.7
Yoruba	11	4.6
Igbo	8	3.3
Others	6	2.5
Educational Status		
No formal education	31	12.9
Primary school	45	18.8
Secondary school	64	26.7
Tertiary Education	41	17.1
Quranic	59	24.6

Table 2: Types and Severity of Hearing loss among the diabetic patients

Types of hearing loss	Frequency	Percentage (%)
Sensorineural - Mild	102	42.5
- Moderate	34	14.2
- Severe	14	5.8
- Profound	4	1.7
Total patients with Sensorineural	**154**	**64.2**
Conductive hearing loss	6	2.5
Mixed hearing loss	2	0.8
Total no of patients with hearing loss	**162**	**67.5**
Normal Hearing	78	32.5
Overall total patients	**240**	**100**

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FIGURE 1: TYPES OF DM

Type I
8(3.3%)

Type II
232(96.7%)

FIGURE 2: LEVEL OF GLYCEMIC CONTROL

Controlled
64(26.7%)

Uncontrolled
176(73.3%)
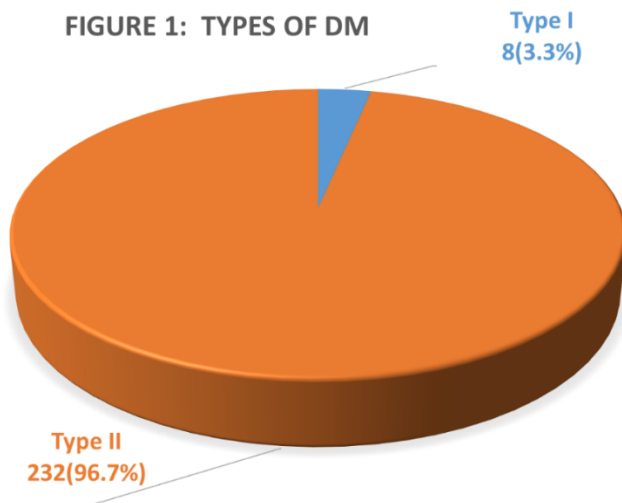
Fig. 3: Self-reported Hearing Loss

202(84.2%)

38(15.8%)

No   Yes

Fig. 4: PTA detected Hearing Loss

162(67.5%)

78(32.5%)

No   Yes
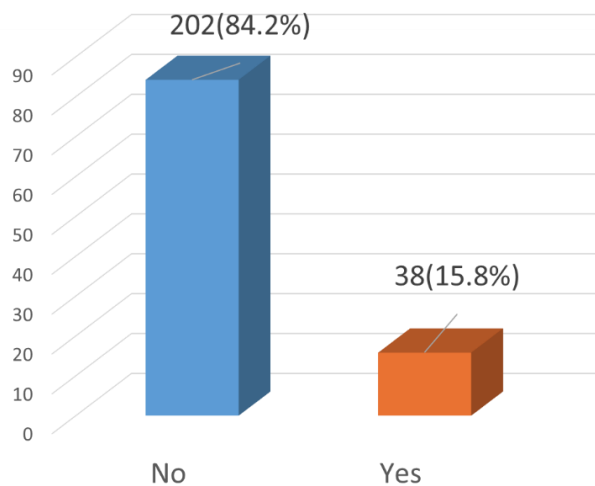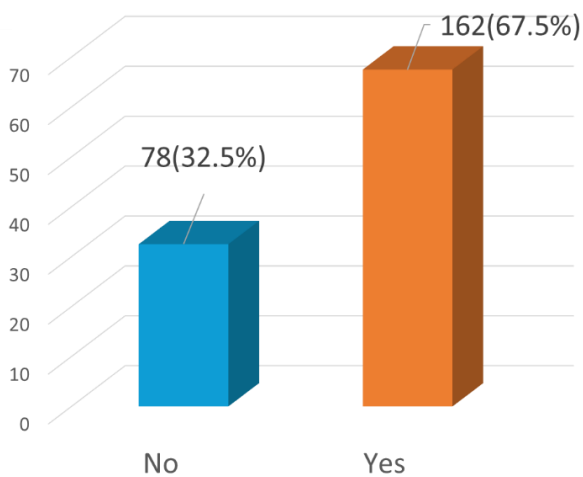
DISCUSSION

It is well known that DM is associated with many microvascular complications. Hearing loss is one of the many microvascular complications associated with DM. The human cochlea has an extensive microvasculature, and it is considered vulnerable to the effects of microangiopathy, which result in hearing impairment.[15,16,17] The effect of diabetes on the cochlea and the auditory nerve may occur through the accumulation of sorbitol, which can damage the

function of the nerve, leading to hearing loss. Other effects of DM on the cochlea include; angiopathic changes in the stria vascularis, atrophy of the spiral ganglion, and degeneration of the myelin sheath.[18]

Several studies also demonstrated a high prevalence of hearing impairment in diabetic patients, suggesting that DM may be an independent risk factor for hearing loss, justifying the need for prevention of hearing loss in these patients.[19,20] However, despite the need for evaluation and prevention of hearing loss among DM patients, few studies

have been conducted in our environment. The importance of prevention of hearing loss must be emphasized, because most cases of hearing loss are irreversible. Once the damage to the cochlear hair cells is severe, the hearing loss is substantial and irreversible. Therefore, all efforts should be made to target the primary etiology and risk factors of hearing loss in order to mitigate this problem. From an employment perspective, hearing loss can significantly reduce an individual's ability to work in a team, leading to social isolation and impacting upon teamwork and group productivity.[21]

Hearing loss is prevalent among the elderly population, it is reported to be almost twice as common in diabetic adults.[22] In this study, the overall prevalence of hearing loss among diabetic patients was 67.5%. This is in agreement with the findings of a study conducted in Nigeria, which reported prevalence of 71.4% among diabetic patients.23 Our finding was also corroborated by Ferreira et al. in Brazil,[24] Khakurel et al. in Nepal,[7] and Rajendran, et al. in India,[25] who reported prevalences of 63.2%, 72.5%, and 73.58% respectively. The similarity may be due to the similar inclusion and exclusion criteria used. However, a lower prevalence of 43.6% was reported by another study.[26] The lower prevalence in their study may be due to small sample size in their study.

In this study, the patients with hearing loss were further categorized based on severity as; mild, moderate, severe, and profound sensory neural hearing loss. Mild hearing loss was the most common (42.5%) form of severity seen among our patients. This is in concordance with the findings of a study that evaluated the hearing threshold among diabetic patients in South-Western Nigeria. The authors reported a prevalence of 44.3% for mild hearing loss among their patients.[23] However, a lower prevalence of mild hearing loss (22.5%) was reported among diabetic patients in India.[25] The prevalence of moderate hearing loss was found to be 14.2% in this study. This is similar to the findings of researchers in Nigeria,[27] and India.[25] who reported prevalences of 15.6% and 16.0% for moderate and moderately severe hearing loss among their patients, respectively. However, a slightly higher prevalence of moderate hearing loss of 19.2%, 21.4%, and 22.7% were reported among diabetic patients by Lasisi et al.28 Idugboe et al.[23] and Pemmaiah et al.[26] respectively. In this study, the prevalence of severe hearing loss was found to be 5.8 %. Our finding is supported by other authors who reported prevalences of 5.70%, 6.36% and 6.30% for severe hearing loss among diabetic patients respectively.[23,26,27] However, Lasisi et al.[28] reported a higher prevalence of severe hearing loss (20.4%) among their patients.

Considering the type of hearing loss, sensorineural hearing loss was the most common type (64.2%) of hearing loss among the participants in this study, while conductive hearing loss and mixed hearing loss were few, comprised of 2.5% and 0.8% respectively. Sensorineural hearing loss was

also the most common type of hearing loss reported among diabetic patients in Nigeria,[23,28] Nepal,[7] and India.[25]

The strength of this study lies in the performance of pure tone audiometry using a digital diagnostic audiometer calibrated to the ISO standard, which detected a large number of asymptomatic hearing loss among the diabetic patients. This underscores the importance of routine pure tone audiometry for all diabetic patients in order to detect hearing loss early, a practice that could significantly improve patient outcomes. However, one of the limitations encountered was the inability to perform glycosylated hemoglobin (HbA 1c) which gives more details about the glycemic control of the patients.

CONCLUSION

This study revealed high prevalence of hearing impairment among diabetic patients, of whom most had asymptomatic hearing impairment and were not aware of their hearing impairment. This underscores the importance of routine pure tone audiometry for early detection of hearing loss among diabetic patients, a practice that could significantly improve patient outcomes.

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