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Patterns and Factors Associated with Hearing Loss among Adult Patients with Type 2 Diabetes Mellitus

Ali Khalif Gure [a*], Doreen Nakku [b], Amina Seguya [c] and Jamal Abade Mohamed [d]

[a] Department of Ear, Nose and Throat Surgery, Garissa Level 5 Teaching and Referral Hospital, Garissa, Kenya.
[b] Department of Ear, Nose and Throat Surgery, Mbarara University of Science and Technology, Mbarara, Uganda.
[c] Department of Ear nose and throat surgery, Mulago National Referral Hospital, Kampala, Uganda.
[d] Department of General Surgery, Wajir County Referral Hospital, Kenya.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To establish the patterns of hl and associated factors among type 2 DM (T2DM) patients so that intervention is affected
Study Design: A cross-sectional study.
Place and duration of study: Mbarara regional referral hospital's diabetic and ENT clinic from august 2021 to April 2022.
Methodology: using consecutive sampling, we undertook a cross-sectional study at Mbarara regional referral hospital among 260 adult patients with type 2 diabetic mellitus (T2DM). A semi-structured questionnaire was utilized to gather data on demographics and medical factors.

**Corresponding author: E-mail: aligure75@gmail.com;*

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Otoscopy and pure tone audiometry were subsequently done. Data were analyzed using stata v15.0 and results were reported using frequencies and means for continuous data and regression analysis for categorical data. Hearing loss was reported as per who recommendation.

Results: The majority of the participants were female (69.6%) with a mean age of 54.7 years (sd: 12.5). 53.1% of participants had T2DM <5 years, 55.8% had concurrent hypertension and 74% were in poor glycemic control at study time. Almost all had normal otoscopic findings. The overall proportion of hearing loss (HL) was 29.2% (76 of 260). Bilateral SNHL was the most common type of HL at 86.1% (31 of 76) with a combined mild to moderate degree of loss in more than 87% of the cases.

Conclusion: The overall proportion of HL among T2DM patients at MRRH is low and majorly are of mild to moderate SNHL type.

Keywords: Diabetes mellitus; chronic metabolic disorder; insulin production; psychosocial well-being; insulin resistance.

1. INTRODUCTION

Diabetes mellitus (DM) is a systemic chronic metabolic disorder characterized by hyperglycemia due to either low insulin production, ineffective insulin action, or a combination of both. linnenkamp et al., [1]. Across the worldthe incidence of DM is going up, with a projected growth of 98% from 12.1 million in 2010 to 23·9 million in 2030 in sub-saharan africa [2]. DM is classified broadly into 4 groups;

- Type 1 DM
- Type 2 DM
- Gestational DM,
- Special forms of DM

However, type 2 DM (T2DM), is the commonest, and 80-90% of cases are usually as a result of combined effects of insulin resistance and failed replacement insulin production response [3]. Being a multisystem disease with a predilection to affect the cardiovascular system, T2DM is associated with varying chronic microvascular and macrovascular complications such as retinopathy, nephropathy, audiopathy and neuropathies among others [2]. Hearing loss in DM is characterized by an insidious onset and is often bilateral in nature as DM is a systemic illness. When HL manifests, the patient may suffer decreased quality of life in terms of ability to communicate, psychosocial stigmatization, stress, and loss of self-reliance. The effect of HL on the person's QOL, interpersonal communication, psychosocial well-being and the general economic impact is huge. More so both the direct medical expenditures and indirect costs associated with hearing loss are both a personal and economic burden to the patient without the addition of preventable disease-related complications [4]. Therefore, prevention and early identification of patients prone to HL are essential and like other tests audiological monitoring ought to be promoted as part of routine care [5]. Unfortunately, despite the high population of patients with T2DM in Uganda, this is not the case which leaves the patients at risk of late diagnosis and rehabilitation.

Among patients with T2DM the most common type of HL is SNHL at mild to moderate degree and the occurrence may be accentuated by factors such as glycemic control status, duration of DM, comorbidities such as noise exposure and hypertension (HTN) among others [6-9]. Of note is that not all patients with T2DM develop HL, and so it would be informative to identify likely risk factors for HL in this population so modifications in care can be made appropriately where possible or those affected are identified early enough. Many patients in Uganda withT2DM are diagnosed late, have poor compliance to medications due to pill burden or limited buying capacity, and are prone to complications onset [10-14]. There is scarcity of data on the true proportion of HL due to T2DM in Uganda and associated huge socio-economic impacts. The results of this research will fill this gap. We believe the findings of our study would shed light on the burden of HL among type 2 diabetic patients hence highlighting the need for routine audiological screening, In turn this would enable timely interventions and preservation of welfare [15-19]. We anticipated that results from exploring the factors associated with hearing loss among patients with T2DM, would increase health worker's level of suspicion of T2DM patients prone to HL giving them ample information to educate their patients and also make appropriate referrals for further care.

2. MATERIALS AND METHODS

2.1 Study Design and Site

A descriptive crosssectional study was performed at Mbarara regional referral hospital, a tertiary hospital in south western Uganda. This hospital doubles as a tertiary referral center and also as teaching hospital for Mbarara University of Science and Technology with a catchment of over 2.5 million people. The hospital runs a daily Diabetes care clinic which attends to over 5000 patients yearly.

2.2 Inclusion and Exclusion Criteria

We included all adult patients aged 18 years and above, who provided written consent to participate in the study and had been diagnosed with T2DM regardless of duration and treatment.

We excluded patients with medical emergencies that needed prompt treatment whether DM related or not. These patients were eligible for inclusion at a later time when stable.

We also excluded patients with previous history of any ear surgery, patients with congenital or acquired structural ear abnormalities and patients with active ear infections.

2.3 Sample Size Determination

The sample size was calculated using the formula for estimation of single proportion [20]. Based on a prevalence of hearing loss in T2DM patients in Nigeria of 21.6 %,[2] a sample size of 260 T2DM patients was calculated.

2.4 Study Procedures

A consecutive sampling method was utilized in the selecting study participants. Patient files and records are not stored in any particular order, so were consecutively file stock pile until the target sample size was attained. If a participant declined to participate in the study, the next file in the pile was selected.

2.5 Data Collection

A semi structured interviewer administered questionnaire was used to collect data on socio demographics and clinical characteristics of the participants such as duration since DM diagnosis, anti-diabetic drug history including regimen and duration of drug use, hypertensive status, and if on antihypertensive treatment, HIV status, and if on anti-retroviral treatment, renal function status and familial history of congenital hearing loss, the patient's fasting blood sugar (FBS) for the day.

Otoscopic examination was then performed by the principal investigator and status of the external auditory canal (EAC) and tympanic membrane was documented. Any wax or foreign bodies obstructing the EAC was removed prior to Pure tone audiometry (PTA).

A screening PTA was performed on all participants in a sound treated room by an audiology technician using a using a calibrated clinical audiometer (BELL PLUS diagnostic audiometer EN60645-1:2001) with supra-aural earphones. Air conduction thresholds at 250, 500, 1000, 2000, 4000, 6000 & 8000HZ were determined using Hughson-Westlake ascending method. Pure tone averages were calculated for thresholds at 500, 1000, 2000 and 4000Hz.

Participants with pure tone averages equal to or less than 25dB were considered to have normal hearing, the results were explained to the participants, a written copy provided and they were discharged from the study.

Patients with pure tone average above 25dB underwent a full diagnostic PTA to establish the type and degree of HL based on the WHO classification of hearing loss. Results were explained to the patient, a copy of the results provided and they were referred to the ENT clinic for further management and rehabilitation.

2.6 Data Management and Analysis

Data was analyzed using STATA version 15.0. Descriptive statistics was used to describe the sociodemographic and clinical characteristics of study participants and are presented as frequencies.

The proportion of T2DM patients with hearing loss was calculated as a fraction of all T2DM patients with hearing loss out of all those enrolled in the study and this was expressed as a percentage. The type and degree of hearing loss was determined based on the WHO classification of hearing loss. For each type and for each pattern, proportions were calculated as number

with the particular pattern of hearing loss over the total number of patients with hearing loss. These are reported as percentages in tables.

Bivariate logistic regression analysis was performed using the Pearson Chi-square test to determine factors associated with HL. Crude odds ratios (cOR) were determined. Factors with biological significance and factors with a p value of < 0.1 were considered to have a statistically significant relationship with HL and were entered into a multivariate logistic regression model to adjust for confounding.

Multivariate logistic regression analysis was used to generate adjusted odds ratios (aOR), 95% confidence intervals and p values and these are reported in tables. Factors with p value < 0.05 were considered statistically significantly associated with HL.

3. RESULTS

In this chapter, we present the results of the study as per the objectives we set out to achieve in form of figures and tables. We recruited a total of 260 adult participants for the study.

3.1 Participants' Characteristics

The participants had a mean age of 54.7 years (SD: 12.5), with the majority aged 50 years and above (70%), female (69.6%), married (68.1%), peasant (62.7%), and primary or no education (65.4%). About a third of participants reported having ever worked in an environment with loud noise (33.9%) and this is clinically significant given the synergistic effect of noise exposure in the setting of T2DM associated effects and its independent effects on hearing organ.

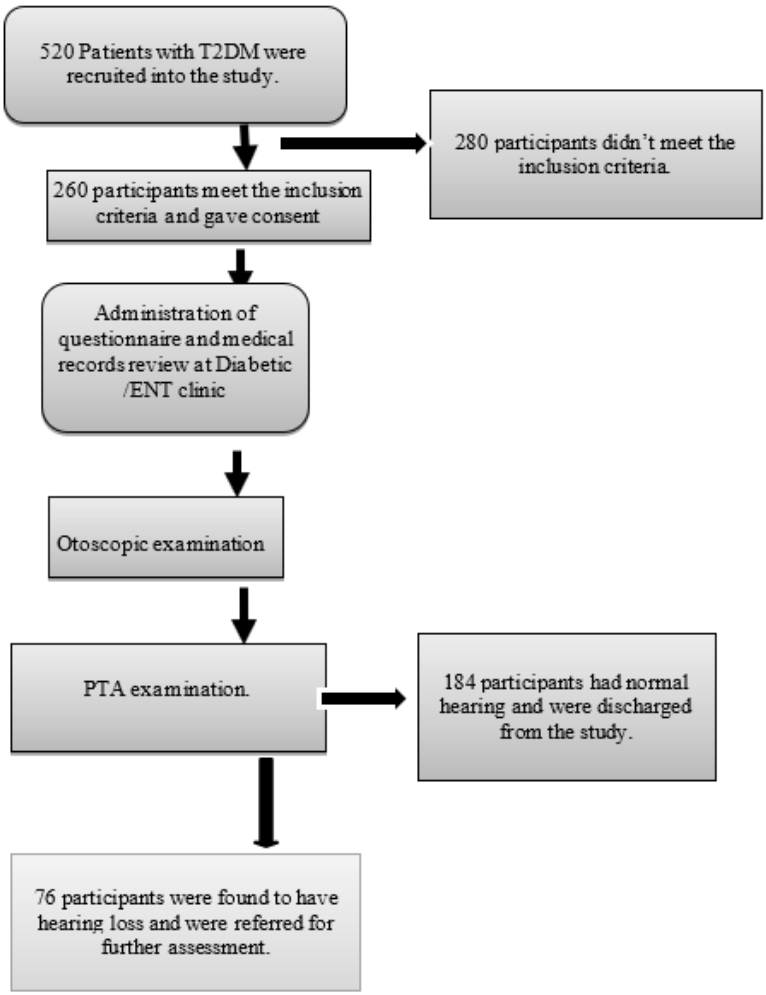

Fig. 1. Study participants' flow chart

Table 1. Sociodemographic and behavioral characteristics of the study participants

Characteristic	n (%)
Gender	
Male	79 (30.4)
Female	181 (69.6)
Mean age in years (SD)	54.7 (12.5)
Age categories in years	
18-29	10 (3.9)
30-39	20 (7.7)
40-49	48 (18.5)
50-59	85 (32.7)
60 and above	97 (37.3)
Marital status	
Unmarried	83 (31.9)
Married	177 (68.1)
Education level	
No formal education	44 (16.9)
Primary education	126 (48.5)
Secondary education	57 (21.9)
Tertiary education	33 (12.7)
Occupation	
Unemployed	11 (4.2)
Business	63 (24.2)
Formal employment	15 (5.8)
Manual/Casual labor	8 (3.1)
Peasant	163 (62.7)
Ever smoked	60 (23.1)
Taken alcohol before	114 (43.9)
Currently taking alcohol	24 (9.2)
Ever worked in an environment with loud noise	88 (33.9)

Majority of the study participants had been diagnosed with T2DM for less than 5 years (53.1% or 138 of 260) and 74.6% (194 of 260) had poor diabetic control.

It was also noted that 95.8 % (249 of 260) of the study participants were on one form treatment with those on oral hypoglycemic accounting for the majority at 61.2% as shown in Table 2 above. Concurrent hypertension and HIV were the commonest comorbidities among the study participants accounting for 68.9% (179 of 260).

Most of the study participants had normal otoscopic findings.

3.2 Proportion of Adult Patients with Type 2 Diabetes with Hearing Loss

The proportion of study participants with hearing loss was noted to be 29.2% (76 of 260). When stratified by age and gender, it was noted that a significant proportion of patients with T2DM developed HL with increasing age. (p=0.003, 95% CI 33.7-53.5).

3.3 Patterns of Hearing Loss among Patients with Type 2 Diabetes

The commonest type of hearing loss recorded was SNHL, which was bilateral in 86.1% and unilateral in 42.5% of participants.

Majority of the study participants with bilateral HL had combined mild to moderate degree of SNHL at 87.1% as shown in table 6 above. About 1 in 10 participants had severe SNHL. 80% of the study participants with MHL had a combined mild to moderate degree of hearing loss.

3.4 Factors Associated with Hearing Loss among T2DM Patients

Following univariate analysis, the only factors that were significantly associated with hearing loss having a p value of < 0.05 were age category and education with a P-value of 0.003 (95% CI 1.19-15.74) and 0.035 (95% CI 1.44-8.84) respectively. Diabetic duration was also noted to have a borderline P value of <0.1.

Factors such diabetic control, BMI, first degree family member with hearing loss and comorbidities such as hypertension and history of working in noisy environment that are known to have clinical significance were found not to be statistically significant.

Table 2. Clinical characteristics of the study participants

Characteristic	n (%)
Duration of diabetes	
Less than 5 years	138 (53.1)
5-10years	77 (29.6)
10-15years	29 (11.2)
More than 15years	16 (6.2)
Diabetic control	
Poor control	194 (74.6)
Good control	66 (25.4)
Diabetic treatment	
Not on treatment	11 (4.1)
Oral hypoglycemic only	159 (61.2)
Insulin only	28 (10.8)
Oral hypoglycemic plus insulin	62 (23.9)
Comorbidities	
Concurrent hypertension	145 (55.8)
Concurrent renal failure	2 (0.8)
HIV	34 (13.1)
Thyrotoxicosis	3 (1.2)
Head trauma	19 (7.3)
BMI	
Underweight	6 (2.3)
Normal weight	74 (28.5)
Overweight	108 (41.5)
Obese range	72 (27.7)
Auditory history	
Ear infection in the last 1 year	2 (0.8)
1st-degree family members with hearing loss.	3 (1.2)
Ototoxic drugs use in the last 6months	5 (1.9)

Table 3. Otoscopic findings of T2DM patients at MRRH

Otoscopic findings	Right ear, n (%)	Left ear, n (%)
Normal otoscopic findings	235 (90.4)	233 (89.6)
Impacted cerumen	22 (8.5)	25 (9.6)
Perforated Tympanic membrane	3 (1.2)	2 (0.8)

Table 4. Proportion of adult patients with T2DM with hearing loss at MRRH

HI prevalence type	N	n	% (95% CI)	P-value
Overall	260	76	29.2 (24.0-35.1)	
Age-specific				0.003
18-29	10	2	20.0 (3.7-62.2)	
30-39	20	3	15.0 (4.4-40.4)	
40-49	48	8	16.7 (8.3-30.5)	
50-59	85	21	24.7 (16.6-35.2)	
60 and above	97	42	43.3 (33.7-53.5)	
Gender-specific				0.359
Male	79	20	25.3 (16.8-36.3)	
Female	181	56	30.9 (24.6-38.1)	

Table 5. Frequency of the different types of hearing loss among T2DM patients at MRRH

Type of hearing loss	Unilateral n (%)	Bilateral n (%)
SNHL	17(42.5)	31(86.1)
Conductive hearing loss	10(25.0)	0(0.0)
Mixed hearing loss	13(32.5)	5(13.9)

Table 6. Degree of HL among T2DM participants with bilateral hearing loss

Degree of hearing loss	SNHL n (%)	Mixed HL n (%)
Mild	15(48.4)	1(20.0)
Moderate	12(38.7)	3(60.0)
Severe	3(9.7)	1(20.0)
Profound	1(3.2)	0(0.0)

Table 7. Results of univariate analysis for factors associated with hearing loss among T2DM patients at MRRH

Characteristic	No HL, n (%)	HL, n (%)	Unadjusted OR (95% CI)	P value
Gender				
Male	59 (74.7)	20 (25.3)	1.0	
Female	125 (69.1)	56 (30.9)	1.3 (0.73-2.40)	0.355
Age in years				0.003
18-29	8 (80.0)	2 (20.0)	1.4 (0.20-10.23)	
30-39	17 (85.0)	3 (15.0)	1.0	
40-49	40 (83.3)	8 (16.7)	1.1 (0.27-4.80)	
50-59	64 (75.3)	21 (24.7)	1.9 (0.50-6.98)	
60 and above	55 (56.7)	42 (43.3)	4.3 (1.19-15.74)	
Marital status				0.169
Unmarried	54 (65.1)	29 (34.9)	0.7 (0.38-1.18)	
Married	130 (73.5)	47 (26.6)	1.0	
Education Level				0.035
No formal education	25 (56.8)	19 (43.2)	3.6 (1.44-8.84)	
Primary education	87 (69.1)	39 (31.0)	2.1 (0.97-4.60)	
Secondary education	47 (82.5)	10 (17.5)	1.0	
Tertiary education	25 (75.7)	8 (24.2)	1.5 (0.53-4.30)	
Occupation				0.255
Unemployed	8 (72.7)	3 (27.3)	1.0	
Business	47 (74.6)	16 (25.4)	0.9 (0.21-3.84)	
Formal employment	13 (86.7)	2 (13.3)	0.4 (0.06-3.01)	
Manual/Casual labor	8 (100.0)	0 (0.0)	1.0	
Peasant	108 (66.3)	55 (33.7)	1.4 (0.35-5.32	
Ever smoked	143 (71.5)	57 (28.5)	1.0	0.638
	41 (68.3)	19 (31.7)	1.16 (0.62-2.17)	
Taken alcohol before	105 (71.9)	41 (28.1)	1.0	0.645
	79 (69.3)	35 (30.7)	1.1 (0.66-1.94)	
Currently taking alcohol	164 (69.5)	72 (30.5)	1.0	0.136
	20 (83.3)	4 (16.7)	0.5 (0.15-1.38)	
Ever worked in an environment with loud noise	119 (69.2)	53 (30.8)	1.0	0.430
	65 (73.9)	23 (26.1)	0.8 (0.45-1.41)	
Duration of diabetes				0.094
Less than 5 years	101 (73.2)	37 (26.8)	1.0	
5-10years	51 (66.2)	26 (33.8)	1.4 (0.76-2.55)	
10-15years	24 (82.8)	5 (17.2)	0.6 (0.20-1.60)	
More than 15years	8 (50.0)	8 (50.0)	2.7 (0.96-7.80)	

Characteristic	No HL, n (%)	HL, n (%)	Unadjusted OR (95% CI)	P value
Diabetic control				0.146
Poor control	142 (73.2)	52 (26.8)	1.0	
Good control	42 (63.6)	24 (36.4)	1.6 (0.86-2.83)	
Diabetic treatment				0.883
Not on treatment	8 (72.7)	3 (27.3)	1.0	
On treatment	176 (70.7)	73 (29.3)	1.1 (0.29-4.29)	
Oral hypoglycemic only	109 (68.6)	50 (31.5)	1.3 (0.76-2.31)	0.322
Insulin only	20 (71.4)	8 (28.6)	1.0 (0.41-2.30)	0.935
Oral hypoglycemic plus insulin	47 (75.8)	15 (24.2)	0.7 (0.37-1.38)	0.311
Comorbidities.				
Concurrent hypertension	98 (67.6)	47 (32.4)	1.4 (0.82-2.46)	0.203
HIV	26 (76.5)	8 (23.5)	0.7 (0.31-1.66)	0.425
Head trauma	13 (68.4)	6 (31.6)	1.1 (0.41-3.08)	0.816
BMI				0.894
Underweight	4 (66.7)	2 (33.3)	1.0	
Normal weight	52 (70.3)	22 (29.7)	0.8 (0.14-4.96)	
Overweight	79 (73.2)	29 (26.9)	0.7 (0.13-4.22)	
Obese range	49 (68.1)	23 (31.9)	0.9 (0.16-5.50)	
Ear infection in the last 1 year	183 (70.9)	75 (29.1)	1.0	0.537
	1 (50.0)	1 (50.0)	2.4 (0.15-39.5)	
1st-degree family members with	182 (70.8)	75 (29.2)	1.0	0.877
hearing loss	2 (66.7)	1 (33.3)	1.5 (0.11-13.58)	
Ototoxic drugs use in the last	181 71.0)	74 (29.0)	1.0	0.604
6months	3 (60.0)	2 (40.0)	1.5 (0.27-9.96)	
Impacted cerumen	165 (72.1)	64 (28.0)	1.0	0.227
	19 (61.3)	12 (38.7)	1.6 (0.75-3.55)	

Table 8. Results of multivariate analysis for key factors associated with hearing loss among T2DM patients at MRRH

Characteristic	Adjusted OR (95% CI)	P
Age in years		
18-29	1.6 (0.22-12.09)	0.627
30-39	1.0	
40-49	0.9 (0.20-3.80)	0.982
50-59	1.4 (0.37-5.54)	0.541
60 and above	3.0 (0.79-11.62)	0.068
Education level		
No formal education	2.7 (1.01-7.14)	**0.049**
Primary education	1.8 (0.77-4.06)	0.176
Secondary education	1.0	
Tertiary education	1.1 (0.36-3.29)	0.881
Diabetic control		
Poor control	1.0	
Good control	1.5 (0.78-2.81)	0.228
Comorbidities		
Concurrent HTN	1.0(0.54-1.93)	0.947
1st-degree family members with hearing loss	0.7 (0.05-8.05)	0.739
Ever worked in an environment with loud noise	1.1(0.6-2.2)	0.696

The factors considered when building the MV model included factors from the univariate analysis with p value <0.05 such as age category and education as well as factors considered to be of biological or clinical significance to HL such as diabetic duration, diabetic control, gender,

history of working in an environment with noise, hypertension and those with first degree family members with hearing loss.

The only statistically significant variable associated with hearing loss was education with the odds of having hearing loss being 2.7 (P value 0.04, 95% CI 1.01-7.14) times higher among participants with no formal education. The odds of having hearing loss were also 3.0 (P value 0.068, 95% CI 0.79-11.62) times higher among participants who were 60 years and above as compared to those in the age category 30-39 years.

4. DISCUSSION

There is a worldwide increase in the number of patients diagnosed with noncommunicable diseases (NCDs) of which T2DM is one. As a chronic condition it has the capability of affecting several different bodily systems and functions of which hearing is one. Although there is a high probability that diabetes is associated with hearing loss, it is easy for patients with diabetes to miss the damage of high blood sugar on hearing function, especially as hearing loss among patients with diabetes is more predominant at high frequencies. Daily activities of patients with diabetes are not normally influenced as everyday speech ranges from about 500 to 2000 hz and the clinical symptoms of hearing loss remain undetected.

4.1 Proportion and Patterns of Hl among Adult Patients with Type 2 Diabetes

The proportion of study participants with hearing loss was noted to be 29.2%. This is significant in Uganda as it translates that 1 in every 3 patients with T2DM has some form hearing loss although more than 80% had mild to moderate degree of hearing loss. There are several clinicopathological explanation on the effects of hyperglycemia on the hearing organ including both micro and macro angiopathic changes within the inner ear as well as neuropathic changes. [21,2,22]. Although it was not statistically significant we noted that almost 1 in every 3 participant with HL had poor glycemic control and this could be the basis for this high proportion in Uganda. Our proportion is slightly higher than a prevalence of 21.6% reported by adebola et al., [23] in a study at a comparable center in Nigeria and yet lower than the global range of 44-69% reported by akinpelu et al., in [23] following a systematic review. The low prevalence we reported as compared to the systematic review could be because unlike the studies considered for the systematic review, we relied only on PTA testing and never employed more advanced electrophysiological tests such as ABR testing which was not readily available to us. When utilized these tests can detect more subtle levels of hearing loss that we may have missed and thus registering a lower prevalence locally.

We also can't negate the contribution of differences in the sample sizes of the studies and study settings especially of the studies included in the systematic review [2,23].

Bilateral SNHL in the mild to moderate degree was the commonest type of HL among our study participants and this could be due to the fact that T2DM being a systemic disease is expected to cause bilateral HL and in our study more than 80% of the study participants presented thus. T2DM is associated with hyperglycemia induced microangiopathy that leads changes within the cochlea such as thickening of basement membrane in the stria vasularis and death of cochlea hair cells due to reduced nutrients supply as a results of thickened capillary walls and decreased blood flow. Similarly high proportion have been reported from several others [24,23,2].

We also noted that increasing age is associated with increase in the risk of developing hearing loss with participants aged 60 years and above having 3 times higher risk of developing hearing loss as compared to those age 30-39 years. This could be due to the fact that aging accentuates the occurrence of HL in T2DM patients and the better health seeking attitude of older patients.

Similar to studies elsewhere, the commonest type of hearing loss we found was predominantly bilateral SNHL and a few cases of mixed hearing loss. This is explained by the pathophysiological effect of T2DM on the inner ear where it is believed to cause/affect the cochlea blood and nutrients supply due to microangiopathic changes with capillaries leading to cochlea hair cells deaths. Rajendran et al. [25], Naser et al. [26], Mozaffari et al., [5], okwiri, [24], hlayisi et al., [27]. However, discrepancy was found in some studies that reported conductive hearing loss secondary to otitis media with effusion (OME) as the commonest type of hearing loss among T2DM participants. They theorized this was caused by decreased nasal mucociliary action

within the middle ear structures experienced by diabetic patients [2,28].

It is interesting to note that the vast majority of patients with bilateral SNHL had a mild to moderate degree of hearing loss (Table 6) and only about 1 out of every10 patients with bilateral SNHL had severe degree of hearing loss. This is important because most cases of mild to moderate hearing loss may not produce sufficient clinical symptoms to necessitate aggressive interventions. however, these mild to moderate degrees of hearing loss may worsened when superimposed upon by other conditions that affect the hearing organ such as HTN, noise and ototoxic drug exposure and hence making early detection through routine screening of patients with T2DM a crucial part of care to reduce the negative impacts associated with hearing loss.

4.2 Factors Associated with Hearing Loss among Patients with T2dm

Age above 60 years and having no formal education were the only factors found to be significantly correlated with hearing loss among T2DM patients with participants aged 60 years shown to have 3 times higher risk of developing hearing loss as compared to those in age bracket 30-39years, (P=0.068, 95% CI 0.79-11.62). Naturally, hearing is known to deteriorate with advancing age in some people, a phenomenon called presbycusis with several theories such sensory epithelial loss within the organ of corti, atrophy of central neural pathways, atrophy of stria vascularis among others given to explain how it comes about. There is a high likelihood that advancing age may accentuate the vascular and neuropathic changes caused by DM on the auditory system and thus act as a synergistic factor to HL [28,23].

In this study participants with no formal education were found to have a higher chance of developing hearing loss as compared to those with secondary education (OR=2.7 95% CI, 1.01-7.14). This could be because most of our patients are from rural settings where there is scarcity of opportunities such as specialist healthcare workers, well equipped hospitals and individual resources capability to cater for expensive out of pocket expenditure associated with chronic medical conditions such as T2DM.

The lack of formal education may have an influence on when a patient seeks formal care for diagnosis and management of T2DM and compliance to care instructions. It is not uncommon to find strong reliance on herbal concoctions for chronic conditions such as T2DM and the effect of these on other body organs is not known.

However, of note, though about 27% of the study participants with hearing loss had poor glycemic control, it did not significantly correlate with the incidence of hearing loss (Table 7). There have been some studies though that reported significant correlation between poor glycemic control and hearing loss Ashkezari et al. [21,2,22].

Other factors such as diabetic duration, treatment modality, hypertension and history of working in a noisy environment, although clinically significant to occurrence of HL showed no correlation in our study [24,2,29,30].

5. CONCLUSSION

i) Proportion and patterns of hearing loss

The overall proportion of hearing loss among T2DM patients at MRRH was noted to be 29.2% which is relatively high in our setting. However this is low when compared to the global range and mild to moderate SNHL is the commonest type of hearing loss in this population.

ii) Associated factors

The factors that increase the odds of having HL in T2DM in our setting include lack of formal education and advancing age while factors such diabetic treatment modality like insulin and history of first-degree family member with hearing loss are likely protective. The multivariate model shows that only a lack of formal education will independently raise the odds of HL among T2DM patients in our setting.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

CONSENT

All adult patients aged 18 years and above, who provided written consent to participate in the study and had been diagnosed with T2DM regardless of duration and treatment.

ETHICAL APPROVAL

As per international standards or university standards written ethical approval has been collected and preserved by the author(s).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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