PATTERNSANDFACTORSASSOCIATEDWITHHEARINGLOSSAMONGADULT PATIENTS WITH TYPE 2 DIABETES MELLITUS AT MBARARA REGIONAL REFERRALHOSPITAL

ABSTRACT

aims:toestablishthepatternsofhlandassociatedfactorsamongtype 2 DMpatientssothatinterventionis affected
studydesign: across-sectional study
place and duration of study:mbarara regional referral hospital among 260 adult patients with t2dm 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 t2dm. A semi-structured questionnaire was utilized to gather data on demographics and medical factors. Otoscopy and puretoneaudiometryweresubsequentlydone.Datawereanalyzedusingstatav15.0andresults reportedusingfrequenciesandmeansforcontinuousdataandregressionanalysisforcategoric al data. Hearing loss was reported as per who recommendation
Results: 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 concurrenthypertensionand74%wereinpoorglycemiccontrol atstudytime.almost all had normal otoscopic findings. The overall proportion of hl was 29.2% (76 of 260). bilateral snhlwasthemostcommontypeofhlat86.1%(31of76)withcombinedmildto moderate degree of loss in more than 87% of the cases.

Conclusion:theoverallproportionofhlamongt2dmpatientsatmrrh is low and majorly of mild to moderate snhl type

introduction

BACKGROUND

diabetes mellitus (dm) is a systemic chronic metabolic disorder characterized by hyperglycemia due to either low insulin production, ineffective insulin action, or a combinationofboth.*(linnenkampetal.,2014).*acrosstheworld,,theincidenceof dmisgoingup*(linnenkampetal.,2014),*withaprojectedgrowthof98%from12·1 millionin2010to23·9millionin2030insub-saharanafrica*(adebolaetal.,2016).* D/m is classified broadly into 4 groups;

- type1dm,
- type2dm,
- gestationaldm,
- specialformsofdm

Howevertype2dm(t2dm),thecommonestin80-90% of casesisusuallyasa resultofcombinedeffectsofinsulinresistanceandfailedreplacementinsulin productionresponse.(*association,2019)*beingamultisystemdiseasewithapredilectio n to affect the cardiovascular system, t2dm is associated with varying chronicmicrovascularandmacrovascularcomplicationssuchasretinopathy, nephropathy, audiopathy and neuropathies among others *(adebola et al., 2016).* Hearing loss in dm is characterized by an insidious onset and is often bilateral in natureasdmisasystemicillness.Whenhlmanifests,thepatientmaysuffer decreasedqualityoflifeintermsofabilitytocommunicate,psychosocial stigmatization,stressandlossofself-reliance.Theeffectofhlontheperson'sqol, interpersonal communication, psychosocial well-being and the general economic impact is huge. More so both the direct medical expenditures and indirect costs associatedwithhearinglossarebothapersonalandeconomicburdentothe patient without the addition of preventable disease-related complications *(huddleetal.,2017*).Therefore,preventionandearlyidentificationofpatientsproneto hearing loss is essential and like other tests audiological monitoring ought to be promotedaspartofroutinecare(*mozaffarietal.,2010)*.Unfortunately,despitethe highpopulationofpatientswitht2dminoursetting,thisisnotthecasewhich leaves the patients at risk of late diagnosis and rehabilitation.

themostcommontypeofhlreportedinthispopulationissnhlatmildtomoderatedegreeand the occurrence may be accentuated by factors such as glycemic control status, duration of dm,comorbiditiessuchasnoiseexposureandhtnamongothers.0fnoteisthatnotallpatients with t2dm develop hi, 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 affectedareidentifiedearlyenough.manypatientsinoursettingwitht2dmarediagnosedlate, have poor compliance to medications due to pill burden or limited buying capacity, and are pronetocomplicationsonset.thereisscarcityofdataonthetrueproportionofhlduetot2dm in our setting 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 especiallyamongstindividualswitht2dmthatarepronetohl.inturnthiswouldenable timely interventions and preservation of welfare. We anticipated that results from exploring the factorsassociatedwithhearinglossamongpatientswitht2dm,wouldincreasehealthworker's levelofsuspicionoft2dmpatientspronetohl,givingthemampleinformationtoeducatetheir patients and also make appropriate referrals for further care.This being a cross sectional study, we hopedourfindings would serve as a benchmarkforfuture longitudinalstudies that mightexplorethefactorsthatincreasetheriskorprotectfromthedevelopmentofaudiological complications in t2dm patients.

MATERIALANDMETHODS

weconductedaquantitativecross-sectionalstudydesignfromaugust2021toapril2022.

STUDYSITE

thestudywasundertakenatthediabeticclinicatmbarararegionalreferralhospital (mrrh) and ent clinic at mrrh. Mrrh doubles as the teaching hospital for Mbarara university of science and technology (must) medical school and as a regional referral hospital. it is located in Mbarara municipality, 260 km southwest of Kampala, the capital city of Uganda. it is a public hospital funded by the government of Uganda through theministry of health.Mrrh isthe referral hospital forsouthwesternUgandaserving10catchmentdistrictswithapopulationofmore than2.5million people. ThedistrictsincludeBuhweju, Bushenyi, Ibanda,Isingiro, Kazo,Kiruhura,Mitooma,Ntungamo,Rubirizi,Rwampora,Sheema,Mbarara,and neighboring districts of Masaka, Iyantonde, Rakai and other regional referral hospitals,fortportal,andKabale.Italsoreceivespatientsfromneighboring

countries (Rwanda, Congo, Tanzania and Burundi). Mrrh has general and specialized outpatient clinics, general wards including obstetrics and gynecology, surgical, pediatric, and medical wards, and specialized units such as anesthesia, dental, ear, nose, and throat (Ent), psychiatry, ophthalmology, orthopedics, neurology, urology, and dermatology. it has a bed capacity of 350 with staff of approximately 300 persons.

The diabetic clinic and Ent clinic are housed within the outpatient department complex in room 9 and 8 respectively. the diabetic clinic under the department of internalmedicineatMrrhisonceweeklyclinic(everyThursday)thatattendtomore than 5,000 diabetic patients yearly. These include patients on regular follow-up and new patients. the clinic is run by consultants and residents within the department as well as nurses and records persons. The Ent clinic is also a twice weeklyclinicthatrunsonTuesdayandThursdaybyconsultantsandresidentsand supportstaffssuchasnurses,audiologicalofficerandrecordsteam.TheEntclinic attends to about 100-130 patients on weekly basis which include patients on regularfollows,referralsandnewpatients.adjacenttotheEntclinicisthespecially designed audiology room where the hearing tests are performed.

POPULATION

TARGETPOPULATION

Thetargetpopulationincludedalldiabeticpatientsattendingthediabeticclinic at mrrh.

STUDYPOPULATION

the study population included all adult patients with t2dm attending the diabetic clinic at mrrh during the study period.

RESULTSANDDISCUSSION

PARTICIPANTS'CHARACTERISTICS

table1:sociodemographicandbehavioralcharacteristicsofthestudy participants

characteristic	n (%)
gender	
male	79(30.4)
female	181(69.6)
meanageinyears(sd)	54.7(12.5)

agecategoriesinyears	
18-29	10(3.9)
30-39	20(7.7)
40-49	48(18.5)
50-59	85(32.7)
60and above	97(37.3)
maritalstatus	
unmarried	83(31.9)
married	177(68.1)
educationlevel	
no formal education	44(16.9)
primary education	126(48.5)
secondaryeducation	57(21.9)
tertiary education	33(12.7)
occupation.	
unemployed	11(4.2)
business	63(24.2)
formal employment	15(5.8)
manual/casuallabor	8 (3.1)
peasant	163(62.7)
ever smoked	60(23.1)
takenalcoholbefore	114(43.9)
currentlytaking alcohol	24(9.2)
everworkedinanenvironmentwithloud noise	88(33.9)

theparticipantshadameanageof54.7years(sd:12.5),withthemajorityaged 50yearsandabove(70%),female(69.6%),married(68.1%),peasant(62.7%), and primary or no education (65.4%) as shown in *table 1*. About a third of participantsreportedhavingeverworkedinanenvironmentwithloudnoise

(33.9%) and this is clinically significant given the synergistic effect of noise exposure in thesettingoft2dm associated effectsanditsindependent effects on hearing organ.

CLINICALCHARACTERISTICSOFTHESTUDYPARTICIPANTS.

table2:atableshowingthe*clinicalcharacteristicsofthestudyparticipants.*

characteristic	n (%)
durationof diabetes	
lessthan5years	138(53.1)
5-10years	77(29.6)
10-15years	29(11.2)
morethan 15years	16(6.2)
diabeticcontrol	
poor control	194(74.6)
goodcontrol	66(25.4)
diabetictreatment	
noton treatment	11(4.1)
oralhypoglycemiconly	159(61.2)
insulin only	28(10.8)
oralhypoglycemicplusinsulin	62(23.9)
comorbidities	
concurrenthypertension	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)
normalweight	74(28.5)
overweight	108(41.5)
obese range	72(27.7)

auditoryhistory earinfectioninthelast1year 1st-degreefamilymemberswith hearing loss. ototoxicdrugsuseinthelast 6months	 2 (0.8) 3 (1.2) 5 (1.9)

clinicalcharacteristicsofthestudyparticipants.

Themajorityofthestudyparticipantshadbeendiagnosedwitht2dmforlessthan 5 years (53.1% or 138 of 260) and 74.6% (194 of 260) had poor diabetic control as shown in table 2.

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 commonestcomorbiditiesamongthestudyparticipantsaccountingfor68.9%(179 of 260).

EAREXAMINATIONFINDINGSAMONGTHESTUDYPARTICIPANTS.

table3:atableillustratingtheotoscopicfindingsoft2dmpatientsatmrrh

otoscopicfindings	rightear,n(%)	left ear,n (%)
normal otoscopic findings	235(90.4)	233(89.6)
impactedcerumen	22(8.5)	25(9.6)
perforated tympanic membrane	3 (1.2)	2 (0.8)

mostofthestudyparticipantshadnormalotoscopicfindingswithabout1in10 having impacted cerumen as shown in table 3 above

PROPORTIONOFADULTPATIENTSWITHTYPE2DIABETESWITHHEARINGLOSS

table4:*proportionofadultpatientswitht2dmwithhearinglossatmrrh*

hiprevalencetype	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)	

The proportion of study participants with hearing loss was noted to be 29.2% (76of260)asshownintable4.whenstratifiedbyageandgender,itwasnoted thatasignificantproportionofpatientswitht2dmdevelopedhlwithincreasing age. (p=0.003, 95% ci 33.7-53.5).

patternsofhearinglossamongpatientswithtype2diabetes

Table5:*frequencyofthedifferenttypesofhearinglossamongt2dmpatientsatmrrh*

typeofhearingloss	unilateral n (%)	bilateral n (%)
snhl	17(42.5)	31(86.1)
conductivehearingloss mixed	10(25.0)	0(0.0)
hearing loss	13(32.5)	5(13.9)

thecommonesttypeofhearinglossrecordedwassnhl,whichwasbilateralin 86.1% and unilateral in 42.5% of participants as shown in table 5.

table6:*degreeofhlamongt2dmparticipantswithbilateralhearing loss*.

degreeofhearing loss	snhl n(%)	mixedhl 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)

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.

factorsassociatedwithhearinglossamongt2dmpatients

table 7*: results of univariate analysis for factors associated with hearing loss among t2dm patients at mrrh*

characteristic	nohl, 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
ageinyears				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)	
60and above	55(56.7)	42(43.3)	4.3(1.19-15.74)	
maritalstatus				0.169
unmarried	54(65.1)	29(34.9)	0.7(0.38-1.18)	
married	130(73.5)	47(26.6)	1.0	
educationlevel				0.035
no formal education	25(56.8)	19(43.2)	3.6(1.44-8.84)	
primaryeducation	87(69.1)	39(31.0)	2.1(0.97-4.60)	
	47(82.5)	10(17.5)	1.0	

secondary education	25(75.7)	8 (24.2)	1.5(0.53-4.30)	
tertiaryeducation				
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)	
takenalcoholbefore	105(71.9)	41(28.1)	1.0	0.645
	79(69.3)	35(30.7)	1.1(0.66-1.94)	
currentlytaking 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)	
durationof diabetes				0.094
lessthan5years	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)	
morethan15years	8 (50.0)	8 (50.0)	2.7(0.96-7.80)	
diabeticcontrol				0.146
poor control	142(73.2)	52(26.8)	1.0	
goodcontrol	42(63.6)	24(36.4)	1.6(0.86-2.83)	

diabetic treatment				0.883
notontreatment	8 (72.7)	3 (27.3)	1.0	
on treatment	176(70.7)	73(29.3)	1.1(0.29-4.29)	
oral hypoglycemiconly	109(68.6)	50(31.5)	1.3(0.76-2.31)	0.322
insulinonly	20(71.4)	8 (28.6)	1.0(0.41-2.30)	0.935
oralhypoglycemic 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
headtrauma	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	
normalweight	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 hearing loss	182(70.8)	75(29.2)	1.0	0.877
	2 (66.7)	1 (33.3)	1.5(0.11-13.58)	
ototoxicdrugsuseinthe last 6months	18171.0)	74(29.0)	1.0	0.604
	3 (60.0)	2 (40.0)	1.5(0.27-9.96)	
impactedcerumen	165(72.1)	64(28.0)	1.0	0.227
	19(61.3)	12(38.7)	1.6(0.75-3.55)	

followingunivariateanalysis,theonlyfactorsthatweresignificantlyassociated 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.factorssuchdiabeticcontrol,bmi,firstdegreefamilymemberwithhearing lossandcomorbiditiessuchashypertensionandhistoryofworkinginnoisy

environment that are known to have clinical significance were found not to be statistically significant.

table8:resultsofmultivariateanalysisforkeyfactorsassociatedwithhearingloss among t2dm patients at mrrh

characteristic	adjustedor (95%ci)	p
ageinyears		
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
60and above	3.0(0.79-11.62)	0.068
educationlevel		
no formal education	2.7(1.01-7.14)	0.049
primary education	1.8(0.77-4.06)	0.176
secondaryeducation	1.0	
tertiary education	1.1(0.36-3.29)	0.881
diabeticcontrol		
poor control	1.0	
good control	1.5(0.78-2.81)	0.228
comorbidities		
concurrenthtn	1.0(0.54-1.93)	0.947
1st-degree family members with hearing loss	0.7(0.05-8.05)	0.739
everworkedinanenvironment with loud noise	1.1(0.6-2.2)	0.696

Thefactorsconsideredwhenbuildingthemvmodelincludedfactorsfrom 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 withfirstdegreefamilymemberswithhearingloss.Theonlystatistically

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 were60yearsandaboveascomparedtothoseintheagecategory 30-39 years.

DISCUSSION

thereisaworldwideincreaseinthenumberofpatientsdiagnosedwithncdsofwhich 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. In this chapter, we discuss the results of study exploring hearing loss among adult t2dm patients at mrrh.

PROPORTIONANDPATTERNSOFHLAMONGADULTPATIENTSWITHTYPE2DIABETES

The proportion of study participants with hearing loss was noted to be 29.2%. this is significant in our setting as it translates that 1 in every 3 patients with t2dm has some form hearing loss although morethan80%hadmildtomoderatedegreeofhearingloss.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. *(ashkezari et al., 2018, adebola et al., 2016, andsunkumetal,2013).*althoughitwasnotstatisticallysignificant 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 our setting. our proportion is slightly higher than a prevalence of 21.6% reported by *adebola et al., 2016* 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 2014 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 alsocan'tnegatethecontributionofdifferencesinthesamplesizes of the studies and study settings especially of the studies included in the systematic *review (adebola et al., 2016, akinpelu et al., 2014).*

bilateral snhl in the mild to moderate degree was the commonest typeofhlamongourstudyparticipantsandthiscouldbeduetothe fact that t2dm being a systemic disease is expected to cause bilateralhlandinourstudymorethan80%ofthestudyparticipants 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*.(okwiri, 2016, akinpelu et al., 201, and adebola et al., 2016).*

wealsonotedthatincreasingageisassociatedwithincreaseinthe 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., 2011, naser et al., 2014, mozaffari et al., 2010, okwiri, 2016, hlayisi et al., 2019)*. However, discrepancy was found insomestudiesthatreportedconductivehearinglosssecondaryto otitis media with effusion (ome) as the commonest type of hearing loss among t2dm participants. they theorized this was caused by decreasednasalmucociliaryactionwithinthemiddleearstructures experienced by diabetic patients*. (adebola et al., 2016, kumari et al., 2016,).*

itisinterestingtonotethatthevastmajorityofpatientswithbilateral 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

makingearlydetectionthroughroutinescreeningofpatientswith t2dm a crucial part of care to reduce the negative impacts associated with hearing loss.

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, hearingisknowntodeterioratewithadvancingageinsomepeople, 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 (kumari et al., 2016, akinpelu et al., 2014).

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 couldbebecausemostofourpatientsarefromruralsettingswhere there is scarcity of opportunities such as specialist healthcare workers,wellequippedhospitalsandindividualresourcescapability 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 uncontrolled dm, it did not significantly correlate withtheincidenceofhearingloss(table7).therehavebeensome studies though that reported significant correlation between poor glycemiccontrolandhearingloss.(ashkezarietal.,2018,adebola et al., 2016, and sunkum et al, 2013).

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 correlationinourstudy(okwiri,2016,adebolaetal.,2016,lietal.,2018, tiwari and mudhol, 2018)

CONCLUSION

PROPORTIONANDPATTERNSOFHL.

the overall proportion of hearing loss among t2dm patients at mrrh was noted to be29.2%whichisrelativelyhighinoursetting.howeverthisislowwhencompared to the global range and mild to moderate snhl is the commonest type of hearing loss in this population.

ASSOCIATEDFACTORS.

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 modalitylikeinsulinandhistoryoffirst-degreefamilymemberwithhearinglossare likelyprotective.themultivariatemodelshowsthatonlyalackofformaleducation will independently raise the odds of hl among t2dm patients in our setting.

references

- adebola,s.o.,olamoyegun,m.a.,sogebi,o.a.,iwuala,s.o.,babarinde,j.a.&oyelakin,a.o. 2016.otologicandaudiologiccharacteristicsoftype2diabeticsinatertiaryhealthinstitutionin nigeria. *brazilian journal of otorhinolaryngology,* 82, 567-573.
- akinpelu,o. v., mujica-mota, m. &daniel,s. j.2014. istype2 diabetes mellitusassociatedwith alterationsinhearing?asystematicreviewandmeta-analysis.*thelaryngoscope,*124,767-776.
- ashkezari,s.j.,namiranian,n.,rahmanian,m.,atighechi,s.,mohajeri-tehrani,m.-r.&gholami,s. 2018. is hearing impairment in diabetic patients correlated to other complications? *journal of diabetes & metabolic disorders,* 17, 173-179.
- association,a.d.2019.2.classificationanddiagnosisofdiabetes:standardsofmedicalcarein diabetes—2019. *diabetes care,* 42, s13-s28.
- chiwanga,f.s.,njelekela,m.a.,diamond,m.b.,bajunirwe,f.,guwatudde,d.,nankya-mutyoba,j., kalyesubula,r.,adebamowo,c.,ajayi,i.&reid,t.g.2016.urbanandruralprevalenceofdiabetes and pre-diabetes and riskfactorsassociatedwithdiabetes intanzania and uganda. *globalhealth action,* 9, 31440.
- helzner,e.p.&contrera,k.j.2016.type2diabetesandhearingimpairment. *currentdiabetes reports,* 16, 3.
- hlayisi,v.-g.,petersen,l.&ramma,l.2019.highprevalenceofdisablinghearinglossinyoungto middle-agedadultswithdiabetes.*internationaljournalofdiabetesindevelopingcountries,* 39, 148-153.
- hong,o.,buss,j.&thomas,e.2013.type2diabetesandhearingloss.*dismon,*59,139-46.
- huddle,m.g.,goman,a.m.,kernizan,f.c.,foley,d.m.,price,c.,frick,k.d.&lin,f.r.2017.the economicimpactofadulthearingloss:asystematicreview.*jamaotolaryngology–head&neck surgery,* 143, 1040-1048.
- kelsey,j.,whittemore,a.,evans,a.&thompson,w.1996.methodsofsamplingandestimationof sample size. *methods in observational epidemiology,* 311, 340.
- kumari,m.s.,meganadh,k.r.,madhavi,j.&jyothy,a.2016.prevalenceofotologicaldisordersin diabetic cases with hearing loss. *journal of diabetes & metabolism,* 7.
- li,j.,zhang,y.,fu,x.,bi,j.,li,y.,liu,b.&zhang,l.2018.alterationofauditoryfunctionintype2 diabetic and pre-diabetic patients. *acta oto-laryngologica,* 138, 542-547.
- linnenkamp,u.,guariguata,l.,beagley,j.,whiting,d.&cho,n.2014.theidfdiabetesatlas methodologyforestimatingglobalprevalenceofhyperglycaemiainpregnancy.*diabetesresearch and clinical practice*, 103, 186-196.
- mozaffari, m., tajik, a., ariaei, n., aliehyaii, f. &behnam, h. 2010. diabetes mellitus and sensorineuralhearinglossamongnon-elderlypeople.*emhj-easternmediterraneanhealth journal, 16 (9), 947-952, 2010*.
- naser,n.e.,hussein,d.s.&saddam,r.2014.audiologicalprofileindiabeticpatients.*kufajournal for nursing sciences,* 4, 125-133.
- okwiri,n.2016.*prevalenceandpatternofsensorineuralhearingimpairmentamongpatients with type 2 diabetes mellitus at the kenyatta national hospital.* university of nairobi.
- olusanya, b. o., davis, a. c. &hoffman, h. j. 2019. hearing loss grades and the international classificationoffunctioning,disabilityandhealth.*bulletinoftheworldhealthorganization,*97, 725.

- padhy,r.n.2014.incidenceofhearingloss,tinnitusandvertigoamongdiabetespatients.*siriraj medical journal,* 66.
- rajendran,s.,anandhalakshmi,m.b.&viswanatha,r.2011.evaluationoftheincidenceof sensorineuralhearinglossinpatientswithtype2diabetesmellitus. *intjbiolmedres,*2,982-7.
- sunkum,a.j.k.&pingile,s.2013.aclinicalstudyofaudiologicalprofileindiabetesmellitus patients. *european archives of oto-rhino-laryngology,* 270, 875-879.
- tazikimohammad,h.&mansourianazad,r.2011.thecomparisonofhearinglossamongdiabetic and non-diabetic patients. *journal of clinical and diagnostic research,* 5, 88-90.
- tiwari,a.&mudhol,r.s.2018.prevalenceofsensorineuralhearinglossamongtype-iidiabetes mellitus patients attending kles dr. prabhakar kore hospital and mrc: a cross-sectional study. *indian journal of health sciences and biomedical research (kleu),* 11, 165.

DEFINITIONS,ACRONYMS,ABBREVIATIONS

hearingimpairment:thistermwillbeusedinterchangeablywithhearinglossandimplies a state of suboptimal hearing compared to someone with normal hearing (hearing thresholds of 25 db or better in both ears averaged at frequencies 0.5, 1, 2, 4 khz) (who 2020).

patternsofhearingimpairment-inthisstudythistermwillencompassboththetypesofhearing loss (sensory neural hearing loss (snhl), conductive hearing loss (chl), and mixed hearing loss (mhl) and the degree of hearing loss (mild, moderate, severe and profound).

hyperglycemia - is the medical term for elevated blood glucose(bloodsugar) – fasting plasma glucose≥7.0mmol/l(126mg/dl)or2–hourpostprandialplasmaglucose≥11.1mmol/l(200mg/dl). elevatedblood sugar occurs when there is little in circulation or the body is not able to utilize insulin well. (american diabetes association).

otoscopicexamination-isanon-invasiveclinicalprocedureusedtoassesstheexternalauditory canalandtympanicmembraneforanysignsofrapture,infection,anatomicalvariationorblockage by wax and/or foreign substances (encyclopedia.com). in our study, this was performed using a hand-held magnifying welch-allyn otoscope.

audiological assessment- is a pain-free, noninvasive hearing test that assesses a person's capability to hear sounds of different pitches or frequencies. though several tests may be performedtoassesshearing,inourstudyweconductedptainasound-treatedboothusingabell plusdiagnosticaudiometer(en60645-1:2001)

bmi	bodymass index
chl	conductivehearingloss
dm	diabetesmellitus
eac	externalauditorycanal
ent	ear,noseandthroat
hba1c	glycatedhemoglobin
hl	hearingloss
hi	hearingimpairment
hiv	humanimmunodeficiencyvirus
iac	internalauditorycanal
ifg	impairedfastingglucose
igt	impairedglucosetolerance
mrrh	mbarararegionalreferralhospital
must	mbararauniversityofscienceandtechnology
mhl	mixedhearingloss
noe	necrotizingotitisexterna
ome	otitismediawitheffusion
pi	principleinvestigator
pta	puretoneaudiometry
ra	researchassistant
snhl	sensoryneuralhearingloss

t1dm	type1diabetesmellitus
t2dm	type2diabetesmellitus