

Tinnitus Evaluation in Type 1 Diabetes Mellitus at Tertiary Hospital Malaysia

Ameen SA¹,
Norasyikin AW²,
Noor Dina H^{1,3},
Fahrin Zara M N^{1,3},
Tyler R.⁴,
Asma Abdullah^{1,3*}

ABSTRACT

Objectives: To determine the prevalence of tinnitus in Type 1 Diabetes Mellitus (T1DM) patients, to evaluate its severity and to correlate it with estimated Glomerular Filtration Rate (eGFR) as well as glycaemia control (HbA1c).

Material and Methods: We performed a questionnaire-based cross-sectional study at Hospital Canselor Tuanku Muhriz (HCTM) from a period of 15 months. A total of 133 T1DM patients who fulfilled our study's criteria were subjected to otoscopy examination, tuning fork test and free field voice test. The mini-Tinnitus Questionnaire (TQ) was used to assess the severity of tinnitus. We were careful to categorize the perceived duration of tinnitus.

Results: The prevalence of tinnitus among T1DM patients was 24.1% (32/133 patients). Out of 32 patients, approximately 78.1% (25 patients) had a compensated level of tinnitus distress and the remaining 21.9% (7/32) had moderate tinnitus. The duration of tinnitus ranged from 2 seconds to 2 minutes, which was ringing and intermittent in nature. The HbA1c and estimated Glomerular Filtration Rate (eGFR) were higher in tinnitus compared to the non-tinnitus group. There was no significant correlation between the severity of tinnitus and HbA1c level or eGFR.

Conclusions: Our study concluded that tinnitus amongst T1DM patients was likely to be non-pathological in view of its short duration with minimal to no distress to the sufferers. An elevated HbA1c may increase the risk of developing tinnitus.

Keywords: Tinnitus, Type 1 diabetes mellitus, Mini- tinnitus questionnaire, Estimated glomerular filtration rate

¹Department of Otorhinolaryngology, University Kebangsaan Malaysia Medical Centre, Kuala Lumpur, Malaysia

²Department of Medicine, University Kebangsaan Malaysia Medical Centre, Kuala Lumpur, Malaysia

³Centre for Ear, Hearing and Speech (Institute-HEARS), Faculty of Health Sciences

⁴Department of Otolaryngology Head and Neck Surgery, Department of Communication Sciences and Disorders, The University of Iowa, Iowa City, United States.

***Send correspondence to**

Asma Abdullah

Department of Otorhinolaryngology, University Kebangsaan Malaysia Medical Centre, Kuala Lumpur, Malaysia, Kuala Lumpur, Malaysia. Tel: 03-9145 6599, Email: asmappukm@gmail.com

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INTRODUCTION

Tinnitus is the perception of sound for which there is no acoustic source external to the head¹. Dauman and Tyler proposed that pathologic tinnitus is head noise lasting at least 5 minutes that occurs more than once per week². A distinction is often made between subjective and objective tinnitus³. Subjective tinnitus refers to an internal sound that is perceived only by the patient, whereas objective tinnitus is considered real noise that can be heard by the patient and the examiner⁴. Failure to treat chronic tinnitus may affect the patient's psychology with varying severity.

Change in the cochlear inner hair cell ion channels (e.g. L-Type calcium, potassium and sodium channels) and receptor systems may predispose to tinnitus⁵⁻⁸. Other predisposing factors are aging, cochlear ablation, noise trauma and global brain activation secondary to tinnitus-inducing agents e.g. salicylate⁹.

A study performed by Mousavi et al in 2021 revealed 26.4% of patients with diabetes suffered with tinnitus (n=250)⁴. They also discussed tinnitus prevalence in previous reports of 19-65% amongst the general population. The National Study of Hearing in the UK (n=48,313) by Davis showed tinnitus prevalence of 10-1% amongst adults.⁵ An Asian population study conducted in Korea (n=19,290) revealed a prevalence of 20.7%⁶. Swain et al found that the prevalence amongst 240 diabetic patients was 29.1%⁷. Baharudin et al recorded a prevalence in Type 2 Diabetes Mellitus (T2DM) patients in University Kebangsaan Malaysia was of 9.1%⁸. Klagenberg et al reported prevalence amongst T1DM patients was as 13.3%⁹.

There are various conditions associated with tinnitus. Otolological conditions are infectious (otitis media, labyrinthitis, mastoiditis), neoplastic (vestibular schwannoma, meningioma), labyrinthine (Meniere's disease, vestibular vertigo, sensorineural hearing loss) amongst others (otosclerosis, presbycusis and noise exposure). Endocrine or metabolic conditions include diabetes mellitus, hypothyroidism, hyperinsulinemia and pregnancy. Neurological conditions include meningitis, migraine and multiple sclerosis. Other conditions are psychiatric (anxiety, depression, emotional trauma), ototoxic medications (diuretics, immunosuppressive drugs, non-steroidal anti-inflammatory drugs (NSAIDs), corticosteroids), systemic lupus erythematosus (SLE), rheumatoid arthritis, hypertension, head injury and temporo-mandibular joint disorders¹⁰.

MATERIALS AND METHODS

A questionnaire-based cross-sectional study was done over a period of 15 months at the Endocrine Clinic (Adult and Pediatric) and Primary Care Clinic Hospital Canselor Tuanku Muhriz (HCTM) following approval from local research and Ethics Committee. The study inclusion criteria included patients with T1DM diagnosed at HCTM with or without hypertension, and patients aged 12 to 50 years. The results of renal profile and HbA1c level were documented. Exclusion criteria included patients

who refused to participate in the study, incomplete questionnaires, patients with pre-existing tinnitus and hearing loss. There is no standardized definition for tinnitus used in research worldwide; therefore, we used the British Tinnitus Association's definition of tinnitus, which is the "Perception of sound in the absence of any corresponding external sound". Our study of tinnitus was independent of tinnitus duration.

Our study patients underwent a hearing assessment to rule out hearing loss as part of the exclusion criteria. This was followed by an otoscopy examination, tuning fork test, as well as a Free Field Voice Test. Informed consent was obtained from patients who fulfilled the inclusion and exclusion criterias. Demographic data and other relevant information pertaining to the research was obtained via questionnaire. Patients with tinnitus were given the mini-TQ questionnaire. All incomplete questionnaires resulted in patient exclusion. The mini-tinnitus questionnaire is an abridged version of Tinnitus Questionnaire. Patients were provided with the mini-TQ in 2 languages, which was randomly distributed amongst patients. All the data obtained will be collected and analysed using SPSS software. Correlations between these variables were also assessed using the Spearman Correlation test. Statistic significance was set at p value of less than 0.05 ($p < 0.05$). Chi-Square test was used to assess variable in groups (Figure 1).

RESULTS

A total of 133 patients were recruited. Table 1 shows the epidemiology of the patients. Of the 133 patients, 45.9% (61) of them were males and 54.1% (72) were female. Most of the participants (48.1%) are from the '21-30' age group. The majority of the participants were Chinese (54.1%), followed by Malay (35.3%), Indian (8.3%) and Punjabi (2.3%).

The prevalence of tinnitus amongst T1DM patients in this study was 24.1% (32).

Table 2 shows the epidemiology and tinnitus characteristics in the tinnitus group. Most of the patients with tinnitus are from the '12-20' years group. All of them have intermittent and ringing-type tinnitus. The majority of the patients (65.6%) had tinnitus for a duration of less than 10 seconds.

Table 3 shows the co-morbidities amongst the tinnitus group of patients. Only two (6%) had hyperlipidemia, one (3%) had a history of repaired Patent Ductus Arteriosus (PDA), and 2 (6%) had hypothyroidism and was on thyroxine supplementation.

Table 4 shows the percentage of tinnitus across the age groups. Most of the participants with tinnitus belong to the '12-20' age group (12.8%) with 17 participants, followed by '21-30' age group (9%) with 12 participants and least was in the '31-40' age group.

Table 5 shows the severity of tinnitus based on the mini-TQ questionnaire amongst the tinnitus group of patients. The

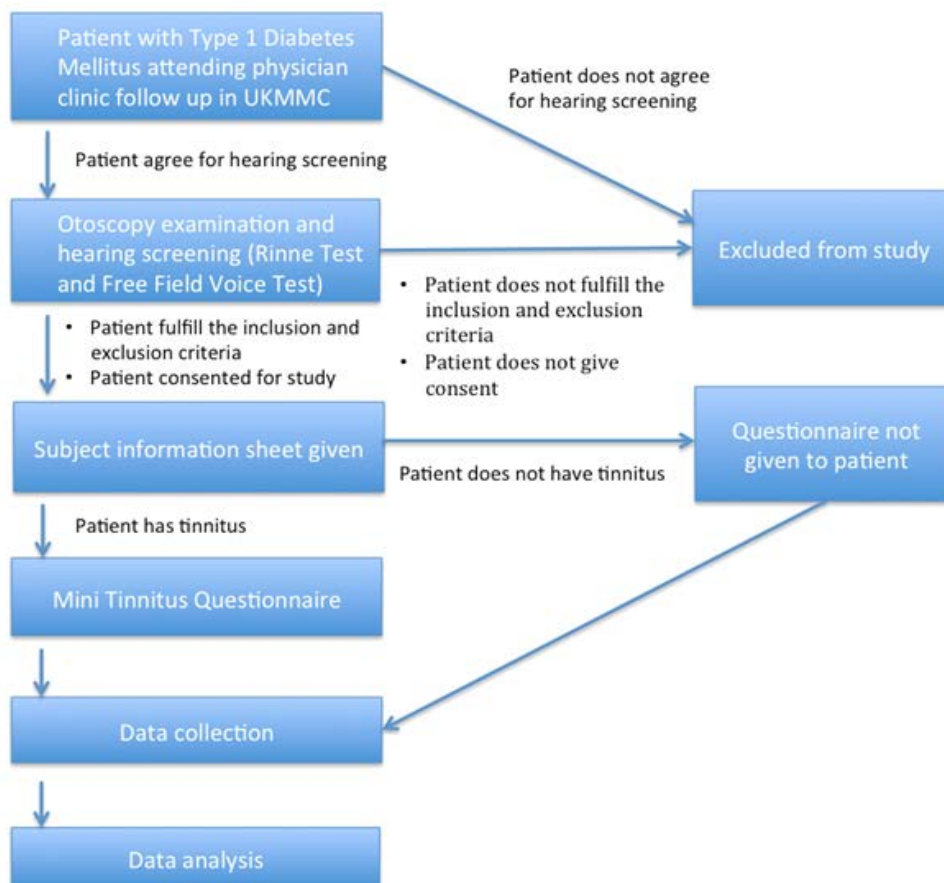


Figure 1: Shows the flow of our study.

Table 1: Shows the epidemiology of the patients.

Epidemiology of Type 1 diabetes Mellitus patients	
AGE	No (%)
12-20 years old	46 (34.6)
21-30 years old	64 (48.1)
31-40 years old	15 (11.3)
41-50 years old	8 (6.0)
GENDER	
Male	61 (45.9)
Female	72 (54.1)
RACE	
Malay	47 (35.3)
Chinese	72 (54.1)
Indian	11 (8.3)
Others	3 (2.3)

majority of patients (n=25, 78.1%) have a compensated level of tinnitus distress (no clinically relevant distress due to the tinnitus), whilst the others (n=7, 21.9%) have a tinnitus severity of moderate distress level. None of them were in the 'severe distress' or 'most severe distress' group.

Table 6 compares the HbA1c level between tinnitus and non-tinnitus groups HbA1c level was statistically significantly higher in the tinnitus group compared to the group without tinnitus (U= 1112, p=0.008).

Table 7 shows correlation of HbA1c level with mini-TQ total score (tinnitus severity) amongst the tinnitus group of participants. The results shows that there is small negative correlation between HbA1c level and tinnitus severity, however, this is not statistically significant (p>0.05).

Table 8 shows correlation between eGFR with mini-TQ total score (tinnitus severity). The result shows that there is small negative correlation between them but the result is not statistically significant (p>0.05).

Table 2: Shows the epidemiology and tinnitus characteristics in the tinnitus group.

Age Group	No (%)
12-20 years old	16 (50)
21-30 years old	13 (40.6)
31-40 years old	3 (9.3)
Gender	
Male	20 (62.5)
Female	12 (37.5)
Race	
Malay	15 (46.9)
Chinese	17 (53.1)
Tinnitus Localisation	
Right	11 (34.4)
Left	9 (28.1)
Both	12 (37.5)
Tinnitus Character	
Intermittent	32 (100)
Tinnitus noise type	
Ringing	32 (100)
Tinnitus duration	
<10secs	21 (65.6)
10-59secs	10 (31.3)
60secs-30secs	1 (3.1)

Table 3: Shows the co-morbidities amongst the tinnitus group of patients.

Comorbid	n	%
Hypertension	1	3.1
Hyperlipidaemia	2	6.2
Heart disease (PDA)	1	3.1
Thyroid disease (hyperthyroidism)	2	6.2
Others (Allergic rhinitis, Asthma)	2	6.2

Table 4: Shows the percentage of tinnitus across the age groups.

Type 1 DM/ Age group	Without tinnitus		With tinnitus		X ²	P-Value
	n	%	n	%		
12-20	29	21.8%	17	12.8%	7.845	0.049
21-30	52	39.1%	12	9.0%		
31-40	12	9.0%	3	2.3%		
41-50	8	6.0%	0	0.0%		
TOTAL	101 (75.9%)		32 (24.1%)			

Table 5: Shows the severity of tinnitus based on the mini-TQ questionnaire amongst the tinnitus group of patients.

Mini TQ Severity Index (n=32)	Frequency	Percent (%)
Compensated	25	78.1
Moderate distress	7	21.9
Severe distress	0	0.0
Most severe distress	0	0.0

Table 6: compares the HbA1c level between tinnitus and non-tinnitus groups.

HbA1c Mean ± SD	Without tinnitus (n=101)	With tinnitus (n=32)	Mann-Whitney U test		
	8.65 ± 1.86	9.87 ± 2.30	U	Z	p-value
Mean rank	62.01	82.75	1112.00	-2.654	0.008

Table 7: shows correlation of HbA1c level with mini-TQ total score (tinnitus severity) amongst the tinnitus group of participants.

	Tinnitus Severity	HbA1c level	
Tinnitus Severity	Pearson Correlation	1	-0.141
	Sig. (2-tailed) N	32	0.441
			32
	Spearman Correlation coefficient	1	-0.138
	sig. (2 tailed)N	32	0.451
			32

Table 8: Shows correlation between eGFR with mini-TQ total score (tinnitus severity).

	Tinnitus Severity	eGFR level	
Tinnitus Severity	Pearson Correlation	1	-0.141
	Sig. (2-tailed) N	32	0.441
			32
	Spearman Correlation coefficient	1	-0.138
	sig. (2 tailed)N	32	0.451
			32

DISCUSSION

Tinnitus may cause substantial distress. It may manifest as annoyance, anxiety, depression, lack of concentration and sleep disturbance¹¹ Diabetic microangiopathies and neuropathy affects the sensory organs i.e. the auditory pathway, and may cause symptoms such as hearing loss, tinnitus and vertigo¹² Tinnitus commonly precedes hearing loss, which is described as high frequency, sensorineural, and progressive¹³ In this study, the prevalence of tinnitus amongst T1DM is 24.1% (32/133). It is higher compared to a (13.3%) study done by Klagenberg et al⁹ One possible cause for a higher prevalence of tinnitus, may be due to the criteria of tinnitus chosen in this study, which was independent of the duration.

Tinnitus prevalence in the general population increases with age and usually peaks at around 70 years of age, whereby the prevalence then starts to drop as age increases^{4,19}. Our study showed a higher prevalence in the younger age group, albeit young T1DM patients. Most of the participants with tinnitus (56.3%) reported tinnitus for approximately 5 seconds, and it was 'ringing' and 'intermittent' in nature. The time between each tinnitus episode varied. In our opinion, patterns of tinnitus in this study are believed to be non-pathological due to the fact that the longest duration of tinnitus recorded lasted for only 2 minutes. The majority of the patients (n=25, 78.1%) have a compensated level of tinnitus distress (no clinically relevant distress due to the tinnitus), whilst the others (n=7, 21.9%) have tinnitus severity of moderate distress level. This shows that most T1DM patients with tinnitus have mild tinnitus which rarely causes distress. This was assumed by the fact that none of the patients complained of tinnitus to physicians during their consultations.

A study in Taiwan showed that Chronic kidney Disease (CKD) increased the risk of developing tinnitus¹⁴ A combination of factors resulting from CKD, including abnormal electrolytes, urea and creatinine levels, may lead to cochlear microcirculation dysfunction causing damage to the cochlear¹⁵ In this study, we found a negative correlation of eGFR with tinnitus severity, albeit

not statistically significant. This study also revealed that there is no significant correlation of HbA1c with tinnitus severity, supported by a study with the same conclusion amongst diabetes T2DM Table 2 patients¹⁶

HbA1c reflects the average glucose levels of the previous 3 months. The prolonged hyperglycemic state may disturb brain and inner ear function, which may lead to the reduced processing of complex sounds. This may be a contributing factor to the occurrence of tinnitus and hearing impairment¹⁷⁻¹⁹ Srinivas found that the prevalence of sensorineural hearing loss is was high (>85%) amongst subjects with HbA1c of more than 8.18 HbA1c levels in patients with tinnitus was found to be significantly higher than those without tinnitus in this study.

CONCLUSION

The prevalence of tinnitus amongst T1DM patients in this study was 24.1%. Based on the mini-TQ, 78.1% (n=25) had a compensated level of tinnitus distress and 21.9% (n=7) had a tinnitus severity of moderate distress level. Causes of tinnitus in T1DM are multifactorial. Duration of tinnitus ranged from 2 seconds to 2 minutes, was ringing and intermittent in nature, and therefore, of non-pathological type. The group with tinnitus had a significantly higher level of HbA1c compared to those without tinnitus. There was no significant correlation found between the severity of tinnitus with HbA1c level and eGFR in our study.

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