EFFECTS OF INCREASED SERUM GLUCOSE LEVEL ON HEARING CAPABILITIES OF HYDERABAD SINDH RESIDENCE

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ABSTRACT

BACKGROUND: Diabetes mellitus (DM) is one of the metabolic diseases that cause hyperglycemia, either because of a lack of insulin or a loss of sensitivity to insulin receptors. DM damages the hearing system of humans. Researchers throughout the world are endeavoring to establish a link between diabetes mellitus and hearing loss.

METHODOLOGY: This was a cross-sectional study conducted in the OPD of ENT (Ear Nose and Throat), Liaquat University Hospital Hyderabad from January 2023 to March 2023, after approval of all protocols. The study was approved by the Ethical committee of Sind University Jamshoro. A specific criterion was established to select the participants. For analysis purposes, patients were divided into two groups: Group A comprised 56 diabetes patients, while in Group B, 55 non diabetic patients were selected. After obtaining consent for examination in writing, a detailed otological examination, tuning fork test, and pure tone audiometry were performed. Random blood sugar level was estimated by the Care Sense N glucometer (Model GM505PAD, made in Korea). Graph Pad Prism5 was used for data analysis. A P value less than 0.05 was taken as significant.

RESULTS: The current study revealed that patients who had a higher blood glucose level were significantly (p-value = 0.02) suffering from hearing loss as compared to those who had a normal sugar level.

CONCLUSION: The current study suggests that hearing loss is a more prevalent disorder in patients with diabetes mellitus as compared to non-diabetic people. This study concludes that tinnitus and vertigo are more commonly associated with hearing loss.

KEY WORDS: Diabetes mellitus, hearing loss, pure tone audiometry, tinnitus, and vertigo

INTRODUCTION

Diabetes mellitus is a metabolic disorder of uncontrolled blood glucose levels that affects the normal function of body systems. [1] Diabetes mellitus is classified into two major groups: 'Type 1 and Type 2 diabetes mellitus.

In Type 1, pancreatic beta cells are unable to make insulin, and in Type 2, beta cells synthesize a sufficient amount of insulin, but the peripheral body cells don't show sensitivity to insulin. In both cases, the peripheral blood glucose level is raised, leading to hyperglycemia. Diabetes mellitus is one of the most prevalent diseases in the world. Diabetes mellitus produces multiple disorders in the human physiological system. [2]

It is the seventh-most preventable disease worldwide. It is a rapidly spreading disease, which is estimated by the fact that in 2013, three hundred and eighty-nine million people were suffering from this catastrophic disease. It is predicted that around 590 million people will become victims of this disease in 2040. According to the American Diabetes Association, the rate of hearing loss in non-diabetic patients is 30% less than in patients with diabetes mellitus, which is a sensorineural type of hearing loss. [3]

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According to recent research, Pakistan now has diabetes mellitus as a major disease that causes many microvascular and macro vascular complications in people. The prevalent factors for diabetes mellitus in Pakistani people are malnutrition, an uncontrolled diet, a decrease in breastfeeding duration, and a lack of energy-consuming activities. [4]

Sensorineural hearing loss is due to defects in the cochlea, cochlear nerve, and hearing center in the brain. There are different causes of sensory hearing loss, which include genetic, viral, and traumatic reasons. Hearing is one of the special senses of humans that is used for social communication, also called social sense. It helps a person communicate with his or her social environment and also helps the person's wellbeing.[5]

According to the WHO, hearing loss occurs when a person has a loss of >35 dB in the better ear. WHO states that hearing loss is one of the major disabilities in the world. Because hearing sense is a base for other physiological and anatomical functions of the body, a defect in hearing, either impairment or permanent loss, will also hinder the development of other senses of the body like speech, cognition, and language. WHO suggests that proper screening for hearing should be performed by the age of 1 month, a diagnostic test for impaired hearing by the age of 3 months, and if intervention is required, at the age of 6 months.[6] Sensory neural hearing loss (SNHL) is most commonly seen in elderly patients or patients with an age above 60, which shows that hearing loss is an ageing process, but in the case of diabetic patients, the hearing loss is not dependent upon ageing but can affect any age group, even a person in his or her third decade of life. [7]

Diabetes mellitus also involves other systems, including cardiovascular, neurological, and nephrological complications. It also produces otological complications, including hearing loss and tinnitus. [8]

Hearing loss is more prevalent in men than in women, who are more frequently victims of hearing loss in comparison to men, who have a profound loss of hearing. The duration of diabetes mellitus also increases the frequency of hearing loss. [9]

The pathological changes that occur in diabetes mellitus that lead to hearing loss are either its angiopathic effects or its neuropathic effects. The effect of diabetes mellitus over hearing on tissue level is through the polyol pathway, in which sorbitol levels decrease, causing low levels of myinositol that cause neuropathy of the nerves and cochlea of the inner ear. [10] Diabetic angiopathy is either directly affecting the blood supply of the cochlea or indirectly causing eight cranial nerve degeneration. [11]

It is observed after many studies carried out in 1992 that show a person who has diabetes mellitus from birth is also susceptible to hearing loss; e.g., Van den Ouweland concludes from his research that people with mitochondrial mutations will also inherit diabetes mellitus and sensorineural hearing loss. [12]

Vertigo is a sensation in which a person feels that either their surroundings or themselves are rotating. The lesion behind vertigo may be in the peripheral vasculature, in the brain stem, cerebellum, or vestibular apparatus. Vertigo is usually associated with tinnitus and hearing loss. [13]. The current study thus attempts to establish a link between a higher blood glucose level and hearing abnormalities.

MATERIAL & METHODS

This was a cross-sectional study conducted from January 2022 until the end of March 2023. This study was carried out in the Outpatient Department (OPD) of Liaquat University Hospital, Hyderabad. The approval for the collection of data was obtained from patients and administration in written. A total of 110 participants took part in the study. Diabetics and non-Diabetics: both types of patients were selected who attended the ENT (ear, nose, and throat) OPD. Both male and female patients took part in the study. The age limit was between 20 and 40 years, with no history of previous ear disease, trauma, or use of ototoxic drugs. Hearing loss was documented when the hearing threshold was more than 25 dB (decibel) in the ear gap on the audiogram of the right and left ear. Patients with any ear infection, history of head injury, use of ototoxic medications, work in noisy places or experience explosions, family history of hearing loss, or suffering from any clinical disorder except diabetes mellitus were excluded from the study.

After taking a detailed history, the patients underwent extensive tuning fork tests, an otoscopic examination, and pure tone

audiometry on an audiometer (Model: MAICO MA 39, Germany). The random blood sugar test was performed through a glucometer (model: GM505PAD). A blood glucose level greater than 140 mg/dl was considered as higher sugar level according to WHO criteria. All data regarding hearing loss, tinnitus, and vertigo were recorded in a structured questionnaire performa. The statistical analysis was done by Graph Pad Prism5. Fisher's exact test, odds ratio, likelihood ratio, and specificity and sensitivity were calculated as appropriate.

RESULTS

As shown in Table 1, those who were suffering from a higher blood glucose level were significantly (p-value = 0.02) suffering from hearing loss as compared to those with a normal glucose level. The hearing loss is 2.5 times greater (odds ratio = 2.5, likelihood ratio = 1.5) in patients with a higher glucose level than normal.

Table.1: Blood glucose level in normal versus hearing loss patient.

Serum Glucose level	**No hearing loss**	**Hearing loss**	Total	***p*-value**	***95% CI***	***Odds ratio***	***Likelihood ratio***	***Sensitivity& Specificity***
Glucose level (80-140mg/dl)	31(56.36%)	24(43.64%)	55(100%)	0.02	1.07to 2.56	2.5	1.5	0.62&0.60
Above 140mg	19(33.93%)	37(66.07%)	56(50.45%)					
TOTAL	50(45.05%)	61(54.95%)	111(100%)					

As shown in Table.2; those who were suffering from higher blood glucose level were significantly (*p*-value= 0.004) suffering from tinnitus as compared to those were having normal blood glucose level. The tinnitus was found 3.1 times greater (Odds ratio= 3.1, likelihood ratio= 1.7) in patient with higher glucose level than normal.

Table.2: Blood glucose level in normal versus patients having Tinnitus symptom.

Serum Glucose level	**TINITUS ABSENT**	**TINITUS PRESENT**	**Total**	***p*-value**	***95% CI***	***Odds ratio***	***Likelihood ratio***	***Sensitivity & Specificity***
Glucose level (80-140mg/dl)	35(31.53%)	20(18.01%)	55(49.55%)	0.004	0.5036 to 0.7664	3.1	1.7	0.63 &0.64
Above 140mg	20(18.01%)	36(32.43%)	56(50.45%)					
TOTAL	55(49.54%)	56(50.45%)	111(100%)					

As illustrated in Table.3; those who were suffering from higher blood glucose level were significantly (*p*-value= 0.0005) suffering from vertigo as compared to those were having normal blood glucose level. The vertigo was 4.1 times greater (Odds ratio= 4.1, likelihood ratio= 2.1) in patient with higher glucose level than normal.

Table.3: Blood glucose level in normal versus patient having vertigo symptom.

Serum Glucose level	**Vertigo absent**	**Vertigo present**	Total	***p*-value**	***95% CI***	***Odds ratio***	***Likelihood ratio***	***Sensitivity & Specificity***

Glucose level (80-140mg/dl)	40(36.03%)	15(13.51%)	55(49.55%)	0.0005	1.287 to 2.663	4.1	2.1	0.64&0.69
Above 140mg	22(19.81%)	34(30.63%)	56(50.45%)					
TOTAL	55(49.54%)	56(50.45%)	111(100%)					

DISCUSSION

Diabetes mellitus is one of those disorders in recent history that has spread throughout the world. It not only affects the metabolic system of the human body but also produces generalized damage throughout the human physiological system. The current research was conducted to study the effects of diabetes mellitus on human hearing capabilities. The people who were diabetic suffered more from the incidence of hearing loss (61.1%) than those who were not diabetic (43.6%). It was also detected that diabetic patients are more likely to suffer from tinnitus (32.43%) and vertigo (30.63%) in addition to hearing loss. This effect also coincides with a literature review study that was conducted by Gioacchini et al in 2023, showing that diabetes mellitus produces hearing loss in a similar fashion as does age-related presbyaccusis.[15] This fact was also confirmed by research done by Abdul Bari et al in 2008 stating that Diabetes mellitus is the key factor in causing hearing impairment.[16] According to the study of Shailendra D and Mane et al carried out in 2021, it was observed that diabetes mellitus causes microvascular damage to the ear by various mechanisms, of which the most important is the damage to the Na/K ATPase pump that plays an important role in hearing conduction to the brain.[8] A study conducted by Joythi Anand et al in 2019 gives the same conclusions as ours. Their study was about the correlation between hearing loss and levels of HbA1c and shows that people with increased HbA1c were more prone to hearing loss (97%) in comparison to people with normal HbA1c (35%).[7] In a study conducted by Khalid Al et al., it was discovered that hearing loss is produced by 8th cranial nerve damage, either in the periphery or at the cochlea. [17]

The current study also noted a close link between vertigo, tinnitus, and hearing loss, while the study conducted by Sunita M. also suggested the same result.[13] These results were also verified by a study conducted by Mura M. [14] It was concluded that diabetes mellitus usually leads to hearing loss, tinnitus, and vertigo. In the study conducted by Mousavi SHG, it was detected that diabetes mellitus causes neuronal damage and vascular impairment to dilate, which leads to hearing loss and vertigo. [18]

DECLARATIONS

Authors contributions
Syed Farhan Uddin: Conception and design, Experimentation, Manuscript write-up, Final approval of the article.

Kiran Waheed: Manuscript write-up

Habib-ur-Rahman Chohan: Data collection

Naila Noor: Data Collection

Jamshed Warsi: Statistical analysis,

Syed Zain Ul Abdeen; Data collection
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