Original Article
DOI: https://doi.org/10.70749/ijbr.v3i7.2221

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://ijbr.com.pk
ISSN: 2960-2793/ 2960-2807

Effect of Diabetes Mellitus on the Sensorineural Hearing Loss

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ARTICLE INFO

Keywords: Sensorineural Hearing Loss, Diabetes Mellitus, Hba1c, PTA, Risk Factors, Complications.

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Declaration
Authors' Contribution
All authors equally contributed to the study and approved the final manuscript

Conflict of Interest: No conflict of interest.

Funding: No funding received by the authors.

Article History
Received: 13-06-2025 Revised: 02-07-2025
Accepted: 13-07-2025 Published: 15-07-2025

ABSTRACT

Diabetes mellitus (DM) is a chronic, long-term disease causing consistently elevated blood glucose levels due to inadequate insulin production, targeting people of all ages, genders, and geographical areas worldwide. DM raises the incidence of sensorineural hearing loss (SNHL) in adult population. The present cross-sectional and observational study is focused on the prevalence of DM, its impact on hearing ability, complications, and risk factors that contribute to the chronic condition of DM across the population of city Rawalakot, Azad Jamu & Kashmir. The status of DM and hearing ability were evaluated using a combination of HbA1c and pure tone audiometry (PTA) test, respectively, while data on the risk factors and complications were collected via questionnaire. The results of the present study suggested that out of 200 individuals, 60% were diabetic and 40% were non-diabetic. The results of the present study suggested a significant increasing trend in DM prevalence with age. Females have a higher prevalence (55%) compared to males (45%). The present study suggested a strong correlation between SNHL & diabetes ($P < 0.05$). Severe hearing loss is prevalent in both genders, with females having a higher prevalence rate (56%) compared to males (51%). Prolonged diabetic duration (>9 years) and poor glycemic control (HbA1c>8) adversely affected the hearing ability. DM is strongly linked ($P> 0.05$) to various health related complications, including retinopathy, nephropathy and urinary tract infections. Moreover, hypertension, anxiety, stress, and a sedentary lifestyle are significant risk factors for DM. Early diagnosis, preventive interventions, time-to-time blood glucose monitoring, and regular hearing assessment are needed for preventing and managing DM and SNHL.

INTRODUCTION

Diabetes mellitus (DM) is an adverse, long-term condition typified by consistently excessive blood glucose levels resulting from inadequate insulin synthesis. DM affects individuals of all ages, genders, and geographic locations and is one of the major causes of fatality and morbidity globally (Lancet, 2023; Hussain et al., 2024). There are two main types of DM. Type 1 diabetes mellitus (T1DM) requires insulin injections because of the autoimmune disease that can destroy beta-pancreatic cells, impairing insulin production (Alvarenga et al., 2005; David et al., 2015). T2DM, a complex metabolic disease, is characterized by hyperglycemia, which is caused by concurrent insulin resistance. Its prevalence is rapidly increasing as a result of rising average life expectancy, rising obesity rates, and westernizing lifestyles in developing nations (Hossain et al., 2007; De Rosa et al., 2018). Based on the estimates from the World Health Organization (WHO), this condition affects 422 million people worldwide and that figure is predicted to be double in 2030.

The bulk of morbidity and death among diabetic patients is caused by complications associated with the DM (Tripathi and Srivastava, 2006; Chamine et al., 2022). Microvascular and macrovascular are the two primary types of diabetes long-term complications (Deshpande et al., 2008; Papatheodorou et al., 2018). Macrovascular conditions, such as peripheral artery disease, coronary heart disease, and stroke, as well as microvascular disorders like diabetic nephropathy, retinopathy, and peripheral neuropathy, are complications that have historically been linked to DM (Fowler, M. J., 2008; Shah et al., 2015; Tomic et al., 2022). The link between DM and HL is receiving considerable attention these days. According to several studies, DM raises the incidence of SNHL in adult people (Oh et al., 2014; Deng et al., 2023). DM can cause microvascular damage and raise blood viscosity as well as thrombotic episodes. These microvascular damages can affect the inner ear, leading to a condition called SNHL (Chen et al., 2019; Chen et al., 2025). The effects of diabetes mellitus on the ear can range from a decreased quality of life to an increase in mortality. These effects can include the inability to recognize sound, the danger of falling, and the development of tinnitus. Even though research on DM and HL sometimes reveals a correlation, determining

causality is frequently challenging. Few studies have showed the pathophysiological link between DM and HL since there is no appropriate animal model of the disease, and human cochlear tissue cannot be accessed *in vivo* (Feeny et al., 2012; Gioacchini et al., 2023). By 2050, at least 700 million people globally are predicted to have some kind of hearing loss, with aging being a significant contributing cause. Finding possible risk and prevention factors is crucial because there are presently no medications that can cure SNHL or restore normal hearing (Lin et al., 2010; Chen et al., 2025). Several studies showed that DM is correlated with several microvascular issues. According to several studies, microangiopathy may be the cause of SNHL in diabetic individuals (Mohammed et al., 2024; Kumar et al., 2024). While hearing loss is quite frequent in the elderly, it is nearly twice as common in individuals with diabetes. Additionally, several studies showed that a significant number of diabetic individuals had hearing impairment, indicating that DM may be a possible factor for hearing impairment in and of itself, supporting safeguards for this disease in these patients (Calvin and Watley 2015; Konrad-Martin, et al., 2015; Felício et al., 2018). Elangovan and Spankovich, (2019) reported that over a century has been spent researching the connection between DM and the vestibular system. The majority of population-based studies on hearing loss in people with diabetes (PWD) have found a bilateral, high-frequency SNHL that progresses slowly. There is still much to learn about the precise processes behind the degenerative alterations of the inner ear and the auditory nerve, despite the expanding body of research on the pathophysiology of DM related HL utilizing a variety of animal models and other human investigations. Keeping in view the high prevalence of DM and associated risk factors, the present study was designed to evaluate the impact of of DM on the sensorineural hearing loss in different age groups and gender.

MATERIALS AND METHODS

A total of 200 patients (100 males and 100 females) were randomly selected from the department of ENT, Civil-Military Hospital, and Ali-Emran Hospital, Rawalakot, Azad Jamu & Kashmir. The patients were categorized into age groups viz: 20-29 years, 30-39 years, 40-49 years, 50-59 years, and 60-70 years consisted of both diabetic and non-diabetic individuals. As a part of a comprehensive investigation, the presence of auditory deficiencies among individuals with diabetes was assessed using a combination of audiometric and otological tests, with the HbA1c test serving as a complementary measure to evaluate the patient's glycemic control and hearing ability. Venous blood samples were collected from the cubital veins of the patients to measure their HbA1c levels. Patients with reduced hearing ability were underwent an examination using an otoscope.

The PTA was conducted in a portable, sound treated room to minimize external noise interference. Clinical diagnostic audiometer was used to assess pure-tone hearing detection thresholds. The audiometer was calibrated in accordance with the criteria of American National Standards Institute and had a soundproof booth. In a double-walled audio booth, the pure-tone air and bone conduction range between (500–4000 Hz) thresholds were evaluated using a clinical PTA. The average PTA thresholds for air conduction at 500, 1000, 2000, and 4000 Hz were calculated using the formula PTA/4 = (threshold at 500 Hz + 1000 Hz + 2000 Hz + 4000 Hz)/4. The intensity range for each frequency was 10 to 120 dB hearing loss. By monitoring the patient's response to varying intensities at each tested frequency, the hearing thresholds of the patient were documented. For both ears, pure-tone air conduction thresholds were evaluated in dB hearing level. The degree of hearing loss in afflicted people was measured by using the World Health Organization's (WHO) defined criteria. A pure-tone average of thresholds > 25 dB in both the right and left ears was used to identify hearing loss. Data on the complications and prevalence of diabetes were collected via interviewer administered questionnaire. The information on the clinical evaluation, including age, gender, body mass index (BMI), use of medicine, diabetic duration, smoking status, risk factors, family history, and other complications were gathered via questionnaire. Patients with a history of ototoxic drug use, ear diseases, ear surgery, ear trauma, ear infections, exposure to loud noises, a family history of hearing loss, smoking, alcohol use, or other conditions that could impair hearing function were excluded from the present study.

Statistical Analysis

Data on the relationship between diabetes and SNHL with respect to age and gender were analyzed by ordinal logistic regression using SPSS. The prevalence of diabetes with respect to age and gender was analyzed via percentage. Descriptive statistics were used to summarize the participant clinical, and audiometric data. The risk factors and complications of diabetes were analyzed by ANOVA. Significant value was set at $P < 0.05$.

RESULTS

Results of the present study suggested that 60% individuals including both genders were diabetic with T2DM being the most common (87.5%) and only 12.5% individuals have T1DM. Most diabetic individuals had the DM duration for 5–8 years (30%) or 1–4 years (24.5%), while only 5.5% had it for 9–12 years. Poor glycemic control was evident, as 60% had HbA1c levels ≥8, while only 40% had HbA1c levels ≤8. A positive family history of DM was seen in 62% of participants. Regarding treatment, 22% individuals were on medication, 20.5% were using insulin, and 57.7% were reported to have no treatment. Notably, participants showed SNHL, with both right ear (R.E) having mean range of 48.23 dB and left ear (L.E) have means 50.5 decibels that indicates that the left ear was more effected than right ear. (Table 1).

Table 1. Prevalence, duration and clinical characteristics of diabetic individuals of population of City Rawalakot, Azad Jamu & Kashmir

Parameters	Category	Frequency	Percentage (%)
Genders	Male	100	50.0
	Female	100	50.0
Age group	20-29	41	20.5
	30-39	31	15.5
	40-49	39	19.5
	50-59	27	13.5
	60-70	62	31.0
DM status	Diabetic	120	60.0
	Non-diabetic	80	40.0
Types of Diabetes	Type 1 diabetes	15	12.5
	Type 2 diabetes	105	87.5
DM Duration	1-4 years	49	24.5
	5-8 years	60	30.0
	9-12 years	11	5.5
HbA1c level	≤8	80	40.0
	≥8	120	60.0
Family History	Yes	124	62.0
	No	76	38.0
Medication Use	Medicine	44	22.0
	Insulin use	41	20.5
	No	115	57.7
Sensorineural Hearing Loss		200	100
R.E dB		200(48.23)	100
L.E dB		200 (50.5)	100

Prevalence of Diabetes Mellitus among the Population of City Rawalakot, Azad Jamu & Kashmir

The results of the present study suggested a distinct trend: as people age, the percentage of non-diabetic people falls, while the prevalence of diabetes rises in both genders. The prevalence of DM in different genders and age group are shown in Figure 1. The present study shows that out of 200 individuals, 60% were diabetic individuals and 40% were non-diabetic individuals. Results of the present study suggested that females were more affected (55%) with DM compared to males (45%). 55 Moreover, 75% males in the age group of 20–29 years were non diabetic whereas 25% males were diabetic. Females in the same group, 32% do not have diabetes, and 68% do have diabetes. This suggests that the proportion of females with diabetes is much greater than that of males, especially in the younger population. The prevalence of male diabetic individuals was 35% of the population under the age group 30-39, whereas non-diabetic individuals comprise 65%. However, 33% of women were non diabetic, whereas 67% of them do have diabetes. Male diabetic individuals increase to 60% while non-diabetics decrease to 40% in the 40–49 years of age range, 15% of the females in this cohort do not have diabetes, compared to 85% who do have diabetes in the same age group. In the 50–59 years age range, 77% of women have diabetes and 23% do not, whereas 65% of men have the disease and 35% do not. Men in the 60 70 age range are 63% diabetic and 37% non-diabetic, while women are a startling 88% diabetic and only 12% non-diabetic individuals. This shows that women in the age group 60-70 are more affected (88%) than males (63%). The results of the present study unequivocally demonstrate that the prevalence of diabetes rises sharply with age, with women disproportionately impacted at all age groups, given that age and gender have a strong correlation with the occurrence of DM. (Figure 1).

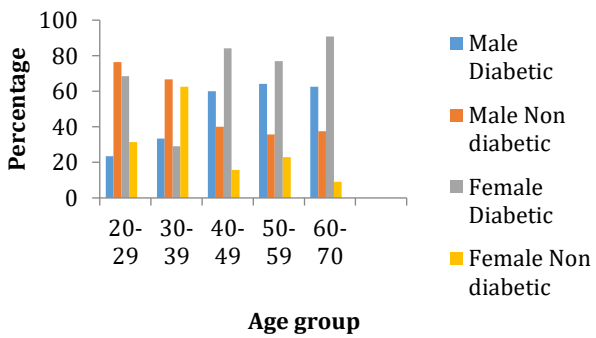

Figure 1. Prevalence of the Diabetic Population across Different Age Groups and Genders

Association between Diabetes Mellitus and SNHL across Different Age Groups

The association between DM and SNHL with respect to age and gender are shown in Table 2. The present study shows a strong association of SNHL between age, gender, duration of diabetes, family history and poor glycemic control (HbA1c > 8) of diabetic people.

Gender-Based Comparison

Out of the 120 diabetic participants, 33% diabetic individuals were female and 27.5% were males. The majority of males had moderate (31.5%) and severe (51.9%) SNHL. Comparably, 18.2% of the females had mild hearing loss, 25.7% had moderate hearing loss, and 56% had severe hearing loss. None of the females had normal hearing ability. There is a significant correlation between the degree of hearing loss and gender, as indicated by the P-value (<0.05) for both genders. Although severe hearing loss is highly prevalent in both genders, it was somewhat more prevalent in female (56%) compared to males (51%).

Age-Wise Distribution

The severity of SNHL increased as the people age. There were no occurrence of normal or mild hearing in the 20–29 years of age range (n = 17), but severe hearing loss was quite common, occurring in 13 (76.5%) and moderate in 4 (23.5%). The study reveals that there are no cases of normal hearing in the 30–39 years of age group (n = 10), however 40% had severe HL, 30% had moderate HL, and 30% had mild hearing loss (P < 0.05). Similar trends were seen in the 40–49 years age range (n = 28), where 25% had moderate HL and 50% had severe HL (P < 0.05).

Family History

Data on the association of family history and diabetes are shown in Table 2. The results of the present study suggested that out of 120 diabetic individuals, 86 individuals have family history of diabetes. Out of 86 individuals 62.7% were experiencing severe hearing loss. Significant value (P>0.05) a strong association between family history and diabetes.

Duration of Diabetes

Hearing ability of diabetic individuals was significantly impacted by the duration of DM (P>0.05). Moreover, HL was primarily mild to moderate among diabetic individuals having diabetes duration of 1–4 years. Individuals who have had diabetes duration of 5-8 years have severe (71.1%) HL, suggesting that the incidence of HL increased with increase in duration of diabetes. The greatest severity was seen in diabetic individuals with diabetes duration of 9–12 years, facing 81.8% severe and 18.2% moderate hearing loss. (P<0.001)

HbA1c Level

The results of present study indicates that SNHL is affected by the incidence of diabetes (P<0.05; Table 2). Severe HL was observed in diabetic individuals with >8 HBA1c (P<0.05).

Hearing loss in non-diabetic individuals

Hearing ability was assessed across different parameters in non-diabetic population that is shown in table 3. The results of the present study suggested that out of 80 non-diabetic individuals (34%) were normal, while (58.7%) had mild hearing loss. (P > 0.05). Among the female individuals (n=34), (64.7%) had mild (20.6%) had normal (11%) had moderate and only (2.9%) had severe HL. Across all age categories, mild hearing was most prevalent 54.2% individuals in the 20–29 years age group had mild loss, 25% had normal loss, and 4.2% had severe HL (P > 0.05). Similar patterns were shown in the age groups 30–39 and 40–49, where over 60% experienced moderate loss and no severity of hear loss (P > 0.05). Age group 50–59 and 60–70 years had slightly greater percentages of mild HL, around 56–63%.

Out of 80 non-diabetic individuals 76.3% individuals with a family history, experiencing mild HL and 13.2% HL, had normal hearing, and 10.5% had substantial hearing loss and no severe cases were noted (P-value-0.91). Among all non-diabetic participants 28.8% had normal hearing and 49 (61.3%) had moderate hearing based on HbA1c levels. However, 1.3% individuals had serious loss. The result of the study shows that HbA1c < 8%, indicating that there is no meaningful connection between glycemic management and hearing in non-diabetic individuals (P-value of 0.31). Table 2.

Comparison of the Severity of SNHL among Diabetic and Non-Diabetic Individuals across Different Genders and Age Groups

The variations in SNHL between diabetic and non-diabetic individuals according to age, gender, and diabetic status are shown in table 4. The results of the present study suggested that the degree of HL worsens with age in diabetic individuals. All diabetic males in the 20–29 years age range had moderate to severe HL (75%). There is no significant connection, as indicated by the left ear (P>0.05). However, with a significant right ear (P-value 0.034) mild and severe HL emerged equally in the 30- 39 years age group (25% each). However, 66.7% of people in the 40–49 age range had severe HL, and a significant correlation was shown by the left ear (P-value 0.04). In the 50–59 years and 60–70 years age groups, where 50% and 76.9% of people, respectively, had significant hearing loss, this tendency became more pronounced.

A correlation between aging, diabetes, and HL in males was confirmed by the very significant P-values in both ears in these age groups: 0.001 (left) and 0.037 (right) for 50–59 years age group, and 0.02 (left) and 0.006 (right) for 60–70 years age group. Among female diabetic individuals left ear (P-value 0.02) indicates significance association, 42.9% of people in the 20–29 years age group had mild HL and 86% had severe HL. With a left ear P-value of 0.015 and a right ear P-value of 0.03, the 30–39 years age group had a greater risk of severe hearing problem (56.3%). The Moderate HL predominated in the 40–49 years age range (50%), and while the right ear (P-value 0.05), suggesting borderline significance, the L.E P-value was 0.09 (not significant). About 65% of participants in the 50–59 years age group reported severe HL and there were significant correlations in both ears (P-value 0.001 for the left and 0.04 for the right). However, 65 % of individuals have severe HL among the 60–70 years age group of diabetic females, even though 46.2% had mild and 15.4% had moderate HL. However, a p-value of 0.04 for the right ear indicated considerable significance.

As compared to diabetic peoples the prevalence of

moderate to severe HL was much lower in males and females without diabetes. In every age category, the majority of non-diabetic males and females had normal to mild HL. There was no significant correlation between non-diabetic status and SNHL, as indicated by P-value > 0.05. As shown in table 4 P-values for left and right ears were 0.67 and 0.84, respectively, indicating no significant connection in non-diabetic males within the age group 60–70, despite the appearance of some mild cases. Similarly, all P-values (0.72, 0.74, 0.87, and 0.78) indicating that non-diabetic females, irrespective of age, had moderate or no HL (Table 3).

Comparison of Age, Family History and HbA1c in Diabetic and Control Group

The mean age of the diabetic group was 49.9 ± 15.09 years, which was significantly higher than that of the control group (40.1 ± 15.06 years, P-value 0.001*), indicating that advancing age may be associated with a greater risk of developing diabetes. In terms of family history, diabetic individuals showed a mean score of 1.28 ± 0.45, which was significant (P-value 0.01), suggesting that a positive family history plays a notable role in the onset of this chronic condition. Although the control group had a slightly higher mean of 1.52 ± 0.50, the association was not significant (P-value 0.06). Furthermore, HbA1c levels were elevated in the diabetic group (8.83 ± 2.20, p = 0.001*), confirming poor long-term glycemic control. In contrast, the control group maintained normal HbA1c levels (5.59 ± 0.439) with no significant variation (P-value 0.887 > 0.05), indicating stable blood glucose regulation in non-diabetic individuals. These findings highlight age, family history, and elevated HbA1c as significant indicators in diabetic patients (Table 4)

Table 2. Association between Diabetes Mellitus and SNHL across Different Age Groups

Parameters	Diabetic Status	Total Subject (120)	Normal (%)	Mild (%)	Moderate (%)	Severe (%)	P-Value
	Diabetic						
Gender							
Male		54(27.5)	1 (1.9)	8 (14.8)	17 (31.5)	28(51.9)	0.01
Female		66(33)	0 (0)	2 (18.2)	17 (25.8)	37 (56)	0.01
Age Groups							
20-29		17(0.8)	0 (0)	0 (0)	4 (23.5)	13(76.5)	0.01
30-39		10(0.5)	0 (0)	3 (30)	3 (30)	4 (40)	0.01
40-49		28(14)	1(3.6)	6 (21.4)	7 (25)	14 (50)	0.01
50-59		19(0.9)	0 (0)	3 (15.8)	8 (42.1)	8 (42.1)	0.001
60-70		49(24.5)	0 (0)	8 (17.4)	12 (26.1)	26(56.5)	0.001
Family History		86(43)	1 (1.2)	12 (14)	19 (22.1)	54(62.7)	0.01
DM Duration							
(1-4) years		49(24.5),	0 (0)	17(34)	19(38.8)	13(26.5)	0.014
(5-8) years		59(29.5)	1 (1.7)	3(5.1)	13(22)	42(71.1)	0.09
(9-12) years		11(0.5)	0 (0)	0 (0)	2(18.2)	9 (81.8)	0.001
HbA1c >8		65(32.5)	1 (1.5)	6 (9.2)	17 (26.2)	41 (63)	0.001
	Non-diabetic						
Gender							
Male		46(23)	16(34.8)	27(58.7)	3(6.5)	0(0)	0.45
Female		34(17)	7 (20.6)	22 (64.7)	4 (11)	1 (2.9)	0.89
Age Group							
20-29		24(12)	6 (25)	13 (54.2)	4 (16.7)	1 (4.2)	0.76
30-39		21(10)	6 (28.6)	13 (61.9)	2 (9.5)	0 (0)	0.82
40-49		11(0.5)	2 (18.2)	9 (81.8)	0 (0)	0 (0)	0.99
50-59		8(0.4)	3 (37.5)	5 (62.5)	0 (0)	0 (0)	0.75
60-70		16(0.8)	6 (37.5)	9 (56.3)	1 (6.3)	0 (0)	0.14
Family History		38(19)	5 (13.2)	29 (76.3)	4 (10.5)	0 (0)	0.91
HbA1c ≤8		80 (40)	23(29.1)	48 (60.8)	7 (8.9)	1 (1.3)	0.31

Table 3. Comparison of the Bilateral SNHL among Diabetic and Non-Diabetic Individuals across Different Genders and Age Groups

Gender	Age Groups	DM status	Sensorineural Hearing Loss				p-value	
			Normal %	Mild %	Moderate %	Severe %	Left ear	Right ear
		Diabetic						
Male	20-29		0 (0)	0 (0)	1 (25)	3 (75)	0.13	0.034
	30-39		0 (0)	0 (42.9)	2 (66.7)	1 (33.3)	0.64	0.23
	40-49		1 (8.3)	3 (25)	3 (25)	5 (41.7)	**0.05**	0.48
	50-59		0 (0)	0 (0)	3 (33.3)	6(66.7)	**0.04**	0.037
	60-70		0 (0)	5 (19.2)	8 (30.8)	13 (50)	**0.001****	0.006
Female	20-29		0 (0)	0 (0)	3 (23.1)	10(86.9)	**0.02**	0.713
	30-39		0 (0)	3 (42.9)	1 (14.3)	3 (40)	0.15	0.76
	40-49		0 (0)	3 (18.8)	4 (25)	9 (56.3)	0.015	**0.05***
	50-59		0 (0)	3 (30)	5 (50)	2 (20)	0.09	**0.04***
	60-70		0 (0)	3 (15)	4 (20)	14 (65)	**0.001****	**0.04***
		Non-Diabetic						
Male	20-29		5(38.5)	6 (46.2)	2 (15.4)	0 (0)	0.62	0.31
	30-39		3 (50)	3 (50)	0 (0)	0 (0)	0.66	0.74
	40-49		2 (25)	6 (75)	0 (0)	0 (0)	0.82	0.67
	50-59		2 (40)	3 (60)	0 (0)	0 (0)	0.68	0.73
	60-70		4(28.6)	9 (64.3)	1 (7.1)	0 (0)	0.99	0.84
Female	20-29		1 (9.1)	7 (63.6)	2 (18.2)	1 (9.1)	0.67	0.97
	30-39		3 (20)	10(66.7)	2 (13.3)	0 (0)	0.72	0.74
	40-49		0 (0)	3 (100)	0 (0)	0 (0)	0.67	0.87
	50-59		1(33.3)	2 (66.7)	0 (0)	0 (0)	0.89	0.65
	60-70		6(50)	0 (0)	3(20)	0 (0)	0.45	0.78

Table 4. Comparison of Age, Family History and HbA1c in Diabetic and Control Group

Parameter	Diabetic Group (n=120)	p-value	Control Group (n=80)	p-value
Age	49.9 ± 15.09	0.001***	40.1 ± 15.06	0.449
Family History	1.28± 0.45	0.01*	1.52± 0.50	0.06
HbAIc	8.83 ± 2.20	0.001***	5.59 ± 0.439	0.887

Prevalence of SNHL in Female Population across Different Age Groups

The incidence of SNHL in female population and its age group is shown in Figure 2. The results of the current study show a clear trend of SNHL in female diabetic individuals of all age groups. The females diabetic individuals is age group 20-29 years: were experiencing mild moderate and severe HL, only few of females have normal hearing suggests that hearing problems might sometimes start early in diabetic individuals. The majority of females in the 30–39 year age group had mild HL, with the remaining 12% falling into each of the following categories: normal, mild, moderate, and severe. This indicates that more than half of the women in this category already have moderate HL. The degree of HL rises for females aged 40-49, majority of them experiencing severe HL, and few of the females have normal hearing. Female under 50–59 year age range have mild (15%) and moderate HL (15%), few of cases also experiencing severe HL. The majority of females under the 60-70 years age group have severe HL. A very few individuals in this age range have normal hearing, which indicates a sharp reduction in auditory ability in diabetic population.

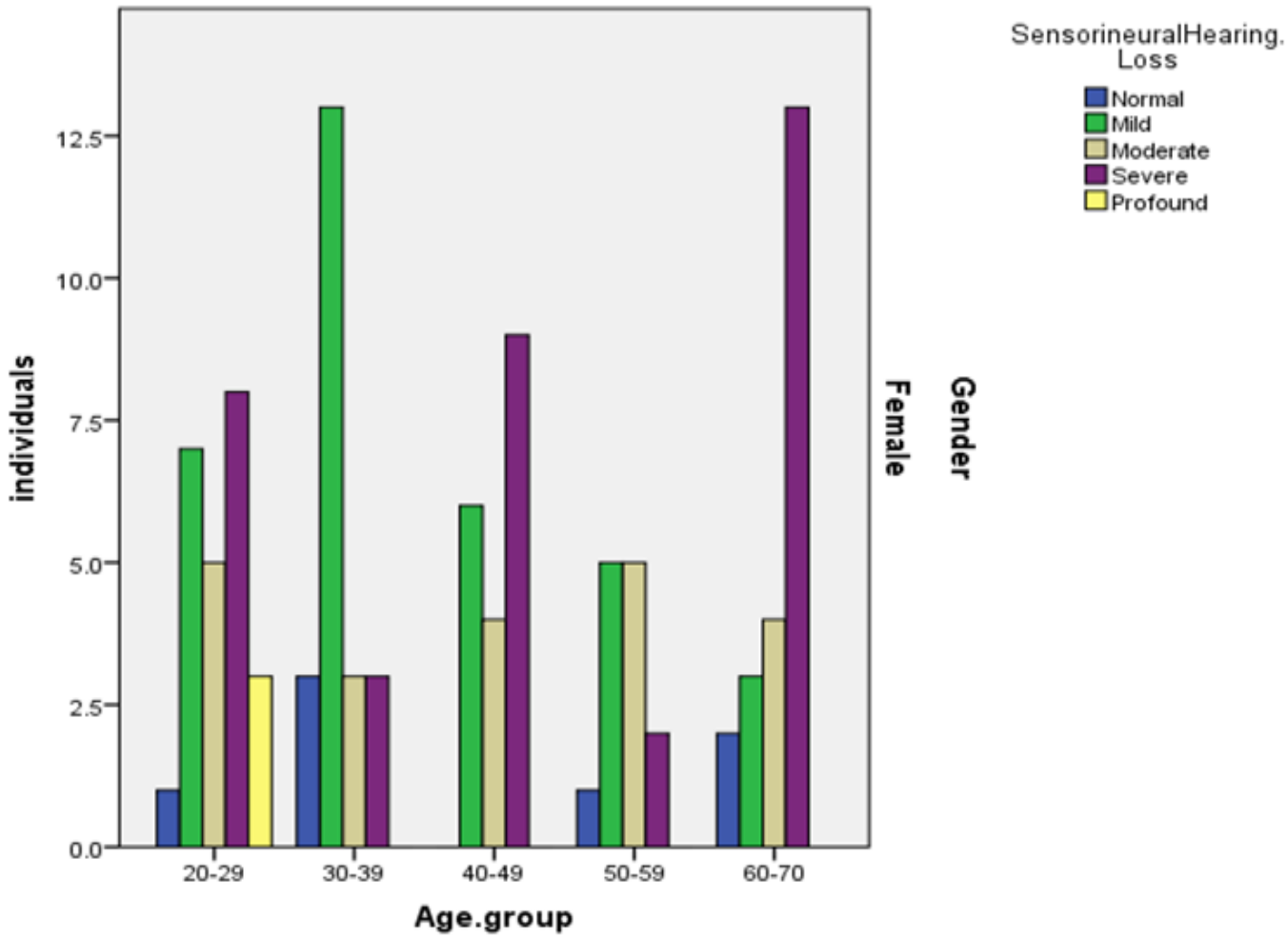

Figure 2. Prevalence of SNHL among Female Population of Different Age Group

Prevalence of Sensorineural Hearing Loss among Male Population of Different Age Groups

Prevalence of SNHL across the different age groups among male population shown below in Figures 3 The result of the present study shows that male under the age group 20-29 years had a comparatively healthy hearing profile, except few mild (32%) and 16% have mild and severe HL. Individuals in age group 30-39 year age group have majority of mild HL, few of cases have severe hearing loss. Male under the 40–49 year age group had mild HL, compared to 39% with mild and 22% with severe hearing loss and 33% of men in the 50–59 age range have severe hearing loss, whereas 17% of people have mild or moderate hearing loss. The most severe kind of HL was reported in the oldest age group 60–70 years have by severe (51.2%) closely followed by mild (42%) HL. Only few of the individuals in this age category have normal hearing. The result of the study shows that age is highly correlated with SNHL severity in male populations.

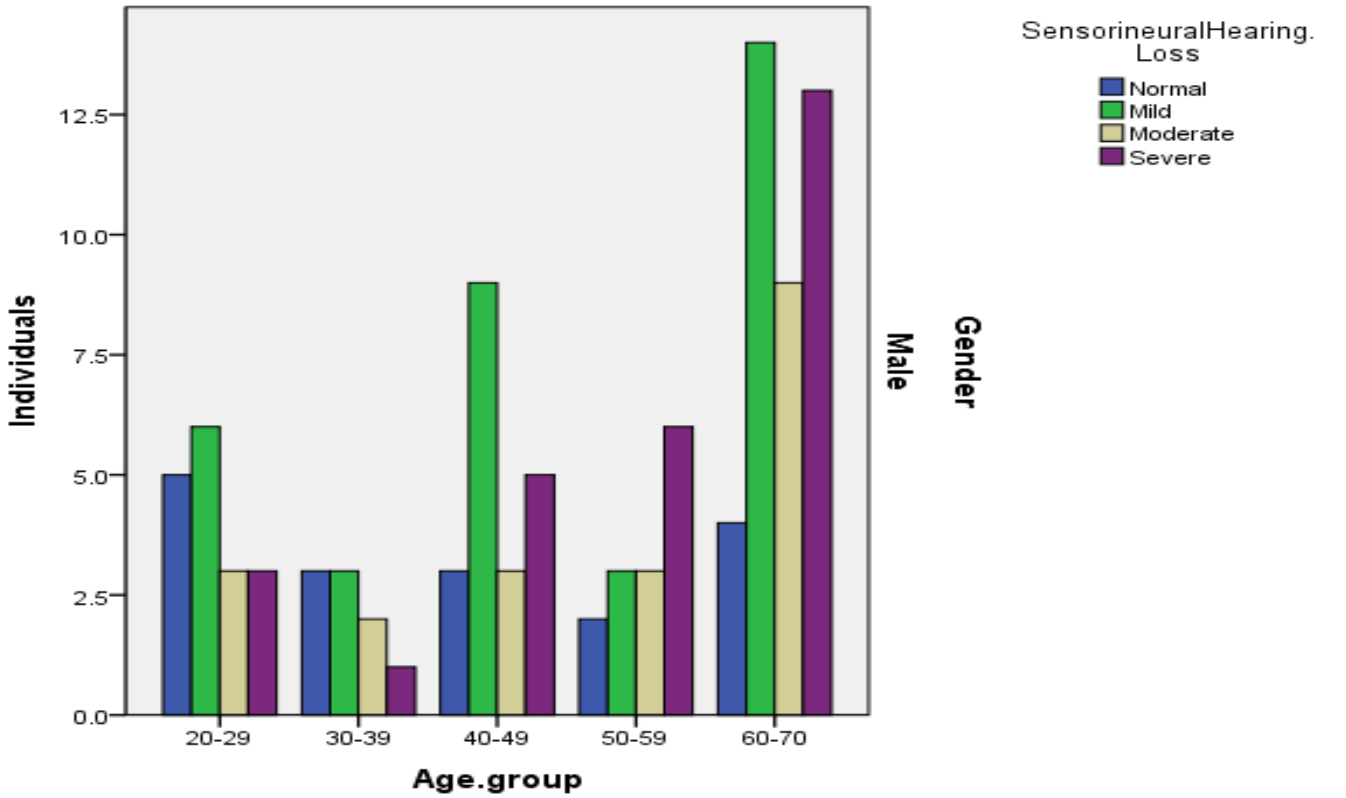

Figure 3. Prevalence of SNHL across different Age Groups among the Male Population

Risk Factors and Complications Affecting the Diabetic Population of the City Rawalakot, Azad Jammu and Kashmir

Data on the risk factors and complications affecting the diabetic population are shown in Table 6. The result of the present study shows that there is significant associations between diabetes and several complications and risk factors, as indicated by the F and P values. Retinopathy shows a significant relationship with diabetes (F = 21.544, P < 0.001), suggesting that individuals with diabetes are more prone to developing eye-related issues. SNHL also presents a strong association (F = 26.221, P < 0.001), indicating that diabetes may contribute to auditory complications. However, liver disease is non-significantly linked to diabetes (F = 9.011, P >0.05), Nephropathy demonstrates the highest F-value (F = 42.626, P < 0.001), emphasizing a strong correlation between diabetes and kidney damage. Urinary tract infections 76 77 (UTIs), (F = 16333), still show a significant link with diabetes (P 0.05), but it was somewhat effecting diabetic individuals. Inactive life style factors and metabolic conditions, including hypertension (F = 13.099, P < 0.01), have all been shown to have significant associations with diabetes, except hypercholesterolemia (F = 3.099, P value=0.80), Results indicates that diabetes both worsens existing health issues and is influenced by these chronic conditions. Moreover, anxiety (F = 17.16, P < 0.03) and stress (F = 26.03, P =< 0.05), emphasizing the importance of exercise in the prevention or management of diabetes.

Table 6. Analytical results for Various Risk Factors and Complications of Diabetic Individuals

Parameters	F value	P-value
Retinopathy	21.544	0.001***
Sensorineural Hearing Loss	26.221	0.001***
Liver disease	9.011	0.871
Nephropathy	42.626	0.001***
UTI	16.333	0.01**
Cardiovascular Disease	8.9311	0.793
High B.P	13.099	0.01**
High Cholesterol	17.83	0.183
Anxiety	17.16	0.03**
Stress	26.03	0.05**
Inactive lifestyle	7.960	0.05**

Comparison of Various Risk Factors of DM Among Different Genders and Age Groups

The youngest age range 20-29 years, of all female respondents reported a larger figure for every ailment at approximately 25, while male respondents registered roughly 17 cases for every ailment. The study suggested that women in this early age bracket suffered approximately 32% more cases than men. In the 30-39 age group, women continued to report more cases, approximately 22 per ailment, while men reported only 9, indicating that women suffered almost 59% than female individuals. In the 40-49 age range, the number of cases across genders was almost identical. Both males and females appeared to show around 19 to 20 cases each, suggesting equilibrium in the distribution of health problems among the two genders. Preceding the 60-70 years age group, both males and females in the 50-59 range exhibited some decline, with each reporting an approximate 14-15 occurrences per condition. However, there is a notable increase in males, having approximately 40 cases per condition. Females have comparatively fewer at 24 cases, resulting in the 79 understanding that older males have a 40% increase in medical cases as compared to the females within the same age bracket. All complications do worsen with age, increasing most significantly in older males. Factors suggesting that Health conditions are chronic are cohesive within gender and age categories. The distribution of high blood pressure, high cholesterol, anxiety/depression, stress and physical activity, are the myriad of multifaceted health issues with age and gender are shown in Figure 4

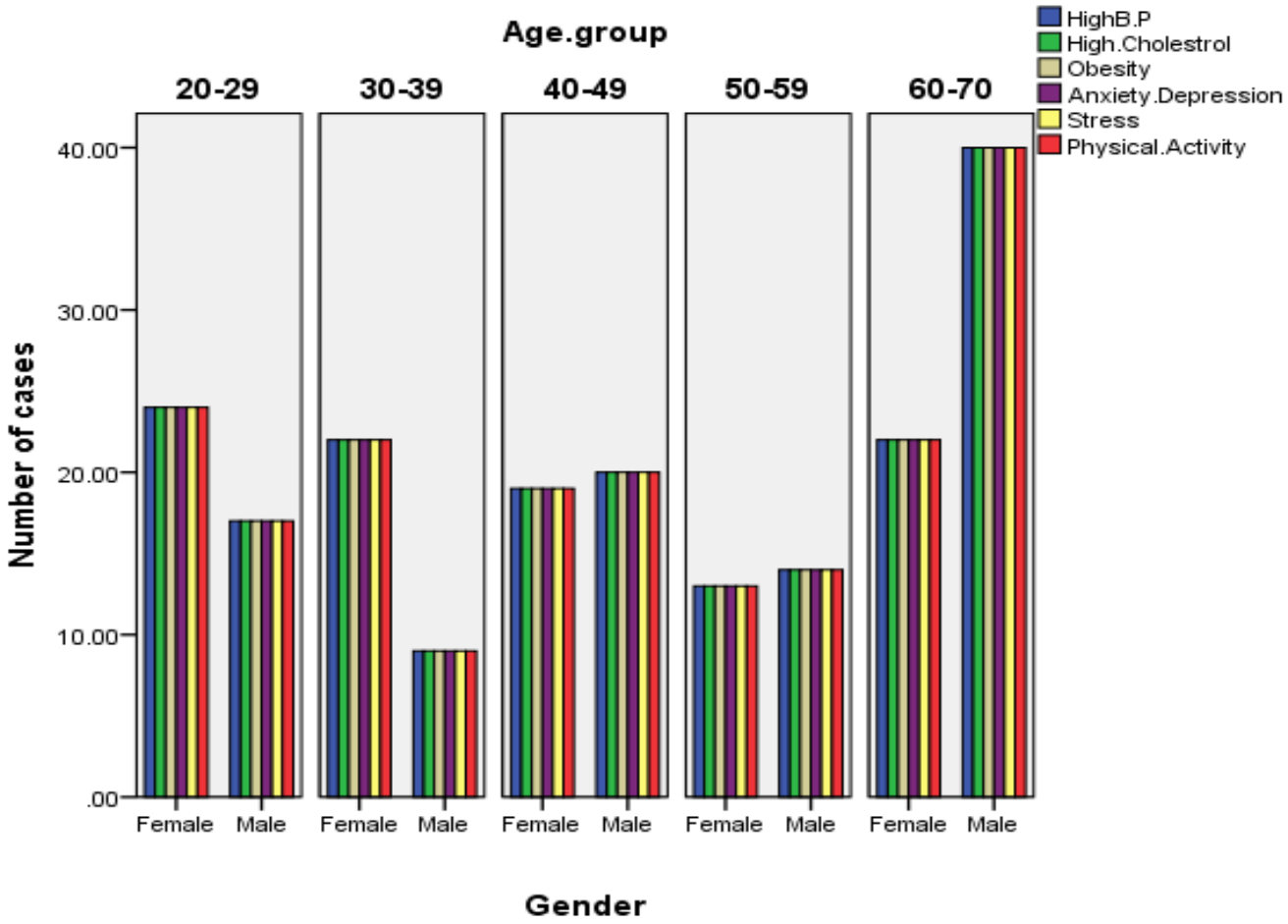

Figure 4. Risk Factors Affecting Diabetic Population Across Different Age Groups and Gender

DISCUSSION

Diabetes mellitus affects every system in our bodies and is a prevalent non-communicable metabolic disorder. Diabetes mellitus is growing increasingly prevalent in the general population, and the medical community have to pay close attention to the consequences diabetes has on our body's numerous organs. Diabetes mellitus, which was formerly more prevalent in wealthy nations, is becoming more prevalent in our nation as well. Any area of the body may experience difficulties from DM to varying degrees. Therefore, everyone must be aware of these consequences in order to take the appropriate precautions to avoid them and enable people with diabetes to have relatively fulfilling lives. One of the key unique senses that provides us with and enhances our daily lives is hearing. Our ability to hear allows us to communicate with others, work, and make money. A vital component of speaking is hearing. It enables us to live contentedly and without limitations. A hearing impairment will negatively impact a person's quality of life by interfering with their social and personal lives.

The present study included 200 participants with an equal gender distribution of 100 males and 100 females. A total of 60% individuals including both genders were diabetic with T2DM being the most common (87.5%) and only 12.5% individuals have T1DM. Most diabetic

individuals had the DM duration for 5–8 years (30%) or 1–4 years (24.5%), while only 5.5% had it for 9–12 years. Poor glycemic control was evident, as 60% had HbA1c levels ≥8, while only 40% had HbA1c levels ≤8. A positive family history of DM was seen in 62% of participants. Regarding treatment, 22% individuals were on medication, 20.5% were using insulin, and 57.7% were reported to have no treatment. The average age of the diabetic group was significantly older (49.9 ± 15.09 years) than the control group (40.1 ± 15.06 years) with a highly significant P-value (< 0.001).

According to the previous study reported by Asgar et al. (2024) that people with T2DM had a significant prevalence of SNHL. But severity of SNHL was not related to the duration of DM and family history of diabetes. The results of the present study are in contradiction to the previous study reported by Asgar et al. (2024). Those with a family history of diabetes (p< 0.01) are more likely to experience SNHL. The severity of SNHL rises with the duration of diabetes; people who have had diabetes duration (>9 years have the greatest rates. Additionally, individuals who have poor glycemic control (HbA1c > 8) are experiencing moderate to severe hearing loss. The elevated blood glucose levels and prolonged diabetic duration may contribute to the degeneration of auditory nerve, which transmits the sound to the brain. Such neural damage can result in SNHL. Previous study Babu et al. (2024) reported that SNHL is linked to diabetes affects around 90% of individuals. Those individuals with adequate glycemic control had either normal hearing or moderate HL (37%), while those with uncontrolled glycemic control (HbA1c levels >8%) had a greater degree of severe HL (31%). The results of the present study are in line with previous study reported by Babu et al. (2024). Those with a family history of diabetes (p< 0.01) are more likely to experience SNHL. Study reported by Srinivas et al. (2016) shows that there is no remarkable correlation between the gender of DM patients and their hearing loss. The results showed that there is a strong interaction between SNHL and the longer duration, older age group, and uncontrolled DM (HbA1c>8). The result of the present study is in contradiction with the previous study that although both genders have SNHL but females are experiencing more severe SNHL (56%) than male diabetic individuals (51.9%).

At the same time present study supported the previous study that the severity of SNHL rises with the diabetes duration (>9 years). Additionally, individuals who have poor glycemic control (HbA1c > 8) are experiencing moderate to severe hearing loss. The reason may be that the pathophysiological alterations and micro vascular degeneration caused by DM affect auditory-vestibular architecture and function in diabetic individuals. At the same time, the results show that anxiety and depression seem to be more prevalent among female diabetics. So, stress and depression may be the risk factors contributing to these chronic conditions. Another reason may be the inactive lifestyle that was prominent in the 60-70 age group, around 43.5% of the female population was inactive. A more comprehensive understanding of the connection between diabetes and hearing loss may be possible in the future if all diabetic patients are screened for hearing loss in a multicentric longitudinal research. To avoid hearing loss, diabetic people might be counseled to maintain adequate control over their blood sugar levels.

CONCLUSION.

The present study investigated the effect of DM on SNHL among different age groups and genders of the population of city Rawalakot Azad Jamu & Kashmir. Moreover, the complications and probable risk factors of DM were also investigated. Results of the present study suggested a strong association between DM and SNHL in both genders. Females have the most prevalent SNHL compared to males, but the percentage of hearing loss increases with age in both genders. Prolonged diabetic duration (>9 years) and poor glycemic control (HbA1c >8) adversely affected the hearing ability of individuals. People who have had the disease for often linked with complications such as retinopathy and nephropathy, UTI, heart and liver issues. The findings suggested that more severe hearing loss is associated with hypertension and stress, emphasizing the need for regular hearing tests among diabetic patients. The prevalence of DM rises sharply with age in both genders. Results suggested that females are more affected by DM compared to males, moreover, retinopathy and nephropathy were highlighted health-issues as compared to the non- diabetic population. A sedentary lifestyle also emerges as a significant risk factor, highlighting the crucial role of regular exercise in managing diabetes. Effective management and control of diabetes-related health concerns depend on gender sensitive intervention techniques. Early diagnosis, and preventive interventions, time- to-time blood glucose monitoring, and regular hearing assessment are needed for preventing and managing DM and SNHL.

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