

Chances of Presbycusis in Minangkabau Elderly Patients with Type 2 Diabetes Mellitus Without Complications in Padang City

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ABSTRACT

Background: Presbycusis is a loss of hearing ability that occurs slowly with age. One of the risk factors that plays a role in the occurrence of presbycusis is diabetes mellitus. Diabetes mellitus is an extrinsic factor that affects cochlear blood flow and reduces nutrient transport through deoxygenation, resulting in secondary degeneration of the organ of corti and the auditory nerve. Aim: To assess the increase in the chance of presbycusis in elderly people with type 2 diabetes mellitus without complications in the Minangkabau tribe in Padang City. Method: This research is unpaired categorical analytical research with a case control design using primary data. Samples were selected using consecutive sampling technique. Data analysis used univariate and bivariate analysis using the Chi-Square test. Results: Presbycusis was most commonly found in the young elderly group, 16 people (84.2%), the gender of the presbycusis elderly was mostly female, 12 people (63.2%), the longest time diagnosed with diabetes mellitus, the most presbycusis elderly was ≥ 5 years, 13 people (68.4%), the Minangkabau tribe with the most presbycusis elderly is Jambak 5 people (26.3%). The highest audiometric description of elderly people was mild, 16 people (45.7%). The majority of elderly people experienced mild presbycusis, 10 people (30.3%). There is a significant increase in the chance of presbycusis in elderly people with type 2 diabetes mellitus without complications with $p=0.015$ and an OR calculation of 3.431. Conclusion: There was an increased chance of presbycusis in elderly people with type 2 diabetes mellitus without complications.

Keywords: Elderly, Minangkabau Tribe, Presbycusis, Type 2 Diabetes Mellitus,

INTRODUCTION

Presbycusis is an age-related hearing loss. Presbycusis is the most common cause of hearing loss in elderly adults (Bhojraj K, Peter VZ, 2022). This disorder occurs most often at the age of > 65 years and occurs in 30-45% of the elderly (Asyari A et al, 2019). Pure tone audiometry in presbycusis patients shows bilateral and symmetrical sensorineural hearing loss that begins to occur at high pitches (Savitri E et al, 2022).

Presbycusis can occur as a result of the degeneration process of the inner ear causing changes in the structure of the cochlea and N VII (Safitri M et al, 2022). This hearing loss can cause decreased speech perception, psychological changes such as depression, social isolation although some hearing functions are still good (Rolim LP et al, 2018). However, this hearing loss can limit social activities and cause severe quality of life disturbances (Ogawa T, 2018).



This incidence of presbycusis can be overcome by controlling the risk factors that cause it. Risk factors that cause presbycusis include family genetic history, gender, noise exposure, unhealthy lifestyle, comorbidities such as hypertension, and metabolic diseases. Diseases such as hypertension, diabetes mellitus can directly affect the flow of cochlear blood vessels and decrease nutrient transport due to changes in blood vessels, which results in secondary degeneration of the nervous nerves (Soepardi E et al, 2017). Based on a 2017 study in Brazil on the effects of systemic diseases that showed the results that chronic diseases that most often affect the elderly such as hypertension and diabetes mellitus may be related to the occurrence of hearing loss (Rolim LP et al, 2018).

The aging process is closely related to insulin resistance, as is the case with insulin resistance associated with Type 2 Diabetes Mellitus (DMT2). A disturbed blood glucose regulation system can result in an increase in blood glucose more than normal. Blood glucose will increase with age, so the aging process will result in more and more elderly people being at risk of DMT2 (Agoes Azwar et al, 2021).

Type 2 diabetes mellitus is a serious threat to the world, especially developing countries such as Indonesia. Diabetes mellitus is one of the main health problems in the community that has short-term and long-term complications (Saputri RD, 2020). Complications that occur due to DMT2 disease can be in the form of disorders in blood vessels, both macroangiopathy and microangiopathy. Complications of macroangiopathy generally affect the heart, brain, and peripheral blood vessels, while microangiopathy disorders can occur in the eyes and kidneys (Soelistijo Soebagijo Adi et al, 2019). Microangiopathy can occur in all blood vessel capillaries in the body of DMT2 patients. Changes that occur in the blood vessels of the inner ear due to microangiopathy are in the labyrinth, especially regarding the vascular stria, & internal auditory artery.

This microangiopathy can later cause the corti organ to experience atrophy and a decrease in hair cells. This will cause the supply of nutrients and oxygen to the cochlea to be disrupted, which leads to a decrease in hearing function (Sonia PM). A study conducted by Mishra A in 2019 on DM patients 74% of cases had sensorineural hearing loss and 26% of cases had normal hearing (Mishra A). Another study conducted by Wuwung Febrina in 2015 on DM patients 76.3% had hearing loss and 23.7% had normal hearing (Wuwung FR et al, 2015).

There is also a genetic relationship between Minangkabau individuals and the occurrence of DM. According to research conducted by Syamsurizal, et al. in 2014 stated that Minangkabau individuals with the TCF7L2 gene are 2.5 times more likely to suffer from DM compared to individuals without the gene, where the TCF7L2 gene rs7895340 variant in Minangkabau people can trigger susceptibility to DM because there is a decrease in GLP-1 secretion, which then affects insulin secretion. When the individual experiences DM, it will increase the incidence of metabolic presbycusis which occurs due to defects and vascular changes that affect the energy production process in the cochlea and vascular stria atrophy which can cause hearing loss (Buthaina, 2021).

METHOD

This research was conducted at the health center that has the largest number of elderly people in Padang City, namely the Andalas Health Center, and the Lubuk Begalung Health Center in West Sumatra Province from February 2023 to December 2023. The type of research used is observational analysis using a case control design. The sampling technique used is the consecutive sampling technique. The sample size in this study was determined by the formula of the size of the unpaired categorical analytical sample. Based on the formula, the minimum sample size in the study was 35 people in each group. The total sample of cases and controls is 70 people. The tools

used to make measurements in this study are an otoscope that is useful for assessing the condition of the ear canal and tympanic membrane of the patient, and audiometry to assess the type and degree of hearing loss.

The way this research works is to collect data from medical records and conduct an otoscopy examination to assess the condition of the ear canal and tympanic membrane. The next examination is an audiometric test to determine the presence of sensorineural deafness or presbycusis. Finally, the researcher collected and grouped the data that had been obtained Univariate analysis aimed to describe and explain the characteristics of each research variable. The data from each variable studied will be processed and analyzed and produce a frequency distribution and percentage of each variable. Bivariate analysis aims to connect two variables, namely independent variables and bound variables. The formula used is the Chi-Square test which aims to determine the relationship or influence of two variables and measure the strength of the relationship between one variable and the other.

RESULT AND DISCUSSION

A. Characteristics of Elderly People with Type 2 Diabetes Mellitus Without Complications and Elderly People Without Type 2 Diabetes Mellitus in the Minangkabau Tribe in Padang City

Table 1. Characteristics of Elderly People with Type-2 Diabetes Mellitus Without Complications and Elderly Without Type 2 Diabetes Mellitus in the Minangkabau Tribe in Padang City.

Characteristics of the Elderly	Subject n (%)	Control n (%)
Age		
Young	31 (88,6%)	33 (94,3%)
Middle Age	4 (11,4%)	2 (5,7%)
Elderly	0 (0%)	0 (0%)
Gender		
Male	11 (31,4%)	5 (14,3%)
Female	24 (68,6%)	30 (85,7%)
Long DM		
≤5 Years	20 (57,1%)	0 (0%)
≥5 Years	15 (42,9%)	0 (0%)
Tribe		
Caniago	4 (11,4%)	2 (5,7%)
Piliang	3 (8,6%)	2 (5,7%)
Jambak	5 (14,3%)	3 (8,6%)
Kampai	3 (8,6%)	2 (5,7%)
Korong Gadang	2 (5,7%)	3 (8,6%)
Parak Panjang	3 (8,6%)	3 (8,6%)
Kutia anyie	2 (5,7%)	3 (8,6%)
Lubuk Batang	1 (2,9%)	1 (2,9%)
Malayu	3 (8,6%)	3 (8,6%)
Pagacancang	2 (5,7%)	1 (2,9%)
Pauh	3 (8,6%)	3 (8,6%)
Tanjung	4 (11,4%)	7 (20%)
Koto	0 (0%)	2 (5,7%)

Source: Data Processing

Based on table 1, showing the description of the subjects of 35 respondents, the most age is the young elderly, namely 31 people (88.6%) while the intermediate elderly are 4 people (11.4%) and the advanced elderly have no respondents. Meanwhile, in the control group, the results were obtained that of the 35 respondents, the most age was the easy elderly, namely 33 people (94.3%), while the intermediate elderly were as many as 2 people (5.7%) and the advanced elderly had no respondents. Based on the gender of the respondents, the results were obtained in the subject group, namely the most gender was female as many as 24 people (68.6%), followed by male sex as many as 11 people (31.4%). Meanwhile, in the control group, the most elderly were females, which was 30 people (85.7%), followed by male sex as many as 5 people (14.3%). Based on the length of diagnosis of diabetes mellitus, the results were obtained that as many as 20 people (57.1%) with type 2 diabetes mellitus had suffered from the disease for less than 5 years, while there were 15 people (42.9%) with type 2 diabetes mellitus who had suffered from the disease for more than 5 years.

Based on the characteristics of the Minangkabau tribe, it was found in the case group that the most Minangkabau tribe was Jambak which was 5 people (14.3%) then followed by the Caniago and Tanjuang tribes as many as 4 people (11.4%), Piliang, Kampai, Parak panjang, Malayu and Pauh tribes as many as 3 people (8.6%), Korong Gadang, Kutia Anyie, Pagacancang tribe as many as 2 people (5.7%) and the smallest percentage was in the elderly of the Lubuk Batang tribe which was 1 person (2.9%). Meanwhile, in the control group, the most Minangkabau tribe was Tanjuang, which was 7 people (20%), followed by the Jambak, Korong Gadang, Parak Panjang, Kutia Anyie, Malayu and Pauh tribes as many as 3 people (8.6%), the Caniago, Piliang, and Kampai tribes, as many as 2 people (5.7%) and the smallest percentage, namely the elderly of the Lubuk Batang and Pagacancang tribes, namely 1 person (2.9%).

B. Characteristics of Elderly with Diabetes Mellitus Type-2 Without Complications and Non-Diabetic Mellitus Type 2 Elderly in the Minangkabau Tribe in Padang City

Table 2. Characteristics of Elderly with Type 2 Diabetes Mellitus Without Complications and Non-Diabetes Mellitus Type 2 Elderly in the Minangkabau Tribe in Padang City.

Characteristic	Presbycusis	No Presbycusis	Presbycusis	No Presbycusis
	n (%)	n (%)	n (%)	n (%)
Age				
Young	16 (84,2%)	15 (93,8%)	7 (77,8%)	26 (100%)
Middle Age	3 (15,8%)	1 (6,3%)	2 (22,2%)	0 (0%)
Elderly	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Gender				
Male	7 (36,8%)	4 (25%)	2 (22,2%)	3 (11,5%)
Female	12 (63,2%)	12 (75%)	7 (77,8%)	23 (88%)
Long DM				
≤5 Years	6 (31,6%)	14 (87,5%)	0 (0%)	0 (0%)
≥5 Years	13 (68,4%)	2 (12,5%)	0 (0%)	0 (0%)
Tribe				

Caniago	3 (15,8%)	1 (6,3%)	1 (11,1%)	1 (3,8%)
Piliang	1 (5,3%)	2 (12,5%)	1 (11,1%)	1 (3,8%)
Jambak	5 (26,3%)	0 (0%)	2 (22,2%)	1 (3,8%)
Kampai	0 (0%)	3 (18,8%)	0 (0%)	2 (7,7%)
Korong Gadang	1 (5,3%)	1 (6,3%)	1 (11,1%)	2 (7,7%)
Parak Panjang	2 (10,5%)	1 (6,3%)	1 (11,1%)	2 (7,7%)
Kutia anyie	1 (5,3%)	1 (6,3%)	0 (0%)	3 (11,5%)
Lubuk Batang	0 (0%)	1 (6,3%)	0 (0%)	1 (3,8%)
Malayu	3 (15,8%)	0 (0%)	0 (0%)	3 (11,5%)
Pagacancang	0 (0%)	2 (12,5%)	1 (11,1%)	0 (0%)
Pauh	1 (5,3%)	2 (12,5%)	1 (11,1%)	2 (7,7%)
Tanjung	2 (10,5%)	2 (12,5)	1 (11,1%)	6 (23,1%)
Koto	0 (0%)	0 (0%)	0 (0%)	2 (7,7%)

Source: Data Processing

Based on table 2, it shows that in the subject group, presbycusis was most commonly found in the young elderly group, which was 16 people (84.2%), while in the control group, the most presbycusis was also found in the young elderly group, which was 7 people (77.8%). Based on the gender, the most common results were found in 12 (63.2%), while in the control group the most presbycusis was female, which was 7 people (77.8%). Based on the length of diabetes mellitus, the subjects who experienced the most presbycusis were found to have 13 people (68.4%) with type 2 diabetes mellitus who had suffered from the disease for more than 5 years. Based on the Minangkabau Tribe, it was found that the most presbycusis in the subject group was the Jambak tribe, which was 5 people (26.3%), while in the control group, the most Minangkabau tribe was found to be Jambak, which was 2 people (22.2%).

C. Increased Chance of Presbycusis in Uncomplicated Diabetes Mellitus Patients

Table 3. Increased Chance of Presbycusis in Uncomplicated Diabetes Mellitus Patients

Variable	Type 2 DM without complications		OR 95% CI	P value
	Yes	Non-DM		
	n (%)	n (%)		
Presbycusis	19 (54,3%)	9 (25,7%)		
Normal	16 (45,7%)	26 (74,3%)	3,431	0,015
Total	35 (100%)	35 (100%)		

Source: Data Processing

Table 3 presenting the results of the Chi Square test analysis. The results of the analysis are presented in the form of cross-row and column tables. Based on the table, the respondents who experienced presbycusis were more likely to experience presbycusis in the uncomplicated Type 2 DM group of 19 people (54.3%) than in the uncomplicated Type 2 DM group of 9 people (25.7%). The results of the Chi Square analysis test showed that there was a meaningful relationship between uncomplicated Type 2 DM and the incidence of presbycusis (P - value 0.015). The results of the OR calculation showed that respondents who had uncomplicated Type 2 diabetes were 3.4 times more likely to develop presbycusis compared to elderly people who did not have

uncomplicated type 2 diabetes mellitus.

DISCUSSION

A. Characteristics of Elderly People with Type 2 Diabetes Mellitus Without Complications and Elderly People Without Type 2 Diabetes Mellitus in the Minangkabau Tribe in Padang City

1. Age

In this study, the age of the elderly is grouped into three categories, namely young seniors ranging from 60 years old to 69 years old, middle-aged elderly people with ages from 70 years to 79 years, and elderly people with an age of more than 80 years. The results of the study concluded that from 35 groups of subjects, the most age results were young elderly people, which was 88.6%, while 35 elderly people in the control group were young elderly, which was 94.3%. In the subject group, the most results were obtained from presbycusis in the young elderly, which was 84.2% and in the control group, the most results were obtained from presbycusis in the elderly, which was 77.8%.

A study conducted by Arief, et al. in Makassar where elderly respondents were selected from the age of more than 60 years, based on a statistical test of the age of people with diabetes mellitus to hearing loss obtained meaningful results ($p < 0.05$) (Limardjo A et al, 2014). A study conducted by Bener, et al. in Qatar where samples aged more than 50 years showed that the prevalence of hearing loss was higher in older people over 60 years old who had type-2 diabetes mellitus compared to older people who did not have type-2 diabetes (Bener A et al, 2013).

Presbycusis occurs as a result of the degeneration process. The decrease in the number of ganglion cells begins at the age of 60 years and there is a decrease in the number of hair cells by 20% at the age of 70. Damaged hair cells cannot come back. This affects the ability of the auditory system to process sound (Safitri M et al, 2022). Along with age, cell damage due to oxidative stress increases and accumulates over the years, which eventually causes the aging process of Reactiveoxygen Species (ROS) to cause damage to mtDNA and cochlear tissue protein complexes, resulting in dysfunction of the auditory organs (Putri EA et al, 2023).

As people with diabetes mellitus age, it causes impaired insulin secretion, and a gradual decrease in insulin sensitivity so that it can have an effect on glucose tolerance in the blood. The effect caused on the hearing organ in patients with type-2 diabetes mellitus is in the tunica intima, vascular walls, basilar membrane and vascular stria damage and thickening due to plaque buildup. The thickened walls of blood vessels (endothelials) cause a lack of oxygen and nutrients which has an effect on decreasing endocochlear potential and inner ear sensitivity. Damage to vascular stria cells will result in the loss of endolymphatic ion composition, where the function of vascular stria cells is useful for maintaining the composition of endolymph ions. Damage to the corticous organ caused by hyperglycemia occurs changes or loss of outer hair cells and loss of the nucleus of support cells that cause hearing loss. As people with diabetes mellitus age, the incidence of hearing loss increases (Wuwung FR et al, 2015). Although it is known that advanced age will cause the occurrence of presbycusis, for people with diabetes mellitus under the age of 50, these symptoms will appear earlier. Even though age is a confounding factor for the incidence of hearing loss in people with diabetes mellitus, diabetes mellitus itself is responsible for the occurrence of hearing loss.

Based on the Central Statistics Agency (BPS) reported, the life expectancy of the Indonesian population reached 73.93 years in 2023, while in the West Sumatra area the life expectancy of the population reached 69.90 in 2022. In line with this study, the most elderly were found in the age group of 60-69 years, and not the elderly in the age group over 80 years old (BPS Provinsi Sumatera Barat, 2022).

2. Gender

In this study, gender was categorized into 2, namely male and female, obtained from 35 groups of subjects, the most gender was obtained was female 68.6% and male 31.4%. Meanwhile, the 35 respondents in the gender control group had the most women, namely 85.7% women and 14.3% men. In the subject group, namely 35 elderly people, the most results were obtained with presbycusis, which was 57.1%, while those who did not suffer from presbycusis were the most, namely in women, 63.2%, and in the control group, which was 35 elderly people, the most results were obtained with presbycusis, namely in women 77.8%. Based on data from the Padang City Health Office in 2022, the number of visits by elderly patients at the Andalas Health Center was 3,268 people who were female while 2,966 people were men. At the Lubuk Begalung Health Center, the number of visits from female elderly patients was 2,789 people, while the number of visits from male patients was 2,531 people.

In line with research conducted by Sheetal, et al. in India stated that female patients with Type-2 DM have a greater likelihood of experiencing hearing loss compared to men. The same thing was also found in a study conducted by Srinivas, et al. in 2016 in India where it was found that female Type-2 DM sufferers experienced more sensorineural hearing loss than men (Srinivas C V et al, 2016).

Research conducted by Kim et al in Korea found that there is a significant difference in men worse than women. This difference occurs because men experience more exposure to noise, especially in the workplace, than women (No TKim S et al, 2014). Research in South Carolina USA, found that the frequency of men is 52.1% more than women 48.4% (Lin FR et al, 2013). Research conducted by Rikha & Yussy in the city of Bandung obtained the results that men suffer from presbycusis more than women. The hermeneutics of hearing loss in men have a larger number compared to women. Men experience more hearing loss at high frequencies and only slightly at low frequencies when compared to women (Fatmawati R et al, 2021).

The high incidence of DM in women is due to differences in body composition and sexual hormone levels between adult men and women. Adipose tissue is more abundant in women than in men. The difference in fat content between men and adult women is 15-20% in men while women have a fat content of 20-25% of body weight. Reduced concentrations of the hormone estrogen in menopausal women cause fat reserves, especially in the abdominal area, to increase, resulting in increased free fatty acid secretion, which is easy to accumulate and can increase the risk of women suffering from type-2 DM 3 to 7 times higher than in men.¹³ In addition, women also tend to be more at risk of developing type 2 diabetes mellitus because women have higher cholesterol than men and there are differences in physical activity and daily lifestyle which greatly affect the incidence of type 2 diabetes mellitus (Milita F et al, 2021).

3. Long Time Suffering from DM

In this study, the longtime suffering from diabetes mellitus (DM) was grouped into two categories, namely the elderly who suffered from DM ≤ 5 years old and the elderly who suffered from DM ≥ 5 years. The results of the study concluded that from 35 respondents in the subject group, the elderly who suffered from DM ≤ 5 years were the most, namely 57.1%, while the elderly who suffered from DM ≥ 5 years were 42.9%. In the case group, which is 35 elderly people, the most results were obtained from presbycusis, namely in the elderly who suffer from DM ≥ 5 years old 68.4%, while those who suffer from presbycusis in the elderly DM ≤ 5 years as much as 31.6%.

The length of time you suffer from DM will determine the severity of the complications that will be experienced. Based on the duration of the disease, the results of this study are in accordance with research conducted by Pujhi & Edy in North Sumatra

stating that the most frequent for the duration of suffering from Type-2 DM is at the duration of 0-5 years (42.3%). From several studies, it was found that there is a meaningful relationship between the length of suffering and hearing loss (Wuwung FR, 2015).

Based on research conducted by Arief, et al. in Makassar in a statistical test conducted on patients with type-2 diabetes mellitus who have suffered for more than 10 years and who have suffered from hearing loss for less than 10 years, meaningful results were obtained ($p < 0.05$). This shows that the longer a person suffers from type-2 diabetes mellitus, the higher the risk of hearing loss (Limardjo A et al, 2014). This result is in accordance with a study conducted by Mozaffari, et al. in 2013, it was reported that the average time for people with type 2 diabetes mellitus to experience hearing loss was 11.7 ± 7.6 years ($p < 0.001$). Factors that are more influential on the decrease in the hearing threshold are the occurrence of hyperglycemia and the length of time the hyperglycemia occurs. The impact of Diabetes Mellitus on tissue damage is related to the occurrence of hyperglycemia (Krismanita DN et al 2017).

The state of hyperglycemia stimulates the polyol groove which causes an increase in sorbitol due to the reduction of glucose by the enzyme aldose reductase. This accumulation of sorbitol causes neuropathy due to a decrease in myo inositol and a decrease in $\text{Na}^+ \text{K}^+$ ATPase activity. This is also in accordance with a study conducted by Bainbridge and Oluwatosin in Brazil which stated that patients with high and very high fasting blood sugar levels had a greater proportion of hearing loss incidence than patients with normal or low blood sugar (Galicia-Garcia U et al, 2020). According to research conducted by Gupta, all research subjects with blood sugar levels greater than 301 mg/dl experienced presbycusis (Krismanita DN et al, 2017). Presbycusis in patients with type-2 diabetes mellitus is included in the type of metabolic presbycusis (Strial presbycusis) where atrophy occurs in the vascular stria occur. Atrophy in vascular stria is caused by a decrease in the elasticity of blood vessels where the walls of blood vessels thicken and the lumen narrows, so this process can cause hearing loss in people with type 2 diabetes mellitus. In this metabolic presbycusis the audiogram picture is flat, it can be started at low frequencies until the minimum hearing limit exceeds 50 db (Swati Dadhich et al, 2018).

4. Minangkabau Tribe

In this study, the results were obtained in the case group of 35 elderly respondents who had the most Jambak tribe which was 14.3% and the least Lubuk Batang tribe only 2.9% and in the control group of 35 elderly respondents the most had the Tanjuang tribe which was 20% and the least tribe namely Lubuk Batang and Pagacancang 2.9%. In the subject group, namely 35 elderly people, the most results were obtained from presbycusis, namely in the Jambak tribe 26.3% and in the control group, namely 35 elderly people, the most results were obtained from presbycusis, namely the Jambak tribe 22.2%.

Based on research conducted by Syamsurizal et al., in 2014 the results were obtained that the TCF7L2 gene variant of the rs variant 7895340 found polymorphism in 28 people (42.42%) of subjects with type 2 diabetes mellitus, the TCF7L2 gene variant, the rs 7895340 variant can be used as a genetic marker of DMT2 in the Minangkabau ethnicity (Syamsurizal et al, 2014). Another study conducted by Buthaina et al in 2021 found that there was a relationship between metabolic-GRS and a higher BMI (Buthaina, 2021).

5. Uncomplicated Associations of Type-2 Diabetes Mellitus with Presbycusis Incidence

Based on this study, from 70 respondents consisting of 35 samples of patients with type-2 diabetes mellitus without complications as a case group, and 35 samples without type-2 diabetes mellitus as a control group, it was found that presbycusis were more experienced in the uncomplicated type-2 diabetes mellitus group, which was 54.3%, while in the group that did not suffer from type-2 diabetes mellitus without complications as much as 25.7%. Uncomplicated type-2 diabetes mellitus has a 3.4 times greater risk of developing presbycusis than those who do not have type-2 diabetes mellitus. The value of $p=0.015$ was obtained so that it can be concluded that the relationship between uncomplicated type-2 diabetes mellitus and the incidence of presbycusis in the elderly of the Minangkabau tribe in Padang City has a meaningful relationship.

This is in line with research conducted by Febrina, et al. in 2015 in Manado found that 23.7% had normal hearing and 76.3% had hearing loss.¹⁵ Almost the same results were obtained from a study by Baskhar et al. in 2014 in India, namely 78.2% of people with diabetes mellitus experienced presbycusis events, while 38% of non-diabetic patients did not experience presbycusis. All diabetic patients who participated in the study reported experiencing slow progressive hearing loss. In this study, diabetic patients had a higher frequency threshold (Bhaskar KN et al, 2024). Another study by Aniruddh, et al. in 2018 in India found that 96 people (76.8%) had sensorineural hearing loss and 29 others with normal hearing. The same thing was also found in a study conducted by Swati, et al in 2018 in India obtained the results of hearing status in DM patients that 73% of diabetics suffer from SNHL.

Another risk factor that can worsen hearing is metabolic diseases such as diabetes mellitus. Diabetes mellitus can cause microangiopathy of the cochlear organs, atrophy and reduced hair cells. Neuropathy in vasa nervosum nerve VIII, ligaments and spiral ganglions is characterized by Schwann cell damage, myelin degeneration, and axon damage which can result in hearing loss. Hearing loss in patients with Type 2 DM has almost the same characteristics as presbycusis, namely bilateral, progressive and sensorineural type, especially at high frequencies. The difference is that in type 2 DM the hearing loss is more severe (Edward Y et al, 2013).

Several studies have found vascular abnormalities in the inner ear that histopathologically show changes in microangiopathy, namely the formation of precipitates on the walls of blood vessels so that thickening of the walls of blood vessels occurs. This microangiopathy disorder mainly occurs in the capillaries of the vascular stria vascula, subsequently it can occur in the auditory artery of the internus, the auditory artery of the modiolus, in the vasa nervosum ganglion spirale and demyelination of the auditory nerve. The exact mechanism of this change has not yet been explained, but when it is linked to the fact that cells and tissues of the body depend on insulin for glucose transport, it seems that hyperglycemic plays a significant role in the process of occurrence.

Long-lasting hyperglycemia can spur non-enzymatic protein glycosylation reactions, which take place in various body tissues. Several clinical studies provide information on the correlation between the duration of hyperglycemia and the progression of microangiopathy in DM patients. Controlled glycemia status close to normal can inhibit and possibly even prevent microangiopathy.³⁴

Glucose is bound to proteins by non-enzymatic chemical reactions. This process begins with the attachment of glucose to the amino acid group, which continues with a series of biochemical reactions with the formation of an amadori product, the next reaction produces the final product, namely AGE's which is irreversible. In this glycosylation reaction, free radicals are formed as a result of glucose autooxidation that takes place at the time of the formation of AGE's of amadori products, which are highly

reactive oxidants that have ototoxic properties, including denaturation and aggregation effects.

Increased production of AGE's reduces the elasticity of the blood vessel wall (arteriosclerosis) and results in the binding of plasma proteins to the basal membrane, resulting in thickening of the blood vessel wall with narrower lumens. As a result of microangiopathy of the corticous organs, atrophy and reduction of hair cells will occur. Meanwhile, neuropathy occurs due to microangiopathy in the VIII nervosum nerve vasa and the spiral ligament vasa which results in spiral ganglion atrophy and denielination of nerve fibers VIII and affects the function of the hearing organ.

The buildup of free radicals such as ROS caused by personal health and lifestyle factors is the most commonly accepted mechanism in explaining the incidence of presbycusis. In the body, these free radicals will react chemically in the cell including DNA, proteins, cytosols, cell surface receptors, and membrane lipids so that they affect intracellular processes. Free radicals produced by mitochondria will induce lipid peroxidation in the cochlea by forming malondialdehyde (MDA) and 4-hydroxyonenal which are toxic to cells so that the apoptosis process occurs. The production of other vasoactive lipid peroxidase such as isoprostan causes a decrease in blood rate in the cornea so that nerve impulses are ischemic and in a long period of time will experience cell necrosis.

CONCLUSION

The characteristics of the elderly obtained were the youngest elderly, female gender, long-term suffering from diabetes mellitus ≤ 5 years, and the Jambak Tribe. The characteristics of the elderly presbycusis obtained were the youngest elderly, female gender, long-term suffering from diabetes mellitus ≥ 5 years, and the Jambak Tribe. The results of the audiometer image of the most research subjects are mild degrees. The proportion of presbycusis of the most research subjects is mild degree presbycusis. There was a significant increase in the incidence of presbycusis with the study subjects. If the elderly suffer from DMT2, the risk of presbycusis will be 3,431 times greater than that of non-DM elderly.

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