

The Relationship of Comorbidity with Hearing Loss in the Elderly in Nursing Homes

Eunike Arganta Malvin Sihaloho¹, Yuliani Mardiaty Lubis², OK Yulizal³

^{1,3}Faculty of Medicine, Dentistry, and Health Sciences, Universitas Prima Indonesia, ²PUI
Phyto Degenerative & Lifestyle Medicine, Universitas Prima Indonesia
eunikesihaloho@gmail.com, yuli_fananie@yahoo.com, yulizal.tech@gmail.com

ABSTRACT

Presbycusis, or age-related hearing loss, is a common condition among the elderly. Comorbidities such as hypertension and diabetes mellitus are hypothesized to exacerbate hearing loss through vascular and metabolic mechanisms. However, evidence regarding their direct relationship in nursing home populations remains inconclusive. This study aimed to analyze the relationship between comorbidities (hypertension and diabetes mellitus) and the type and degree of hearing loss among elderly residents in a nursing home. A cross-sectional study was conducted involving 58 elderly residents (aged ≥ 60 years) at the Binjai Elderly Social Services Unit. Blood pressure was measured and categorized according to JNC 2017 guidelines, while random blood sugar levels were assessed using a glucometer. Hearing loss was evaluated through pure-tone audiometry. Most participants had sensorineural hearing loss (56.9% in the right ear; 62.1% in the left ear), with mild to moderate severity being most prevalent. Stage 2 hypertension was identified in 41.4% of participants, while 15.5% had diabetes. Statistical analysis showed no significant correlation between blood pressure and the type or degree of hearing loss in either ear ($p > 0.05$). Similarly, random blood sugar levels were not significantly associated with hearing loss type or severity ($p > 0.05$). There is no significant relationship between comorbidities (hypertension and diabetes mellitus) and the type or degree of hearing loss among elderly nursing home residents. These findings suggest that *presbycusis* in this population may be more strongly influenced by physiological aging processes than by the metabolic and vascular effects of these comorbidities.

Keywords: *presbycusis, elderly, hypertension, blood sugar levels, audiometry*

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INTRODUCTION

According to Law Number 13 of 1998 concerning the Welfare of the Elderly, an elderly person is defined as someone aged 60 years and above (Arnăutu et al., 2024; Yévenes-Briones et al., 2021). A population structure is considered aging when the proportion of people aged 60 years or older reaches 10 percent or more (Adioetomo, 2018). In Indonesia, the percentage of elderly people has increased significantly by at least 4% over more than a decade (2010–2022), reaching 11.75%. In addition, life expectancy rose from 69.81 years in 2010 to 71.85 years in 2022. The increasing number of elderly people can bring positive impacts if they remain active, healthy, and productive. However, aging is generally accompanied by a decline in physical abilities and health, leading to reduced productivity. This condition is also associated with an increase in degenerative diseases and disabilities, which in turn raises the need for long-term care and assistance for the elderly (Directorate of Public Welfare Statistics, 2023).

Globally, population aging has become a major concern. It is estimated that by 2030, one in six people in the world will be aged 60 years or older. The global elderly population is projected to grow from 1 billion in 2020 to 2.1 billion by 2050 (World Health Organization, 2024). This demographic shift poses significant challenges in the fields of public health, social welfare, and economics, particularly in maintaining the quality of life, health, and independence of the elderly population (Deal et al., 2019; Wu et al., 2020).

One of the most common health problems experienced by the elderly is age-related sensorineural hearing loss, known as *presbycusis*. This condition is the leading cause of hearing

decline among older adults worldwide and typically develops progressively, bilaterally, and irreversibly. Presbycusis usually begins with difficulty hearing high-frequency sounds, which gradually extends to lower frequencies. It is not only associated with damage to the cochlear organ but also with central nervous system dysfunction and impaired auditory information processing (Yang et al., 2023).

Several factors influence the onset and severity of presbycusis, such as exposure to noise, ototoxic agents, genetics, metabolic diseases, and lifestyle (Wang & Puel, 2020). These factors act through mechanisms such as oxidative stress, mitochondrial DNA damage, low-grade inflammation, and decreased cochlear vascularization. As people age, the body's ability to neutralize free radicals diminishes, along with its tissue repair functions. Consequently, permanent damage occurs to cochlear cells responsible for hearing, contributing to the development of presbycusis in older adults (Yang et al., 2023).

Presbycusis can be prevented or managed by addressing its risk factors, including family history, gender, noise exposure, unhealthy lifestyle, and comorbidities such as hypertension and diabetes mellitus. Hypertension and diabetes can directly affect blood flow to the cochlea, reducing nutrient transport and accelerating secondary neural degeneration (Triansyah et al., 2024). However, there is no international consensus on the exact definition of comorbidity. Generally, comorbidity is defined as the coexistence of two or more conditions that are not direct consequences of one another. Such conditions can accelerate disease progression, increase premature mortality risk, and burden healthcare systems (Li et al., 2021).

Hyperglycemia in diabetic patients can impair immune function by inhibiting chemotaxis and phagocytosis and reducing the ability of immune cells to generate superoxide radicals. Moreover, hyperglycemia causes osmotic diuresis, endothelial injury, and mitochondrial dysfunction, all of which increase the risk of complications and mortality among elderly patients (Razavi Nematollahi & Omereg, 2023). It can also lead to sensorineural hearing loss due to microangiopathy that damages small blood vessels in the inner ear, such as the labyrinthine artery. This microcirculatory dysfunction decreases oxygen and nutrient supply to the organ of Corti, leading to atrophy and loss of cochlear hair cell function (Lee et al., 2023; Triansyah et al., 2024).

In addition to diabetes, hypertension is another major modifiable risk factor for hearing loss. Hypertension, characterized by elevated systemic arterial pressure, commonly occurs with aging due to decreased elasticity of large arteries. This condition increases systolic blood pressure, pulse pressure, and cardiac workload (Glazier, 2022). Previous research by Yang et al. (2023) demonstrated that inflammaging, or age-related inflammation, triggers the emergence of metabolic diseases such as hypertension and diabetes. Both diseases are strongly associated with hearing loss among the elderly or Age-Related Hearing Loss (ARHL).

A study by Bener et al. (2022) involving 855 patients aged 25–65 years and 50 patients aged 65 years and older found a significant correlation between hypertension and hearing loss. Among the 855 hypertensive patients, 184 (21.5%) suffered from hearing impairment. Multivariate regression analysis revealed that vertigo, high blood pressure, vitamin D deficiency, obesity, sleep disorders, and metabolic syndrome were significant predictors of hearing loss. These findings reinforce the theory that metabolic and vascular disorders play crucial roles in hearing decline among the elderly.

Based on the findings of previous studies, it is evident that aging, chronic inflammation, and comorbidities such as hypertension and diabetes are interrelated factors contributing to hearing loss in older adults. The studies conducted by Bener et al. (2022) and Yang et al. (2023) provide a strong scientific foundation for exploring the relationship between inflammaging, metabolic diseases, and sensorineural hearing loss. Therefore, this research aims to investigate the relationship between comorbidities and hearing loss among elderly residents in nursing homes, as well as to contribute to the improvement of early detection and management of hearing disorders among the elderly. The research question is whether there is a relationship between comorbidities and hearing loss among elderly individuals in nursing homes. The general objective of this study is to determine the relationship between comorbidities experienced by elderly residents and hearing loss in nursing homes.

The specific objectives include: (1) identifying the demographic characteristics of elderly individuals with hearing loss based on age and gender; (2) determining the number of elderly individuals with comorbidities in nursing homes who experience hearing loss, along with the types and degrees of hearing loss; and (3) examining the relationship between comorbidities and the type and degree of hearing loss among elderly residents in nursing homes. The benefits of this research are threefold: first, for the general public, the findings can help nursing homes improve healthcare services and awareness of early detection of hearing disorders; second, for researchers, the study enhances understanding of the relationship between comorbidities such as hypertension and diabetes mellitus and hearing loss among elderly nursing home residents; and third, for students, the study serves as a reference for exploring other factors contributing to hearing loss or presbycusis in the elderly.

METHOD

The research design was a cross-sectional analytical study, where primary data were collected directly to determine the relationship between comorbidities and hearing loss among elderly residents in nursing homes. Purposive sampling was used to select participants based on predetermined inclusion and exclusion criteria. Hearing loss was assessed using a calibrated pure-tone audiometer, while comorbidities such as hypertension and diabetes were examined using a glucometer and sphygmomanometer. All data were obtained from elderly residents at UPTD Pelayanan Sosial Lanjut Usia Binjai, under the Department of Social Affairs of North Sumatra Province, in 2025. The collected data were analyzed statistically with SPSS software.

The study took place in May 2025, after obtaining Ethical Clearance and formal research approval from the institution. The population consisted of 60 elderly residents living in the facility. The sample size was calculated using the Slovin formula to ensure representativeness. Inclusion criteria included elderly residents who consented to participate, did not use hearing aids, had no physical activity limitations, had a history of hypertension and/or diabetes mellitus, had clean ear canals, and were free of mental retardation. Participants unable to complete or cooperate with the audiometric test, those with amnesia, or uncooperative during data collection were excluded.

The independent variable was hearing loss, and the dependent variable was comorbidity—specifically hypertension and diabetes mellitus. Research instruments included a pure-tone audiometer for hearing assessment, a digital glucometer (Sinocare brand) for blood glucose measurement, and a sphygmomanometer to measure blood pressure and confirm

hypertension. Physical assessments ensured participants had no ear canal obstructions or related complications.

Data analysis followed an observational analytic approach with a cross-sectional design to examine the relationship between hearing loss and comorbidities. Data collected via purposive sampling and clinical measurements were processed using SPSS. Univariate tests described participant characteristics, while Spearman's correlation analyzed the strength and direction of the relationship between hearing loss and comorbidities. All procedures complied with research ethics standards and instrument accuracy to ensure valid and reliable results.

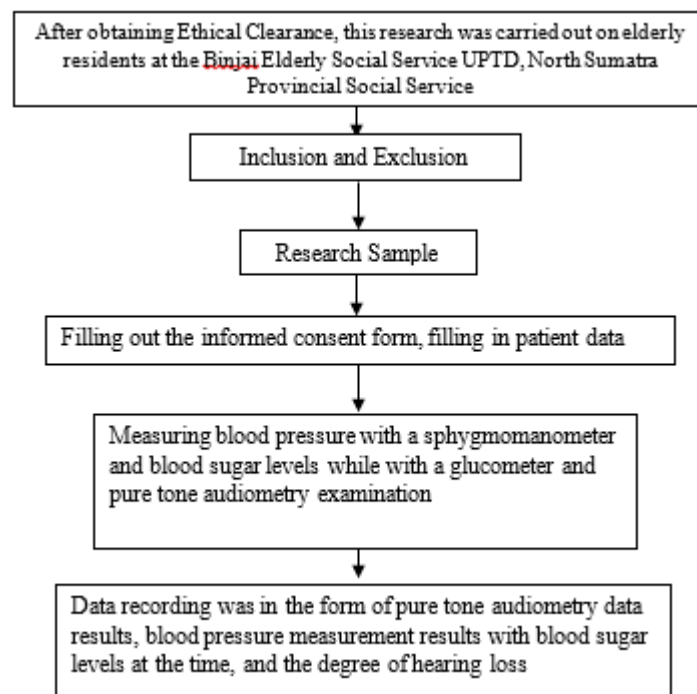


Figure 1. Research Flow
Source: Processed from research data, 2025

RESULTS AND DISCUSSION

Univariate Analysis

This study involved 58 respondents residing at the UPTD Pelayanan Sosial Lanjut Usia Binjai, Department of Social Affairs of North Sumatra Province. The sample consisted of elderly individuals aged between 60 and over 91 years, all of whom met the inclusion criteria. Based on demographic characteristics, the largest age group was 60–65 years, comprising 26 respondents (44.8%). In terms of gender distribution, the majority were female, with 33 respondents (56.9%), while 24 respondents (43.1%) were male. Regarding comorbidity distribution, blood pressure measurements showed that 41.4% of the elderly suffered from stage 2 hypertension ($\geq 140/\geq 90$ mmHg), making it the most common type of hypertension among residents. Additionally, 27.6% of respondents had normal blood pressure, 20.7% had high blood pressure, and 10.3% were classified as stage 1 hypertensive. These findings indicate that hypertension is relatively prevalent among elderly individuals living at the institution. Meanwhile, for random blood glucose levels, 84.5% of respondents had values within the normal range, while 15.5% were diagnosed with diabetes due to elevated glucose levels.

Hearing assessment using pure-tone audiometry was conducted on both ears at frequencies between 250 Hz and 8000 Hz, with the average hearing threshold (PTA) measured at 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz. The most common type of hearing loss in the right ear was sensorineural hearing loss (33 respondents; 56.9%), followed by mixed hearing loss (9 respondents; 15.5%) and conductive hearing loss (11 respondents; 19.0%), with only 5 respondents (8.6%) having normal hearing. On the left ear, the distribution pattern was slightly different, with 36 respondents (62.1%) experiencing sensorineural hearing loss, 8 respondents (13.8%) having mixed hearing loss, and 9 respondents (15.5%) experiencing conductive hearing loss, while 5 respondents (8.6%) retained normal hearing, similar to the right ear.

Bivariate Analysis

Relationship of Blood Pressure with Type of Hearing Loss

Table 1. Distribution of Right Ear Hearing Loss Types by Blood Pressure Category (N=58)

Blood Pressure Categories	Normal	Conductive Deafness	Fire at Sensorineural	Mixed Deafness	Total
Normal (<120/80 mmHg)	1 (1.7%)	2 (3.4%)	11 (19.0%)	2 (3.4%)	16
Elevated (120-129/<80 mmHg)	3 (5.2%)	3 (5.2%)	4 (6.9%)	2 (3.4%)	12
Stage 1 hypertension (130-139/80-89 mmHg)	0 (0.0%)	1 (1.7%)	4 (6.9%)	1 (1.7%)	6
Stage 2 hypertension (≥140/≥90 mmHg)	1 (1.7%)	5 (8.6%)	14 (24.1%)	4 (6.9%)	24
Total	5 (8.6%)	11 (19.0%)	33 (56.9%)	9 (15.5%)	58

Source: Primary research data, 2025

In the 58 elderly who participated in the study, the most common type of hearing loss in the right ear was sensorineural at 56.9%, followed by mixed and conductive types at 15.5% and 19.0%, and 8.6% had normal hearing. The distribution of hearing loss types did not change significantly by blood pressure group (normal, elevated, stage 1 hypertension, and stage 2 hypertension). Pearson Chi-Square statistical test results = 7,357; df = 9; p = 0.600. Therefore, there was no significant correlation between the type of hearing loss of the right ear and changes in blood pressure.

Table 2. Distribution of Left Ear Hearing Loss Types by Blood Pressure Category (N=58)

Blood Pressure Categories	Normal	Conductive Deafness	Fire at Sensorineural	Mixed Deafness	Total
Normal (<120/80 mmHg)	0 (0.0%)	2 (3.4%)	12 (20.7%)	2 (3.4%)	16
Elevated (120-129/<80 mmHg)	3 (5.2%)	4 (6.9%)	5 (8.6%)	0 (0.0%)	12
Stage 1 hypertension (130-139/80-89 mmHg)	0 (0.0%)	0 (0.0%)	4 (6.9%)	2 (3.4%)	6
Stage 2 hypertension (≥140/≥90 mmHg)	2 (3.4%)	3 (5.2%)	15 (25.9%)	4 (6.9%)	24

Total	5 (8.6%)	9 (15.5%)	36 (62.1%)	8 (13.8%)	58
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Source: Primary research data, 2025

In the 58 elderly people who participated in the study, the most common type of left ear hearing loss was sensorineural at 62.1%, followed by conductive at 15.5%, mixed at 13.8%, and normal at 8.6%. When the distribution of these disorder types was compared by blood pressure category (normal, elevated, stage 1, and stage 2 hypertension), Pearson's Chi-Square test showed no statistically significant difference ($\chi^2=13.990$; $df=9$; $p=0.123$). The proportion of sensorineural deafness appeared to be higher in the stage 2 hypertension group (15 out of a total of 24 elderly people with stage 2 hypertension who had sensorineural hearing loss in the right ear) than in the other categories, but the variation did not reach significance, so in this sample blood pressure status was not associated with the difference in distribution of the type of hearing loss in the right ear.

Relationship of Blood Sugar During Hearing Loss

Table 3. Distribution of Right Ear Hearing Loss Types by Blood Sugar Category During (N=58)

Blood Sugar Categories	Normal	Conductive Deafness	Fire at Sensorineural	Mixed Deafness	Total
Normal (<200 mg/dL)	5 (8.6%)	8 (13.8%)	29 (50.0%)	7 (12.1%)	49
Diabetes (>200 mg/dL)	0 (0.0%)	3 (5.2%)	4 (6.9%)	2 (3.4%)	9
Total	5 (8.6%)	11 (19.0%)	33 (56.9%)	9 (15.5%)	58

Source: Primary research data, 2025

Although the group with normal blood sugar levels and the diabetic group (>200 mg/dL) had proportionally different distribution of hearing loss types, the statistical test showed a value of $p = 0.444$ ($p > 0.05$) and degree of freedom (df) = 3, so the difference was not statistically significant. This means that there is no significant relationship or difference between the blood sugar category and the type of hearing loss in the right ear of the elderly. In other words, the prevalence of sensorineural, conductive, mixed, or normal hearing loss cases is not affected by the current blood sugar status in the population .

Table 4. Distribution of Left Ear Hearing Loss Types by Current Blood Sugar Category (N=58)

Blood Sugar Categories	Normal	Conductive Deafness	Deafness at Sensorineural	Mixed Deafness	Total
Normal (<200 mg/dL)	5 (8.6%)	5 (8.6%)	32 (55.2%)	7 (12.1%)	49
Diabetes (>200 mg/dL)	0 (0.0%)	4 (6.9%)	4 (6.9%)	1 (1.7%)	9
Total	5 (8.6%)	9 (15.5%)	36 (62.1%)	8 (13.8%)	58

Source: Primary research data, 2025

The distribution of hearing loss types in the left ear of the elderly in this study was not affected by their random blood sugar levels. The normal and diabetic groups showed statistically comparable frequencies of sensorineural, conductive, mixed, and normal hearing loss. There was no significant difference between the normal blood sugar group and diabetes

in the distribution of hearing loss types in the left ear, according to the results of the Pearson Chi-Square test, which showed a value of $p = 0.064$ ($p > 0.05$) with a degree of freedom (df) = 3. This suggests that the type of hearing loss in the participants' left ear is not statistically affected by their random blood sugar status, either normal or diabetic.

Table 5. Spearman Correlation Results between Blood Pressure, Blood Sugar Current, and Degree of Hearing Loss in the Elderly (N=58)

Variable	Degree of Hearing Loss of the Right Ear	Degree of Left Ear Hearing Loss
Blood pressure	$r = 0,042, p = 0,755$	$r = 0,106, p = 0,428$
Blood Sugar During	$r = 0,086, p = 0,519$	$r = 0,033, p = 0,805$

Source: Primary data from statistical analysis, 2025

Spearman's correlation analysis showed that there was no meaningful relationship between blood pressure and the degree of hearing loss in both the right and left ears. Likewise, blood sugar levels when there is no significant correlation with the degree of hearing loss in both ears. Low coefficient values and p-values of more than 0.05 indicate that blood pressure and blood sugar comorbidities are not correlated with the rate of hearing loss in this population. The Spearman correlation coefficient is denoted by r . The direction and intensity of the relationship between the two variables is measured by the value of r . There is no correlation indicated by an r -value close to zero, a unidirectional relationship is indicated by a positive r -value, and an inverse relationship is indicated by a negative r -value. The r -value in these data was very low ($r = 0.042$; $r = 0.106$), which suggests that there was no relationship at all or very weak. A probability value that indicates whether there is a statistically significant relationship between the two variables is called a p , or p , value. The relationship is considered significant if $p < 0.05$. All p -values in this table ($p = 0.755$; $p = 0.428$) are significantly above 0.05, indicating that there is no meaningful relationship.

Demographic Characteristics of Elderly Individuals with Hearing Loss by Age and Gender

Based on the demographic characteristics of the respondents, the largest age group was 60–65 years, consisting of 26 respondents (44.8%). In terms of gender, most participants were female, with 33 respondents (56.9%), while 24 respondents (43.1%) were male. Previous studies have shown that the prevalence of hearing loss in the elderly increases with age, particularly within the 60–65 age group, where hearing loss can range from mild to severe. Men are generally more prone to hearing impairment than women, largely due to biological processes and environmental exposure, including hormonal differences, physical activity, and occupational risks that increase men's vulnerability to hearing loss (Xuewen & Jianbo, 2021). However, this study found that elderly women in nursing homes were more likely to experience hearing loss than men. This difference may be attributed to certain factors affecting elderly women living in institutional settings, such as quality of care and social aspects within the nursing home environment. Furthermore, women's longer life expectancy is a key factor explaining their higher prevalence of hearing loss. According to Pusdatin (2017), women

generally live longer than men, placing them in older age categories (>60 years) where the likelihood of presbycusis and other sensorineural disorders increases. Presbycusis, a progressive and gradual degeneration of hearing associated with aging, is the leading cause of hearing impairment in the elderly and becomes more prevalent with advancing age. Since more women reach very old age (over 70 years), they naturally represent a higher proportion of individuals affected by presbycusis and other hearing disorders.

Number of Elderly Individuals with Comorbidities and the Type and Degree of Hearing Loss

In this study conducted at UPTD Pelayanan Sosial Lanjut Usia Binjai, most elderly individuals with hearing loss also had comorbidities, primarily hypertension and diabetes mellitus. However, statistical analysis revealed no significant relationship between these comorbidities and the type or degree of hearing loss, indicating that hearing impairment in the elderly is more strongly influenced by aging and presbycusis. The majority of participants experienced sensorineural hearing loss associated with cochlear and auditory nerve degeneration due to aging. This type of hearing loss was most prevalent in both ears, accounting for approximately 56.9% in the right ear and 62.1% in the left ear, while mixed and conductive hearing losses were less common. In terms of hearing degree, mild to moderate impairment was most frequent, with mild cases predominating in the right ear and moderate to severe cases more common in the left ear. A study conducted among elderly residents of Swiss nursing homes (aged 65–105 years) reported that hearing loss was widespread among this population, frequently coexisting with comorbidities such as hypertension and diabetes (Mikos et al., 2025). Nevertheless, another comprehensive study found that while hearing loss is common among nursing home residents, there was no significant variation in hearing loss type or severity directly related to diabetes or hypertension, suggesting that age-related sensory decline exerts a greater impact on hearing function (Besser et al., 2018). Although managing comorbidities remains important for overall elderly health, these conditions do not significantly affect the type or severity of hearing impairment. Therefore, audiological care and preventive strategies for the elderly in nursing homes should prioritize early screening and interventions targeting age-related changes rather than focusing solely on metabolic comorbidities. This aligns with the findings of this study, which indicate that comorbidities do not significantly influence the type or degree of hearing loss, reaffirming that sensorineural degeneration and the aging process play a more substantial role in presbycusis among older adults.

Relationship Between Comorbidities and the Type and Degree of Hearing Loss Among the Elderly in Nursing Homes

The results of this study showed that among 58 elderly residents in the nursing home, most suffered from mild to moderate sensorineural hearing loss. Approximately 63.5% experienced moderate hearing loss, while 36.5% had mild impairment. Although many participants had a history of hypertension and diabetes, statistical analysis revealed that these conditions did not significantly influence the type or severity of hearing loss. Research on elderly nursing home residents has highlighted that hearing loss is a common sensory disorder within this population. Most residents suffer from chronic conditions such as hypertension and diabetes; however, large-scale studies have demonstrated no significant statistical relationship between these

comorbidities and hearing loss severity or type. The main factor affecting hearing loss remains the natural aging process and auditory system degeneration. For instance, a large-scale study involving more than 130,000 elderly nursing home residents in Switzerland aged 65–105 years found that despite the high prevalence of comorbidities, these conditions did not significantly affect hearing loss severity or type. Similarly, a systematic review of audiological care for older adults with comorbidities reported inconsistent or weak associations between diabetes, hypertension, and hearing loss, indicating that these chronic diseases are not direct causes of hearing impairment. Presbycusis affects more than 65% of individuals over 60 years old, and by 2025, it is estimated that out of 1.2 billion people aged 60 and above worldwide, approximately 500 million will be affected by presbycusis (Wang & Puel, 2020).

This study found that most respondents aged 60–65 years experienced predominantly mild hearing loss, with 23 individuals in the right ear and 35 in the left ear affected. Although many elderly participants had both hearing loss and comorbidities, there was no significant association between these variables. The results align with previous research, which also found no meaningful link between comorbidities and hearing loss, suggesting that their relationship is complex. These findings are consistent with several earlier studies that found no significant correlation between comorbidities and hearing loss. The lack of association may be attributed to the dominance of presbycusis among older populations and the complex interplay between comorbidities and hearing decline, which can be influenced by disease duration, metabolic-vascular factors, and confounding variables such as age and individual characteristics (Gioacchini et al., 2023). Diabetes has been associated with sensorineural hearing loss due to microangiopathy (thickening of the capillary basement membrane in the stria vascularis), cochlear synapse damage, and mitochondrial dysfunction. However, causality is difficult to establish due to confounding factors such as age, sex, noise exposure, and ototoxic medications. In the study “Diabetes Mellitus and Hearing Loss: A Complex Relationship” (Gioacchini et al., 2023), when confounding factors were controlled, the association between diabetes and hearing loss weakened or disappeared. Similarly, no significant correlation was found between the degree of hearing loss and hypertension among elderly nursing home residents in South Tangerang. The relationship was simpler, being more closely linked to age and systolic pressure at certain frequencies rather than the presence of hypertension itself. A longitudinal cohort study, ELSA-Brasil, which examined the incidence of hearing loss over four years in adults with and without hypertension, found that while hypertension was crudely associated with higher hearing loss incidence, the association disappeared after comprehensive adjustment for variables such as age, sex, education, race/ethnicity, income, smoking, diabetes, and noise exposure (Padilha et al., 2022).

CONCLUSION

The study found that the most affected age group for hearing loss in nursing homes was between 60 and 65 years, with females comprising the majority. While many elderly had hypertension (particularly stage 2) and diabetes, these comorbidities did not significantly influence the type or severity of hearing loss, which was predominantly sensorineural and ranged from mild to moderate. The results emphasize that aging and presbycusis are primary factors in hearing decline among the elderly, rather than the presence of hypertension or diabetes. Future research could explore other potential contributing factors, such as

environmental or genetic influences, and investigate effective interventions for preventing or managing hearing loss in this population.

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