

## Hearing loss in patients with dementia in Saudi Arabia

Laila Alqabani, MBBS, Lena Alotaibi, MBBS, Jullanar Alkhunein, MBBS, Reema alduaiji, MBBS, Reema Alqadiri, MBBS, Fawaz Alibrabim, MD, Salih binSalih, MD, PhD, Hashim Balubaid, MD.

### ABSTRACT

**الأهداف:** تهدف هذه الدراسة إلى تحديد مدى انتشار فقدان السمع لدى المرضى الذين يعانون من الخرف، وفحص استخدام المعينات السمعية لدى المصابين بفقدان السمع، والتأكد مما إذا كان سبب فقدان السمع مركزيًا أو طرفيًا في الأصل.

**المنهجية:** أجريت الدراسة على 143 مريضًا مصابًا بالخرف في المملكة العربية السعودية في الفترة من 2020 إلى 2023 في مدينة الملك عبد العزيز الطبية، الرياض، المملكة العربية السعودية، لتحديد فقدان السمع. شملت الدراسة المرضى الذين تزيد أعمارهم عن 60 عامًا والذين يعانون من الخرف وفقدان السمع والأمراض العصبية. تم استبعاد المصابين بمرض باركنسون والصرع الثانوي. تم تحليل البيانات لمعرفة التركيبة السكانية والسمات السريرية والعوامل المؤهلة والعلاج ومدة الخرف وتطوره ونتائج فقدان السمع. تم إجراء جميع التحليلات الإحصائية باستخدام برنامج IBM SPSS، الإصدار 29.0.0، حيث تم تحديد الأهمية الإحصائية عند قيمة تبلغ أقل من 0.05 أو يساوي 0.05 وفاصل ثقة قدره 95%.

**النتائج:** أشارت النتائج إلى أن 88.8% من 143 مريضًا أصيبوا بالخرف، وكان مرض الزهايمر هو النوع الأكثر انتشارًا. كما أن 18.2% لديهم مشاكل في السمع، 11.2% لديهم شكاوى أخرى. تم إجراء قياس السمع في 15.4% من الحالات. كان فقدان السمع موجودًا لدى 14.7% من المرضى، وكان فقدان السمع ثنائيًا في المقام الأول، ويتراوح من الخفيف إلى الشديد.

**الخلاصة:** أوضحت هذه الدراسة العلاقة بين فقدان السمع وبداية الخرف وشددت على الحاجة إلى التقييم والتدخل المبكر للأفراد الذين يعانون من ضعف السمع.

**Objectives:** To determine the prevalence of hearing loss in patients with dementia, examine the use of hearing aids in those with hearing loss, and ascertain if the cause of hearing loss is central or peripheral in origin.

**Methods:** A retrospective cohort study involving 143 patients with dementia which was conducted in Saudi Arabia from 2020 to 2023 in King Abdulaziz Medical City, Riyadh, Saudi Arabia, to determine hearing

loss. The study included patients aged  $\geq 60$  years who had dementia, hearing loss, and neurological diseases. Those with Parkinson's disease and secondary epilepsy were excluded. Data was analyzed for its demographics, clinical features, predisposing factors, treatment, dementia duration and progression, and hearing loss outcomes. All statistical analyses were performed using IBM's SPSS software, version 29.0.0. Statistical significance was established at a  $p$ -value of  $\leq 0.05$  and a confidence interval of 95%.

**Results:** The findings indicated that 88.8% of the 143 patients exhibited dementia, with Alzheimer's disease being the most prevalent type. Moreover, 18.2% had hearing issues, and 11.2% had other complaints. Audiometry was performed in 15.4% of the cases. Hearing loss was present in 14.7% of the patients, being primarily bilateral, ranging from mild to severe.

**Conclusion:** This study has clarified the link between hearing loss and dementia onset and has emphasized the need for early evaluation and intervention for individuals with hearing impairment.

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From the College of Medicine (Alqabani, Alkhunein, alduaiji, Alqadiri), King Abdullah International Medical Research Center (Alqabani, Alotaibi, Alkhunein, alduaiji, Alqadiri, Alibrabim, binSalih, Balubaid), Department of Medicine (binSalih, Balubaid), Division of Neurology (Alibrabim), Department of Medicine King Abdulaziz Medical City, Ministry of National Guard – Health Affairs, Riyadh, Kingdom of Saudi Arabia

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Address correspondence and reprint request to: Dr. Laila Alqabani, College of Medicine, King Saud bin Abdulaziz University for Health Sciences, Riyadh, Kingdom of Saudi Arabia. E-mail: Lailaalqabani065@gmail.com  
ORCID: <https://orcid.org/0009-0003-5023-6003>

Dementia is a progressive decline of cognitive function, including social and occupational functioning. It is known to be associated with

cerebrovascular pathologies and Alzheimer's disease (AD). A thorough assessment of a patient's cognitive changes in daily activities and medical history is necessary.<sup>1</sup>

While dementia is caused by cortical degeneration that often begins in the multimodal cortex, acquired hearing loss is primarily triggered by cochlear injury. The fact that hearing loss may be effectively treated with hearing aids or cochlear implants, whereas it is challenging, if not impossible, to reverse cortical degeneration, has considerable practical implications as well. Peripheral auditory function and extensive brain abnormalities linked to dementia may be connected via several biological and psychological routes. Numerous potential theories for the relationship between hearing loss and dementia are classified into 4 conjectures. In the first explanation, a common pathology caused by vascular disease or AD damages the cochlea and the ascending route and results in hearing loss and dementia. According to the second one, the depleted environment resulting from hearing loss alters the hippocampus and auditory cortex in the brain, which leads to a decline in cognitive reserve and a diminished resistance to dementia. The third explanation proposes that increased medial temporal lobe (MTL) activity and a broader network during speech-in-noise analysis compete for the network's resources, which are also required for other higher-order cognitive functions. The fourth explanation is related to the interaction between the pathophysiology of AD and impaired pattern-analysis activity in the MTL during challenging listening.<sup>2</sup>

The elderly population experiences a significant decline in their quality of life due to hearing loss. In addition, previous studies have proposed that cognitive impairment could be influenced by hearing loss.<sup>3,4,5</sup>

Moreover, one study collected data from patients with AD, mild cognitive impairment and those with or without hearing loss. Patients were evaluated using magnetic resonance imaging, and volume reduction was noted in those with AD and hearing loss, which showed a significant correlation between hearing loss and cerebellar and brainstem diseases.<sup>6</sup>

Along with similar studies stating the risk of developing cognitive decline in those with Age-Related Hearing Loss (ARHL). However, hearing loss in middle age can contribute to dementia as well.<sup>7</sup>

Regarding local studies on dementia and hearing loss, relevant data are considerably lacking in Saudi Arabia. Therefore, this study aimed to investigate the prevalence, magnitude, and association between hearing loss and dementia in elderly patients.

**Methods.** This retrospective cohort study examined hearing loss among patients with dementia in Riyadh, Saudi Arabia. The data were acquired from electronic health records. Patients' electronic records from April 3rd, 2020, to November 19th, 2023, were reviewed after obtaining access from the medical records department in the hospital, and 143 patients were included.

Demographic data such as age, date of birth, gender, nationality, weight and height, body mass index (BMI), smoking, marital status, treatment, and outcomes were collected. Regarding past medical history, data on stroke, diabetes mellitus, head trauma, hypertension, cardiac disease, sleep apnea, as well as other conditions such as pulmonary, psychiatric, endocrine, nephrology/genitourinary, neurological, and musculoskeletal diseases were collected. In addition, dementia and hearing loss data, including the type of dementia, duration and progression of the disease, the presence of hearing problems, hearing loss and its type, and medications prescribed for dementia, were collected. Patients  $\geq 60$  years of age with any type of dementia, hearing loss, and neurological diseases such as secondary epilepsy developed after dementia were included. Those with end-stage renal disease, tumors, infections, and liver cirrhosis and those  $< 60$  years of age were excluded. Data utilized in this study were obtained from administrative datasets available at the Institutional Review Board of King Abdullah International Medical Research Centre (KAIMRC), an independent, nonprofit research institute. Informed consent and patient confidentiality were maintained throughout the study; no names or MRNs were mentioned, and serial numbers were used for each patient. Data was stored on password-protected computers and were accessible only to the team members. Data collection was completed after KAIMRC granted approval number IRB/2829/23.

A comprehensive statistical analysis was performed on the dataset, encompassing descriptive and inferential methodologies. Initially, a descriptive analysis was conducted to summarize the participants' demographic characteristics, including age, sex, and other features. This analysis provided an overview of the study population. Subsequently, inferential analyses, such as the binary logistic regression model, were employed to identify the adjusted predictors of hearing loss and dementia among the participants. Statistical significance was established at a  $p$ -value of  $\leq 0.05$  and a 95% confidence interval. All

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**Table 1 -** Sociodemographic and other parameters of patients with dementia assessed for hearing loss.

Parameters	Frequency (n = 143)	(%)
<i>Sex</i>		
Female	60	(42.0)
Male	83	(58.0)
<i>Age (Years)</i>		
Mean (SD)	74.5 (8.2)	
Range	60–97	
<i>Weight (Kg)</i>		
Mean (SD)	69.7 (13.5)	
Range	33–100	
<i>Height (cm)</i>		
Mean (SD)	159.7 (9.9)	
Range	106–181	
<i>BMI</i>		
Underweight	9	(6.3)
Normal	43	(30.1)
Overweight	47	(32.9)
Obese Class I	33	(23.1)
Obese Class II	11	(7.7)
<i>Nationality</i>		
Saudi	143	(100.0)
<i>Marital status</i>		
Married	118	(82.5)
Single	21	(14.7)
<i>History of smoking</i>		
No	141	(98.6)
Yes	2	(1.4)
<i>Need for caregiver</i>		
No	45	(31.5)
Yes	94	(65.7)

statistical analyses were performed using IBM's SPSS software, version 29.0.0.

**Results.** In our study, 143 patients were assessed for hearing loss, of which 60 (42.0%) were women and 83 (58.0%) were men. The mean age was 74.5 years (SD=8.2) and ranged from 60 to 97 years. Body measurements revealed a mean weight of 69.7 kg (SD=13.5) and a mean height of 159.7 cm (SD=9.9). BMI distribution indicated that (6.3%) were underweight, (30.1%) were average weight, (32.9%) were overweight, (23.1%) were obese (Class I), and (7.7%) were obese (Class II). All participants were Saudi nationals; (82.5%) were married, and (14.7%) were single. Smoking history was minimal (1.4%). Most participants (65.7%) required a caregiver for their healthcare.

Table 2 depicts the hearing-related aspects in patients with dementia. The majority (88.8%) suffered

**Table 2 -** Prevalence of hearing loss, severity, and type of medications used in patients with dementia.

Parameters	Frequency (n = 143)	(%)
<i>Suffering from dementia</i>		
No	16	(11.2)
Yes	127	(88.8)
<i>Type of dementia</i>		
Alzheimer's disease	85	(59.4)
Vascular	13	(9.1)
Mixed	19	(13.3)
Others	8	(5.6)
<i>Mean duration of memory loss (Years)</i>		
Mean (SD)	4.1 (2.3)	
Range	1-13	
<i>Progression of dementia</i>		
No	14	(9.8)
Yes	106	(74.1)
<i>Medication used for dementia</i>		
Cholinesterase Inhibitors	35	(24.5)
Memantine	36	(25.2)
Both	40	(28.0)
<i>Presence of hearing problem</i>		
No	117	(81.8)
Yes	26	(18.2)
<i>Complaints of Hearing problem</i>		
Tinnitus	9	(6.3)
Others	16	(11.2)
<i>Audiometry done or not</i>		
No	118	(82.5)
Yes	22	(15.4)
<i>Presence of hearing loss</i>		
No	123	(86.0)
Yes	21	(14.7)
<i>Type of hearing Loss</i>		
Bilateral	20	(14.7)
<i>Severity of hearing Loss</i>		
Mild to Moderate	10	(7.0)

from dementia, with AD being the most prevalent type (59.4%), followed by vascular (9.1%), mixed (13.3%), and others (5.6%). The mean duration of memory loss was 4.1 years (SD=2.3) and ranged from 1 to 13 years. Dementia progression was noted in (74.1%) of the patients. Medications included cholinesterase inhibitors (24.5%), memantine (25.2%), and a combination of both (28.0%). Hearing problems were reported by (18.2%), with tinnitus in (6.3%) and other complaints in (11.2%). Audiometry was performed in (15.4%) of the patients. Hearing loss was present in (14.7%), being primarily bilateral, ranging from mild to severe.

**Table 3 -** Adjusted sociodemographic predictors of hearing loss among patients with dementia.

Parameters	B	Sig.	Exp(B)	95% CI	
				Lower	Upper
Age	.038	.291	1.039	.968	1.115
Sex (Male)	-1.546	.045*	.213	.047	.964
Weight	-.003	.945	.997	.919	1.082
Height	.044	.400	1.045	.943	1.158
BMI	-.071	.898	.931	.312	2.779
Marital Status (Married)	1.735	.123	5.669	.625	51.394
Smoking History	-19.241	.999	.000	.000	.
Constant	-5.678	.457	.003		

**Table 4 -** Adjusted comorbidity-related predictors of hearing loss in patients with dementia.

Parameters	B	Sig.	Exp(B)	95% CI	
				Lower	Upper
Stroke	.888	.118	2.430	.799	7.387
Diabetes	.283	.685	1.327	.338	5.212
Head Trauma	-18.641	.999	.000	.000	.
Hypertension	-.099	.888	.906	.229	3.578
Cardiac Disease	-.846	.254	.429	.100	1.837
Pulmonary Disease	-17.694	.999	.000	.000	.
Psychiatric Disease	1.775	<b>.035</b>	5.901	1.132	30.750
Endocrine Disease	2.177	<b>.008</b>	8.819	1.765	44.055
Nephrology and Genitourinary Diseases	1.783	<b>.037</b>	5.947	1.116	31.683
Musculoskeletal Diseases	2.079	.052	7.998	.984	65.021
Neurological Diseases	1.644	.108	5.174	.696	38.472
Constant	-3.303	.000	.037		

Table 3 shows the adjusted sociodemographic predictors of hearing loss among patients with dementia. Age exhibited a nonsignificant association (B=0.038, Sig=0.291, Exp(B)=1.039), suggesting a marginal increase in the odds of hearing loss with each unit increase in age. The male sex was a significant predictor (B=-1.546, Sig=0.045\*), indicating a lower likelihood of hearing loss in men. Weight, height, and BMI showed nonsignificant associations. Marital status (being married) was nonsignificant (B=1.735, Sig=0.123) but implied a higher likelihood of hearing loss. Smoking history exerted an extremely negative impact (B=-19.241, Sig=0.999), indicating a substantial but nonsignificant reduction in the odds of hearing loss among nonsmokers. These adjusted predictors offer insights into the nuanced relationships between sociodemographic factors and hearing loss in patients with dementia.

Table 4 shows the adjusted comorbidity-related predictors of hearing loss among patients with dementia. Patients with a history of stroke exhibited a marginally insignificant positive association with hearing loss

(B=0.888, Sig=0.118), suggesting 2.43 times higher odds of experiencing hearing loss. Diabetes, on the contrary, displayed a nonsignificant positive association (B=0.283, Sig=0.685). Notably, head trauma and pulmonary disease did not demonstrate any significant association. Psychiatric disease (B=1.775, Sig=0.035), endocrine disease (B=2.177, Sig=0.008), nephrology and genitourinary diseases (B=1.783, Sig=0.037), and musculoskeletal diseases (B=2.079, Sig=0.052) showed significant positive associations, implying an increased likelihood of hearing loss in patients with these comorbidities. Neurological diseases presented an insignificant positive association (B=1.644, Sig=0.108). These findings emphasize the complex interplay between specific comorbidities and the risk of hearing loss in the context of dementia.

Table 5 shows the adjusted sociodemographic predictors associated with the predisposition of elderly patients to develop dementia. Age exhibited a nonsignificant positive association (B=0.023, Sig=0.543), signifying a marginal increase in the odds of developing dementia with each unit increase in age.

**Table 5** - Adjusted sociodemographic predictors that predispose elderly patients to develop dementia.

Parameters	B	Sig.	Exp(B)	95% CI	
				Lower	Upper
Age	.023	.543	1.023	.951	1.100
Sex (Male)	.218	.783	1.244	.263	5.892
Weight	-.025	.530	.975	.902	1.055
Height	-.031	.558	.969	.873	1.076
BMI	.130	.807	1.139	.402	3.223
Marital Status (Married)	.144	.873	1.154	.198	6.724
Smoking History	19.530	.999	.000	.000	.
Constant	6.546	.458	696.674		

**Table 6** - Adjusted past comorbidity-related predictors that predispose elderly patients to develop dementia.

Parameters	B	Sig.	Exp(B)	95% CI	
				Lower	Upper
Stroke	.185	.794	1.203	.301	4.811
Diabetes	-.723	.378	.485	.097	2.420
Head Trauma	18.690	.999	.000	.000	.
Hypertension	.791	.334	2.206	.444	10.965
Cardiac Disease	.527	.539	1.693	.316	9.070
Pulmonary Disease	18.996	.999	.000	.000	.
Psychiatric Disease	1.069	.351	2.913	.309	27.512
Endocrine Disease	1.068	.358	2.910	.298	28.442
Nephrology and Genitourinary Diseases	-.510	.545	.600	.115	3.129
Musculoskeletal Diseases	.345	.787	1.412	.116	17.197
Neurological Diseases	-.457	.628	.633	.100	4.022
Constant	1.635	.040	5.131		

Sex, weight, height, BMI, and marital status did not reveal significant associations, alluding that these factors may not be strong predictors of dementia. Interestingly, smoking history emerged as a highly positive predictor (B=19.530, Sig=0.000), indicating a substantial but nonsignificant increase in the odds of developing dementia among individuals with a history of smoking. Overall, these findings suggest that in this study, age and other sociodemographic factors may not be strong predictors of dementia; however, an association was observed with a history of smoking, which highlights the potential impact of lifestyle factors on dementia development.

Table 6 shows the adjusted past comorbidity-related predictors associated with the predisposition of elderly patients to develop dementia. Stroke exhibited a nonsignificant positive association (B=0.185, Sig=0.794), implying no substantial impact on the odds of developing dementia. Diabetes also displayed a nonsignificant negative association (B=-0.723, Sig=0.378). Both head trauma and pulmonary disease demonstrated nonsignificant positive impacts

(B=18.690 and B=18.996, respectively), suggesting a substantial increase in the odds of dementia for patients with a history of these conditions. Hypertension (B=0.791, Sig=0.334), cardiac disease (B=0.527, Sig=0.539), psychiatric disease (B=1.069, Sig=0.351), endocrine disease (B=1.068, Sig=0.358), and musculoskeletal disease (B=0.345, Sig=0.787) exhibited nonsignificant associations. Nephrological and genitourinary diseases and neurological diseases showed nonsignificant negative associations. These findings imply that past comorbidities, such as head trauma and pulmonary disease, may play a significant role in predisposing elderly patients to develop dementia. Other commodities demonstrated mixed associations.

**Discussion.** This 143-patient analysis provided a framework for addressing some of the health issues observed in patients with dementia. This research examined the extent and relationship between dementia and hearing loss in the elderly population. According to the findings of this study, the likelihood of developing dementia may be positively correlated with hearing loss.

Previous studies have reported that (35%) of dementia risk factors are modifiable, with hearing loss accounting for (9.1%) of the total.<sup>8</sup> Other risk factors include types 1 and 2 diabetes, depression, obesity, hypertension, and smoking. Of these, (65%) are hereditary in nature. According to the sociodemographic analysis conducted in the dementia population (Table 3), a proportionate increase in the prevalence of hearing loss was observed in elderly patients; however, it was not significant. In this study, older individuals were shown to have a higher prevalence of hearing loss, which supports previous findings that age is one of the determinants of hearing loss in patients with dementia. The incidence of ARHL is increasing, both in its correlation with cognitive function and due to the prevalence of common health conditions in elderly individuals.<sup>9,10</sup>

While this study demonstrated that the male gender is an essential contributor to hearing loss among individuals with dementia, other research has provided limited support for this assertion. On the other hand, a research study examining the impact of hearing aids on the elderly discovered that males exhibited a greater propensity (6.44%) for developing dementia (8.76%) in comparison to females. This finding implies that there are gender-related disparities in the correlation between auditory impairment and the likelihood of developing new instances of cognitive decline. Furthermore, it is important to highlight that there are differences in cognitive decline between men and women. While it is true that men who are cognitively normal tend to experience a more pronounced change in cognitive performance compared to women, it is important to note that AD is in fact more prevalent in women, even when considering their longer lifespan.<sup>11,18</sup>

Impaired hearing was significantly associated with a 7 percent greater risk of dementia, according to a recent study involving 573,088 participants. Furthermore, individuals with hearing loss who did not use hearing aids had a greater risk of dementia than those who did.<sup>12</sup>

Moderate to severe hearing loss was linked to a higher prevalence of dementia among 2413 older individuals in the US, a nationally representative sample, according to another study. Compared with individuals with mild hearing loss, those with moderate to severe hearing loss were more likely to be older, male, and have a lower educational level.<sup>13</sup>

Nevertheless, when analyzing the sociodemographic variables associated with the results of the investigation into the probability of dementia in older individuals, it was observed that gender and age did not emerge as essential predictors (Table 5). On the other hand, the study found that individuals with a history of smoking

had a higher risk of dementia, although this relationship was not statistically significant. A study has identified that ARHL, in conjunction with gender, could potentially serve as a risk factor for the development of dementia. The research findings indicated a correlation between elevated levels of tau and  $\beta$ -amyloid, two proteins linked to dementia and commonly found in Alzheimer's disease, and a deterioration in auditory function.<sup>10,14</sup> Our findings provide support for the hypothesis that smoking status is associated with an increased risk of developing dementia despite the lack of research on this subject.

One of the significant causes of depression, social isolation, and loneliness was the lack of verbal communication resulting from hearing loss. Furthermore, these factors can aggravate cognitive impairment. Hence, there is a correlation between perceived social isolation and decreased general cognitive function, accelerated cognitive decline, and depressive mental states.<sup>8,9</sup> According to the results of subgroup analyses presented in this study, hearing loss and psychiatric disorders were significantly correlated (Table 4).

Other factors that showed positive relationships with hearing loss in this analysis were the presence of endocrine, nephrological, and genitourinary diseases. Although other comorbidity variables exhibited a favorable correlation, they remained statistically insignificant (Table 4). In contrast to the findings of other studies regarding head injury and hearing loss, these were significant in the group aged 65–74 years.<sup>10</sup> Additional comorbidities that could be linked to dementia and hearing loss have been reported, which include the duration of hospital stay, diabetes mellitus, head injury, hypertension, hyperlipidemia, chronic renal disease, rheumatoid arthritis, asthma, and depression.<sup>8,15</sup>

In this cohort study, the most common form of dementia was AD, followed by vascular, mixed, and other types. Audiometry was used to evaluate the condition of specific patients. A valuable diagnostic instrument for assessing hearing impairment is pure-tone audiometry, which individuals can use to derive advantages from its utilization. Furthermore, the development of dementia and cognitive impairment is prevalent in individuals who experience hearing loss. There is a correlation between hearing impairment and a higher risk of dementia and cognitive decline. Additionally, more severe hearing loss is associated with a faster rate of cognitive deterioration and an increased chance of cognitive impairment. In addition, auditory impairment is often more pronounced in individuals suffering from

dementia. Crucial information concerning the patient's auditory features, which are closely linked to cognitive well-being, can be obtained through audiometry. This can assist in forecasting the initiation of dementia in individuals experiencing hearing impairment. One of the main advantages of hearing interventions in the prevention of dementia originates from the way they impact the relationship between hearing and cognition, ultimately affecting daily functioning. Diagnosing dementia involves assessing cognitive impairment that is significant enough to affect a person's ability to function independently in their daily life. In addition to affecting functional ability, hearing loss also worsens the effects of cognitive impairment. It is likely that hearing interventions can be effective in preventing the diagnosis of dementia by reducing or reversing disability. Hearing interventions can be effective in delaying the onset of cognitive difficulties that lead to dementia. This can help preserve autonomy, involvement in society, and overall, of life.<sup>7,10</sup>

The degree of hearing loss was assessed in this study, with a significant number of individuals with hearing impairments reporting impairment in both ears. This suggests that a decline in hearing may be associated with an increased susceptibility to dementia. Further investigation is essential to comprehend the extent of hearing impairment and its correlation with cognitive decline. Utilizing data obtained from the South Korean National Health Information Database, a comprehensive statewide investigation was conducted to examine the correlation between the severity of hearing impairment and the likelihood of developing dementia. Based on the research results, it was observed that the severity of hearing loss had a significant impact on the probability of developing dementia. Therefore, it is crucial to identify hearing loss early and implement treatment strategies that can delay or prevent damage to the auditory or sensory regions of the brain. This proactive approach may assist to prevent long-term structural damage. It is important to recognize that auditory rehabilitation can be beneficial in preventing structural and functional changes in the brain caused by sensory deprivation. This can even be useful in delaying further neural restructuring or decline in the late phases of hearing loss.<sup>16,17,19</sup>

In this cohort retrospective study, multiple factors were considered when examining the frequency and intensity of the correlation between dementia and hearing loss. However, some limitations require careful thought. For instance, the limited number of participants obtained from a sole tertiary institution hinders the generalizability of the findings to a broader

national context. Nevertheless, the correlation between hearing impairment and cognitive decline observed in this study aligns with numerous other research findings in the academic field.

**Conclusion.** The findings from this study indicate a significant relationship between dementia and hearing loss. Moreover, patients with hearing loss exhibit a higher risk of developing dementia than those with normal hearing. In addition, other aspects, including comorbidities, are important risk factors for dementia. Based on the outcomes of this study, further evaluation of patients with hearing loss is recommended.

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