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Research Article

Influence of Hearing Aid Fitting on the Cognitive Profile of Older Adults: A Pre–Post Intervention Study

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Abstract

Introduction: In addition to compromising sound perception, presbycusis can affect cognitive functions such as attention, memory, and language, justifying investigations into the relationship among hearing, cognition, and the use of hearing aids.

Purpose: To examine the influence of hearing aid use on performance in the Mini-Mental State Examination, Semantic Verbal Fluency, attention, and working memory.

Methodology: This prospective observational pre–post study included 60 older adults (≥60 years) with bilateral hearing loss and no prior use of hearing aids. Individuals with cognitive impairment, neurological diseases, or severe/profound hearing loss without linguistic code were excluded. Sociodemographic and audiological data were collected, and cognitive tests were applied before and after the intervention. Analyses employed descriptive statistics and hypothesis testing.

Results: The mean age was 70.1 ± 7.9 years, with a predominance of moderate sensorineural hearing loss (≈48%). After hearing aid fitting, there was a significant improvement in MMSE scores (from 20.73 ± 3.80 to 22.62 ± 3.27; $p < 0.001$), as well as in working memory, language, verbal fluency, and task execution time. Older adults with mild hearing loss showed better cognitive performance compared to those with moderate loss.

Conclusion: Hearing aid use in older adults was associated with improved performance in global cognition and in domains related to attention, working memory, language, and semantic verbal fluency after six months of follow-up.

Introduction

Population aging is a global phenomenon and, in Brazil, it has occurred at an accelerated pace. According to demographic census estimates, the population with disabilities in the country is 18.6 million individuals, and by 2050, the number of older adults will exceed 30% of the national population [1]. This scenario presents important challenges, as aging is frequently associated with chronic conditions, including hearing loss. In Brazil, hearing healthcare is guaranteed by

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the Unified Health System, which organizes care in medium- and high-complexity services, including diagnosis, auditory rehabilitation, and multidisciplinary follow-up [2].

During the initial period of presbycusis, a gradual deterioration of the auditory sensory and neural systems occurs. This results in reduced neural support, decreased speech perception and comprehension, especially in environments with competing noise. At this stage, deficits emerge in several cognitive domains, including reduced memory for new information. Potential sources of these declines include slower processing, diminished working memory capacity, and reduced attentional focus [3]. These changes reflect the challenges faced by this population in understanding accelerated speech, which is commonly used in everyday interactions.

When identifying markers for aging with quality of life, cognitive function stands out as a key element. This process involves a subjective approach and can be achieved by recognizing individual characteristics, expressed through the promotion of physical and mental well-being and active participation in society [4]. Advancing age can lead to a reduction in functional capacity; moreover, the increasing incidence of degenerative diseases and cognitive decline has become more common in this population, making individuals more vulnerable and in need of additional care. The slowing of mental abilities may be related to sensory losses inherent to aging [5].

Communication is fundamental for social interaction and for maintaining cognitive functions throughout aging. In this context, assistive technologies, auditory rehabilitation programs, and cognitive training emerge as promising alternatives to support autonomy and active social participation among older adults [6]. Studies show that the use of hearing aids stimulates brain functions, enabling intervention in the decline and reinforcing the importance of adequate detection and treatment (Lin et al., 2013).

Notably, the study of cognitive functions related to language has received increasing scientific interest, as the interaction among these functions can influence communication, socialization, and daily living activities. Understanding this relationship is essential for developing strategies such as the use of assistive technologies, cognitive training, and auditory rehabilitation programs, with the goal of promoting active and satisfactory social engagement. Furthermore, these studies provide valuable information for the development of public policies aimed at managing hearing healthcare, helping to ensure access to quality services for individuals with hearing disabilities.

Methods

This study employed a prospective observational pre–post design with repeated cognitive measures obtained before hearing aid fitting and after six months of follow-up. In the first phase, an initial assessment was conducted, including anamnesis, audiological examinations, fitting of the Hearing Aid (HA), and the initial administration of cognitive tests. In the second phase, auditory reassessment and re-administration of cognitive tests were performed. Because no control group was included, the findings should be interpreted as longitudinal associations related to hearing aid use rather than definitive causal effects.

Between these two phases, participants attended periodic follow-up visits for device adjustments and guidance on proper use. Data collection and testing were carried out in a medium- and high-complexity auditory rehabilitation service located in Aracaju, Sergipe. The service is accredited by the Brazilian Ministry of Health for diagnosis, indication, and fitting of conventional hearing aids and auditory implants, and it has the physical infrastructure, human resources, and technological equipment required for auditory rehabilitation.

The study was approved by the Research Ethics Committee of the Federal University of Sergipe, CAAE: 55186221.1.0000.5546, in accordance with Resolution No. 466/2012 of the Brazilian National Health Council. All participants were informed about the study objectives, procedures, risks, and benefits, and voluntarily signed the Informed Consent Form (ICF).

The sample consisted of 64 individuals recruited between September 2022 and February 2025, referred by the Control, Evaluation, Audit and Regulation Center of the Municipal Government of Aracaju, with complaints of hearing loss and who met the inclusion criteria: age ≥ 60 years; residence in the state of Sergipe; hearing loss confirmed by audiological examinations; no prior use of hearing aids; and availability to participate in all study stages.

Exclusion criteria were applied to remove participants with neurological diseases associated with marked cognitive impairment; profound hearing loss without oral language; or orofacial motor impairments preventing speech production, or scores suggestive of significant cognitive impairment according to education-adjusted MMSE-2 cutoff scores recommended for the Brazilian population. Four participants did not complete all study stages and were excluded from the final analysis. Thus, the final sample consisted of 60 participants.

To minimize measurement variability, all cognitive assessments were administered by the same trained examiner under standardized environmental conditions and in the same sequence at both assessment moments. Hearing aid adherence was monitored during follow-up visits through patient reports and device data logging, allowing adjustments and reinforcement of usage guidance when necessary.

During anamnesis, information was collected regarding hearing loss, associated symptoms, comorbidities, socioeconomic and demographic aspects, expectations, and family involvement. Audiological examinations were performed to characterize the individual hearing profile, support HA selection, and when necessary, create the earmold. After device fitting, the initial cognitive tests were administered, and participants received guidance on the importance of device use, daily care, and handling.

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For HA programming, the Hi-Pro interface was used, connected to a computer running Windows XP and the NOAH v4.0 platform (HIMSA). The HA–Hi-Pro connection was performed via cable or Bluetooth. One month after HA delivery, participants returned for follow-up, device adjustments based on data logging, and clarification of handling-related doubts.

The second phase took place six months after the HA fitting. In this phase, participants underwent auditory reassessment, including functional gain in an acoustic booth and reprogramming adjustments when necessary. Cognitive tests were then re-administered, allowing comparison between initial and final assessments. Data collection in both phases was carried out by the same examiner, ensuring procedural standardization.

Audiological assessment included pure-tone audiometry, speech recognition thresholds, speech discrimination testing, acoustic immittance measures, and acoustic reflex evaluation, following standardized international criteria and calibration procedures.

Audiological examinations were conducted in an acoustic booth using Interacoustics audiometers, models AD229 and AC40, with supra-aural TDH39 earphones calibrated according to ISO 389 standards. Hearing level classification followed Lloyd and Kaplan (1978), and type was determined according to Silman and Silverman (1997).

Acoustic immittance measures were obtained using the Interacoustics AT235h device with ipsilateral Standard earphones and contralateral TDH-39 earphones, calibrated according to ISO 389 and IEC 645-1/1027 standards. Tympanometric curves were classified as follows: type A, Ad, Ar, B, and C. These classifications followed Jerger (1970). Acoustic reflex testing involved ascending sound stimuli at 500, 1000, 2000, and 4000 Hz in ipsilateral and contralateral modes.

Cognitive screening was performed using the Brazilian adapted version of the Mini-Mental State Examination (MMSE-2) [7]. The instrument was administered individually under standardized conditions in a quiet and well-lit environment and assesses orientation, attention, memory, language, and visuospatial abilities. Scores were interpreted according to Brazilian normative recommendations adjusted for educational level [8].

Semantic Verbal Fluency was then administered. Participants were asked to name as many animals as possible within 60 seconds. Performance was based on the total number of correct responses, excluding repetitions or items outside the category. This test assesses semantic memory, sustained attention, planning, and cognitive flexibility and is sensitive to early cognitive changes [9].

Attention and working memory were assessed using the Brief Neuropsychological Assessment Instrument (Neupsilin), a validated Brazilian tool for evaluating attention, memory, language, and executive functions [10]. Tasks included measures of sustained attention, working memory, verbal repetition, and short-term visual memory. Administration followed standardized procedures.

Statistical analysis included descriptive measures (mean, median, standard deviation, interquartile range, absolute and relative frequencies) and hypothesis testing. Data normality was assessed using the Shapiro–Wilk test. Because variables showed non-normal distribution, non-parametric methods were applied. The Wilcoxon signed-rank test was used for paired comparisons, the Mann–Whitney U test for independent samples, and the Kruskal–Wallis test followed by Dunn's post hoc test for multiple comparisons when appropriate. Given the relatively small sample size and non-normal distribution of several variables, non-parametric methods were considered more appropriate for the analyses. Analyses were conducted using R software version 4.3.2, adopting a significance level of 5%.

Results

The sample consisted of 60 older adults, with a mean age of 70.12 ± 7.91 years and bilateral hearing loss. A slight predominance of males was observed (53.33%). Regarding educational level, individuals with incomplete elementary education were more frequent (45%). With respect to the type and degree of hearing loss, there was a predominance of sensorineural loss and moderate bilateral degree. Speech recognition thresholds averaged 47.42 ± 14.77 dB in the right ear and 46.92 ± 16.26 dB in the left ear. Immittance testing showed a predominance of type A tympanograms (81.67%) and absence of acoustic reflexes in most participants (98.33%) (Table 1).

Regarding sociodemographic aspects, most of the sample resided in the Aracaju health region. With respect to occupation, the most frequent activities were agriculture and manual labor. Nearly half of the respondents reported previous exposure to noisy environments, particularly in industrial and commercial settings. Table presents descriptive variables of the sample and highlights that 46.7% of the individuals reported being married, with the majority self-identifying as brown (pardo). Approximately 47 older adults reported a family income ranging from one to two minimum wages. Among the participants, 85% reported difficulty hearing and a family history of hearing loss. The most frequent symptoms associated with hearing loss were tinnitus and dizziness. A high prevalence of arterial hypertension and diabetes was also observed among the clinical comorbidities reported (Table 2)

When comparing the two assessment moments, a significantly better performance was observed after hearing aid fitting across all cognitive tests administered ($p < 0.05$), as shown in Table 3.

When stratified by degree of hearing loss, individuals with mild hearing loss showed higher mean scores on the working memory and repeated sequence tests compared with those with moderate hearing loss, both before and after the intervention ($p < 0.05$). No significant differences were observed between

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Table 1: Sociodemographic and Auditory Profile of the Study Participants.

Characteristics	Values
Age	
Mean (Standard Deviation)	70.12 (7.91)
Median [Q1, Q3]	70.50 [64.50, 75.50]
Sex, n / N (%)	
Female	28 / 60 (46.67%)
Male	32 / 60 (53.33%)
Education, n / N (%)	
Complete Elementary School	16 / 60 (26.67%)
Incomplete Elementary School	27 / 60 (45.00%)
Complete High School	8 / 60 (13.33%)
Complete Higher Education	9 / 60 (15.00%)
Degree of Hearing Loss (Worse Ear), n / N (%)	
Mild	19 / 60 (31.67%)
Moderate	29 / 60 (48.33%)
Severe/Profound	12 / 60 (20.00%)
Degree of Hearing Loss (Better Ear), n / N (%)	
Mild	29 / 60 (48.33%)
Moderate	28 / 60 (46.67%)
Severe/Profound	3 / 60 (5.00%)
Asymmetry, n / N (%)	
No	42 / 60 (70.00%)
Yes	18 / 60 (30.00%)
Configuration, n / N (%)	
Mild/Mild	19 / 60 (31.67%)
Mild/Moderate	9 / 60 (15.00%)
Moderate/Moderate	20 / 60 (33.33%)
Mild/Severe	1 / 60 (1.67%)
Moderate/Severe	8 / 60 (13.33%)
Severe/Severe	3 / 60 (5.00%)
Degree of Hearing Loss – Right Ear, n / N (%)	
Mild	23 / 60 (38.33%)
Moderate	29 / 60 (48.33%)
Severe/Profound	8 / 60 (13.33%)
Degree of Hearing Loss – Left Ear, n / N (%)	
Mild	25 / 60 (41.67%)
Moderate	28 / 60 (46.67%)
Severe/Profound	7 / 60 (11.67%)
Type of Hearing Loss – Right Ear, n / N (%)	
Mixed Loss	10 / 60 (16.67%)
Sensorineural	50 / 60 (83.33%)
Type of Hearing Loss – Left Ear, n / N (%)	
Mixed Loss	7 / 60 (11.67%)
Sensorineural	53 / 60 (88.33%)
Speech Recognition Threshold – Right Ear	
Mean (SD)	47.42 (14.77)
Median [Q1, Q3]	45.00 [37.50, 55.00]
Speech Recognition Threshold – Left Ear	
Mean (SD)	46.92 (16.26)
Median [Q1, Q3]	45.00 [35.00, 55.00]
Speech Recognition Percentage Index – Right Ear	
Mean (SD)	0.85 (0.13)
Median [Q1, Q3]	0.88 [0.76, 0.96]
Speech Recognition Percentage Index – Left Ear	
Mean (SD)	0.86 (0.12)
Median [Q1, Q3]	0.88 [0.80, 0.96]
Tympanogram Type – Right Ear	
A	49 / 60 (81.67%)
Ad	1 / 60 (1.67%)
Ar	5 / 60 (8.33%)
B	2 / 60 (3.33%)
C	3 / 60 (5.00%)
Acoustic Reflex – Right Ear	
Absent	59 / 60 (98.33%)
Present	1 / 60 (1.67%)
Reflex Absent 0.5 kHz	53 / 59 (89.83%)
Reflex Absent 1 kHz	53 / 59 (89.83%)
Reflex Absent 2 kHz	55 / 59 (93.22%)
Reflex Absent 4 kHz	59 / 59 (100.00%)
Tympanogram Type – Left Ear	
A	49 / 60 (81.67%)
Ad	1 / 60 (1.67%)
Ar	7 / 60 (11.67%)
B	1 / 60 (1.67%)
C	2 / 60 (3.33%)
Acoustic Reflex – Left Ear	
Absent	59 / 60 (98.33%)
Present	1 / 60 (1.67%)
Reflex Absent 0.5 kHz	54 / 59 (91.53%)
Reflex Absent 1 kHz	54 / 59 (91.53%)
Reflex Absent 2 kHz	56 / 59 (94.92%)
Reflex Absent 4 kHz	59 / 59 (100.00%)

Table 2: Sociodemographic and Healthy Profile of the Study Participants.

Variables	Values
Occupation	
Agriculture and manual activities	21 (35.0%)
Commerce and services	11 (18.3%)
Technical/college-level professionals	11 (18.3%)
Transportation and industry sector	10 (16.7%)
Domestic work	7 (11.7%)
Marital Status	
Married	28 (46.7%)
Divorced	5 (8.3%)
Single	12 (20.0%)
Widowed	15 (25.0%)
Family Income	
1 minimum wage	17 (28.3%)
2 minimum wages	30 (50.0%)

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3 minimum wages	13 (21.7%)
Self-reported Skin Color/Race	
White	10 (16.7%)
Black	10 (16.7%)
Brown (Pardo)	40 (66.7%)
Systemic Arterial Hypertension (SAH)	
No	22 (36.7%)
Yes	38 (63.3%)
Diabetes	
No	31 (51.7%)
Yes	29 (48.3%)
Self-reported Hearing Difficulty	
Sometimes	5 (8.3%)
No	4 (6.7%)
Yes	51 (85.0%)
Tinnitus	
Sometimes	2 (3.3%)
No	22 (36.7%)
Yes	36 (60.0%)
Dizziness	
Sometimes	3 (5.0%)
No	35 (58.3%)
Yes	22 (36.7%)
Family History of Hearing Loss	
No	29 (48.3%)
Yes	31 (51.7%)
Worked in a Noisy Environment	
No	32 (53.3%)
Yes	28 (46.7%)

Table 3: Cognitive Test Performance Before and After 6 Months of Hearing Aid Use.

Characteristics	1. Before (N=60)	2. After (N=60)	p-value
MMSE-2			<0.001[1]
Mean (Standard Deviation)	20.73 (3.80)	22.62 (3.27)	
Median [Q1, Q3]	21.00 [18.00, 23.00]	23.00 [21.00, 25.00]	
Backward Counting			<0.001[1]
Mean (Standard Deviation)	16.05 (5.33)	17.02 (4.68)	
Median [Q1, Q3]	19.00 [12.50, 20.00]	19.50 [15.50, 20.00]	
Time (s)			<0.001[1]
Mean (Standard Deviation)	34.60 (15.00)	31.92 (11.27)	
Median [Q1, Q3]	32.00 [24.50, 40.00]	30.00 [24.00, 38.00]	
Digit Repetition			0.002[1]
Mean (Standard Deviation)	4.92 (1.89)	5.23 (1.64)	
Median [Q1, Q3]	5.00 [4.00, 7.00]	5.00 [4.00, 7.00]	
Working Memory			<0.001[1]
Mean (Standard Deviation)	3.78 (2.01)	4.47 (1.84)	
Median [Q1, Q3]	3.00 [2.00, 6.00]	4.00 [3.00, 6.00]	
Repeated Sequence			<0.001[1]
Mean (Standard Deviation)	2.68 (1.19)	3.08 (1.03)	
Median [Q1, Q3]	2.00 [2.00, 4.00]	3.00 [2.00, 4.00]	
Visual Memory			<0.001[1]
Mean (Standard Deviation)	2.13 (0.85)	2.47 (0.65)	
Median [Q1, Q3]	2.00 [2.00, 3.00]	3.00 [2.00, 3.00]	
Language – Repetition			<0.001[1]
Mean (Standard Deviation)	8.17 (1.36)	8.78 (1.04)	
Median [Q1, Q3]	8.00 [7.00, 9.00]	9.00 [8.00, 10.00]	
Semantic Verbal Fluency			<0.001[1]
Mean (Standard Deviation)	14.10 (4.12)	15.35 (3.80)	
Median [Q1, Q3]	14.50 [11.50, 17.00]	15.00 [12.50, 18.00]	

[1] Wilcoxon signed-rank test with continuity correction. Legend: SD – Standard Deviation; IQR – Interquartile Range.

degrees of hearing loss for the remaining domains: MMSE-2, backward counting, execution time, digit repetition, visual memory, and verbal fluency (Table 4).

In the intragroup analysis, there was a significant improvement in cognitive performance after the intervention among participants with mild and moderate hearing loss. Among those with mild loss, significant increases were observed in MMSE-2 ($p < 0.001$), working memory ($p = 0.006$), repeated sequence ($p < 0.001$), and language – repetition ($p = 0.049$). In addition, execution time was reduced ($p < 0.001$). In the group with moderate hearing loss, mean gains were also observed in MMSE-2 ($p < 0.001$), working memory ($p = 0.029$), repeated sequence ($p < 0.001$), and language – repetition ($p = 0.049$). Execution time was likewise reduced ($p < 0.001$). In the group with severe/profound loss, although mean increases were observed across all cognitive domains evaluated, the differences did not reach statistical significance, which should be interpreted cautiously due to the reduced sample size and limited statistical power of this subgroup analysis ($n = 3$) (Table 5).

Discussion

Hearing loss has a high prevalence among older adults, affecting approximately half of individuals over 60 years of age [11]. Studies have demonstrated a significant association between hearing impairment and cognitive decline, suggesting that reduced auditory perception may contribute to cognitive overload, social isolation, and, consequently, declines in functions such as attention, memory, and processing speed [7].

In this context, the present study aims to correlate hearing loss and cognitive decline within the broader issue of population aging. The importance of auditory stimulation in older adults through the use of hearing aids lies in its potential to slow the progression of conditions that affect memory and language abilities. A similar study conducted by the *Lancet Commission* showed that several risk factors may directly influence dementia symptoms, including hearing loss. The authors highlight the importance of hearing aid fitting as an important ally in reducing, delaying, or preventing dementia, while promoting socially active aging [6].

To estimate the association between presbycusis and cognitive functions, Loughrey [12] conducted a systematic

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Table 4: Comparison of cognitive performance among different types of hearing loss at the Pre- and Post-Intervention moments.

	Before, N = 60				After, N = 60			
Characteristics	**Mild** N = 29	**Moderate** N = 28	**Severe/Profound** N = 3	**p-value**¹	**Mild** N = 29	**Moderate** N = 28	**Severe/Profound** N = 3	**p-value**¹
MMSE-2				0.491				0.753
Mean (SD)	21.24 (3.89)	20.29 (3.55)	20.00 (6.00)		22.79 (3.48)	22.36 (3.07)	23.33 (4.04)	
Median [Q1; Q3]	22.00 [19.00; 24.00]	19.50 [18.00; 23.00]	20.00 [14.00; 26.00]		24.00 [21.00; 25.00]	23.00 [20.50; 24.50]	21.00 [21.00; 28.00]	
Backward Counting				0.209				0.091
Mean (SD)	17.24 (4.45)	14.54 (6.06)	18.67 (1.53)		18.21 (3.92)	15.57 (5.25)	19.00 (1.73)	
Median [Q1; Q3]	19.00 [18.00; 20.00]	17.00 [10.00; 20.00]	19.00 [17.00; 20.00]		20.00 [19.00; 20.00]	18.00 [11.00; 20.00]	20.00 [17.00; 20.00]	
Execution Time (s)				0.270				0.792
Mean (SD)	37.21 (18.56)	31.18 (10.28)	41.33 (7.77)		32.59 (13.22)	30.82 (9.20)	35.67 (10.69)	
Median [Q1; Q3]	31.00 [25.00; 41.00]	31.50 [22.00; 39.50]	39.00 [35.00; 50.00]		30.00 [25.00; 38.00]	30.00 [23.00; 38.00]	30.00 [29.00; 48.00]	
Digit Repetition				0.498				0.901
Mean (SD)	5.03 (2.21)	4.86 (1.53)	4.33 (2.08)		5.24 (1.92)	5.21 (1.40)	5.33 (1.15)	
Median [Q1; Q3]	5.00 [4.00; 7.00]	5.00 [4.00; 6.00]	5.00 [2.00; 6.00]		6.00 [4.00; 7.00]	5.00 [4.00; 6.50]	6.00 [4.00; 6.00]	
Working Memory				0.027*				**0.007***
Mean (SD)	4.48 (2.15)	3.18 (1.72)	2.67 (0.58)		5.10 (1.78)	3.86 (1.78)	4.00 (1.00)	
Median [Q1; Q3]	4.00 [3.00; 6.00]	3.00 [2.00; 4.00]	3.00 [2.00; 3.00]		5.00 [4.00; 6.00]	3.50 [3.00; 4.50]	4.00 [3.00; 5.00]	
Repeated Sequence				0.087				**0.011***
Mean (SD)	3.03 (1.35)	2.36 (0.95)	2.33 (0.58)		3.41 (1.09)	2.75 (0.89)	3.00 (1.00)	
Median [Q1; Q3]	3.00 [2.00; 4.00]	2.00 [2.00; 2.50]	2.00 [2.00; 3.00]		4.00 [3.00; 4.00]	3.00 [2.00; 3.00]	3.00 [2.00; 4.00]	
Visual Memory				0.436				0.883
Mean (SD)	2.21 (0.98)	2.04 (0.74)	2.33 (0.58)		2.45 (0.69)	2.46 (0.64)	2.67 (0.58)	
Median [Q1; Q3]	2.00 [2.00; 3.00]	2.00 [1.50; 3.00]	2.00 [2.00; 3.00]		3.00 [2.00; 3.00]	3.00 [2.00; 3.00]	3.00 [2.00; 3.00]	
Language – Repetition				0.003*				0.266
Mean (SD)	8.76 (1.15)	7.68 (1.33)	7.00 (1.00)		9.00 (0.96)	8.61 (1.13)	8.33 (0.58)	
Median [Q1; Q3]	9.00 [8.00; 10.00]	8.00 [6.50; 9.00]	7.00 [6.00; 8.00]		9.00 [8.00; 10.00]	8.50 [8.00; 10.00]	8.00 [8.00; 9.00]	
Verbal Fluency				0.059				0.243
Mean (SD)	14.69 (3.82)	13.07 (4.22)	18.00 (3.61)		15.38 (4.10)	14.96 (3.52)	18.67 (2.08)	
Median [Q1; Q3]	15.00 [13.00; 18.00]	12.00 [9.50; 16.50]	17.00 [15.00; 22.00]		15.00 [12.00; 19.00]	15.00 [12.50; 17.50]	18.00 [17.00; 21.00]	

¹Kruskal–Wallis test

Legend: SD – Standard Deviation; IQR – Interquartile Range; * indicates statistically significant values. MMSE-2 – Mini-Mental State Examination.

review with meta-analysis, including 36 studies and a total of 20,264 individuals. A significant correlation was found between cognition and age-related hearing loss, suggesting a potential biomarker and an important risk factor for mental function decline. In our research, we observed a significant increase in total scores in cognitive tests conducted six months after hearing aid fitting.

The findings of this study revealed that bilateral sensorineural hearing loss, ranging from mild to moderate degree, was the most frequent form among the older adults evaluated, an observation widely described in the literature as characteristic of presbycusis. Previous studies indicate that aging of the auditory system is associated with degeneration of hair cells and central neural pathways, resulting in elevated thresholds and difficulty in speech discrimination, especially in noisy environments [13,14]. The predominance of symmetrical and sloping audiometric configurations observed in our study also reinforces the classic audiometric profile of aging, described by Barbosa et al. [15].

The speech recognition index (SRI) showed average scores below 88% for most participants, indicating impaired speech intelligibility. These results are similar to those described by Borges et al. [16], who found average SRI values around 80% in older adults with presbycusis. This difficulty in speech comprehension may be attributed to both degradation of peripheral auditory pathways and reduced speed of central auditory processing, a common phenomenon in older individuals [17]. In immittance testing, type was predominant, with A tympanograms and mostly absent acoustic reflexes. These findings suggest preserved middle-ear integrity but compromised central auditory pathways and brainstem function, possibly age-related.

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Table 5: Comparison of Cognitive Performance Before and After Six Months of Hearing Aid Use for Each Degree of Hearing Loss

	Mild, N = 58			**Moderate**, N = 56			**Severe/Profound** , N = 6		
Characteristics	**1. Before N = 29**	**2. After N = 29**	**p-value[1]**	**1. Before N = 28**	**2. After N = 28**	**p-value[1]**	**1. Before N = 3**	**2. After N = 3**	**p-value[1]**
MMSE-2			<0.001*			<0.001			0.250
Mean (SD)	21.24 (3.89)	22.79 (3.48)		20.29 (3.55)	22.36 (3.07)		20.00 (6.00)	23.33 (4.04)	
Median [Q1; Q3]	22.00 [19.00; 24.00]	24.00 [21.00; 25.00]		19.50 [18.00; 23.00]	23.00 [20.50; 24.50]		20.00 [14.00; 26.00]	21.00 [21.00; 28.00]	
Backward Counting			0.002*			0.003			>0.999
Mean (SD)	17.24 (4.45)	18.21 (3.92)		14.54 (6.06)	15.57 (5.25)		18.67 (1.53)	19.00 (1.73)	
Median [Q1; Q3]	19.00 [18.00; 20.00]	20.00 [19.00; 20.00]		17.00 [10.00; 20.00]	18.00 [11.00; 20.00]		19.00 [17.00; 20.00]	20.00 [17.00; 20.00]	
Execution Time (s)			<0.001			0.425			0.250
Mean (SD)	37.21 (18.56)	32.59 (13.22)		31.18 (10.28)	30.82 (9.20)		41.33 (7.77)	35.67 (10.69)	
Median [Q1; Q3]	31.00 [25.00; 41.00]	30.00 [25.00; 38.00]		31.50 [22.00; 39.50]	30.00 [23.00; 38.00]		39.00 [35.00; 50.00]	30.00 [29.00; 48.00]	
Digit Repetition			0.098			0.027			0.371
Mean (SD)	5.03 (2.21)	5.24 (1.92)		4.86 (1.53)	5.21 (1.40)		4.33 (2.08)	5.33 (1.15)	
Median [Q1; Q3]	5.00 [4.00; 7.00]	6.00 [4.00; 7.00]		5.00 [4.00; 6.00]	5.00 [4.00; 6.50]		5.00 [2.00; 6.00]	6.00 [4.00; 6.00]	
Working Memory			0.002			<0.001			0.174
Mean (SD)	4.48 (2.15)	5.10 (1.78)		3.18 (1.72)	3.86 (1.78)		2.67 (0.58)	4.00 (1.00)	
Median [Q1; Q3]	4.00 [3.00; 6.00]	5.00 [4.00; 6.00]		3.00 [2.00; 4.00]	3.50 [3.00; 4.50]		3.00 [2.00; 3.00]	4.00 [3.00; 5.00]	
Repeated Sequence			0.018			0.005			0.346
Mean (SD)	3.03 (1.35)	3.41 (1.09)		2.36 (0.95)	2.75 (0.89)		2.33 (0.58)	3.00 (1.00)	
Median [Q1; Q3]	3.00 [2.00; 4.00]	4.00 [3.00; 4.00]		2.00 [2.00; 2.50]	3.00 [2.00; 3.00]		2.00 [2.00; 3.00]	3.00 [2.00; 4.00]	
Visual Memory			0.039			0.002			>0.999
Mean (SD)	2.21 (0.98)	2.45 (0.69)		2.04 (0.74)	2.46 (0.64)		2.33 (0.58)	2.67 (0.58)	
Median [Q1; Q3]	2.00 [2.00; 3.00]	3.00 [2.00; 3.00]		2.00 [1.50; 3.00]	3.00 [2.00; 3.00]		2.00 [2.00; 3.00]	3.00 [2.00; 3.00]	
Language – Repetition			0.078			<0.001			0.346
Mean (SD)	8.76 (1.15)	9.00 (0.96)		7.68 (1.33)	8.61 (1.13)		7.00 (1.00)	8.33 (0.58)	
Median [Q1; Q3]	9.00 [8.00; 10.00]	9.00 [8.00; 10.00]		8.00 [6.50; 9.00]	8.50 [8.00; 10.00]		7.00 [6.00; 8.00]	8.00 [8.00; 9.00]	
Verbal Fluency			0.015			<0.001			0.586
Mean (SD)	14.69 (3.82)	15.38 (4.10)		13.07 (4.22)	14.96 (3.52)		18.00 (3.61)	18.67 (2.08)	
Median [Q1; Q3]	15.00 [13.00; 18.00]	15.00 [12.00; 19.00]		12.00 [9.50; 16.50]	15.00 [12.50; 17.50]		17.00 [15.00; 22.00]	18.00 [17.00; 21.00]	

[1] Wilcoxon signed rank test with continuity correction.

[2] Wilcoxon signed rank exact test; Wilcoxon signed rank test with continuity correction.

Legend: SD – Standard Deviation; IQR – Interquartile Range; MMSE-2 – Mini-Mental State Examination.

Such results align with the auditory aging processes described by Gordon-Salant [18], who emphasizes reduced neural excitability and synaptic loss as factors limiting stapedius reflex responses. The influence of sociodemographic factors on cognitive performance in older adults is widely recognized. In the present study, a predominance of participants with low educational levels was observed, a condition that may be related to reduced neural reserve and, consequently, greater susceptibility to cognitive decline.

The literature reports that higher education acts as a protective factor, contributing to the maintenance of cognitive functions and reducing dementia incidence [19,20]. Furthermore, individuals with lower schooling tend to seek auditory rehabilitation services later, which may limit the cognitive benefits derived from early hearing aid use [21].

In this study, most participants had occupations in agriculture, services, transportation, and industry—fields associated with higher exposure to noise and ototoxic agents. These occupational factors are recognized contributors to noise-induced hearing loss and aggravators of presbycusis [22].

The socioeconomic analysis of participants showed that most older adults using hearing aids provided by the Brazilian Unified Health System (SUS) had low family income, concentrated within up to three minimum wages. This profile highlights the economic vulnerability of this group, which often depends on public provision to access hearing devices. National studies indicate that individuals with lower income tend to seek auditory rehabilitation later, which may compromise potential cognitive and communicative gains resulting from early hearing aid use [23].

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It is noteworthy that all participants were in the process of adapting to hearing aids and had confirmed hearing loss. In the state of Sergipe, studies indicate that most older adults who use public health services reside in Aracaju, the state capital, where specialized services are concentrated [24].

These data align with our findings, in which more than half of the participants lived in Aracaju. Additionally, data released by the Sergipe State Health Secretariat in 2024 indicate that auditory health services have restored quality of life to hundreds of users, highlighting the social and functional impact of these interventions. Regarding sex differences, although this study did not find significant differences, Lundgren et al. [25] observed that cognitive impairment tends to be more strongly associated with untreated hearing loss in women. These authors emphasize that delayed access to auditory treatment may limit the cognitive benefits of rehabilitation, reinforcing the importance of early detection and intervention.

Among the reported associated symptoms, the most prevalent were hearing loss, followed by tinnitus and dizziness. According to Melo et al. [26], tinnitus is frequently reported by older adults with presbycusis and may be related to emotional impact, anxiety, and concentration difficulties. In addition to interfering with cognitive load, tinnitus can exacerbate auditory discomfort and affect daily activities.

Regarding comorbidities, the most prevalent in this study were systemic arterial hypertension and diabetes mellitus, both widely recognized for their negative effects on the auditory system. Hypertension may compromise cochlear perfusion, leading to alterations in the microcirculation of the inner ear and impairing the function of hair cells [27]. Diabetes mellitus is associated with metabolic changes in the stria vascularis and reduced glucose transport to the auditory nerve, contributing to degenerative and inflammatory processes [15].

Recent evidence from the *Brazilian Longitudinal Study of Adult Health* (ELSA-Brasil) reinforces the influence of cardiovascular and metabolic comorbidities on hearing. In a four-year follow-up analysis, individuals with hypertension showed a higher incidence of hearing loss [28], and participants with diabetes performed worse on speech perception tests [29]. However, after adjusting for age, sex, education, occupational noise exposure, and other confounders, this association lost statistical significance—indicating that aging remained the primary independent risk factor.

Stratified analysis indicated that individuals with mild hearing loss showed superior cognitive performance compared with those with moderate loss, evidencing a relationship between hearing loss degree and cognitive impairment. These results support findings by Lin et al. [30], who reported an approximately threefold higher risk of cognitive decline in older adults with moderate to severe hearing loss.

Moreover, the absence of significant improvement in participants with severe/profound loss may reflect both low sample size and limited neural plasticity at advanced stages of sensory deprivation, underscoring the need for early auditory interventions to maximize cognitive benefits.

The results of this study demonstrated significant cognitive improvement in older adults after six months of hearing aid use, as evidenced by gains in Mini-Mental State Examination (MMSE-2) scores, verbal fluency tests, and Neupsilin performance. These findings align with evidence from Amieva et al. [31], who observed lower dementia incidence among older adults using hearing aids, suggesting that auditory rehabilitation may serve as a protective factor against cognitive decline. Similarly, Maharani et al. [32] reported that hearing aid use was associated with attenuation of immediate and delayed memory decline.

The analysis showed that hearing aid use exerted a positive influence on cognitive performance, particularly in semantic verbal fluency tasks, after six months of adaptation. The significant increase in average scores between the pre- and post-intervention periods indicates that rehabilitation of auditory perception provides measurable benefits to higher-order cognitive functions, such as lexical retrieval and semantic organization. These findings support the hypothesis that auditory stimulation may enhance neural plasticity and functional reorganization of cortical networks involved in both hearing and cognition.

Previous studies support this relationship between auditory amplification and improved cognitive performance. Lin et al. [30] and Deal et al. [33] demonstrated that regular hearing aid use is associated with decelerated cognitive decline and preserved verbal abilities in older adults with mild to moderate hearing loss. Wayne [34] reported that auditory deprivation overloads attentional and working-memory resources, which may explain cognitive impairment in individuals who do not use amplification.

The significant interaction effect observed between degree of hearing loss and time of assessment reinforces that the cognitive impact of hearing aids is more evident in individuals with mild and moderate losses, possibly due to greater residual auditory capacity and integrity of cortical pathways responsible for auditory-cognitive integration. Conversely, the absence of significant improvement in those with severe and profound losses may reflect limitations in acoustic perception and reduced neuronal plasticity, as described by Dawes et al. [35].

These findings indicate that the degree of hearing loss acts as a moderator of cognitive response to amplification. Hearing aid adaptation was associated with significant improvement in MMSE-2 total scores after six months of use. This result is consistent with findings by Ito and Owada (2020), who observed increased MMSE scores in older adults with hearing loss after hearing aid use, especially in attention/concentration, verbal comprehension, and constructive praxis domains.

Longitudinal studies, such as Magrini [36], also found significant MMSE increases after three months of hearing aid use, suggesting that auditory rehabilitation promotes early cognitive gains even within relatively short periods. Application of the Neupsilin instrument at two moments, during adaptation and six months after hearing aid use, revealed significant improvements in cognitive performance in subtests related to attention, memory, language, verbal fluency, and executive functions.

These results corroborate findings associating enhanced auditory stimulation with preservation and strengthening of cognitive processes in older adults, reducing the risk of progressive decline [31,32]. Owing to its multifactorial nature, Neupsilin allows for comprehensive assessment of cognitive performance changes and is considered a useful tool for longitudinal monitoring [10].

This study has some limitations that should be considered when interpreting the findings. Repeated administration of cognitive instruments such as the MMSE-2 and Neupsilin may have produced practice effects, in which participants demonstrate improved performance due to familiarity with test procedures rather than actual cognitive changes. Practice effects are recognized in longitudinal neuropsychological assessments and may partially influence repeated cognitive measures.

Another limitation concerns the small number of participants with severe/profound hearing loss, which may have reduced the statistical power of subgroup analyses. Finally, the six-month follow-up period may not be sufficient to determine the long-term cognitive effects associated with hearing aid use [37-50].

Conclusion

The intervention involving the use of hearing aids in older adults with bilateral hearing loss was associated with improved performance in overall cognitive performance and in specific domains related to attention, working memory, language, and semantic verbal fluency.

Data availability statement

We will not make available response files that contain the responses recorded by the Brazilian standards suggested by the Research Ethics Committee.

Contributions

SCCS and RQG determined the objective and design of the study; SCCS contributed to the construction and development of this study and led data collection, wrote the results and discussion, and finalized the manuscript. JSA and RQG contributed to the final revisions of the manuscript for publication.

References

1. Brazilian Institute of Geography and Statistics (BR). National Health Survey: 2019: life cycles: Brazil. Rio de Janeiro: IBGE; 2021. Available from: https://www.ibge.gov.br/en/statistics/social/justice-and-security/16840-national-survey-of-health.html?edicao=19375
2. Brazil. Ministry of Health. Ordinance No. 2,073, September 28, 2004. Establishes the National Policy for Hearing Health Care. Brasília: Ministry of Health; 2004. Available from: https://www.scielo.br/j/codas/a/VHvCCzzY6RJMhwPqXnGF54R/?lang=en
3. Wingfield A, Tun PA, McCoy SL. Hearing loss in older adulthood: what it is and how it interacts with cognitive performance. Curr Dir Psychol Sci. 2005;14(3):144-8. Available from: https://doi.org/10.1111/j.0963-7214.2005.00356.x .
4. Rinaldi J, et al. Sixteen-year predictors of successful aging from a Southern Brazilian cohort: the PALA study. Dement Neuropsychol. 2018;12(3):228-34. Available from: https://doi.org/10.1590/1980-57642018dn12-030002 .
5. Silva JNMA, et al. Predicting dimensions of clinical-functional conditions and cognition in the elderly. Rev Bras Enferm. 2020;73. Available from: https://doi.org/10.1590/0034-7167-2019-0162
6. Livingston G, et al. Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. Lancet. 2020;396(10248):413-46. Available from: https://doi.org/10.1016/s0140-6736(20)30367-6
7. Spedo CT, et al. Brazilian adaptation of the Mini-Mental State Examination. 2nd ed. São Paulo: Hogrefe; 2018. Available from: https://doi.org/10.1590/s0004-282x1998000400014
8. Brucki SMD, et al. Suggestions for utilization of the Mini-Mental State Examination in Brazil. Arq Neuropsiquiatr. 2003;61(3B):777-81. Available from: https://doi.org/10.1590/s0004-282x2003000500014
9. Rodrigues RA, et al. Semantic verbal fluency in Brazilian elderly: normative data and influence of demographic variables. Rev Bras Ter Cogn Comport. 2008;14(2):97-106. Available from: https://www.scielo.br/j/prc/a/K9yY8yrmWb76fkHXNwfrfWj/?lang=en
10. Fonseca RP, et al. Brief Neuropsychological Assessment Instrument – NEUPSILIN. São Paulo: Vetor Editora; 2009.
11. World Health Organization. World report on hearing. Geneva: WHO; 2021. Available from: https://www.who.int/publications/i/item/9789240020481
12. Loughrey DG, et al. Association of age-related hearing loss with cognitive function, cognitive impairment, and dementia: a systematic review and meta-analysis. JAMA Otolaryngol Head Neck Surg. 2018;144(2):176. Available from: https://doi.org/10.1001/jamaoto.2017.2513
13. Yamasoba T, et al. Current concepts in age-related hearing loss: epidemiology and mechanistic pathways. Hear Res. 2013;303:30-8. Available from: https://doi.org/10.1016/j.heares.2013.01.021
14. Homans NC, et al. Prevalence of age-related hearing loss, including sex differences, in older adults in a large cohort study. Laryngoscope. 2017;127:725-30. Available from: https://doi.org/10.1002/lary.26150
15. Barbosa HJC, et al. Clinical-epidemiological profile of patients with hearing loss. J Health Biol Sci. 2018;6(4):424-30. Available from: https://aimdrjournal.com/wp-content/uploads/2021/11/EN3_OA_Meddoctor_2_6_25.pdf
16. Borges MGS, et al. Correlations between audiological assessment and cognitive screening in older adults. Rev CEFAC. 2016;18(6):1285-93. Available from: https://doi.org/10.1590/1982-021620161865616
17. Eckert MA, Matthews LJ, Dubno JR. Self-assessed hearing handicap in older adults with poorer-than-predicted speech recognition in noise. J Speech Lang Hear Res. 2017;60(1):251-62. Available from: https://doi.org/10.1044/2016_jslhr-h-16-0011
18. Gordon-Salant S, et al. Auditory temporal processing and aging: implications for speech understanding in older adults. Audiol Res. 2011;1(1). Available from: https://doi.org/10.4081/audiores.2011.e4
19. Clouston SAP, et al. Education and cognitive decline: an integrative analysis of global longitudinal studies of cognitive aging. J Gerontol B Psychol Sci Soc Sci. 2020;75(7). Available from: https://doi.org/10.1093/geronb/gbz053
20. Forte G, Favieri F, Casagrande M. Heart rate variability and cognitive function: a systematic review. Front Neurosci. 2019;13:710. Available from: https://doi.org/10.3389/fnins.2019.00710
21. Rutherford BR, et al. Sensation and psychiatry: linking age-related hearing loss to late-life depression and cognitive decline. Am J Psychiatry. 2018;175:215-24. Available from: https://doi.org/10.1176/appi.ajp.2017.17040423 .

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22. Lie A, et al. Occupational noise exposure and hearing: a systematic review. Int Arch Occup Environ Health. 2020;93(8):963-81. Available from: https://doi.org/10.1007/s00420-015-1083-5

23. Silva SM, Lima RC, Santos CM. Access to hearing rehabilitation in the Unified Health System: socioeconomic and demographic barriers. Rev Bras Otorrinolaringol. 2020;86(5):562-70. Available from: https://doi.org/10.1097/MOO.0000000000000386

24. Santana MRR, et al. Hearing screening in older adults: characterization of a hospital-based population. Rev Serg Saúde Pública. 2024;3(1).

25. Lundgren P, et al. Performance in men and women aged 60-96 years: data from the Swedish “Good Aging in Skåne” population study. J Clin Med. 2024;13(8):2415. https://doi.org/10.3390/jcm13082415 .

26. Melo JJ, et al. Prevalence of tinnitus in older adults with and without a history of occupational noise exposure. Int Arch Otorhinolaryngol. 2012;16(2). Available from: https://doi.org/10.7162/S1809-97772012000200011

27. Menezes TN, et al. Prevalence and control of arterial hypertension in older adults: a population-based study. Rev Port Saúde Pública. 2016;34(2):117-24. Available from: https://doi.org/10.5935/abc.20180274

28. Cruickshanks KJ, et al. Hearing loss incidence and hypertension: findings from the ELSA-Brasil longitudinal study. PubMed. 2022. PMID:35476106.

29. Bittencourt AG, et al. Diabetes mellitus and sensorineural hearing loss: findings from the ELSA-Brasil baseline data. Clinics (Sao Paulo). 2022;77.

30. Lin FR, et al. Hearing loss and incident dementia. Arch Neurol. 2011;68(2):214-20. Available from: https://doi.org/10.1001/archneurol.2010.362

31. Amieva H, et al. Death, depression, disability, and dementia associated with self-reported hearing problems: a 25-year study. J Gerontol A Biol Sci Med Sci. 2018;73:1383-9. Available from: https://doi.org10.1093/gerona/glx250 .

32. Maharani A, et al. Longitudinal relationship between hearing aid use and cognitive function in older American adults. J Am Geriatr Soc. 2018;66:1130-6. Available from: https://doi.org/10.1111/jgs.15363 .

33. Deal JA, et al. Hearing impairment and incident dementia and cognitive decline in older adults: the Health ABC Study. J Gerontol A Biol Sci Med Sci. 2017;72(5):703-9. Available from: https://doi.org/10.1093/gerona/glw069

34. Wayne RV, Johnsruede IS. A review of causal mechanisms underlying the link between age-related hearing loss and cognitive decline. Ageing Res Rev. 2015;23(Pt B):154-66. Available from: https://doi.org/10.1016/j.arr.2015.06.002

35. Dawes P, et al. Hearing loss and cognition: the role of hearing aids, social isolation, and depression. PLoS One. 2015. Available from: https://doi.org/10.1371/journal.pone.0119616

36. Magrini AM, Momensohn-Santos TM. Verification of the influence of hearing aid use on cognitive performance in older adults. Distúrb Comun. 2017;29(1):122-32. https://doi.org10.23925/2176-2724.2017v29i1p122-132 .

37. Barnett MJ, Doroudgar S, Khosraviani V, Ip EJ. Multiple comparisons: to compare or not to compare, that is the question. Res Social Adm Pharm. 2022;18(2):2331-4. Available from: https://doi.org/10.1016/j.sapharm.2021.07.006

38. Brazil. Ministry of Health. GM/MS Ordinance No. 587, October 7, 2004. Provides for the organization and implementation of State Hearing Health Care Networks. Brasília: Ministry of Health; 2004.

39. Brucki SMD, et al. Normative data for category verbal fluency testing in our setting. Arq Neuropsiquiatr. 1997;55(1):56-61. Available from: https://doi.org/10.1590/s0004-282x1997000100009

40. Carvalho GA, Caramelli P, Ferraz MP. Mini-Mental State Examination: adaptations and standardizations for Brazilian older adults. Dement Neuropsychol. 2016;10(1):39-46. Available from: https://doi.org/10.1590/s0004-282x1998000400014

41. Conover WJ. Practical nonparametric statistics. New York: John Wiley & Sons; 1999. Available from: https://www.scirp.org/reference/referencespapers?referenceid=4098140

42. Folstein M, Folstein S, McHugh P. “Mini-mental state”. A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res. 1975;12(3):189-98. Available from: https://www.academia.edu/6585944/Mini_mental_state_A_practical_method_for_grading_the_cognitive_state_of_patients_for_the_clinician

43. Fonseca RP, et al. Application of NEUPSILIN in older adults: analysis of cognitive functions and clinical implications. Rev Bras Geriatr Gerontol. 2017;20(4):589-600.

44. Government of Sergipe. Service for people with hearing loss has already restored quality of life to 100 residents of Sergipe. Sergipe State Health Department; 2024. Available from: https://saude.se.gov.br.

45. Haile LM, et al. Hearing loss prevalence, years lived with disability, and hearing aid use in the United States from 1990 to 2019: findings from the Global Burden of Disease Study. Ear Hear. 2024;45(1):257-67. Available from: https://doi.org/10.1097/aud.0000000000001420

46. Oti EU, Olusola MO, Esemokumo PA. Statistical analysis of the median test and the Mann-Whitney U test. Int J Adv Acad Res. 2021;7(9):44-51. Available from: https://ijaar.org/articles/v7n9/ste/Statistical%20Analysis%20of%20the%20Median%20Test%20and%20the%20Mann-Whitney%20U%20Test.pdf

47. R Core Team. R: a language and environment for statistical computing. Vienna: R Foundation for Statistical Computing; 2023. Available from: https://www.R-project.org/.

48. Silva SM, Lima RC, Santos CM. Access to hearing rehabilitation in the Unified Health System: socioeconomic and demographic barriers. Rev Bras Otorrinolaringol. 2020;86(5):562-70.

49. Systems of Speech-Language Pathology Councils. Guidelines for basic audiological assessment. Brasília; 2017.

50. Souza RR, et al. Sample size and Shapiro-Wilk test: an analysis for soybean grain yield. Eur J Agron. 2023;142:126666. Available from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4082791

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