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INDICATORS OF COGNITIVE DECLINE IN PERSONS WITH PRESBYCUSIS

INDIKATORI PADA KOGNITIVNE FUNKCIJE KOD OSOBA SA PREZBIAKUZIJOM

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Summary

Introduction. Presbycusis or age-related hearing loss is a physiological elevation of hearing threshold and is one of the leading chronic health problems. A growing number of studies show a correlation between hearing loss in old age and decline in cognitive function. **Material and Methods**. The Serbian version of the Montreal Cognitive Assessment test was used, and the study included 56 subjects with a confirmed diagnosis of presbycusis of which 29 (51.8%) were hearing aid users. **Results.** The score of cognitive function in the respondents was lower compared to the results of previous research (mean = 19.07; standard deviation = 5.03). Also, there were significant differences between the scores of cognitive function in persons who used amplification and persons who did not. There was no significant correlation between gender, employment status, and the degree of hearing impairment, while the correlation was significant between the level of education, age, the length of hearing aid use, and the number of hours per day a person used a hearing aid. Regression analysis showed that about 88% of the variance of the dependent variable could be explained by four variables: age, level of education, length of hearing aid use, and daily level of hearing aid use. **Conclusion.** Persons with presbycusis from the territory of the Autonomous Province of Vojvodina showed poor performance scores on the cognitive ability test compared to the results of other researchers. The results showed that the length of hearing aid use and the daily level of hearing aid use significantly affect the cognitive functions in persons with presbycusis.

Keywords: Cognition; Presbycusis; Cognitive Dysfunction; Persons With Hearing Impairments; Surveys and Questionnaires; Hearing Aids

Sažetak

Uvod. Staračka nagluvost podrazumeva fiziološko povećanje praga sluha i jedan je od vodećih hroničnih zdravstvenih problema. Sve veći broj istraživanja pokazuje međusobnu povezanost gubitka sluha u starosti i pada kognitivne funkcije. **Materijal i metode.** Korišćena je srpska verzija Montrealske procene kognicije, a studija je obuhvatila 56 ispitanika sa potvrđenom dijagnozom prezbiakuzije, od čega je 29 (51,8%) korisnika slušnih aparata. **Rezultati.** Skor kognitivnog funkcionisanja ispitanika bio je niži u odnosu na rezultate prethodnih istraživanja (srednja vrednost = 19,07; standradna devijacija = 5,03). Postoje značajne razlike između skora kognitivnog funkcionisanja osoba koje koriste amplifikaciju i osoba koje je ne koriste. Nema značajne korelacije sa polom i statusom zaposlenja, kao ni stepenom oštećenja sluha. Korelacija je značajna sa stepenom obrazovanja, starošću, dužinom korišćenja slušnog aparata, kao i brojem sati u danu u kom osoba koristi slušni aparat. Regresionom analizom utvrđeno je da oko 88% varijanse zavisne promenljive objašnjavaju četiri varijable – starost, stepen obrazovanja, dužina korišćenja i dnevni nivo korišćenja slušnog aparata. **Zaključak.** Osobe sa prezbiakuzijom sa teritorije Autonomne Pokrajne Vojvodine pokazale su prosečno niže postignuće na testu kognitivnih sposobnosti u odnosu na rezultate drugih istraživača. Rezultati su pokazali da dužina korišćenja slušnog aparata, ali i korišćenja slušnog aparata na dnevnom nivou, značajno utiču na kognitivne funkcije osoba sa prezbiakuzijom.

Ključne reči: kognicija; presbiakuzija; kognitivna disfunkcija; osobe sa oštećenjem sluha; ankete i istraživanja; slušna pomagala

Introduction

Presbycusis is a physiological process that leads to a gradual loss of hearing. Presbycusis is a progressive, bilateral, permanent hearing impairment that occurs as a result of degenerative changes in the structures of the inner ear and/or auditory nerve [1]. According to the World Health Organization [2] presbycusis affects every third person over the age of 65, half of the adults over the age of 75, the majority of adults over the age of 80, and almost all people over the age of 90. The latest report [3] estimates that globally more than 1.2 billion people live with some degree of hearing loss. The World Health Organization points out that if appropriate measures of prevention and care for hearing health are not taken by 2050, the number of people with hearing impairment will double and more than 700 million will require some kind of hearing intervention.

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Abbreviations

HA – hearing aid
SD – standard deviation
MoCA – Montreal Cognitive Assessment

The decline in cognitive function is another health challenge that globally affects the elderly population and includes a wide range of conditions, from mild impairment of cognitive function to severe dementia [4]. The increasing incidence of these conditions in adulthood and the devastating impact they may have on the quality of life of individuals, their families and society, have made the prevention and treatment of cognitive function decline a public health priority [5]. The most common domains of cognitive functions affected by aging are the speed of information processing, memory, and attention. The number of people suffering from dementia has rapidly increased, and it is expected that the number will increase to 152 million by 2050 [5–7]. A growing number of studies show the connection between hearing loss in older people and various forms of decline in cognitive function such as dementia, Alzheimer's disease etc. [8, 9]. Hearing impairment causes a load at the level of cortical auditory processing and the available cognitive resources are diverted to auditory processing [4, 10]. Other theories suggest that hearing loss in old age leads to social isolation and then to a decline in cognitive functions [11] or that the reason for the connection lies in the (common) cause of both conditions, i.e. that hearing loss is an early manifestation of cognitive pathology [12]. Thomson et al. [13] claim that the link between the decline in cognitive functions and hearing loss was confirmed in all analyzed studies, which supports the hypothesis that hearing loss is one of the risk factors for the decline in cognitive function.

Timely diagnosis of hearing impairment and auditory rehabilitation of persons with presbycusis can reduce the impact of hearing impairment on cognitive deterioration, thus reducing healthcare costs, increasing the quality of life and facilitating daily functioning of these persons [14]. Timely diagnosis of hearing loss should insure adequate amplification, which implies the use of hearing aids (HAs) for minor hearing impairments or the use of cochlear implants for severe and profound hearing impairments [9]. The research aimed to determine the indicators of cognitive function decline in persons with confirmed presbycusis in the territory of Vojvodina. The research also examined the impact of hearing-aid amplification on the cognitive status of persons with presbycusis.

Material and Methods

The research was conducted from March to July 2022, in the territory of the Autonomous Province of Vojvodina, Republic of Serbia. The research sample included 56 persons with presbycusis, patients of the Clinic of Otorhinolaryngology and Head and Neck Surgery of the Clinical Center of Vojvodina. The questionnaire was anonymous. Out of the total number of respondents, there were 26 (46.4%) males and 30 (53.6%) females, of which 29 (51.8%) used a HA. The average age was 73.41 years with a standard deviation (SD) of 8.07; 11 subjects (19.6%) had a moderately severe hearing loss (56 – 70 decibels - dB), 29 subjects (51.8%) had severe (71 – 90 dB), and 16 subjects (28.6%) had a profound hearing loss (over 90 dB). The mean length of use of HA was 5.65 years (SD = 5.12). On average, the respondents used the HA 8.97 hours per day (SD = 3.96). There were more unemployed respondents (34; 60.7%). The approval of the Ethics Committee of the Clinical Center of Vojvodina (decision number 00-57) was obtained for conducting the research. For this research, the Serbian version of the Montreal Cognitive Assessment (MoCA) [15] was used. The consent to use this instrument was obtained by the author, and the research was conducted by a certified researcher. The MoCA [16] is a test for rapid assessment of cognition, which includes seven domains in 11 tasks: visuospatial and executive function, naming, memory, attention, language, abstraction, delayed recall, and orientation. The MoCA is a 30-point scale, with a result of 26 or more points being considered good, and it takes about 10 minutes.

The dependent variable was the cognitive status of persons with presbycusis, evaluated by the Serbian version of the MoCA test. This variable is numerical, discontinuous and quantitative according to the way its value is expressed, and according to the possibility of being influenced by other variables, it is defined as endogenous. Independent variables were defined through two larger groups: variables related to sociodemographic factors and variables related to hearing impairment. Variables related to hearing impairment included the degree of hearing impairment defined as a quantitative indicator of a person's hearing status, divided into three categories (moderately severe hearing impairment: 56 – 70 dB, severe hearing impairment: 71 – 90 dB, and profound hearing impairment: over 90 dB). The length of hearing aid use was defined as a quantitative, numerical, discontinuous indicator of experience in the use of auditory amplification, expressed in months. The third variable related to the length of hearing aid use during one day was defined as a quantitative, numerical, discontinuous indicator of actual hearing aid use expressed through the number of hours during the day. Variables related to sociodemographic factors included age, defined as a numerical, discontinuous and quantitative indicator, the level of employment, defined as a qualitative indicator of the person's current working ability, consisting of two categories - employed and unemployed, and finally the level of education, as a quantitative indicator of the level of acquired education, divided into four categories (primary education, secondary school, high school, and university).

Data processing was performed using the Statistical Package for the Social Sciences version 20.0. Descriptive statistics methods were frequencies, percentages, contingency coefficient, measures of central tendency and dispersion measures, as well as appropriate inferential statistics methods (Student's t-test, Pearson's correlation analysis, multiple linear regression analysis). Using the Kolmogorov-Smirnov test, we examined the normality of the distribution of scores and the results showed there is no statistically significant deviation (Z

Table 1. Descriptive values of cognitive function scores of persons with presbycusis (No. = 56)
Tabela 1. *Deskriptivne vrednosti procene skora kognitivnog funkcionisanja osoba sa presbiakuzijom* (*Br.* = 56)

Cognitive function *Kognitivna funkcija* (Max)	Min *Min*	Max *Maks.*	M *M*	Mdn *Mdn*	SD *SD*	IQR *IQR*	SEM *SEM*	95% Confidence interval *Interval poverenja* 95%
Visuospatial, executive *Vizuoprostorne, egzekutivne f.* (5)	1	5	3.59	4	1.35	2	0.18	3.23 - 3.95
Naming/*Imenovanje* (3)	2	3	2.88	3	0.33	0	0.05	2.79 - 2.96
Attention/*Pažnja* (6)	0	6	3.54	3.50	1.44	1	0.19	3.15 - 3.92
Language/*Jezik* (3)	0	3	1.45	1.50	0.93	1	0.12	1.20 - 1.70
Abstraction/*Apstrakcija* (2)	0	2	0.93	1	0.71	1	0.09	0.74 - 1.12
Delayed recall/*Odgođeno prisećanje* (5)	0	3	0.84	0	1.06	1	0.14	0.56 - 1.12
Orientation/*Orijentacija* (6)	3	6	5.82	6	0.60	0	0.08	5.66 - 5.98
Total score/*Ukupan skor* (30)	6	28	19.07	19	5.03	5	0.67	17.55 - 20.13

Legend: Min - minimum score; Max - maximum score; M - mean; Mdn - median; SD - standard deviation; IQR - interquartile range; SEM - standard error
Legenda: min – minimum rezultata; max – maksimum rezultata; M – aritmetička sredina; Mdn – medijana; SD – standardna devijacija; IQR – interkvartalni raspon; SEM – standardna greška

Table 2. Descriptive measures of cognitive achievement, differences between the group of subjects using HA and the group not using HA
Tabela 2. *Deskriptivne mere kognitivnog postignuća ispitanika, razlike između grupe ispitanika koja koristi slušni aparat i koja ga ne koristi*

Cognitive function *Kognitivna funkcija* (Max)	Using HA/*Koristi SA*				Not using HA/*Ne koristi SA*				
	Min *Min*	Max *Maks.*	M (SD) *M (SD)*	Mdn *Mdn*	Min *Min*	Max *Maks.*	M (SD) *M (SD)*	Mdn *Mdn*	t-test *t-test*
Visuospatial, executive *Vizuoprostorne, egzekutivne f.* (5)	2	5	4.07 (0.99)	4	1	5	3.07 (1.49)	3	-2.95**
Naming/*Imenovanje* (3)	2	3	2.93 (0.26)	3	2	3	2.81 (0.40)	3	-1.31
Attention/*Pažnja* (6)	2	6	4.24 (1.27)	4	0	5	2.78 (1.22)	3	-4.39**
Language/*Jezik* (3)	1	3	1.93 (0.75)	2	0	2	0.93 (0.83)	1	-4.75**
Abstraction/*Apstrakcija* (2)	0	2	1.00 (0.76)	1	0	2	0.85 (0.66)	1	-0.77
Delayed recall/*Odgođeno prisećanje* (5)	0	3	1.28 (1.25)	1	0	1	0.37 (0.49)	0	-3.51**
Orientation/*Orijentacija* (6)	6	6	6 (0)	6	3	6	5.63 (0.84)	6	-2.38*
Total score/*Ukupan skor* (30)	14	28	21.52(4.38)	21	6	23	16.44 (4.34)	17	-4.34**

Legend: HA - hearing aid; Min - minimum score; Max - maximum score; M - mean; Mdn - median; SD - standard deviation;
Legenda: SA – slušni aparat; - min – minimum rezultata; max – maksimum rezultata; M – aritmetička sredina; Mdn – medijana; SD – standardna devijacija; * $p \leq .05$; ** $p \leq .01$ *Perit officiu reicillanda et perest, corporepres essi volupta spelige nimpost, ent.*

= 0.095, p = .20). The internal consistency of the MoCA test was checked by calculating Cronbach's alpha coefficient, the reliability at the level of the overall scale was high (α = 0.85).

Results

The analysis of results showed that the arithmetic mean was lower than the cut-off score determined by the authors **(Table 1)**. Only eight respondents (14.24%) scored 26 points or more.

Descriptive measures of the subjects' cognitive performance on the MoCA test, as well as the values of the Student's t-test were used to test the difference between the group of subjects who used HA and subjects who did not **(Table 2)**.

More than one-third of the respondents (37.93%) who used HAs had good results (score ≥ 26), while in the group of persons who did not use HAs there were no respondents with good results. The t-test for independent samples showed a statistically significant difference between the test groups in almost all domains, as well as in the total score. The mutual correlations of the predictor variables are shown in **Table 3**.

Socio-demographic variables did not show a significant correlation between the MoCA scores and gender and employment status, while the correlation between the level of education was positive and significant. The age of the subjects significantly and negatively correlated with the MoCA scores, showing that young respondents had better cognitive functions compared to the older subjects. A positive correlation was established between the length of HA use and the number of hours a day a person used a HA and the MoCA score, but there was no significant connection between the degree of hearing impairment, as expected.

Table 3. Intercorrelations of predictor variables of cognitive status
Tabela 3. *Međusobne korelacije prediktorskih varijabli kognitivnog statusa*

	1.	2.	3.	4.	5.	6.	7.	8.
1. Gender/*Pol*	1							
2. Employment status/*Status zaposlenja*	-.02	1						
3. Age/*Starost*	.11	.49**	1					
4. Education level/*Stepen obrazovanja*	-.12	.03	.06	1				
5. Degree of impairment/*Stepen oštećenja*	.12	.20	.08	-.16	1			
6. Length of HA use/*Dužina korišćenja SA*	-.14	.16	-.07	.33*	.42**	1		
7. Use of HA per day/Korišćenje SA na dan	-.17	-.02	-.25	.36	.74**	.74**	1	
8. MoCA score/*MoCA skor*	-.12	-.23	-0.72**	0.40**	-.05	.56**	.70**	1

Legend: * p ≤ .05; ** p ≤ .01; HA - hearing aid; MoCA score - Montreal Cognitive Assessment
*Legenda: * p ≤ .05; ** p ≤ .01; SA – slušni aparat; MoCA skor – skala Montrealska procena kognicije*

Table 4. Characteristics of the total score indicators on the MoCA scale in a linear model
Tabela 4. *Karakteristike indikatora ukupnog skora na skali Montrealska procena kognicije po linearnom modelu*

	B	SE	β	T	p/*p*
Constant/*Konstanta*	-40,61	2.08		19.51	.000
Age/*Starost*	-.36	0.03	-.65	13.20	.000
Education level/*Stepen obrazovanja*	1.29	0.25	.26	5.25	.000
Length of HA use/*Dužina korišćenja SA*	.23	0.08	.21	2.99	.004
Use of HA per day/*Korišćenje SA na dan*	.28	0.07	.29	3.94	.000

Legend: HA - hearing aid; MoCA score - Montreal Cognitive Assessment
Legenda: SA – slušni aparat; MoCA skor – skala Montrealska procena kognicije

Correlations from 0.3 to 0.7, as well as those close to the value of 0.3, justified the application of regression analysis [17]. The Bonferroni adjustment was used to avoid errors. The alpha value was reduced in the four factor model and it was adjusted to 0.0125. Again, we gained significant correlations and a model was proposed to test the contributions of selected features for predicting the cognitive status of persons with presbycusis.

The analysis of variance, which is a test of the null hypothesis, according to which the coefficient of determination is equal to zero, gave a high F-coefficient ($F = 104.83$, $p < .001$), which showed that the regression analysis was justified and that we could expect an approximate F value in the future samples of the same size or larger samples with the same characteristics [17]. **Table 4** presents the linear regression coefficients between the cognitive status of persons with presbycusis and the previously mentioned factors.

The results showed that the four factor model had an acceptable fit to the data and represented a statistically significant proportion of the variance ($R2 = 0.88$, $p < .000$), which means that about 88% of the variance of the dependent variable is explained by four variables - age, level of education, length of HA use, and the number of hours per day in which a person uses HA.

Discussion

This research aimed to determine the indicators of cognitive function decline in persons with presbycusis. The results showed lower average MoCA scores in the subjects included in this study than in subjects from other studies that included people with presbycusis: in Italy (M = 21.8) [18], Canada (M = 24.4) [19] and China (M = 25) [20]. In the study by Urqueta et al. [21], over 50% of people with hearing loss had good MoCA scores. In a 2013 study [22], the authors concluded that people with hearing loss experience 30% to 40% faster cognitive decline. On average, a person with hearing loss would need 7.7 years for a five-point decline on cognitive tests compared to 10.9 years in people without hearing loss [22].

The analysis of the results of this study indicate significant differences in the cognitive function of persons who use amplification and persons who do not, which speaks in favor of the protective effect of amplification on the decline of cognitive functions. The difference in the MoCA scores regarding the cognitive function between these two groups was five points in favour of persons using amplification ($M_{amp} = 21.52$; $M_{non\text{-}amp} = 16.44$). Similar results were obtained by authors from Italy, whose subjects using amplification achieved a score of 23.71 points compared to the non-amplified group who scored 19.89 points [18]. In our research, people using amplification were significantly more successful in most individual test domains (Visuospatial and executive functions, Attention, Language, Delayed recall, Orientation), as well as in the total score, which is in line with the results of other research [23, 24]. The greatest differences between the two groups of subjects were in the following

domains: Language, Attention, as well as in the total score, while persons with amplification were more successful in the domains of Naming and Abstract thinking, but the difference between the groups was not significant. Several tasks from the two domains of the MoCA test rely on listening, i.e. a correct answer first requires a correctly perceived stimulus. These tasks are from the domain of Language and Attention, which could be the cause of the greatest differences between the two groups of respondents (amplified/non-amplified) precisely due to poor auditory perception and processing in the group of people who do not use amplification.

Correlation analyses show that there is no correlation between hearing loss and the cognitive function score, which contradicts with some earlier research that concluded that hearing loss is associated with accelerated cognitive decline and incident cognitive impairment in older adults [22, 25]. Results also showed that there is a negative correlation between the cognitive function score and age, which also coincides with earlier research on this topic [22, 25], that is, the older the person, the lower the cognitive ability. The authors [25] claim that people with a higher degree of education willingly accept various aids, including a HA, and this fact could be the reason for better cognitive functions in people with higher degree of education.

The length of HA use showed a statistically significant positive correlation with the cognitive function test score, which indicates that people who use HA for a greater number of years have higher cognitive function scores. The correlation between cognitive function test scores and the number of hours of HA use daily was also positive and statistically significant, that is, people who use their HA for a longer time during the day have higher scores on the cognitive function test. Through further regression analyses, it was established that about 88% of the variance of the dependent variable is explained by four variables - age, level of education, length of use of a HA, and the number of hours per day in which a person uses a HA. The results are in accordance with the research results of Brewster [26] who concluded that after 12 weeks of using amplification for a minimum of nine hours a day, a significant shift in hearing function, reduction of depressive symptoms, and the cognitive function score was achieved in persons with presbycusis. Naylor G. et al. [27] concluded that the use of a hearing aid reduces the risk of dementia and that better cognitive function is associated with longer use of the device; they also emphasized the importance of the availability and use of hearing aids, regardless of current cognitive status or age.

Conclusion

People with presbycusis from the territory of the Autonomous Province of Vojvodina showed a lower mean achievement on the cognitive ability test compared to the results of other researchers which indicates the need for better care of elderly people with presbycusis in the region of Vojvodina in order to prevent deterioration of their cognitive functions. The results of this research showed that the length of hearing aid use, in terms of the listening experience with amplification and the use of a hearing aid daily, significantly affects the preservation of the cognitive function of people with presbycusis. Age, level of education, length of use, and the number of hours a day in which a person uses a hearing aid showed a significant correlation with the cognitive function scores and it is recommended to establish more precise relationships between the mentioned factors on a larger sample of respondents through further research. This research is particularly significant, considering that it is the first research dealing with this topic in the territory of Vojvodina, and it may be the first step towards a better understanding of the indicators of cognitive function decline and understanding the importance of timely diagnosis and amplification in elderly people with impaired hearing.

References

1. Looi LM, Ganten D, McGrath PF, Gross M, Griffin GE. Hearing loss: a global health issue. Lancet. 2015;385(9972):943-4.

2. World Health Organization. Deafness and hearing loss [Internet]. 2023 [cited 2023 Feb 28]. Available from: https://www.who.int/news-room/fact-sheets/detail/deafness-and-hearing-loss

3. World Health Organization. World report on hearing [Internet]. 2021 [cited 2023 Jan 15]. Available from: https://www.who.int/publications/i/item/9789240020481

4. Campbell J, Sharma A. Compensatory changes in cortical resource allocation in adults with hearing loss. Front Syst Neurosci. 2013;7:71.

5. Bernabei R, Bonuccelli U, Maggi S, Marengoni A, Martini A, Memo M, et al. Hearing loss and cognitive decline in older adults: questions and answers. Aging Clin Exp Res. 2014;26(6):567-73.

6. Livingston G, Sommerlad A, Orgeta V, Costafreda SG, Huntley J, Ames D, et al. Dementia prevention, intervention, and care. Lancet. 2017;390(10113):2673-734.

7. Krsteska R. Risk factors for dementia of the Alzheimer and vascular type. Med Pregl. 2009;62(5-6):201-6.

8. Deal JA, Sharrett AR, Albert MS, Coresh J, Mosley T, Knopman D, et al. Hearing impairment and cognitive decline: a pilot study conducted within the atherosclerosis risk in communities neurocognitive study. Am J Epidemiol. 2015;181(9):680-90.

9. Sharma R, Chern A, Golub J. Age-related hearing loss and the development of cognitive impairment and late-life depression: a scoping overview. Semin Hear. 2021;42(1):10-25.

10. Tun PA, McCoy S, Wingfield A. Aging, hearing acuity, and the attentional costs of effortful listening. Psychol Aging. 2009;24 (3):761-6.

11. Mick P, Kawachi I, Lin FR. The association between hearing loss and social isolation in older adults. Otolaryngol Head Neck Surg. 2014;150(3):378-84.

12. Wayne RV. Johnsrude 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.

13. Thomson RS, Auduong P, Miller AT, Gurgel RK. Hearing loss as a risk factor for dementia: a systematic review. Laryngoscope Investig Otolaryngol. 2017;2(2):69-79.

14. Lim MYL, Loo JHY. Screening an elderly hearing impaired population for mild cognitive impairment using Mini-Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA). Int J Geriatr Psychiatry. 2018;33(7):972-9.

15. Kljajević V. Montrealska procena kognicije: srpska verzija. Aktuelnosti iz neurologije, psihijatrije i graničnih područja. 2009;17 (3-4):31-9.

16. Nasreddine Z, Phillips N, Bédirian V, Charbonneau S, Whitehead V, Collin I, et al. The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment. J Am Geriatr Soc. 2005;53(4):695-9.

17. Pallant J. SPSS survival manual: a step by step guide to data analysis using IBM SPSS. 7th ed. London: Routledge; 2021.

18. Castiglione A, Benatti A, Velardita C, Favaro D, Padoan E, Severi D, et al. Aging, cognitive decline and hearing loss: effects of auditory rehabilitation and training with hearing aids and cochlear implants on cognitive function and depression among older adults. Audiol Neurootol. 2016;21(Suppl 1):21-8.

19. Dupuis K, Pichora-Fuller MK, Chasteen AL, Marchuk V, Singh G, Smith SL. Effects of hearing and vision impairments on the Montreal Cognitive Assessment. Neuropsychol Dev Cogn B Aging Neuropsychol Cogn. 2015;22(4):413-37.

20. Fu X, Liu B, Wang S, Eikelboom RH, Jayakody DMP. The relationship between hearing loss and cognitive impairment in a Chinese elderly population: the baseline analysis. Front Neurosci. 2021;15:749273.

21. Urqueta Alfaro A, Guthrie DM, Phillips NA, Pichora-Fuller MK, Mick P, McGraw C, et al. Detection of vision and/or hearing loss using the interRAI Community Health Assessment aligns well with common behavioral vision/hearing measurements. PLoS One. 2019;14(10):e0223123.

22. Lin FR, Yaffe K, Xia J, Xue QL, Harris TB, Purchase-Helzner E, et al. Hearing loss and cognitive decline in older adults. JAMA Intern Med. 2013;173(4):293-9.

23. Shen J, Sherman M, Souza PE. Test administration methods and cognitive test scores in older adults with hearing loss. Gerontology. 2019;66(1):24-32.

24. Cuoco S, Cappiello A, Scarpa A, Troisi D, Autuori M, Ponticorvo S, et al. Neuropsychological profile of hearing-impaired patients and the effect of hearing aid on cognitive functions: an exploratory study. Sci Rep. 2021;11(1):9384.

25. Ge S, McConnell ES, Wu B, Pan W, Don X, Plassman BL. Longitudinal association between hearing loss, vision loss, dual sensory loss, and cognitive decline. J Am Geriatr Soc. 2020;69(3):644-50.

26. Brewster KK, Pavlicova M, Stein A, Chen M, Chen C, Brown PJ, et al. A pilot randomized controlled trial of hearing aids to improve mood and cognition in older adults. Int J Geriatr Psychiatry. 2020;35(8):842-50.

27. Naylor G, Dillard L, Orrell M, Stephan BCM, Zobay O, Saunders GH. Dementia and hearing-aid use: a two-way street. Age Ageing. 2022;51(12):afac266.

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