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Check the influence of hearing aid use on cognitive screening in the elderly

Verificar a influência do uso do aparelho auditivo no rastreio cognitivo de idosos

Comprobar la influencia del uso de audífonos en el examen cognitivo de adultos mayores

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Abstract

Introduction: *Hearing loss in the elderly influences their quality of life and can indirectly influence the preservation of the integrity of their cognitive system. Studies show that the use of hearing aids can be considered as a strategy to improve the quality of life of this population and also their cognitive performance. The aim of this study was to investigate the influence of hearing aid use on the score of the cognitive performance of elderly patients after three months of using the device.* ***Methods:*** *descriptive, exploratory and retrospective study in a health facility, through the analysis of medical records of the elderly first users of hearing aids. There were checked: demographic data, clinical characteristics, audiometric tests, questionnaire for self assessment of hearing handicap for the elderly (HHIE-S) and the Mini-Mental State Examination (MMSE) in the first and second return, after delivery of hearing aids.* ***Results:*** *53 elderly were adapted to the inclusion criteria, with a mean age of 64 years, tinnitus and dental changes being the clinical features that stood out. There was a statistically significant difference between before and after the use of the hearing aid for HHIES, and MMSE also showed a statistically significant increase, especially for older people with higher levels of education.* ***Conclusion:*** *The education was a factor that interfered with cognitive examination after three months of use of hearing aids, demonstrating thr need of more longitudinal researches focusing on hearing loss and aspects of cognition in the elderly.*

Keywords: *Hearing loss; Cognition; Aged*

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Resumo

Introdução: *A perda auditiva no idoso influencia na sua qualidade de vida e indiretamente pode influenciar na preservação da integridade do seu sistema cognitivo. Estudos mostram que o uso de aparelhos auditivos pode ser considerado como uma estratégia para melhorar a qualidade de vida desta população e também seu desempenho cognitivo.* ***Objetivo****: verificar a influência do uso do aparelho auditivo na pontuação do exame de rastreio cognitivo de idosos após três meses de uso do dispositivo.* ***Método:*** *estudo descritivo, exploratório e retrospectivo, realizado em uma unidade de saúde, através da análise de prontuário de idosos primeiros usuários de aparelho auditivo. Foram verificados: dados demográficos, características clinicas, exames audiométricos, questionário de auto avaliação do handicap auditivo para idosos (HHIE-S) e o mini exame do estado mental (MEEM) no primeiro e no segundo retorno, após a entrega dos aparelhos auditivos.* ***Resultados:*** *adequaram-se aos critérios de inclusão 53 idosos, com média de idade de 64 anos, sendo o zumbido e as alterações dentárias as características clínicas que mais se destacaram. Houve diferença estatisticamente significante antes e após o uso do aparelho auditivo para o HHIES e o MEEM também apresentou um aumento estatisticamente significativo, principalmente para os idosos com maior nível de escolaridade.* ***Conclusão:*** *A escolaridade foi um fator que interferiu no exame cognitivo após os três meses de uso do AASI, porém indicam-se mais pesquisas longitudinais enfocando a perda auditiva e aspectos ligados à cognição do idoso.*

Palavras-chave: *Perda auditiva; Cognição; Idoso*

Resumen

Introducción: *La pérdida auditiva en adultos mayores influye en su calidad de vida y puede influir indirectamente en la preservación de la integridad de su sistema cognitivo. Los estudios demuestran que el uso de audífonos puede ser considerado como una estrategia para mejorar la calidad de vida de esta población y también su rendimiento cognitivo.* ***Objectivo:*** *investigar la influencia del uso de audífonos en la puntuación de rendimiento cognitivo de adultos mayores después de tres meses de usar el dispositivo.* ***Métodos:*** *Estudio descriptivo, exploratorio y retrospectivo realizado en un centro de salud, a través del análisis de las historias clínicas de los adultos mayores primeros usuarios de audífonos. Se utilizaron datos demográficos, características clínicas, exámenes audiométricos, cuestionario de autoevaluación de la discapacidad auditiva para los adultos mayores (HHIE-S) y el Mini Examen del Estado Mental (MMSE) en la primera y segunda vuelta, después de la entrega de los audífonos.* ***Resultados:*** *se adecuaron a los criterios de inclusión 53 adultos mayores, con un pormedio de 64 años de edad. El zumbido y los problemas dentarios fueron las características que mas se destacaron. Hubo una diferencia estadísticamente significativa antes y después de usar el audífono para el HHIES, y el MMSE también mostró un aumento estadísticamente significativo, especialmente para los adultos mayores con niveles más altos de educación.* ***Conclusión:*** *La educación fue un factor que interfirió con el examen cognitivo después de tres meses de uso de audífonos, pero se sugier la necesidad de más investigación longitudinal centra en la pérdida y los aspectos de la cognición de la audición en las personas mayores.*

Palabras claves: *Pérdida Auditiva; Cognición; Anciano*

Introduction

With the improvements in health quality and in housing and food conditions, the elderly population has been gradually increasing in Brazil. The percentage of individuals over 60 years old have increased from 8.6% in 2000 to 10.8% in 2010. At the same time, 6.7% of the general population is reported to have at least one severe deficit – visual, auditory, motor and/or mental –, and 1.1% have reported severe hearing impairment[1].

Hearing loss in the elderly may be related to several of these individuals' health issues, such as the acceleration of cognitive decline, increase of dementia risks, falls, hospitalizations, balance/gait problems and depression. There are also social and emotional implications, loss of autonomy, and even financial difficulties[2].

The alterations found in audiometric thresholds for higher frequencies, usually above 2000 Hz, cause frequent complaints of difficulties to understand speech, especially in environments with competitive noise. This speech perception difficulty may not be verified in routine audiometric exams, because many elderly individuals have problems that may be due to temporal processing and to the decline of binaural processing, which are not very simple clinical measures[3].

One of the therapeutic resources to fix this communication difficulty of the elderly with hearing loss is the use of hearing aids (HA), which helps the rescue of damaged hearing abilities. However, even with the use of this type of resource, such abilities are not spontaneously recovered. The use of HA provides the "hearing", which corresponds to the access to acoustic information; however, "listening" to the auditory information takes more than that: it takes the information to be processed in the central nervous system; it takes attention, memory, interest, motivation, and cognition. These aspects are important to achieve an adequate communication[4].

An effective communication demands interpretation and auditory information processing. In this processing, the ascendant/afferent pathway (bottom-up) performs the sensory encoding and the descendant/efferent pathway (top-down) integrates cognition and language, thus affecting the final processing of the auditory input[5]. To interpret acoustic information, connections of cognitive functions must be activated all around the brain: the right hemisphere that contributes to speech comprehension (suprassegmental processes) and the left hemisphere that helps the lexical-semantic processing[6].

The psychological and functional consequences of the connections between cognitive centers (attention and memory functions), reward areas (limbic), and auditory pathways are subjects of study for many fields. The auditory system information depends on the connectivity of subcortical, peripheral and cortical areas, that is, non-auditory regions (visual, somatosensory, limbic, association areas) that innervate auditory centers. Moreover, memory, communication abilities, learning, and experiences also influence auditory centers[7].

Hearing loss may be associated with cognitive decline by a causal relationship, mediated by social isolation or cognitive aspects, or even by a neurobiological mechanism. This decrease of cognitive load interferes with mental fatigue, demanding more from the brain when hearing a speech at a noisy environment[8]. Literature shows that using HA has positive effects on cognition and other functional domains. It also emphasizes the need for further intervention studies to determine the effects of rehabilitation on the hearing ability and on minimizing the consequences of hearing loss[9].

In face of the interconnection between cognitive centers and hearing loss in the elderly, this study hypothesized that three months using hearing aids would influence the outcomes of the cognitive screening of the participants. The aim of this study was to verify the influence of the use of hearing aids on the cognitive performance score of elderly subjects.

Methods

This is a descriptive exploratory retrospective study conducted at a Specialized Unit of the Unified Health System (SUS) in Belém (PA), Brazil. It was approved by the Research Ethics Committee under number 43831015.1.0000.5482.

Participants

The sample in this study comprised the medical records of patients that met the following inclusion criteria: to be enrolled at the unit between 2014 and 2015, to have diagnosed hearing loss, and to never have previously used hearing aids. All children were excluded from the sample.

Data collection

After this initial survey, 156 medical records were selected, from which only 53 presented complete data for the final analysis [FIGURE 1].

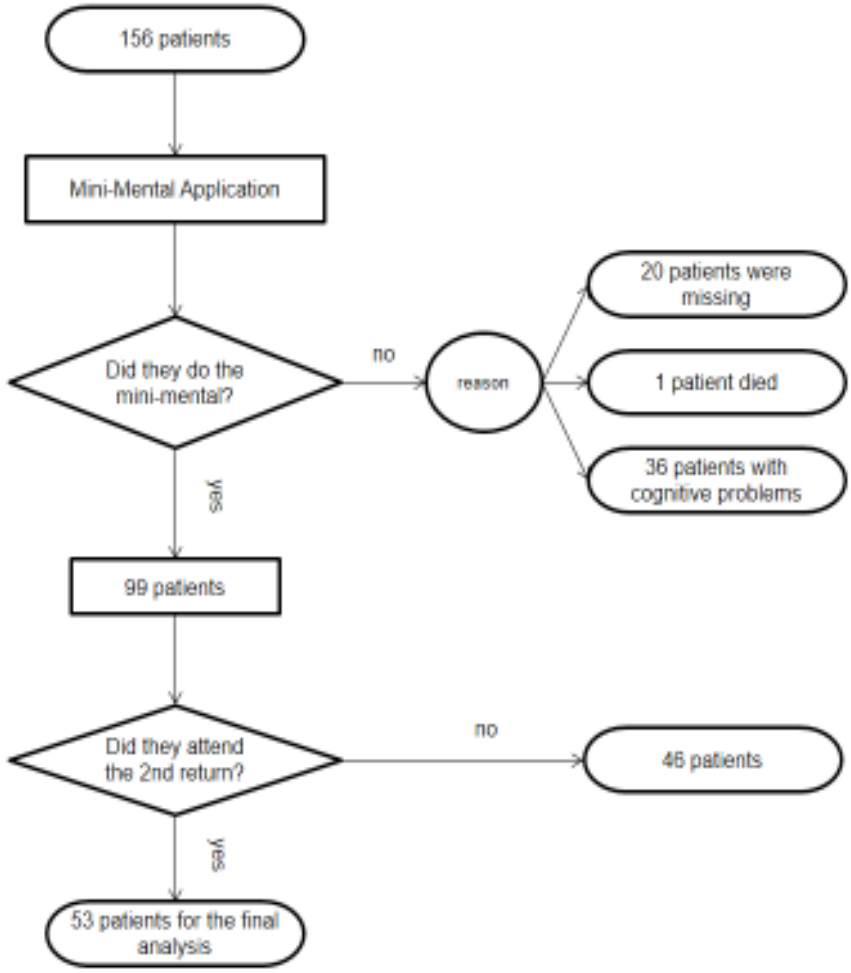

Figure 1. Flowchart of the total number of patients analyzed

Data collection surveyed the following information:

- Sociodemographic data: age, gender, city of residence, and level of education.
- Clinical characteristics: presence of tinnitus, infection, family history of hearing loss, diabetes, renal alterations, vestibulopathy, otologic surgery, sudden hearing loss, allergies, hypertension, inflammation of the joints, visual alterations, manual dexterity, and dental alterations.

Results of pure-tone air and bone-conduction audiometry, and classification of the degree of hearing loss (mild, moderate, moderately severe, severe, and profound)[10], the type of hearing loss (sensorineural, conductive, or mixed), and the audiometric configuration[11].

Scores on the Brazilian Portuguese adaptation[12] of the Mini-Mental State Examination (MMSE), which allows tracking the cognitive functions of orientation, attention and calculation, language, evocation and visuo-constructive ability. The results were classified based on the following cut-off scores: for illiterate subjects, scores lower than or equal to 15; for subjects with 1 to 11 years of schooling, scores lower than or equal to 22; and for subjects with more than 11 years of schooling, scores lower than or equal to 27. The maximum score is 30 points.

Scores on the self-assessment questionnaire Hearing Handicap Inventory for the Elderly – Screening (HHIE-S), adapted into Brazilian Portuguese[13]. The questionnaire has ten questions divided into five items that correspond to the social/

situational scale, and five other items that correspond to the emotional scale. The possible answers are "yes" (four points), "sometimes" (two points), and "no" (zero points).

The MMSE and the HHIE-S were applied in two different moments: the first return after 20 days using the hearing aids, and the second return, after three months of use.

Statistical analysis

The descriptive analysis of the data was conducted using absolute and relative frequencies, measures of central tendency (mean and median) and dispersion (standard deviation, minimum and maximum).

For analyzing the questionnaires, initially the normal distribution of the scores was verified using the Komolgorov-Smirnov test. As normality was not established, the non-parametric Wilcoxon test for repeated measures was applied. Data distribution was also presented in box plot graphs. A descriptive level of 5% ($p<0.05$) was assumed for statistical significance. Data were tabulated on Excel and analyzed using the Statistical Package for the Social Sciences (SPSS) 22.0 for Windows.

Results

We selected 156 medical records, from which 53 met the inclusion criteria. Data analysis showed that 58.5% of the sample comprised female subjects, and 41.5%, male subjects. The mean age was 64.4 years (SD=16.2), with a median of 67.4 years and a range from 22.3 to 91.6 years.

All subjects had hearing loss, were new hearing aid users, and had the data regarding gender, city of residence and level of education available (TABLE 1).

Table 1. Demographic characteristics of the patients, in absolute numbers and percentages

Variable	Category	n	(%)
Gender	Male	22	(41.5)
	Female	31	(58.5)
City	Belém	30	(56.6)
	Ananindeua	5	(9.4)
	Abaetetuba	2	(3.8)
	Breves	2	(3.8)
	Others*	14	(26.4)
Level of education	Illiterate	5	(9.4)
	Incomplete Elementary School	12	(22.6)
	Complete Elementary School	9	(17.0)
	Incomplete Middle School	8	(15.1)
	Complete Middle School	1	(1.9)
	Incomplete High School	1	(1.9)
	Complete High School	13	(24.5)
	Incomplete higher education	2	(3.8)
	Complete higher education	1	(1.9)
	Unknown	1	(1.9)
Total		53	(100.0)

* The category Others corresponds to cities that had only one patient each.

Participants were also surveyed regarding their clinical characteristics: presence of tinnitus, infection, family history of hearing loss, diabetes, renal alteration, vestibulopathy, otological surgery, sudden hearing loss, allergies, hypertension, inflammation on the joints, visual alterations, manual dexterity and dental alterations.

TABLE 2 shows the results obtained on the clinical characteristics of the population studied. Tinnitus (55.1%) and dental alterations (59.2%) were the most frequent clinical signs. Hearing loss classification was also described in TABLE 3.

Table 2. Clinical characteristics of the patients, in absolute numbers and percentage

Variable	Category	n*	(%)
Tinnitus	No	22	(44.9)
	Yes	27	(55.1)
Infection	No	41	(83.7)
	Yes	8	(16.3)
Family history of hearing loss	No	40	(81.6)
	Yes	9	(18.4)
Diabetes	No	40	(81.6)
	Yes	9	(18.4)
Renal alterations	No	41	(83.7)
	Yes	8	(16.3)
Vestibulopathy	No	23	(46.9)
	Yes	26	(53.1)
Otologic surgery	No	46	(93.9)
	Yes	3	(6.1)
Sudden hearing loss	No	47	(95.9)
	Yes	2	(4.1)
Allergies	No	37	(75.5)
	Yes	12	(24.5)
Hypertension	No	28	(57.1)
	Yes	21	(42.9)
Inflamation of joints	No	42	(85.7)
	Yes	7	(14.3)
Visual alterations	No	20	(40.8)
	Yes	29	(59.2)
Manual dexterity	No	46	(93.9)
	Yes	3	(6.1)
Dental alterations	No	20	(40.8)
	Yes	29	(59.2)
Total		49	(100.0)

* For all variables, four patients had unknown values.

Table 3. Classification of hearing loss, in absolute numbers and percentages (n= 53)

Degree of hearing loss	Right ear								Left ear							
	No loss		Mixed		Sensorineural		Conductive		No loss		Mixed		Sensorineural		Conductive	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
None	--	--	--	--	--	--	--	--	1	(1.9)	--	--	--	--	--	--
Mild	--	--	3	(5.7)	5	(9.4)	--	--	--	--	4	(7.5)	4	(7.5)	--	--
Moderate	--	--	14	(26.4)	14	(26.4)	1	(1.9)	--	--	12	(22.6)	14	(26.4)	--	--
Severe	--	--	4	(7.5)	4	(7.5)	--	--	--	--	6	(11.3)	5	(9.4)	--	--
Profound	--	--	3	(5.7)	4	(7.5)	--	--	--	--	1	(1.9)	4	(7.5)	--	--
Total	--	--	24	(45.3)	28	(52.8)	1	(1.9)	1	(1.9)	23	(43.4)	29	(54.7)	--	--

-- there were no cases with these characteristics.

TABLE 4 shows a statistically significant difference between overall scores before and after the use of hearing aids in the total sample. For the HHIE-S, the median was 16 points before adapting the device and 10.8 after its use (p=0.002). The same was verified for the social and emotional scores, respectively p=0.031 and p=0.001. Score distribution can also be observed in FIGURE 2.

Table 4. Analysis of the scores obtained before and after the use of hearing aids.

Variable	n	Mean	(SD)	Median	Minimum	Maximum	p*
Total sample							
HHIE-S							
Before	53	15.8	(8.8)	16.0	2	36	0.002
After	53	10.8	(10.7)	8.0	0	36	
HHIE-S Social							
Before	53	7.8	(5.6)	8.0	0	20	0.031
After	53	5.8	(6.1)	4.0	0	20	
HHIE-S Emotional							
Before	53	8.0	(4.8)	8.0	0	20	0.001
After	53	5.1	(5.4)	4.0	0	20	
MMSE							
Before	53	22.3	(3.9)	23.0	12	30	0.035
After	53	23.2	(3.8)	24.0	12	30	
Patients with level of education lower than complete middle school							
HHIE-S							
Before	34	16.1	(9.0)	16.0	2	36	0.039
After	34	12.6	(11.1)	8.0	0	36	
HHIE-S Social							
Before	34	8.0	(6.2)	8.0	0	20	0.298
After	34	6.9	(6.4)	4.0	0	20	
HHIE-S Emotional							
Before	34	8.1	(4.4)	8.0	0	16	0.042
After	34	5.8	(5.6)	4.0	0	16	
MMSE							
Before	34	21.2	(4.1)	22.0	12	30	0.214
After	34	21.9	(3.9)	22.0	12	29	
Patients with level of education equal to complete middle school or higher							
HHIE-S							
Before	18	15.1	(8.8)	15.0	4	32	0.026
After	18	7.9	(9.3)	5.0	0	36	
HHIE-S Social							
Before	18	7.7	(4.3)	7.0	0	16	0.051
After	18	4.0	(5.3)	2.0	0	16	
HHIE-S Emotional							
Before	18	7.4	(5.7)	6.0	0	20	0.014
After	18	3.9	(5.1)	3.0	0	20	
MMSE							
Before	18	24.4	(2.1)	24.5	22	29	0.035
After	18	25.6	(2.3)	25.0	21	30	

HHIE-S = self-assessment questionnaire Hearing Handicap Inventory for the Elderly – Screening; MMSE = Mini-Mental State Examination; SD = standard deviation
* non-parametric Wilcoxon test; there was one patient with unknown information; $p<0.05$.

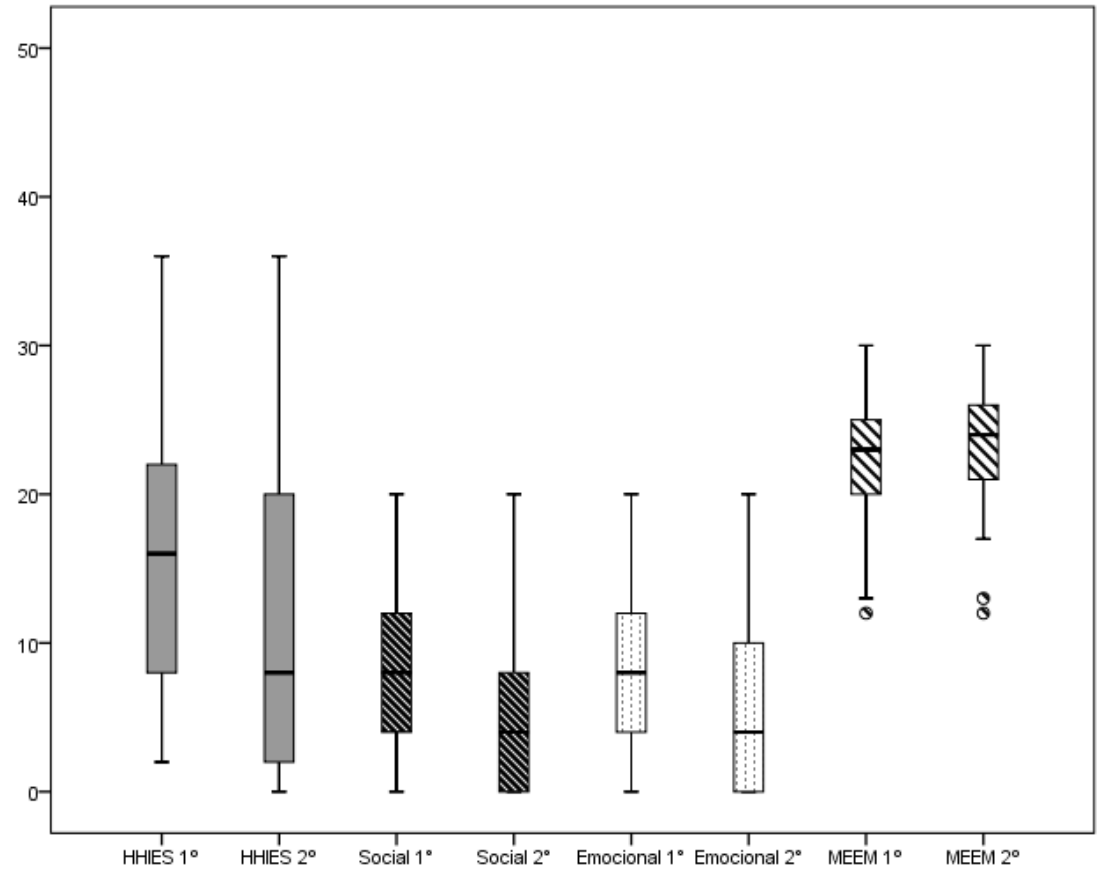

Figure 2. Distribution of patients according to the scores, before and after the use of hearing aids

A significant increase was found in the MMSE score (p=0.035). Before using the hearing aids, the median was 23.0 points, and after, 24.0 points [TABLE 4].

To assess the performance of patients according to the level of education, the sample was divided into patients that did not finish Elementary School and patients that at least completed Elementary School [TABLE 4]. In this analysis, the social score did not present statistical significance for both groups, and the MMSE score only presented significant difference between patients with higher level of education (p=0.035).

FIGURE 3 shows that patients with higher level of education had less dispersion between the minimum and maximum score values obtained on the MMSE. It was identified that the minimum score of patients with lower level of education was 12 points, while the other group had 21 as minimum score.

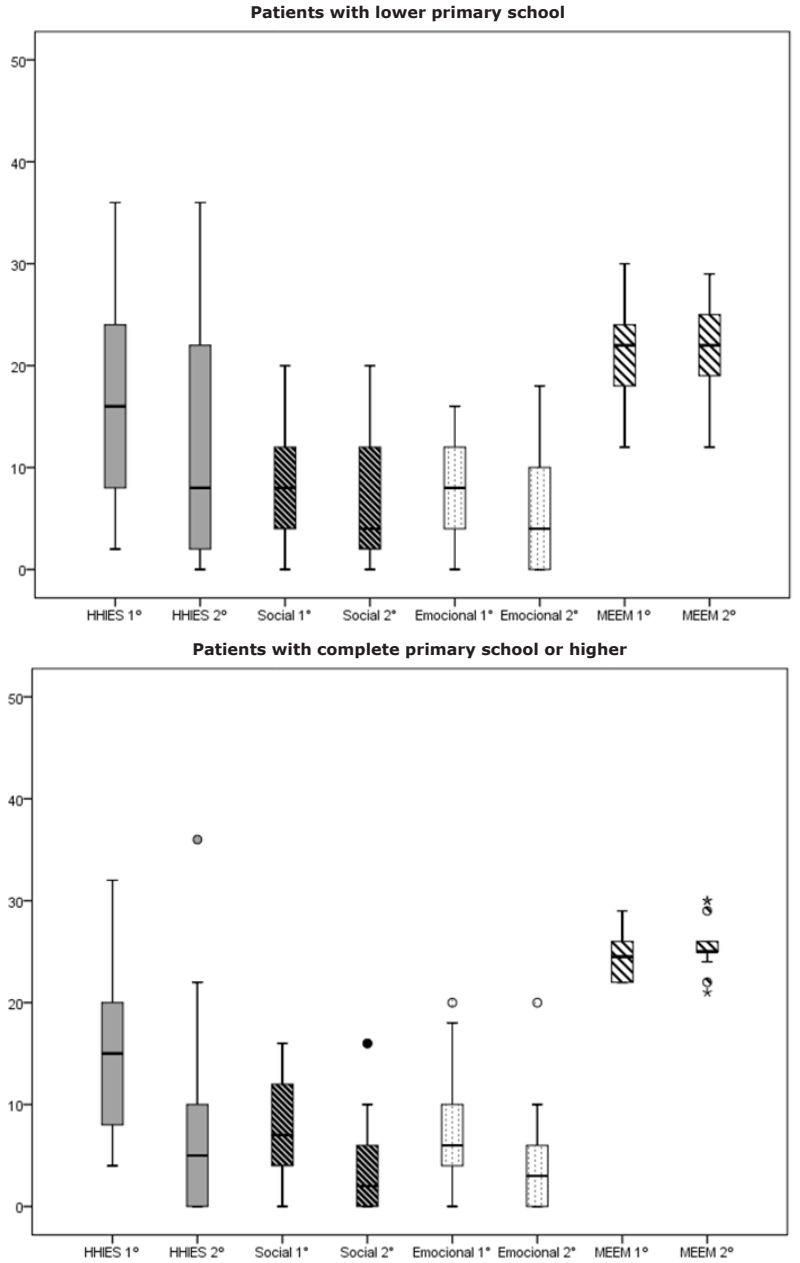

Figure 3. Distribution of patients according to scores and levels of education, before and after the use of hearing aids

Discussion

According to the World Health Organization (WHO) classification[14], in developing countries, individuals with 60 years of age or more are considered elderly. In our sample, the mean age was 64.4 years. Thus, the discussion of the results is based on this mean.

Data analysis showed that most participants presented moderate hearing loss. There was a prevalence of sensorineural hearing loss (26.4%), which was similar between the right and left ears. These results do not corroborate a previous study[15] that reported mild sensorineural hearing loss as the most frequent in their sample of elderly individuals; however, they partially confirm the findings

of another study[16] regarding the moderate degree of hearing loss.

It is important to evaluate the functional evolution of the aspects involved in general health and daily routine of the elderly, since this allows tracking the overall quality of life of this population. The most observed complaints regarding general health and hearing, in this sample, were: tinnitus, vestibulopathy, visual alterations, dental alterations/temporomandibular joint disorder, and hypertension. This corroborates literature findings that report tinnitus[17-19], hypertension[17-19], dizziness[17], and use of dental prosthesis[20] as frequent complaints. It is important to emphasize that, when the elderly individual presents other problems associated with hearing loss, his aural rehabilitation is more difficult, because visual impairments, tinnitus and dizziness, and gait instability make the individual more insecure and dependent.

The elderly with hearing loss presents higher number of associated depression symptoms, cognitive alterations and concentration difficulties, and the use of hearing aids may improve these aspects[21]. In this study, we observed that, after three months using hearing aids, subjects presented improvements in their self-perception of hearing, as verified in the HHIE-S, regarding both social and emotional aspects.

Literature recommends that adults/elderly seeking for speech-language pathology and audiology assistance should also be screened for their cognitive conditions[22], however, there are still controversies about the relationship between hearing and cognition. Some authors suggest that cognitive status interferes with the adaptation and the benefits of using hearing aids[23]. Others, that there are limitations in the association between hearing loss and cognitive decline, since other aspects may contribute to the cognitive decline acceleration of elderly individuals with hearing loss[24,25].

The use of hearing aids was associated with the improvement in cognitive performance, suggesting that better auditory and communication abilities may be a positive factor that makes the individuals cognitively more capable[23]. The findings obtained after analyzing the MMSE in two different moments showed a significant increase in the score ($p=0.035$), showing that, somehow, in this group of subjects, the use of hearing aids had a positive influence on the performance on this test[21].

The positive correlation between MMSE outcomes before and three months after hearing aid adaptation was already verified in a previous study[26], however, this direct individual relationship was not identified in the present study, since a significant difference ($p=0.035$) was found only for patients with higher level of education. Gender, age, and level of education did not influence the MMSE score; hearing loss was the determinant factor for the score on the test[27]. Inferior cognitive aspects (evaluated with neuropsychological tests) were related with poorer hearing thresholds, and it was verified that cognition interferes with the better use of hearing aids during the acclimatization process[28]. This equivalence between the use of hearing aids and improvements on cognitive performance was also verified[23].

Literature also presents many questions about the influence of hearing loss on the general cognitive aspect. It has been hypothesized that elderly subjects that do not use hearing aids and present hearing losses from moderate to severe may be at risk for cognitive decline[29]. The significant relationship between peripheral hearing and cognition still needs further studies that consider the underlying mechanisms involved in the elderly's life[30]. On the other hand[16], it has been identified the proportionality between the degree of hearing loss and the worsening of MMSE outcomes. Still, more studies are necessary to determine whether the use of hearing aids can reduce the cognitive decline in the elderly.

The limitations of this study included the small number of patients that returned for evaluation after three months using the hearing aids, the impossibility to verify the actual number of hours using them (datallogin), and the absence of assessments conducted after the three months of use. This would have allowed us to evaluate whether the cognitive score would have remained the same or improved with hearing aid adaptation and permanent use, due to more exposition to environmental sounds.

Conclusion

The hypothesis of this study was partially confirmed, since the level of education was a factor that interfered with the cognitive examination after three months using hearing aids. The elderly subjects with higher level of education had a small improvement in the MMSE score.

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