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Original articles

Correlations between the audiological evaluation and cognitive screening in elderly

Correlações entre a avaliação audiológica e a triagem cognitiva em idosos

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ABSTRACT

Purpose: to investigate the relationship between the listening performance for pure tone, speech and cognitive performance in elderly patients, considering that the deterioration of auditory input and cognitive skills are common to this population, and it can cause disturbance in communication and the individual functionality.

Methods: this is a cross-sectional observational study in which 103 elderly patients, had their hearing assessed by audiometry and speech, and the cognitive performance assessed by the Mini Mental State Examination (MMSE). Descriptive analyzes and association of tonal average variables was performed in frequencies of 500, 1000, 2000 and 4000 Hz, Index Speech Recognition (SDT) and MMSE scores, and it was adopted a 5% significance level.

Results: it was found a high prevalence of sensorineural hearing loss of varying degrees in elderly patients, and the presence of alterations in speech recognition and MMSE results, confirming that presbycusis and a possible cognitive decline are common to this population. There was no statistical significance in the analysis of the relationship between the pure tone audiometry and MMSE, however, the results found in SDT and MMSE, showed the existence of a significant relationship.

Conclusion: there was no association between hearing loss and cognitive decline in the elderly population studied. However, the analyzes of the speech recognition and cognitive performance indicate that the presence of alterations in speech recognition increases the chance of cognitive impairment

Keywords: Aged; Hearing; Speech Perception; Cognition; Speech, Language and Hearing Sciences

RESUMO

Objetivo: verificar a relação entre o desempenho auditivo para tom puro e fala e o desempenho cognitivo em pacientes idosos, considerando que a deterioração da entrada sensorial auditiva e das habilidades cognitivas é comum a essa população, trazendo consequências para a comunicação e funcionalidade do indivíduo.

Métodos: trata se de um estudo observacional transversal, realizado com 103 idosos, avaliados na audição por meio da audiometria tonal e vocal e no desempenho cognitivo pelo Mini Exame do Estado Mental (MEEM). Foram realizadas análises descritivas e de associação das variáveis média tonal das frequências de 500, 1000, 2000 e 4000 Hz, Índice Percentual de Reconhecimento de Fala (IPRF) e pontuação do MEEM, sendo adotado nível de significância de 5% em todo estudo.

Resultados: constatou se alta prevalência de perda auditiva neurossensorial de graus variados nos idosos avaliados, além da presença de alterações no reconhecimento de fala e nos resultados do MEEM, confirmando que tanto a presbiacusia quanto a existência de um possível declínio cognitivo são comuns a essa população. Não foi encontrada relevância estatística na análise da relação entre a Audiometria Tonal e MEEM, porém, entre o IPRF e MEEM houve associação estatisticamente significante.

Conclusão: não houve associação entre de perda auditiva e o declínio cognitivo na população idosa estudada. No entanto, as análises realizadas entre o reconhecimento da fala aumenta a chance de alteração cognitiva.

Descritores: Idoso; Audição; Percepção da Fala; Cognição; Fonoaudiologia

INTRODUCTION

Population aging is a worldwide process already present even in developing countries like Brazil. According to the 2010 Census, the population aged 65 and over increased from 4.8% in 1991 to 7.4% in 2010, a process that is more accentuated in the South and Southeast regions of the country[1].

At the same time, there is increased interest and actions in public policies geared towards putting the elderly population in the center of numerous studies in health, focusing on the biological process of aging and its consequences, on its epidemiological profile and discussing the structuring of care and rehabilitation services[2].

The aging process leads to impairment of some physiological functions, such as the reduction or loss of sensory inputs. Presbycusis, or auditory sensory loss, is characteristic of the aging process and may constitute one of the most incapacitating communication disorders[3]. The lowering of thresholds at high frequencies, typical of this type of loss, deteriorates the perception of consonant sounds in communication, especially in noisy environments[4]. The decline in the quality of central auditory processing of information and the inability to perform temporal processing of sounds, contributes to generate a frequent complaint of hearing without understanding[5,6].

The impairment of cognitive functions such as memory, language, executive functions, among others, can also be observed during the aging process. This impairment may develop with little interference on the individual's daily life activities. On the other hand it can cause great impact on the autonomy and independence of the elderlies, configuring one of the main geriatric syndromes, the cognitive impairment[7].

Although it is well known that cognitive impairment and hearing loss can interfere with socialization and quality of life of elderlies, there are few professionals in clinical practice who perceive how cognitive decline and hearing impairment can impact separately or jointly on diagnosis and treatment of the elderly population.

The association between hearing loss and impairment of cognition is the topic of several studies[3,8]. Still only a few of them address the relationship between hearing and cognition, going beyond hearing performance for pure tone, to also encompass speech recognition. Given that the communication process in the elderlies with presbycusis is hampered not only by the reduction in hearing sensitivity, but also by the decrease in speech intelligibility[4], the assessment of speech recognition linked to cognitive evaluation may be a source of important information about the functional performance of the elders and their communication.

Therefore, this study aimed to investigate the relationship between the auditory performance for pure tone and speech and cognitive performance in elderly patients, considering that both the deterioration of auditory sensory input and cognitive skills have consequences for communication and functionality of the elderly population.

METHODS

This study was approved by the institution's Ethics Committee, under resolution CAAE 05608012.4.0000.5149. It is a cross-sectional observational study conducted in a multi-professional referral center care for aged population, belonging to a public university hospital in the city of Belo Horizonte.

Patients included in the sample were referred for audiologic assessment after geriatric consultation, presenting hearing complaints or apparent signs of hearing loss, such as difficulty of understanding. They were aware of the research objectives and were requested to sign an Informed Consent Form (ICF).

As inclusion criteria, the population under study was composed of individuals older than 60 years and subjects of cognitive screening test Mini Mental State Examination (MMSE)[9] during a multidimensional geriatric assessment and auditory evaluation in the center where the study took place. Patients were excluded when they did not complete one of such procedures, as well as those that showed hearing loss with conductive components, setting aside the sensorineural presbycusis diagnosis in the average threshold pure tone results.

Thus, the sample consisted of 103 patients of both genders, 43 males (41.7%) and 60 females (58.3%), aged between 60 and 92 years, (average 77). The data for this research were collected in two stages.

In the first stage of the study, patients referred for audiology evaluation underwent anamnesis, otoscopy to exclude obstructions of the external auditory meatus, and tonal and vocal audiometry, as per the routine in the reference service center. The audiometric evaluation was performed with audiometer AVS - 500 -. Vibra Som by two speech therapists, researchers of this study, using a standardized method to collect the thresholds in frequencies ranging from 250-8000 Hz. The existence or lack of hearing loss was classified according to the

average of the tonal auditory thresholds at 500, 1000, 2000 and 4000 Hz, considering as normal audiometry those tests whose average values are less than or equal to 25 dBNA[10]. The auditory performance for listening to the speech was evaluated by testing the Speech Recognition Score (SRS) to monosyllables, considering as normal, results with correct answers equal to or greater than 92%[11].

In a second step, the hospital records of the patients included in the sample were reviewed in order to get the results of the MMSE test performed during the geriatric assessment. This test is a translated and adapted protocol for Brazil[12,13], widely used in clinical practice and research for cognitive screening because it allows to screen and track cognitive decline over the years, additionally providing information on the preservation and/or change in aspects such as memory, language, gnosis, praxis, visual-spatial function and executive function[7]. It evaluates the adequacy of the score obtained by patients according to their level of education. For the purposes of this study, MMSE scores above 13 points for illiterate individuals, scores above 18 points for 1-8 years education and scores higher than 26 points for individuals with education higher than eight years[12] were considered as normal values.

The MMSE was conducted in a quiet office and items were presented at the same order simultaneously in both ears. Only the results for the best ear were considered for analysis, both for the tone average in audiometry, and for SRS.

Regarding the statistical analysis, continuous variables, audiometry, SRS and MMSE were presented through measures of central tendency (average and median) and variability (standard deviation-SD, minimum and maximum). The average frequencies of 500, 1000, 2000 and 4000 Hz and the result of the SRS (in percentage) were correlated with the MMSE through the Pearson's correlation coefficient (r). To determine the fitness of the relationship, we used the following rating scale[14]: 0% - 20%: poor correlation; 21% - 40%: bad correlation; 41% - 60%: regular correlation; 61% - 80%: good correlation; 81% - 100%: excellent correlation. Results were presented using a two-dimensional scatter plot.

Frequency distributions were evaluated for the following categorical variables: Audiometry results, the SRS and the MMSE. Comparisons between the frequencies of results between groups (normal and altered SRS, normal and altered MMSE and normal and altered audiometry) were done using Fisher's exact test. In order to assess the magnitude of the association between the results of the MMSE and the SRS we calculated the odds ratio (OR). The confidence interval (CI) of 95% was calculated in order to evaluate sample variability.

The normal and altered MMSE groups were compared to the results of audiometry and SRS using the Mann-Whitney test and the results were presented in figures format (Box plot).

In all calculations the statistical significance level was 5%. The data were statistically analyzed using SPSS for Windows version 12.0 (Statistical Package for Social Sciences, version 12.0, 2001).

RESULTS

Descriptive analysis of audiometry variables (average threshold pure tone for frequencies 500Hz, 1000Hz, 2000Hz and 4.000 Hz), SRS and MMSE of the 103 subjects in this study are shown in Table 1

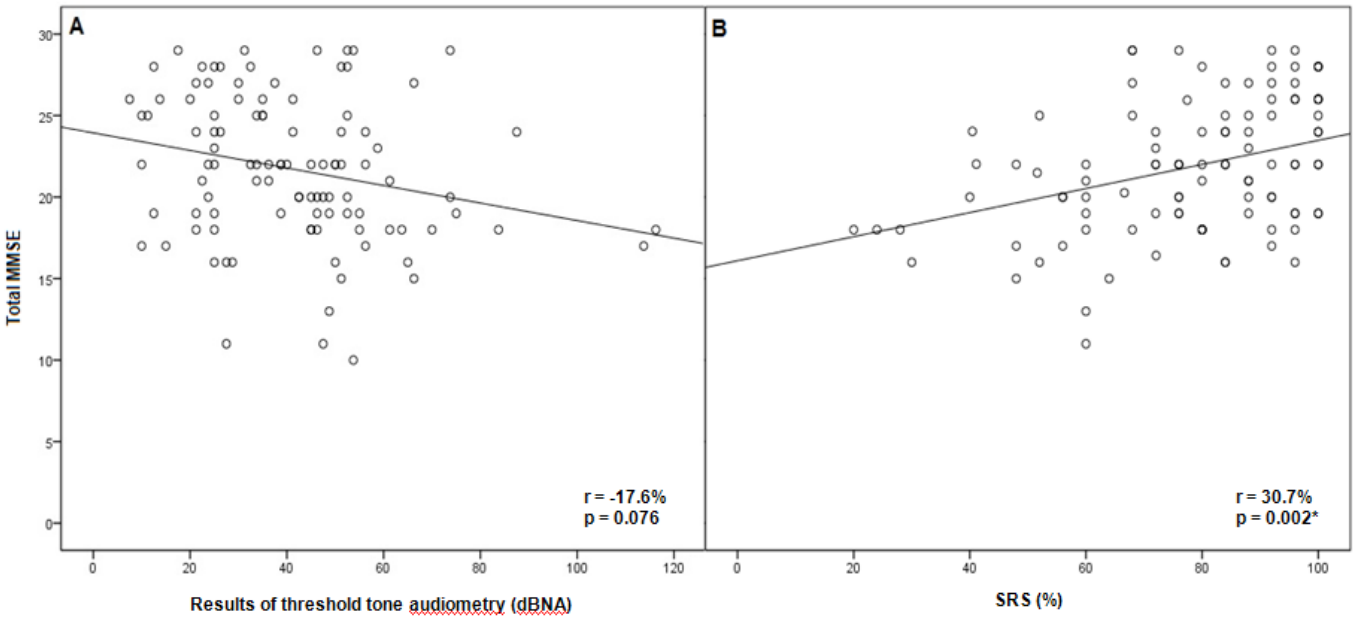
Table 1. Descriptive Analysis of variables Audiometry result, Speech Recognition Score and Mini–Mental State Examination

Study variables description	Average Tone Audiometry (dBNA)	SRS (%)	MMSE
Average	36,09	80,70	21,73
Median	36,00	84,00	22,00
Standard Deviation	15,09	18,07	4,40
Minimum	2,00	20,00	10,00
Maximum	81,00	100,00	29,00

Figure 1 shows the degree of correlation between MMSE and audiometry and between MMSE and SRS in a two-dimensional scatter plot.

It can be seen that there is a statistically significant, positive association between the results found in SRS and those obtained in the MMSE, in which lower values of SRS are associated with lower values of MMSE. This result shows that individuals with poorer performance on speech recognition test tend to have poorer cognitive performance. However, there is no significant correlation between audiometry and MMSE.

Table 2 shows the relationship between the results of the MMSE, pure tone audiometry and SRS using categorical variables (normal and altered).



*Significance Level p<0,05
Caption: Pearson's coefficient; Significance probability; Mini–Mental State Examination; Speech Recognition Score

Figure 1A. Correlation between Mini–Mental State Examination results and Threshold Tone Audiometry
Figure 1B. Correlation between Mini–Mental State Examination results and Speech Recognition Score

Table 2. Relationship between Mini-Mental State Examination, Threshold Tone Audiometry and Speech Recognition Score

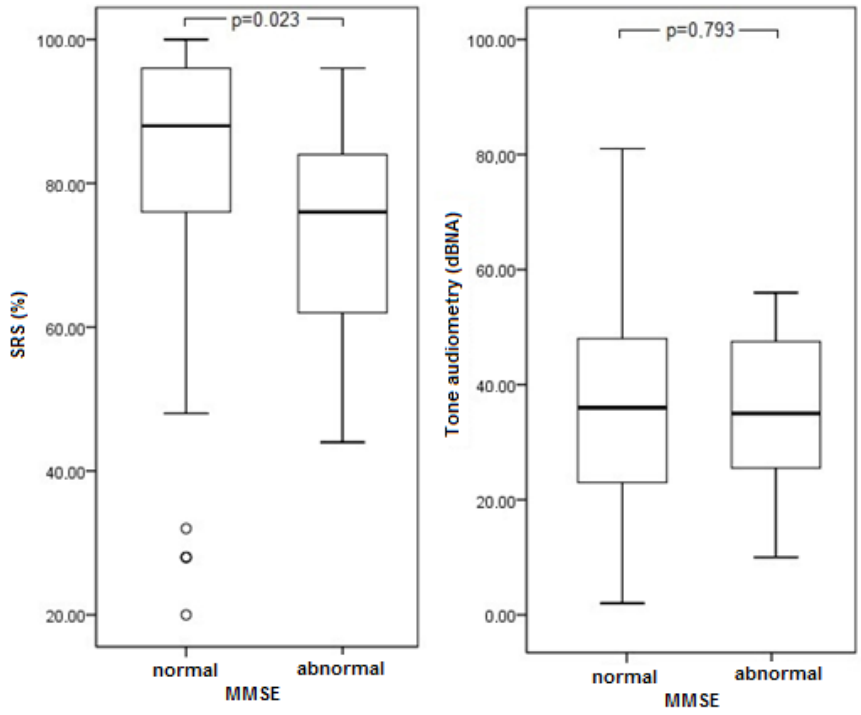
		Threshold Tone Audiometry Results			SRS Results				Total N (%)
		Abnormal N (%)	Normal N (%)	p	Abnormal N (%)	Normal N (%)	p	OR (IC)	
MMSE Results	Impaired N (%)	11 (16)	4 (12)	0,63	13 (20)	2 (5)	0,034*	4,7 (1,01-22,17)	15 (15)
	Normal N (%)	59 (84)	29 (88)		51 (80)	37 (95)			88 (85)
Total N (%)		70 (68)	33 (32)		64 (62)	39 (38)			103 (100)

p = Significance probability (Fisher's Exact Test).
*Significance Level, p<0,05.

Data analysis showed that there is an association between the SRS and MMSE. Among patients with changes in SRS, 20% also have changes in MMSE. In patients presenting normal results in SRS, 95% are also within the normal range for MMSE. There was no statistically significant association between audiometry and MMSE.

We performed an odds ratio analysis to check the possibility that patients with an altered SRS may also have alterations in MMSE, resulting in a ratio of 4.72, ranging from 1.01 to 22.17. Thus, it can be said that those with an altered SRS will be 4.72 times more likely to also have an abnormal MMSE as compared to those with normal SRS. This odds ratio value is significant because its confidence interval does not include the value 1.000.

Figure 2 shows the association between the median values of audiometry and SRS when compared between subjects with normal and altered MMSE.



Caption: p = Significance probability (Mann-Whitney Test).

Figure 2. Comparison of the association between Audiometry and Speech Recognition Score confronting subjects with Min-Mental State Exam normal or abnormal

It was observed that the median value of SRS in the altered MMSE group is statistically significantly lower (p=0.023) than the value of those with a normal MMSE,

DISCUSSION

In this study, focused on a geriatric population referred for audiology assessment, there was a high percentage of sensorineural hearing loss of varying degrees measured by audiometry. Changes in speech recognition evaluated by the SRS were also present in most of the sample, finding the average results of success in this sample to be very close to the average of 75% found in a previous publication[14]. It is well known that the speech recognition and the quality of the central processing of peripheral auditory information are hampered in the 60 years plus population[6], existing a trend towards a gradual decrease in speech intelligibility with the advancing age[14].

The existence of abnormal results in MMSE is consistent with a previous study with 105 patients in a general neurology clinic of a public university hospital that used this same protocol[15]. The study found performance changes in 20% of cases, a lower result than the 61% found in another study of 60 patients with already diagnosed hearing loss, candidates for selection and adaptation of hearing aids in a reference center for Audiology Health Care[16].

In performing the analysis of the association between the pure tone audiometry and MMSE, there was no statistical significance, as described in Table 2 and in the two-dimensional scatter plot 1A. However, there was a statistically significant association between the results found in SRS and MMSE, as shown in Table 2 and Figure 1B. The correlation between SRS and the MMSE was also evident, albeit weak in the correlation analysis (r = 30.7%), making it a less significant result from the statistical point of view.

We found previous studies in the international scientific literature that sought to investigate the relationship between hearing deficits and cognition in the elderly. A 2006 survey in Australia aimed to correlate auditory and visual sensory changes with cognitive change. The presence of cognitive impairment was observed in 18% of 260 individuals assessed with the MMSE, as well as the existence of moderate to severe hearing loss in 54% of 164 participants who had their hearing assessed. No association was found between MMSE scores and hearing loss – as in the present study. The authors attributed this lack of association to an insufficient sample size[17].

A longitudinal research in the Netherlands aimed to verify possible correlations between sensory, auditory and visual, and cognitive deficits of 418 individuals. In this study, the cognitive function was assessed by a neuropsychological evaluation, while hearing acuity was determined by the average hearing thresholds of 1, 2 and 4 KHz. It was concluded that the existence of a prior hearing loss or a decline in hearing acuity throughout the study was associated with a worsening of cognitive performance after the six-year follow-up. Although the size of the effects found in statistical analyzes was small, the results reinforced the hypothesis of a link between visual and auditory sensory acuity and cognitive performance[18]. The findings of the present study corroborate this result.

Longitudinal monitoring was also carried out with 1984 American patients to determine the relationship between hearing loss and cognitive impairment. The research used a modified version of the Mini-Mental Modified State Examination (3MS), which adds components assessing orientation, concentration, language, praxis and memory, as well as another non-verbal test for psychomotor assessment and execution functions. The results showed that the cognitive decline rate was 41% larger in patients with hearing loss, plus a 24% higher risk of developing cognitive impairment in the six-year period compared to non hearing-impaired individuals[19].

Another Brazilian study comprising 33 elderlies, assessed through MMSE, found significantly better scores in individuals with normal hearing or mild losses, as compared to those with moderate or severe loss[3]. A Brazilian survey carried out in 2012, found no significant relationship between the results of the performance of 60 elderly individuals in MMSE related to the speech recognition in monaural task evaluated by SRS, a different result compared with the present study findings. The authors attributed this result to the fact that the speech recognition test was performed in an acoustically controlled environment[5]. They postulate that different results might be found if the test is done in a noisy environment, due to higher operating cognitive demands[20].

The relationship between the SRS and the MMSE found in this study can be explained by the cognitive activity needed to perform the SRS. Having a sensory system capable of receiving the word stimulus is not enough, as a cognitive system to process what has been heard is necessary to allow the correct repetition of the word. As described in the literature, cognition is

responsible for assigning meaning and determining the psychological and emotional aspects related to the information heard. It is associated with speech functions, language and auditory processing[21]. The pure tone audiometry, measures the hearing sensitivity, the sound audible to an individual. On the other hand, in the SRS, it is required that in addition to listening, the individual give meaning to what was heard, a task that demands attention and working memory, among other more complex functions, which can deteriorate jointly with the cognitive decline tested by the MMSE.

It should be noted that the ears allow for a passive information perception, even though the brain activates what is heard according to specific purposes, and cognitive functions such as attention, memory and language are also used while the meaning of the message is being processed[22].

In elderlies with hearing loss, memory and particularly the storage of language information in verbal messages can be impaired[4]. Moreover, the inability to perform binaural synthesis of what was heard may be responsible for the complaint of difficulties in understanding the auditory information, especially in noisy places[16].

Hypotheses that try to explain why the reduction in the quality of sensory input results in less efficient cognitive functioning, affirm that the degradation of information in unfavorable communicative environments leads to efforts in listening, which in turn diverts the cognitive resources to the act of listening. This requires increased recruitment of prior knowledge and of the existent context[20,22]. In this way, a smaller number of possible skills remains available to remember or understand what was heard[22], implying that the greater the demands placed on the processing function of working memory, the fewer the cognitive resources allocated to the information storage function[20].

Some factors mentioned in the literature that explain the relationships between sensory and cognitive decline are related to the generalized body aging processes, which simultaneously affect cognitive and sensory systems and the reduction of auditory sensory input, resulting in the absence of peripheral stimulation and likely emergence of cognitive deficit[17].

Dementia misdiagnosis may occur in hearing disabled or hearing-impaired individuals with subclinical cognitive impairment. However, the literature remarks that both situations are unlikely as there is no evidence that mild cognitive impairment may affect the reliability of the audiometric test, or may cause poor communication with the examiners during the course of cognitive assessment, since they are usually well trained and experienced in working with elderlies[19,23]. However, it is possible that sensory changes influence the assessment of cognitive functions due to the frequent use of protocols with tasks that rely on sight or hearing[17].

It is very important for health professionals who work with elderly patients to be aware of the possibility of the existence of cognitive and hearing decline, combined or not. Screening tools for cognitive functions such as the MMSE and other simple neuropsychological scales can be used in clinical practice for the evaluation and, in the case of audiology rehabilitation, can contribute to the adaptation process of a hearing aid[5].

All elderlies included in the study were referred for audiologic evaluation because of hearing complaints, and after completion of the MMSE for geriatric assessment. Thus, it is possible that cases with advanced cognitive impairment have not been referred, as their providers may have considered that the assessment would bring them a reduced benefit. This may pose a bias in the interpretation of results since it excludes cases of advanced cognitive impairment. However, this limitation also demonstrates the need for greater dissemination of speech therapy with the elderly, because even in already established cognitive decline situations, auditory rehabilitation can be beneficial.

New research must be carried out, using a longitudinal design to study the associations between hearing and cognition, focusing on the different degrees of hearing loss and cognitive deficits. The evaluation of speech recognition degrees in quiet and in noisy environments and of central auditory processing in older adults is also needed, since there may be differences between the findings of peripheral vis-à-vis central hearing. Further specific auditory rehabilitation programs for the elderly are necessary. It is also paramount that pre and post hearing rehabilitation cognitive assessment be carried out in the geriatric patients. This assessment may show the benefits of amplification and hearing rehabilitation for the maintenance of functionality and reduction of social isolation of the elderly presented with hearing and cognitive impairment.

CONCLUSION

Considering that the communication process in the elderlies with presbycusis is hindered not only by

the reduction in hearing sensitivity, but also by the decrease in speech intelligibility, assessment of speech recognition associated to cognitive evaluation may be a source of important information on the functional performance of the elderlies and their communication.

Although this study failed to find an association between cognitive decline and pure tone hearing loss, the analysis performed showed that the existence of changes in speech recognition increases the likelihood of changes in cognitive performance.

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