Hearing Loss in the Elderly: Is the Hearing Handicap Inventory for the Elderly - Screening Version Effective in Diagnosis When Compared to the Audiometric Test?

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Abstract

Introduction Hearing losses inherent to the natural process of aging represent today a major public health issue, despite the little attention that their adequate care still receives. Early recognition and proper management of these shortcomings can significantly improve hearing, as well as the patient's general quality of life, reducing the overall impact of this important and prevalent condition of the aging process.

Objective The aim of this research was to evaluate the accuracy of the Hearing Handicap Inventory for the Elderly - Screening Version (HHIE-S) in the diagnosis of hearing loss in the elderly when compared with the audiometric test.

Methods Through a cross-sectional study, our target population was composed of 138 individuals, aged over 60 and with any otorhinolaryngological complaints, recruited at the Clinic of Otorhinolaryngology and Speech Therapy of the Faculdade de Medicina de Marília (Famema), in the city of Marília, SP, Brazil. Patients already in the process of auditory rehabilitation were excluded, as well as those who did not demonstrate the minimum level of oral understanding necessary to allow the interview.

Results The prevalence of hearing loss according to the questionnaire was of 76.1%, while audiometry showed 79.7%. We found the diagnostic accuracy of the instrument to be of 86.2%, with a sensitivity of 89.1% and a specificity of 75.0%, regardless of gender.

Conclusion Thereby, we conclude that the standardized questionnaire under rating is suitable for the screening of hearing loss in the elderly, given its high accuracy and user-friendly quality.

Keywords
- hearing loss
- presbycusis
- surveys and questionnaires
- audiometry
- aged
- aging

Introduction

The hearing losses inherent to the natural process of aging represent a major public health issue, despite the little attention that they receive regarding their proper management.[1–10]

The test considered the gold standard for evaluating the auditory function is the pure tone audiometry (PTA), which does not consider the loss qualitatively, but classifies the extent of the loss at different frequencies tested.[11–17] There is still no consensus on the most appropriate classification of

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hearing loss regarding the degree of intensity, which is obtained from the arithmetic average of the hearing thresholds found in the different frequencies tested.[18–26]

Hearing impairment refers to any restriction or lack of ability to perceive sound and to perform tasks due to hearing problems experienced by those affected by hypoacusis. On the other hand, hearing handicap refers to the emotional and social aspects resulting from hearing impairment, which can sometimes restrict the individual's participation in everyday activities, as well as impact family relationships and social interactions.[27–29]

In 1982, Ventry and Weinstein[30] developed in the United States the Hearing Handicap Inventory for the Elderly (HHIE), a self-assessment tool containing 25 questions aimed to assess the impact of hearing loss in the emotional and social-situational adjustments of elderly patients who are not institutionalized.[31–36] In 1983, the same authors published a reduced version of the HHIE containing only 10 questions, but also divided between social and emotional aspects: the Hearing Handicap Inventory for the Elderly - Screening Version (HHIE-S), proposed as a screening tool to detect the degree of hearing complaints.[34,37–39]

In 1997, Wieselberg[40] released the pioneering work of translation and adaptation of the HHIE into the Portuguese language. And according to Paiva et al,[41] the translation into Portuguese maintained the validity of the English version.

In view of the relevance of the subject due to the high prevalence of hearing disorders and their harmful consequences;[42] and considering that there are more simple and inexpensive tools for tracking them, we aimed to assess the accuracy of the HHIE-S in the diagnosis of hearing losses in the elderly when compared with PTA; besides, the sensitivity and specificity of the instrument were defined, and the prevalence of hearing disorder in the target population was determined both by the questionnaire and by PTA.

Methods

A cross-sectional study with a quantitative approach was conducted to evaluate the accuracy of the HHIE-S questionnaire as a diagnostic test when compared with PTA, which is considered the gold standard for detecting hearing loss.

The target population of this study consisted of elderly individuals aged over 60 years, who were patients at the Clinic of Otorhinolaryngology and Speech Pathology of Faculdade de Medicina de Marília (Famema), in the city of Marília, SP, Brazil. The individuals included in the study were previously scheduled or referenced in for elective outpatient consultations in the morning, Monday to Friday, thus fulfilling the requirement of being able to present an otorhinolaryngologic complaint. As the location is not a specific hearing loss clinic, individuals scheduled randomly throughout the week did not necessarily have hearing complaints.

Users of hearing aids or patients already in the process of audiological rehabilitation were excluded, as well as those who did not demonstrate a minimum level of listening to allow the questionnaire;[43–46] individuals with active infectious diseases or tumors diagnosed during the otoscopy were also excluded and referred to proper treatment.

The sample size (N) was calculated taking into account previous literature data evaluating the performance of the HHIE-S questionnaire in a population without known hearing disorders.[23,25,47] Thereby, the final N = 138 was achieved.

Data collection only started after the patients read and signed the consent form, thus allowing the use of the data obtained in accordance with the standards set by the Ethics Committee of our Academic Institute. Therefore, the execution of this research was duly approved by the Ethics Committee of the institution, through protocol number 950,987, released on February 10, 2015.

After routine otoscopy, all participants were initially submitted to the HHIE-S questionnaire, aimed at analyzing the perception of hearing handicap.[34,37,48–51] This questionnaire was always applied by the same researcher, and the items read orally by the interviewer and immediately answered by the interviewee, a technique known as face to face. Individuals responded to questions related to hearing skills, indicating when a situation represented a problem.[32,52–54] If requested by the patient, a brief explanation or a new reading was provided. The average time for the whole questionnaire ranged between 5 and 10 minutes, depending on the ability of each interviewee.

After the interview with the HHIE-S questionnaire, the individual was then referred for further examination by PTA, performed by the speech therapists from our clinic, preferably and mostly on the same day as the initial interview; when this was not possible due to logistical or time constraint reasons, the PTA examination was scheduled as a routine service, to be performed within a maximum period of two months. On the day set for the audiometric examination, a new otoscopy was performed initially, but repetition of the HHIE-S was not necessary.[34,37,55–58] For this research, we used the audiometer 229E Interacoustics model (Middelfart, Denmark), set to the proper calibrations, as well as an appropriate acoustic booth.

To include a wider range of frequencies that encompass both the energy of speech sounds and their inteligibility,[59] we adopted the classification proposed by the World Health Organization (WHO),[60] which uses the arithmetic mean of the hearing thresholds at 500 Hz, 1,000 Hz, 2,000 Hz and 4,000 Hz, as well as 25 dB HL as normality threshold. It is important to note that the frequency of 4,000 Hz is among the first to demonstrate an age-related decline, and is, therefore, fundamental in understanding speech, especially in noisy environments.[19,57,61] The classification adopted was made as shown in ►**Table 1**:[60]

The accuracy of the HHIE-S questionnaire was determined by calculating the sensitivity and specificity, comparing the results that were true positive, false positive, true negative and false negative with the PTA. The confidence intervals (CIs) used to estimate the sensitivity, specificity, positive predictive value and negative predictive value were calculated using the exact method of Clopper-Pearson.[62,63] Analyses were performed using the IBM statistics software SPSS 17.0 (North Castle, NY, USA).

Table 1 Audiological classification adopted (WHO)

Normal hearing	0–25 dB HL
Mild hearing loss	26–40 dB HL
Moderate hearing loss	41–60 dB HL
Severe hearing loss	61–80 dB HL
Profound hearing loss	$\geq$ 81 dB HL

Abbreviations: dB HL, decibels hearing level; WHO, World Health Organization.

Results

The demographic and epidemiological data obtained in this study are summarized and presented in ►**Table 2**.

The evaluation by the HHIE-S showed that 33 elderly patients (23.9%) had no perception of hearing handicap; 65 (47.1%) had mild/moderate perception of handicap; and 40 (29.0%) had a significant perception of handicap. Thus, the prevalence of hearing impairment by the HHIE-S questionnaire, considering the absence or presence of any perception of hearing handicap, was of 76.1% (105/138). The prevalence data as classified by the HHIE-S are described in ►**Table 3** (irrespective of sex) and ►**Table 4** (comparing sexes).

Table 2 Clinical and epidemiological characteristics of 138 elderly patients evaluated at the Clinic of Otorhinolaryngology and Speech Therapy of Famema

	Number of patients	Percentage
	Total	**%**
	138	**100%**
Male	71	51.4%
Female	67	48.6%
Average age ± SD	71.6 ± 8.1	–
60–70 years old	71	51.4%
71–80 years old	45	32.6%
> 80 years old	22	15.9%
Schooling		
Elementary School	34	24.6%
Middle School	93	67.4%
High School	06	4.3%
Higher Education	05	3.6%
Diseases*		
Diabetes mellitus	30	21.7%
Hypertension	89	64.5%
Dyslipidemia	23	16.7%
Thyroid disease	17	12.3%
Otologic disease	15	10.9%
Other diseases	68	49.3%

Abbreviation: SD, standard deviation.
Note: * Individuals may have more than one associated disease.

Table 3 Hearing disorder prevalence according to the HHIE-S, irrespective of sex, for 138 elderly patients evaluated at the Clinic of Otorhinolaryngology and Speech Therapy of Famema

Handicap	Elderly population studied	
	Number of patients	Percentage
	TOTAL (138)	% (100%)
Absence	33	23.9%
Mild/Moderate	65	47.1%
Severe	40	29.0%
Any handicap	105	76.1%

Abbreviation: HHIE-S, Hearing Handicap Inventory For The Elderly – Screening Version.

The audiometric evaluation of these patients, considering the overall PTA, showed the following proportions: normal hearing in 28 subjects (20.3%); mild hearing loss in 39 (28.3%); moderate hearing loss in 53 (38.4%); severe hearing loss in 13 (9.4%); and profound hearing loss in 5 subjects (3.6%). The prevalence of hearing impairment by audiometric testing, considering the overall result and including all its degrees of intensity, was of 79.7% (110/138).

►**Table 5** shows the prevalence data of hearing impairment according to PTA and its intensity levels, separated by right and left ear and globally.

Comparing the results obtained from the HHIE-S questionnaire and the overall PTA, we observed that among the 28 individuals with normal hearing by audiometric examination, 21 (75.0%) revealed no handicap, that is, had no perception of hearing handicap. At the other end of the results, among the five individuals with profound hearing loss according to the audiometric examination, four (80.0%) showed a severe handicap, that is, had a significant perception of hearing handicap.

In relation to the moderate hearing losses, we note that among the 53 individuals with such intensity level of hearing loss by audiometric examination, 26 (49.1%) showed a severe

Table 4 Hearing disorder prevalence according to the HHIE-S, comparing sexes, for 138 elderly patients evaluated at the Clinic of Otorhinolaryngology and Speech Therapy of Famema

Handicap	Elderly population studied (N = 138)			
	Number of patients		Percentage	
	♀	♂	♀	♂
Absence	18	15	26.9%	21.1%
Mild/Moderate	31	34	46.3%	47.9%
Severe	18	22	26.9%	31.0%
Any handicap	49	56	73.1%	78.9%

Abbreviations: HHIE-S, Hearing Handicap Inventory for the Elderly – Screening Version; N, number of patients.
Notes: ♀, female; ♂, male.

Table 5 Hearing disorder prevalence according to PTA and its intensity levels, divided by ear (right and left) and overall, for 138 elderly patients evaluated at the Clinic of Otorhinolaryngology and Speech Therapy of Famema

Hearing level (WHO)	Right ear		Left ear		Overall	
	N	%	N	%	N	%
Normal (0–25 dB)	24	17.4%	19	13.8%	28	20.3%
Mild hearing loss (26–40 dB)	36	26.1%	37	26.8%	39	28.3%
Moderate hearing loss (41–60 dB)	51	37.0%	45	32.6%	53	38.4%
Severe hearing loss (61–80 dB)	20	14.5%	24	17.4%	13	9.4%
Profound hearing loss ($\geq$ 81 dB)	07	5.1%	13	9.4%	05	3.6%

Abbreviations: dB, decibels; N, number of patients; PTA, pure tone audiometry; WHO, World Health Organization.

handicap, another 26 (49.1%) showed a mild to moderate handicap, and only 1 (1.9%) revealed no handicap.

The results found in the comparison between both diagnostic methods (HHIE-S and PTA) are shown in ►**Table 6**.

When comparing the overall results of HHIE-S and PTA, irrespective of the intensity levels, that is, simply considering the handicap as absent or present and the audiometric test as normal or abnormal, we found the following results: among the 28 individuals with normal audiometric examinations, 21 (75.0%) showed no handicap, and only 7 (25.0%) showed some perception of hearing handicap. Among the 110 individuals with abnormal audiometric examinations, 98 (89.1%) revealed the presence of some degree of handicap, while only 12 (10.9%) had no perception of any hearing handicap.

►**Table 7** shows the comparison of the overall results of the two diagnostic methods (HHIE-S and PTA) without taking into account the degrees of intensity.

From the previous table (►**Table 7**), we calculated the sensitivity, specificity, and positive and negative predictive values, with their CIs, and the accuracy of the HHIE-S questionnaire compared with the gold standard PTA, considering the overall assessment.

►**Table 8** describes the statistical data of the HHIE-S, showing their calculations and the final results.

When comparing sexes, we calculated the prevalence of hearing impairment according to three criteria: the PTA, the HHIE-S questionnaire, and both methods together.

Thus, according to the overall audiometric examination and considering all the intensity levels, the prevalence of hearing impairment was of 73.1% (49/67) among women, and of 85.9% (61/71) among men.

According to the HHIE-S, and considering any level of handicap, the prevalence of hearing impairment was also of 73.1% (49/67) among women, and of 78.9% (56/71) among men.

And considering both methods together (PTA and HHIE-S), we found a prevalence of 68.7% (46/67) among women, and of 73.2% (52/71) among men.

When we evaluated the sensitivity, specificity and positive and negative predictive values, and their CIs, again considering the two methods together, but now comparing the sexes, we observed that all results were higher for females.

Thus, women showed a sensitivity of 93.9% (46/49), a specificity of 83.3% (15/18), a positive predictive value of 93.9% (46/49) and a negative predictive value of 83.3% (15/18). Among men, we found a sensitivity of 85.3% (52/61), a specificity of 60.0% (6/10), a positive predictive value of 92.9% (52/56) and a negative predictive value of 40.0% (6/15).

►**Table 9** displays the statistical results obtained and described before.

Table 6 Relationship between the results of the HHIE-S and the PTA, according to intensity levels, for 138 elderly patients evaluated at the Clinic of Otorhinolaryngology and Speech Therapy of Famema

	PTA					
	Normal hearing	Mild hearing loss	Moderate hearing loss	Severe hearing loss	Profound hearing loss	Total
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
HHIE-S						
Absence of handicap	21 (75.0%)	11 (28.2%)	01 (1.9%)	0 (0.0%)	0 (0.0%)	33 (23.9%)
Mild/Moderate handicap	06 (21.4%)	26 (66.7%)	26 (49.1%)	06 (46.2%)	01 (20.0%)	65 (47.1%)
Severe handicap	01 (3.6%)	02 (5.1%)	26 (49.1%)	07 (53.8%)	04 (80.0%)	40 (29.0%)
Total	28 (100%)	39 (100%)	53 (100%)	13 (100%)	05 (100%)	138 (100%)

Abbreviation: HHIE-S, Hearing Handicap Inventory For The Elderly – Screening Version; N, number of patients; PTA, pure tone audiometry.
Note: %, percentage (regarding the PTA).

Table 7 Comparison between the overall results of the HHIE-S and the PTA, irrespective of the intensity levels, for 138 elderly patients evaluated at the Clinic of Otorhinolaryngology and Speech Therapy of Famema

	PTA		Total
	Normal	Abnormal	
Handicap			
Absent	21 (75.0%)	12 (10.9%)	33 (23.9%)
Present	07 (25.0%)	98 (89.1%)	105 (76.1%)
Total	28 (100.0%)	110 (100.0%)	138 (100.0%)

Abbreviations: HHIE-S, Hearing Handicap Inventory For The Elderly – Screening Version; PTA, pure tone audiometry.

Discussion

Considering only the HHIE-S questionnaire, we observed that 23.9% of the subjects did not perceive a handicap, while 76.1% reported the perception of some level of handicap (mild/moderate or significant); comparing sexes, we observed perception in 73.1% of women and 78.9% of men. Cruickshanks et al[16] found 33.7% with hearing handicap, considering both sexes; Wieselberg[40] observed 91.0% among women and 86.0% among men; Sestrem[64] found 58.0% among women and 43.0% among men. After reviewing the literature, we found no other studies reporting the prevalence of hearing impairment determined by HHIE-S alone, so that we could make a broader comparative analysis.

It is difficult to compare data on the prevalence of hearing loss among the various published studies, due to differences in sampling, populations and scenarios, as well as due to lack of consensus on audiometric criteria and/or different questionnaires used.[65–68]

Table 8 Statistics of the HHIE-S, compared with the overall PTA, for 138 elderly patients evaluated at the Clinic of Otorhinolaryngology and Speech Therapy of Famema

	Calculus	Results	95% CI
Accuracy	(21 + 98)/138	86.2%	79.4–91.0
Sensitivity	98/110	89.1%	81.7–94.2
Specificity	21/28	75.0%	55.1–89.3
Positive predictive value	98/105	93.3%	86.8–97.3
Negative predictive value	21/33	63.6%	45.1–79.6
Positive LR	Sen/1 – Spe	3.56	1.87–6.79
Negative LR	1 – Sen/Spe	0.15	0.08–0.26

Abbreviations: CI, confidence interval; HHIE-S, Hearing Handicap Inventory For The Elderly – Screening Version; LR, likelihood ratio; PTA, pure tone audiometry; Sen, sensitivity; Spe, specificity.

Table 9 Statistics of the HHIE-S, compared with the overall PTA and comparing sexes, for 138 elderly patients evaluated at the Clinic of Otorhinolaryngology and Speech Therapy of Famema

	Results	95% CI (♀)	Results	95% CI (♂)
Accuracy	91.0%	84.2–97.9	81.7%	72.7–90.7
Sensitivity	93.9%	82.1–98.4	85.2%	73.3–92.6
Specificity	83.3%	57.7–95.6	60.0%	27.4–86.3
Positive predictive value	93.9%	82.1–98.4	92.9%	81.9–97.7
Negative predictive value	83.3%	57.7–95.6	40.0%	17.5–67.1
Positive LR	5.63	1.99–15.86	2.13	0.99–4.59
Negative LR	0.07	0.02–0.22	0.25	0.12–0.51

Abbreviations: CI, confidence interval; HHIE-S, Hearing Handicap Inventory For The Elderly – Screening Version; LR, likelihood ratio; PTA, pure tone audiometry.
Notes: ♀, female; ♂, male.

Considering the overall result of the PTA and including all its degrees of intensity, according to the audiometric classification of the WHO,[19,57,60] we observed a high prevalence of hearing loss: 79.7%. The less serious hearing losses were the most frequently observed, with 28.3% of the subjects with mild hearing loss and 38.4% with moderate hearing loss; the more disabling hearing losses were observed to a lesser extent, with 9.4% of the subjects showing severe hearing loss, and 3.6% a profound hearing loss.

Despite the difficulty in comparing prevalence data, we note singular differences between our research and the studies reviewed. Cruickshanks et al,[16] in a study published in 1998, found an overall prevalence of hearing impairment of 45.9%; Calais,[15] in 2005, found a prevalence of 12% in the age group of 45–64 years, rising to 24% in the 65–74 years age group, and reaching 39% at ages over 75 years; and finally, Sousa et al,[13] in 2009, observed an overall prevalence of 36.1%.

In our study, we found high values in the HHIE-S accuracy (86.2%), sensitivity (89.1%), specificity (75.0%) and positive predictive value (93.3%), whereas only the negative predictive value (63.6%) showed a lower percentage. Rosis et al[25] published in 2009 a study on the accuracy of the HHIE-S in two different scenarios at Universidade Federal de São Paulo: at the Audiology Clinic, with 55 elderly subjects ($\geq$ 60 years) presenting hearing complaints, and at the Geriatrics Clinic, with 23 elderly subjects ($\geq$ 60 years) with some complaints. In the first scenario, they found an accuracy of 58.2%, a sensitivity of 23.5%, a specificity of 73.7%, a positive predictive value of 28.6%, and a negative predictive value of 68.3%. In the second scenario, they found an accuracy of 91.3%, a sensitivity of 94.7%, a specificity of 75.0%, a positive predictive value of 94.7%, and a negative predictive value of 75.0%. Thereby, in the group without mandatory hearing complaints (Geriatrics Clinic) there was a statistical association between the results

obtained from the HHIE-S and the possibility of a hearing disorder. Therefore, only the Geriatrics Clinic has provided results similar to ours. It is important to emphasize that the participants in our research, despite being cared for at a specialized clinic (the Clinic of Otorhinolaryngology and Speech Therapy of Famema), might have otorhinolaryngologic complaints that are not just hearing-related. The previous data also seem to agree with the study of Menegotto et al,[20] published in 2011. This study concluded that, at least at audiology clinics, a scenario in which all patients necessarily have hearing complaints, the questionnaires have not proved to be effective tools for hearing screening. In a sample of 51 adults and elderly subjects, they obtained a low sensitivity (47%) and a high specificity (75%); for this, they used the HHIE-S questionnaire for the elderly, as well as its equivalent for adults, the Hearing Handicap Inventory for the Adults - Screening Version (HHIA-S),[69,70] both later compared with the audiometric examination. Thus, we believe that the questionnaires could be valid in health services not specific to audiology, such as a general clinic of otorhinolaryngology, geriatrics or even primary care. However, further studies are needed to confirm this hypothesis.

Evaluating the results found in our current research, we noticed a greater agreement on the extremes, that is, between individuals with normal hearing and absent handicap (75.0%), and between those with profound hearing loss and severe handicap (80.0%). For this reason, our data suggest that the HHIE-S is more suitable to identify more disabling hearing losses (severe and profound), just as Deepthi and Kasthuri[71] observed in 2012, and to identify with good reliability the absence of hearing disorder.

Among the 110 subjects with abnormal audiometry, 98 (89.1%) showed some degree of perceived handicap, while only 12 (10.9%) showed no perception of hearing handicap. And among 28 individuals with normal hearing, 21 (75.0%) had not perceived handicap, while only 7 (25.0%) showed some degree of perception of hearing handicap.

From the above discussion, we can see that the PTA alone is insufficient to describe the reaction of the individual before a hearing disorder, that is, it does not detect the hearing handicap. At the same time, the HHIE-S alone is not always able to accurately detect auditory sensitivity.

According to several authors,[31,65–68] despite the high prevalence of hearing disorders in the elderly, such an in-depth investigation is still generally restricted to medical evaluations. For this reason, they suggest the hearing screening as a useful tool in primary care, using a standardized questionnaire, such as the HHIE-S.[72,73]

Conclusion

From the results obtained in this study, we conclude that the instrument under evaluation, the HHIE-S questionnaire, is suitable in the screening for hearing loss in the elderly, given its high accuracy and user-friendly quality.

Considering the methods used and the results obtained, we also conclude that there is 10.9% of probability that the elderly with no handicap show a hearing loss, as well as 89.1% of probability that some degree of hearing loss exists in the elderly with a hearing handicap.

Moreover, it is a simple and inexpensive tool, requiring little time for its application, 10 minutes at most, and thus, it can be incorporated into traditional clinical care.

We must keep in mind that no patient should be in a process of rehabilitation without both instruments, the PTA and the HHIE-S, complementing each other.

Besides extending this research to other settings, we believe that the future association of a qualitative research might clarify some yet unknown relevant aspects, such as the possible attitudes and meanings that the elderly take on when undergoing a hearing care interview, which are likely to influence the final results.

We thus hope that such issues may be useful for all health professionals who are interested in furthering such an important subject, which concerns all of us who seek a healthy and humanized aging process.

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