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Review articles

Older adults hearing screening strategies: a bibliometric review

Elisangela Rodrigues Brandão[1]
Renan Dantas Aires Guimarães[1]
Maria Júlia Galindo Soares[1]
Hannalice Cavalcanti[1]

[1] Universidade Federal da Paraíba - UFPB, João Pessoa, Paraíba, Brasil.

ABSTRACT

Purpose: to analyze the profile of publications on methods and instruments used to screen older adults hearing.

Methods: the scientific production on older adults hearing screening methods, searching for articles published between 2016 and 2022. Data were collected from PubMed, Scopus, LILACS, Web of Science, and Google Scholar databases and the articles were categorized according to their year, study type, authors, and screening instrument. Data were also analyzed to suggest potential aspects to be addressed in future research in the area.

Literature Review: altogether, 26 articles were found based on the eligibility criteria. Publications peaked in 2016, followed by 2020. Articles published in the United States predominated (18%), and HHIE-S (hearing handicap inventory for the elderly screening version) was the most used instrument; 90% of the publications were in English, and the most recurrent study type was cross-sectional, followed by instrument validation studies.

Conclusion: the review points out the scarcity of scientific production on older adults hearing screening in both national and international research. The studies approached different populations, screening methods, hearing loss definitions, health systems, and public policies in the countries where they were conducted. Better methodologies must be implemented for future research in the area.

Keywords: Hearing Loss; Presbycusis, Triage; Aged

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Corresponding author:
Hannalice Cavalcanti
Departamento de Fonoaudiologia - Centro de Ciências da Saúde
Universidade Federal da Paraíba, Campus I
Lot. Cidade Universitaria
CEP:58051-900 - João Pessoa, Paraíba, Brasil
E-mail: hannalice.cavalcanti@academico.ufpb.br

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INTRODUCTION

In most countries, the number of older adults is growing, which points to an aging society. Pathologies whose frequencies increase with aging include those related to the inner ears.

Age-related hearing loss results from pathological changes in the auditory pathway and is associated with advancing age[1]. Hearing loss is the third most common chronic disease among older patients, after arterial hypertension and arthritis. According to statistics, about 30% of the world population above 60 years old have hearing loss, whose prevalence may reach 40% in those 70 years old[2]. Most such cases of hearing loss are related to age[3]. Studies have shown that untreated auditory sensory loss is associated with older adults´ decreased quality of life, physical[4-9] and emotional diseases[9-11], and impaired social relations[12,13].

According to the more recent results published in the World Report on Hearing, about 1.5 billion people worldwide have some degree of hearing loss. Approximately 466 million of these – equivalent to 6% of the world population – had a disabling loss ranging from moderate to total loss. Disabling losses occur mainly in older adults, as an estimated one third of those older than 65 years have some type of hearing loss that limits them[2].

Age-related hearing losses reflect changes in the peripheral and central auditory systems. They initially have a greater impact at higher frequencies, which are more important to understand oral language[1]. In general, the first signs of age-related hearing loss are perceived by 60 years old, affecting the conversation frequency range, and subtly progressing to lower tones. Human hearing encompasses frequencies ranging from 20 Hz to 20000 Hz, and speech frequencies range from 400 Hz to 5000 Hz. Most losses occur in frequencies equal to or higher than 2000 Hz[1]. Thus, it becomes challenging to understand the interlocutor's speech, which gets degraded, particularly in the presence of background noise, increasing the cognitive effort. Difficulties to hear speech negatively affect social interactions and family relations.

Given the consequences, the ideal is to reach an early diagnosis. Screening can help identify hearing loss faster in these individuals, favoring precise diagnoses and assertive interventions.

Hearing screening is specifically defined by the American Speech-Language-Hearing Association (ASHA) as a quick pass/fail test, in which "pass" indicates the absence of hearing loss, and "fail" means the need for further assessments or action[14]. Hearing screening is performed with various methods, many of which are represented in the studies reviewed in this paper.

Despite the prevalence and negative results associated with hearing loss in older adults, health professionals often overlook its assessment, as they address only other health needs in consultations[15]. Despite the ASHA recommendation to assess older adults every 3 years after 50 years old, hearing screening is still inconsistent in this population[14].

This review may help health organizations to determine hearing screening methods and strategies with a good cost-benefit ratio. The procedure can be implemented to optimize health services for older patients presented with hearing loss. This review also addresses gaps in the literature to guide future research, thus, it aimed at analyzing the profile of publications on the methods and instruments used in older adults hearing screening.

METHODS

Search and screening

This is a bibliometric review of the state-of-the-art on older adults hearing screening. The search encompassed articles in national and international journals indexed in PubMed, Scopus, LILACS, and Web of Science databases, besides a manual search in Google Scholar; in this case, the 20 first articles – the most searched and referenced ones – were selected. The search took place in June 2021 and was updated in May 2022, regarding the period between June 2021 and May 2022. The following descriptors in English were used, based on the MeSH platform: "hearing loss OR hearing disorder" "screening", and "elderly", combined as follows: "hearing loss OR hearing disorder AND screening AND elderly". The searches in Portuguese retrieved no results. Two researchers searched independently on the same day, using the same descriptors.

After verifying and consolidating the searches, the next step consisted of screening in two stages – in the first one, duplicates were removed, and then the titles and abstracts were assessed. This stage was carried out by two independent reviewers, who classified the articles as "included" or "excluded", according to the previously established eligibility criteria. In case of divergences, they were solved by a third reviewer. After this phase, the Rayyan reference management software was used. Afterward, the two reviewers independently

read the articles in full texts, likewise classifying them as "included" or "excluded". When their opinions conflicted, the third reviewer analyzed the article in question and decided on the issue. Figure 1 presents the selection flowchart.

Eligibility criteria

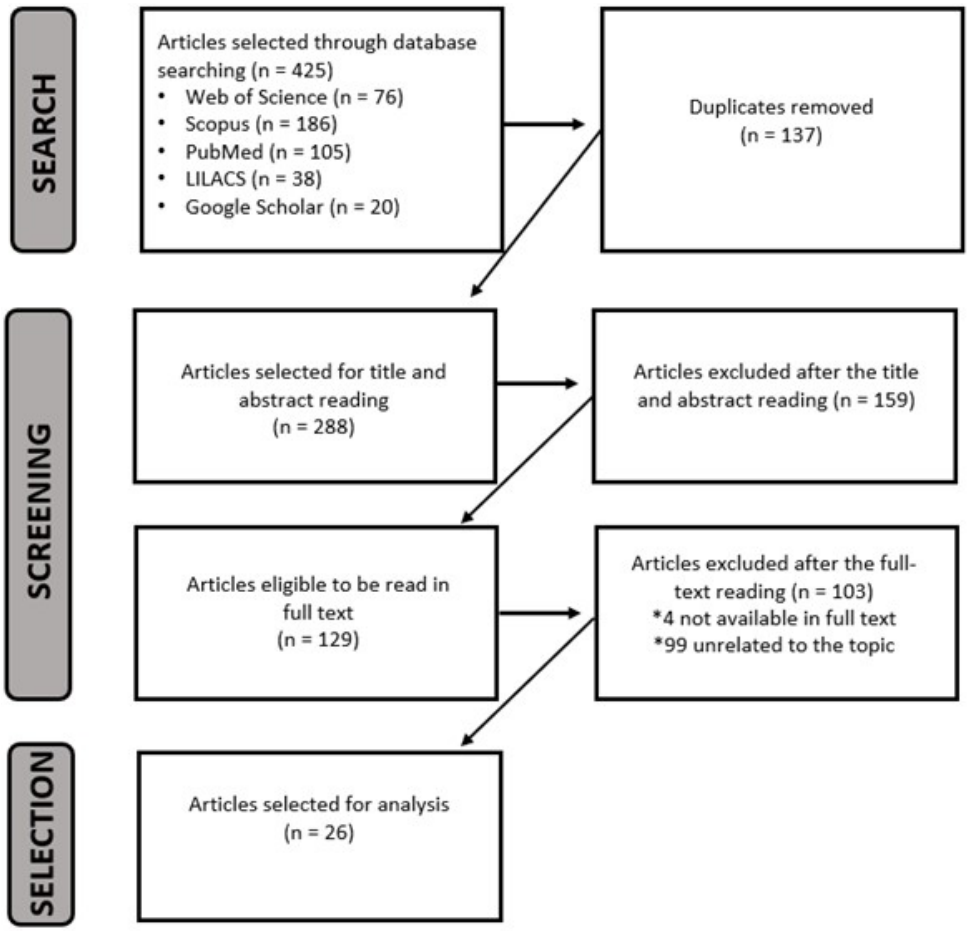
The review included observational, experimental, and cohort studies, published in Portuguese or English after 2016: (a) whose participants were older adults; (b) which used some hearing screening method for this population; (c) whose full text was available in open-access databases or through the CAFe at UFPB (Federated Academic Community at the Federal University of Paraíba). Opinion articles, dissertations, theses, reviews, case series, case studies, and communications were excluded.

Data extraction

In the last stage, the data were extracted into a table with their author, title, year, country, findings, population, screening instrument, study type, and journal – with which charts were created in Microsoft Excel. The chart on hearing screening instruments included those that were mentioned in at least two articles.

LITERATURE REVIEW

Initially, 377 articles were found in the first search, while the second one resulted in 425 articles on the topic. There were 137 duplicates between databases, leaving 288 for the title and abstract reading – after which, 159 articles were excluded for not meeting the inclusion criteria, leaving 129 potentially eligible articles. In the following stage, four articles were excluded because they were not available in full text, and another 99 were not related to the use of hearing screening instruments, totaling 103 excluded articles. Lastly, 26 articles were selected for the study and analysis (Figure 1) and are described in detail in Chart 1.



Caption: n = number of articles

Figure 1. Flowchart of article search and selection

Chart 1. Summary of the articles regarding their title, author, screening instrument, number and age of participants, and main findings

YEAR	TITLE	AUTHOR	INSTRUMENT	N	AGE	FINDINGS
2016	Smartphone-based audiometric test for screening hearing loss in the elderly[16]	Abu-ghanem et al.	uHear™ - an iOS-based application	26	65 to 94	The application had a 100% sensitivity and 60% specificity in screening, as compared with an audiometer. The questionnaire was significantly less precise, ascribing approval scores to three participants who failed both the application and the audiometry.
2016	Perception of hearing loss: use of the subjective faces scale to screen hearing among the elderly[17]	Costa-Guarisco et al.	Subjective faces scale and whispered voice test	164	≥ 60	There was a correspondence between the faces and the degree of hearing loss. Faces 2 and 3 had good sensitivity and specificity indices, with an area under the ROC curve of 0.81. The subjective faces scale seems to be a good, easy-to-apply, low-cost instrument to complement hearing screening in gerontology services.
2016	The development and standardization of Self-assessment for Hearing Screening of the Elderly[18]	Kim et al.	SHSE	83	68 to 84	SHSE is a reliable and valid measure to represent the degree of hearing loss in older adults.
2016	Using the Digits-In-Noise Test to estimate age-related hearing Loss[19]	Koole et al.	DIN test	3,327	≥ 50	The study demonstrates that the DIN test has excellent test characteristics to screen for moderate (or worse) hearing loss. It is not as adequate to detect mild hearing losses.
2016	Implementation of uHear™ - an iOS-based application to screen for hearing loss - in older patients with cancer undergoing a comprehensive geriatric assessment[20]	Lycke et al.	uHear™ - an iOS-based application	33	≥ 70	uHear™ can be used as a tool to screen older patients. It is more sensitive than the whispered voice test and HHIE.
2016	Analyzing use of the Chinese HHIE-S for hearing screening of elderly in a northeastern industrial area of China[21]	Wang et al.	HHIE-S	570	≥ 50	The Chinese version of HHIE-S is adequate to identify hearing loss and approach older adults' rehabilitation needs in an industrial city in continental China.
2016	A hearing self-reported survey in people over 80 years of age in China by hearing handicap inventory for the elderly–complete version vs screening version[22]	Liu et al.	HHIE and HHIE-S	84	80 to 98	HHIE and HHIE-S results revealed that more than half of the older adults did not have self-perceived hearing problems. The Chinese version of HHIE-S can be a convenient tool to investigate hearing loss in people older than 80 years, with the same validity as HHIE.
2017	Screening of hearing in elderly people: assessment of accuracy and reproducibility of the whispered voice test[23]	Labanca et al.	Whispered voice test	210	60 to 97	The Whispered voice test is an effective tool to screen older adults' hearing.
2017	The use of uHear™ to screen for hearing loss in older patients with cancer as part of a comprehensive geriatric assessment[24]	Lycke et al.	uHear™ - an iOS-based application	45	≥ 70	uHear ™ Is a feasible tool with promising results. However, the study concluded that further research is needed.
2017	Simple Tests compare Well with a Hand-held audiometer for hearing loss screening in primary Care[25]	Strawbridge et al.	Direct questions on hearing loss, indirect questions, finger rubbing test, whispered voice test, and audiometry results using a portable audiometer	125	Mean of 72.9 years	The study concluded that simple screening procedures can be used to identify older adults with hearing loss in primary healthcare, making it easier to refer them earlier for additional examinations and treatment.
2017	Initial Results of the Early auditory referral-primary Care (EAR-PC) Study[26]	Zazove et al.	HHI - Hearing Handicap Inventory	1,236	≥55	This feasibility study resulted in significant increases in appropriate referrals of patients at high risk of hearing loss.
2017	Application-based Hearing screening in the elderly population[27]	Livshitz et al.	uHear™ - an iOS-based application	60	≥ 65	uHear is imprecise to assess hearing thresholds to screen older adults. However, when adequately and specifically corrected, tablet-based hearing test with uHear is well accepted by older adults and can be used as an effective hearing screening tool in the older population, especially to rule out significant hearing loss.

YEAR	TITLE	AUTHOR	INSTRUMENT	N	AGE	FINDINGS
2018	Hearing Loss in the Elderly: is the Hearing handicap inventory for the Elderly - screening version effective in diagnosis when compared to the audiometric Test?[28]	Servidoni et al.	HHIE-S	138	≥ 60	The prevalence of hearing loss according to the questionnaire was 76.1%, while the audiometry indicated 79.7%. The diagnostic accuracy of the instrument was 86.2%, with 89.1% sensitivity and 75.0% specificity, regardless of sex. Thus, HHIE-S is adequate to screen hearing loss in older adults, given its high accuracy and ease of use.
2018	Hearing screening and perceived participation restriction in the elderly[29]	Xavier et al.	HHIE-S and portable audiometer	64	Mean of 70 years	53.12% passed the hearing screening, and 46.88% failed it. The correlating variables resulted from the hearing screening and age. The older the age, the more failures occurred. Failures were also associated with a greater perception of restriction in social activities.
2019	A parsimonious approach for screening moderate-to-profound hearing loss in a community-dwelling geriatric population based on a decision tree analysis[30]	Zhang et al.	Pure-tone audiometry and decision tree, using machine learning to optimize audiometry frequency and intensity	1,793	≥ 60	A simple two-stage screening procedure using two tones (2 kHz and 0.5 kHz) selected through decision tree analysis (machine learning algorithm) can be applied to screen moderate to profound hearing loss in a community-dwelling older population in Shanghai.
2019	Screening for hearing loss in the Hong Kong Cantonese-speaking elderly using tablet-based pure-tone and word-in-noise test[31]	Kam et al.	Tablet-automated pure-tone screening test, speech-in-noise test	132	≥ 65	The tablet-automated pure-tone screening test had 0.93 sensitivity and 0.82 specificity, while the speech-in-noise test had 0.81 sensitivity and 0.70 specificity. The tests are reliable and valid to be used as a hearing loss screening test in Hong Kong Cantonese-speaking older adults.
2020	Screening for hearing impairment in older Adults by smartphone-based audiometry, self-perception, HHIE screening questionnaire, and free-field voice Test: comparative evaluation of the screening accuracy with standard pure-tone audiometry[32]	Li et al.	HHIE-S, free-field voice test, and smartphone-based audiometry	41	≥ 65	The sensitivity and specificity of the smartphone-based audiometry test were respectively 0.92 (95% CI 0.60-0.99) and 0.76 (95% CI 0.56-0.89). The smartphone-based audiometry correctly diagnosed the presence of hearing loss, with high sensitivity and specificity.
2020	Comparison of self-reported measures of hearing With an Objective audiometric measure in adults in the English longitudinal study of ageing33	Tsimpida et al.	Self-reported auditory measures, including hearing with background noise	9,666	50 to 89	The self-reported hearing loss measure had a limited agreement with objective hearing loss measures. These findings reinforce the importance of an effective and sustainable hearing loss screening strategy for early detection and intervention in older adults.
2020	Reliability and validity of Self-screening Tool for Hearing loss in Older adults[34]	You et al.	SHSE-R	170	Mean of 72 years	SHSE-R had high internal consistency and reliability in the comparison of the test-retest scores and converging construct and criteria validity, thus making SHSE-R useful to self-assess hearing loss in older adults.
2020	Effective hearing Loss screening in primary Care: the Early auditory referral-primary Care study[35]	Zazove et al.	HHIE	5,893	≥ 55	The electronic alarm to remind physicians to ask their patients older than ≥ 55 years regarding hearing loss significantly increased audiological referrals of at-risk patients.
2020	Sensitivity and specificity of the Hearing handicap inventory for elderly-screening Thai version[36]	Judee et al.	HHIE-S	222	≥ 60	The Thai version of HHIE-S had good sensitivity and specificity boa to screen hearing loss (at 40 dB or more) in Thai older adults. HHIE-S can be used to identify patients with hearing loss and raise awareness of health in Thai older adults.
2020	Score of hearing handicap inventory for the Elderly (HHIE) compared to whisper Test on presbycusis[37]	Purnami et al.	HHIE-S and whispered voice test	60	≥ 65	The whispered voice test is more sensitive than HHIE-S to detect hearing loss in patients with age-related hearing loss.
2021	The effective screening tools for detecting hearing loss in elderly population: HHIE-ST versus TSQ[38]	Chayaopas et al.	HHIE-S; Thai Single Question (TSQ), and pure-tone audiometry	1,109	≥ 60	HHIE-ST reached 88.96% sensitivity (95% CI 85.77–91.64) and 52.19% specificity (95% CI 48.24–56.13) to diagnose hearing loss in Thai older adults, while TSQ had 88.73% sensitivity and 55,93% specificity. A test combining HHIE-ST and TSQ performed better, with 85.29% sensitivity and 60.13%. specificity
2021	Accuracy of affordable instruments for hearing screening in adults and the elderly[39]	Balen et al.	MoBASA – smartphone application	80	18 to 94 years 37 (46.25%) ≥ 60 years	MoBASA proved to be an accurate hearing screening method for older adults with disabling hearing loss.

YEAR	TITLE	AUTHOR	INSTRUMENT	N	AGE	FINDINGS
2022	Sensitivity and specificity of the Speech, Spatial and Qualities of Hearing Scale (SSQ5) for screening hearing in adults[40]	Assef et al.	5 questions from the Speech, Spatial, and Qualities of Hearing Scale (SSQ5)	135	Mean of 49.6 years	SSQ5 in Brazilian Portuguese was appropriate to screen hearing loss in adults with good accuracy, sensitivity, and specificity to detect hearing loss.
2022	A parsimonious approach for screening moderate-to-profound hearing loss in a community-dwelling geriatric population based on a decision tree analysis[41]	Zhang et al.	Pure-tone audiometry at 2 kHz and 42 dBHL, and at 0.5 kHz and 47 dBHL	1,793	≥ 60	Implementing the two tones in a well-calibrated sound generator may create a good, simple, practical, effective, and highly precise screening tool, readily available on all levels of health centers, making it easier to start a broad national hearing screening program for older adults.

Captions: N-number; ROC-Receiver Operating Characteristic Curve; SHSE- Self-assessment for Hearing Screening of the Elderly; DIN-digit-in-noise test; HHIE- hearing handicap inventory for the elderly. HHIE-S hearing handicap inventory for the elderly screening version; CI- confidence interval; SHSE-R Self-assessment for Hearing Screening of the Elderly - revised; HHIE-ST- Thai version of hearing handicap instrument for elderly screening version.

Number of publications over the years

The number of studies published over the years varies considerably – 2016 stands out with seven publications, followed by 2020 (Figure 2). It must be highlighted that, as the search was conducted in May 2022, the number of articles by the end of that year may be greater.

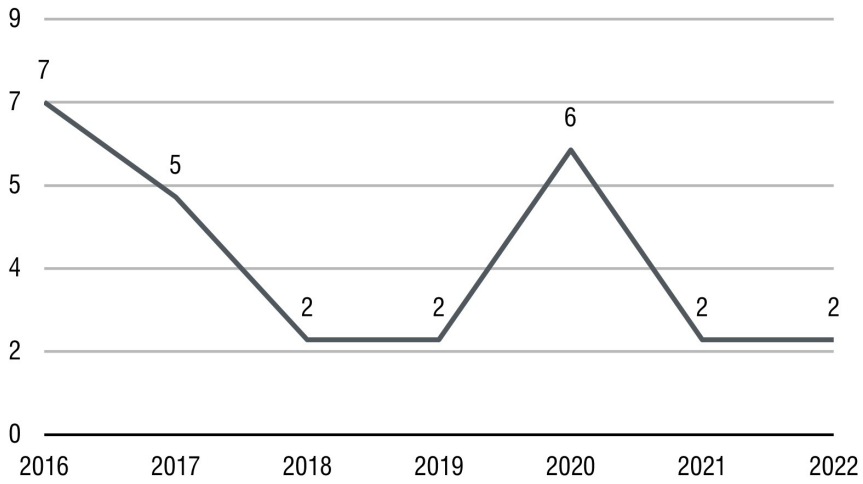


Figure 2. Chart of the number of publications per year (2016-2020)

Studies per country

After the analysis, the countries with the most publications were made evident by the articles selected for this study, with an emphasis on Brazil, China, and the United States (Figure 3). Brazilian studies were conducted by the Federal University of São Carlos, Federal University of Minas Gerais, Marília Medical School, Federal University of Rio Grande do Sul, Federal University of Rio Grande do Norte, and the Santa Casa School of Medical Sciences of São Paulo.

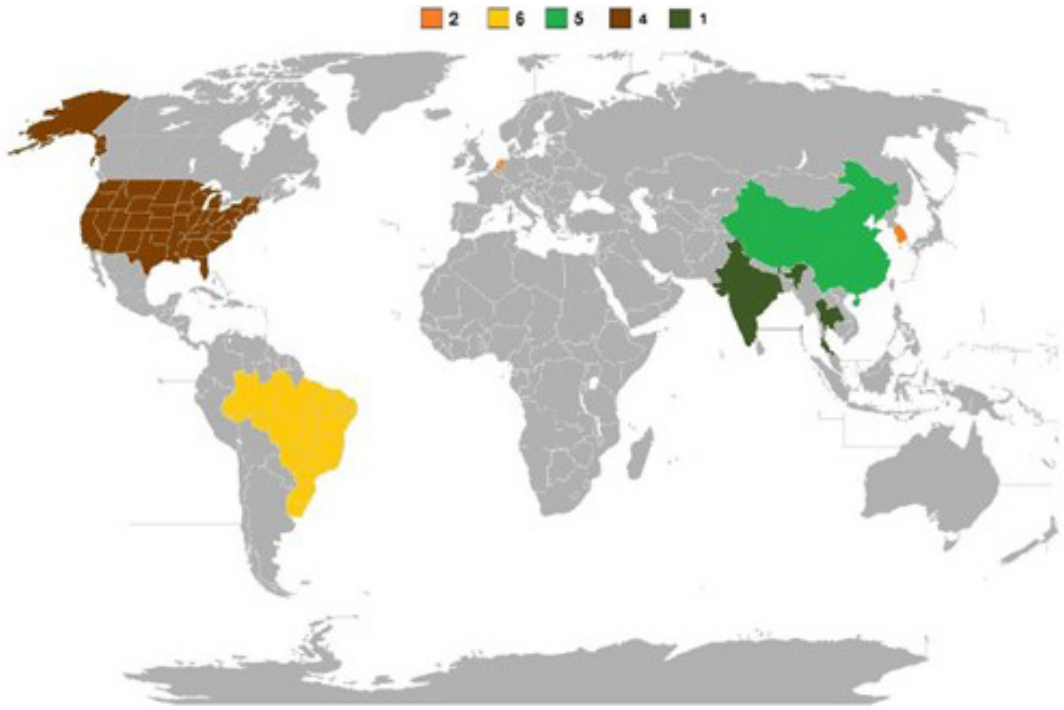
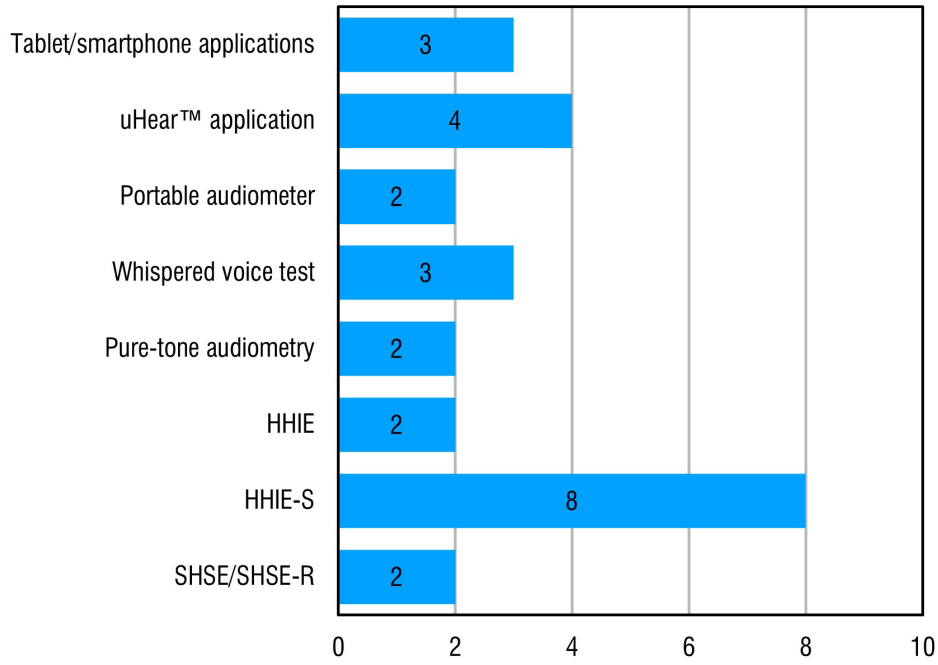


Figure 3. World map highlighting the main countries of origin of the journals

Hearing screening instruments

The review verified which hearing screening instruments are cited in the articles and how many times they were used in the 26 studies – which reported various instruments capable of screening older adults hearing (Figure 4). They included iPhone operating system (iOS) and Android applications, self-perception questionnaires (Hearing Handicap Inventory for the Elderly [HHIE], Hearing Handicap Inventory for the Elderly – screening version [HHIE-s], and Self-assessment for Hearing Screening of the Elderly [SHSE]), pure-tone audiometry, portable audiometer test, and whispered voice test.

One study used the Digits-In-Noise test (DIN) in 3,327 participants and demonstrated that this test has excellent screening characteristics for moderate hearing loss, though inadequate to detect mild hearing loss[19]. Another study from 2020, with 9,666 participants, demonstrated that self-reported hearing measures had limited accuracy and were not sensitive enough to detect hearing loss. The self-reported measure in that study was no more than a questionnaire administered to the participants, asking whether they had difficulties following a conversation with background noise; it was answered on a 5-point Likert scale, in which 1 was excellent; 2, very good; 3, good; 4, average; and 5, poor[33]. No structured questionnaires, interviews, or validated instruments were used.



Captions: HHIE – Hearing Handicap Inventory for the Elderly; HHIE-S – Hearing Handicap Inventory for the Elderly – screening version; SHSE – Self-assessment for Hearing Screening of the Elderly; SHSE-R – Self-assessment for Hearing Screening of the Elderly – revised.

Figure 4. Chart with the hearing screening instruments, presenting the quantitative data and main assessment instruments used in the selected studies

Types of study and levels of evidence

The study types among the articles analyzed were mainly cross-sectional and validation studies. Most of them were cross-sectional, totaling 16 articles, followed by six validation studies. The other ones were cohort and exploratory studies, as shown in Figure 5. It was found that 50% of the selected publications are in the lower levels of the pyramid of scientific evidence. The cross-sectional studies were greatly exposed to methodological confounding variables, also known as biases. The search did not identify any randomized clinical trials.

Attention must be called to the lack of validation studies addressing low-cost self-assessment instruments to be used either by patients or hearing health prevention and promotion programs, as well as cohort studies demonstrating the effectiveness of these screening instruments.

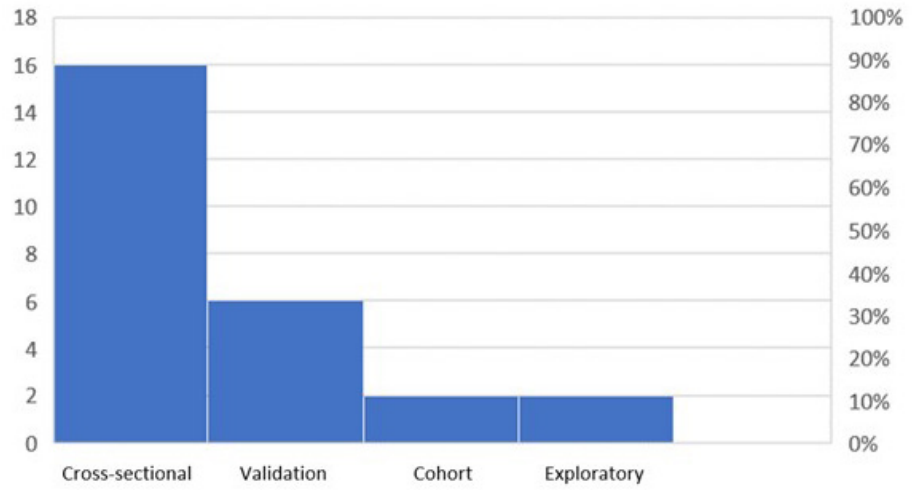


Figure 5. Quantitative data on the study types selected for the review

CONCLUSION

The study pointed out the scarcity of scientific production on older adults hearing screening – a topic little addressed in national and international research. Various screening methods were used, which hinders the comparison of results. This circumstance highlights the need for implementing methodologies for future research on the topic, with quality studies conducted in the area.

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RDAG, MJGS: database search, article writing.