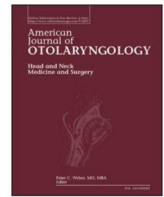
American Journal of Otolaryngology–Head and Neck Medicine and Surgery 47 (2026) 104799

Contents lists available at ScienceDirect

American Journal of Otolaryngology–Head and Neck Medicine and Surgery

journal homepage: www.elsevier.com/locate/amjoto



Relationship between hearing loss, cognitive impairment, and dementia; meta-analysis of cohort studies in which the exposure factor is hearing loss measured by audiometry

Roberto Peribáñez García [a,b], Francisco Álvaro Rodriguez Rodriguez [c,d,*], Blanca Ascaso Adiego [b], María Isabel Adiego Leza [c,d]

[a] San Pablo Health Center, Zaragoza, Spain
[b] Family and Community Medicine, Miguel Servet University Hospital, Zaragoza, Spain
[c] Otorhinolaryngology Department, Miguel Servet University Hospital, Zaragoza, Spain
[d] University of Zaragoza Faculty of Medicine, Zaragoza, Spain

ARTICLE INFO

Keywords:
Hearing loss
Audiometry
Cognitive impairment
Dementia
Cohort study
meta-analysis

ABSTRACT

Introduction-objectives: There is a probable relationship between hearing loss and cognitive decline and dementia: patients with hearing loss appear to develop cognitive difficulties earlier and more frequently. However, the relationship is not completely clear. A meta-analysis of high-quality studies is needed to clarify the nature of this relationship.

Materials and methods: Meta-analysis of cohort studies in which the exposure factor is hearing loss, necessarily measured with pure-tone audiometry, and the outcome is the progression of cognitive decline measured with validated scales or the onset of dementia. The inclusion period for the studies was 2019–2023.

Results: Of the 5349 articles identified, 11 cohort studies were included in the systematic review; and 8 in the meta-analysis. In those where the outcome was dementia (expressed as Hazard Ratio [HR]), a statistically significant relationship was found, with an HR of 1.32 (1.30–1.34), with low heterogeneity and a low risk of publication bias. In those where the outcome was expressed as linear regression (beta), no statistically significant results were found.

Conclusions: There appears to be a relationship between hearing loss and cognitive impairment/dementia. Other forms of hearing loss (such as central hearing loss) need to be evaluated to fully assess the effect and implications of this relationship.

1. Introduction

Cognitive impairment and dementia are a major public health problem that is estimated to affect 131.5 million people worldwide by 2050 [1]. It is a multifactorial disease, associated with non-modifiable risk factors (such as age, sex, childhood educational level) and others that can be addressed (such as cardiovascular risk factors or hearing loss). Hearing loss has been shown to be one of the most significant potentially modifiable factors, with a 7% attributable risk fraction [2]. In a recent Delphi consensus umbrella review of 18 dementia experts, hearing loss was the most interesting modifiable factor to include in future predictive rules or to consider in dementia treatment [3].

On the other hand, age-related hearing loss is a very prevalent health problem (it is estimated that approximately one-third of adults over 65 years of age have hearing loss) [4], with a great impact on the patient's quality of life, which is also undertreated, is easily diagnosed by audiometry and has a treatment: hearing aids [5].

In those studies in which a relationship is found between hearing loss and dementia, hearing loss seems to precede dementia by 5–10 years [6], offering us an opportunity for action: perhaps if we slow down hearing loss or address it early, we can reduce the incidence of cognitive decline and dementia [7].

On the other hand, there are inconsistent results regarding the cause-effect relationship between hearing loss and dementia: while most studies find a positive relationship between the two, some are not so optimistic [8–10]. The nature of this relationship is also unclear, nor is

* Corresponding author.
E-mail address: farodriguez@salud.aragon.es (F.Á. Rodriguez Rodriguez).

https://doi.org/10.1016/j.amjoto.2026.104799
Received 3 August 2025;
Available online 4 March 2026
0196-0709/© 2026 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

its directionality [11]. Although it is not the central theme of the study, it is worth mentioning that there are several theories: that cognitive load with age hinders auditory perception, that the pathophysiological mechanism is common and the deterioration of hearing and higher functions is simultaneous, that poor auditory stimulation reduces brain activity and leads to its atrophy if it persists for a long time, or that the extra effort the brain makes to hear and understand takes resources away from other higher brain functions [11–14].

Furthermore, there is disparity in how hearing loss is measured: sometimes we understand it as the sense of peripheral hearing, sometimes as speech understanding [11], sometimes we measure it using questionnaires, sometimes using audiometry. There is also disparity in the measurement of cognitive impairment (using multiple different cognitive tests) and in the classification of dementia. And much of this evidence comes from case-control studies, which often present significant biases [15]. Cohort studies offer a much higher level of evidence and could be the key to clarifying this association, in addition to being the highest-quality studies that can be ethically acceptable on this topic [8]. Only with sufficiently high-quality studies, such as cohort studies, can we draw appropriate conclusions and try to clarify the nature of the association between hearing loss and cognitive impairment.

Study objective: A systematic review and meta-analysis of cohort studies published between 2019 and 2023 with good quality criteria, in which the exposure factor is hearing loss measured with pure-tone audiometry and the outcome is cognitive decline measured with a test or the onset of dementia. The initial hypothesis is that hearing-impaired patients without cognitive impairment are at greater risk of developing it in the future than their **hearing peers**.

2. Methods

2.1. Study design

The study was designed as a systematic review and meta-analysis of cohort studies in which the exposure factor was hearing loss and the outcome was cognitive decline measured by testing or dementia. The study did not require approval from a Healthcare Ethics Committee, as it was a review of previously approved studies.

2.2. Search strategy and study selection

Searched in Several databases: PUBMED, MEDLINE, and SCOPUS/ WEB OF SCIENCE. The inclusion and exclusion criteria are as follows:

- Study type: Original cohort studies in which the exposure factor is hearing ability, measured exclusively with pure tone audiometry, and the outcome is dementia or cognitive status, measured with validated tests. Controls without hearing loss must always be present. Interventional studies (in which one intervention arm uses hearing aids, the other does not), cross -sectional studies, and case-control studies are excluded. Studies in which hearing loss is measured with diagnostic codes, subjective tests, or through self-reported hearing loss by the patient are also excluded. Narrative reviews and book chapters are also excluded.
- Follow-up period: although not considered an exclusion criterion, studies lasting less than 5 years lost points in the quality assessment (Newcastle-Ottawa).
- Results expressed either as relative risk (RR), Hazard ratio (HR) or as linear regression (where the slope of the curve, beta, is the variation in the result of cognitive tests over time according to the degree of initial hearing loss)
- Publication date: between 2019 and 2023, both inclusive.
- Patient type: Patients with an average age of 50–60 years. Studies on children and those in which patients have an altered cognitive level at the onset of the study are excluded. Studies on sudden sensorineural hearing loss are also excluded.
- Languages: English or Spanish.

The general search strategy used is as follows, adapted to the search engine of each database:

- (AND) DEAFNESS OR DEAF OR SORDERA OR HEARING OR HIPOACUSIA OR HYPACUSIA OR HYPACUSIS OR PRESBIACUSIA OR PRESBYCUSIS OR PRESBYACUSIS OR AUDITORY… in title-abstract
- (AND) DEMENTIA OR DEMENCIA OR COGNITIVE OR COGNITION OR AMENTIA OR COGNITIVO OR COGNICIÓN OR ALZHEIMER OR ALZHEIMER'S… in title-abstract

2.3. Data extraction

An initial preselection of studies was conducted based on their titles and abstracts, followed by a more exhaustive analysis of the preselected articles using the inclusion/exclusion criteria and a full reading of the texts. This process was conducted by a single researcher.

Once the articles for inclusion in the systematic review were obtained, their quality was assessed using the Newcastle -Ottawa rule for cohort studies.

2.4. Analysis

Subsequently, a descriptive analysis of the characteristics of each study was performed: Author, year of publication, country, cohort from which the patients were extracted, number of patients, percentage of losses to follow-up, mean age of patients, % women, distribution by race, % patients with hearing loss, % patients with hearing aids, follow-up period, diagnostic criteria of audiometry, number of times hearing was measured in the study, outcome variable, cognitive tests used, number of times cognition was measured in the study, confounding factors used to correct the statistical analysis, statistical results, conclusions of the study and Newcastle-Ottawa score.

The statistical analysis of the studies, including meta-analysis, was performed by the Methodological Assistance Service (SAME) of the Aragonese Institute of Health Sciences (IACS). Studies whose results were expressed using the Hazard Ratio (those in which the outcome variable was dementia) and those in which the results were expressed as linear regression (beta-curve slope) were analyzed separately.

In the meta-analysis of studies that expressed the outcome as the occurrence of dementia, a forest plot was obtained as an effect analysis, measures of heterogeneity (I2), a funnel plot to assess publication bias, a “Drapery Plot” to calculate the average effect, and a cumulative sensitivity analysis.

When analyzing the articles that express the results as linear regression, it is important to emphasize that the same cognitive test should be used in each included study in order to perform a pooled meta-analysis. Unfortunately, several very disparate cognitive tests are used (see Results below). Therefore, it was initially decided to use the cognitive tests that assessed global cognition (MMSE, 3MS, TICS in Ge, Global Cognition in Jiang), since they were present in all the included studies. However, after discussing this with the statistical team, it was seen that it was not correct to calculate the same meta-analysis for different cognitive tests. For this reason, it was decided to perform a meta-analysis of the articles that used the MMSE and another with those that used the 3MS (see Results below). In these two situations, forest plots were generated for each to estimate the effect, and then assessed heterogeneity (using I2, tau2 and Q statistic) and the possibility of publication bias (using Fail-Safe N, Kendall's Tau, Eggers regression and funnel plot).

3. Results

3.1. Search results

Following the above search strategy, 3943 studies were obtained in Pubmed, of which 45 were preselected. In Embase, 729 articles were obtained and 34 were preselected. In Scopus, 677 articles were obtained, of which 36 were preselected. After removal of duplicates, 59 of the 5349 identified articles were retained for full-text assessment. After exhaustively applying inclusion/exclusion criteria, 49 articles were discarded. Therefore, we were left with 10 articles. The most frequent reasons for article rejection were the following: they presented hearing as a subjective measure (30), only central hearing was measured exclusively (1), hearing was not measured as an isolated variable but as a set of sensory impairments (1), patients were of young average age (3), only HIV positive patients (1), volunteer patients (1), only sudden deafness was mentioned (2), there was no control group of non-hearing patients (2), patients with some cognitive impairment at the beginning (3), the study was not a cohort study (1), the study was interventional (1), the study had very few patients (1), it was impossible to find the full text (1) and the study presented a very complex and varied statistical approach (1).

Subsequently, a systematic review (Myrstad et al.) [16] discovered during the writing of the article was added. In summary, 11 articles remain that meet the criteria for quality assessment, systematic review, and statistical analysis.

Later, the quality criteria for cohort studies (Newcastle-Ottawa rule) were applied. One article showed doubtful results, depending on whether the follow-up period was acceptable or not (Jiang et al.) [17], and two showed poor results (Croll et al., Mohammed et al.) [10,18]. It

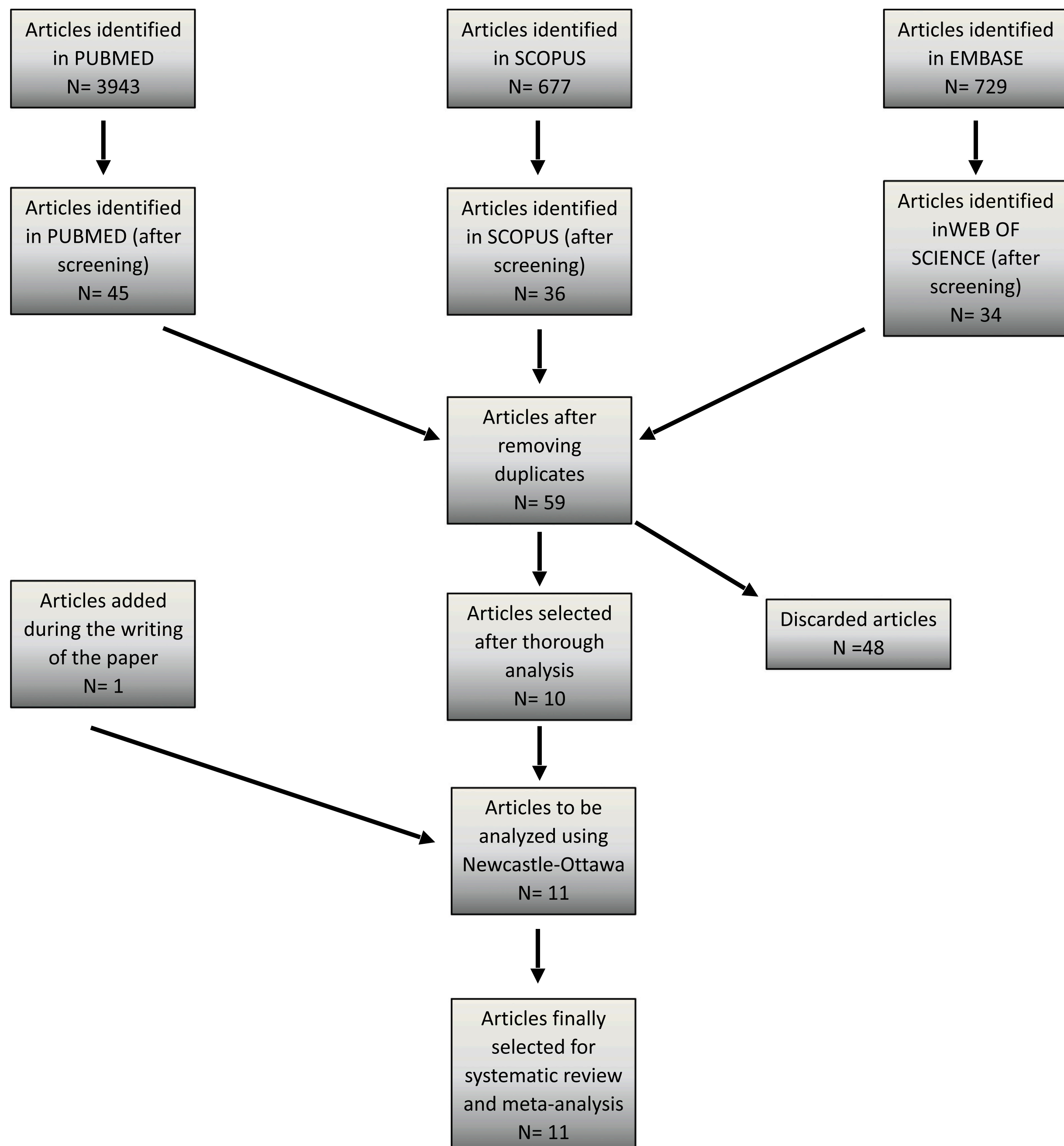


Fig. 1. Flowchart illustrating the process of selecting articles according to PRISMA guidelines.

was decided to retain these studies so as not to further reduce the statistical power of the meta-analysis.

A summary of this selection process can be seen in the flowchart shown in Fig. 1.

Once the 11 final articles were selected for the meta-analysis, a descriptive study was conducted on the baseline characteristics of each study. This descriptive study can be seen in Table 1. For more information on the baseline characteristics of each article, see Appendix 1.

In summary, most of the studies were conducted in the United States (US), all of them with people over 50–60 years of age, with a fairly equal distribution by sex in most of them. Chang et al. [19] is noteworthy due to the large number of patients (almost 40,000). As an outcome variable, 4 articles chose the incidence of dementia (the result expressed as Hazard Ratio in 3 of them [Mohammed et al., Chang et al., Brenowitz et al.] [18–20] and as Relative Risk in 1 of them [Myrstad et al.] [16]). Six of them chose the difference in cognitive test results (the result expressed as the slope observed in a linear regression, beta) (Croll et al., Jiang et al., Alattar et al., Armstrong et al., Ge et al., Chern et al.) [10,17,21–24], and 1 of them opted for both methods (Powell et al.) [25]. The cognitive tests used (and the abbreviations employed) in the studies are the following: Modified Minimental State - 3MS, Minimental State - MMSE, Trail Marking Test- TMT—B, TMT-A, Digit Symbol Substitution Test- DSST, Letter Digit Substitution Test- LDST, Digit Span Forward- DSF, Digit Span Backwards - DSB, California Verbal Learning Test- CVLT, Benton Visual Retention Test- BVRT, Stroop Test- STI, Word Learning Test- 15-WLT, Purdue Pegboard Test- PPT, Telephone Interview for Cognitive Status- TICS, Clock Drawing Task - CLOX1, Letter Fluency Test- LFT, Verbal Fluency Test- VFT, Word Fluency Test - WFT, Category Fluency Test – CFT, Boston Naming Test- BNT, Cognitive Reflection Test- CRT.

There is great variability in the tests used, the most common being the 3MS and the MMSE, which report global cognition.

3.2. Outcome measures and sub-group analysis

The analyses included those expressing results as incidence of dementia, and those using linear regression. Eight of the 11 articles included in the systematic review were included in the meta-analysis. Of the five articles expressing results as incidence of dementia, the Myrstad et al. [16] study was excluded because the results were expressed as RR, making it impossible to compare them statistically with the other articles, which used HR. In the case of studies based on cognitive test variations, the tests that indicated global cognition and were present in all the articles were chosen: the 3MS, MMSE, and TICS (Ge et al.) [23], and Global Assessment (Jiang et al.) [17]. The 3MS and MMSE were initially considered jointly; however, separate analyses were ultimately performed for each test. For this reason, Jiang et al. [17] was excluded because they use their own unique test, and Ge et al. [23], because they use ICT and it is the only one who does so.

The meta-analysis demonstrated a statistically significant association between hearing loss and incident dementia, with a pooled Hazard Ratio of 1.32 (95% CI 1.30–1.34) (Fig. 2). No significant heterogeneity was observed ($I^2 = 0\%$; p for heterogeneity > 0.05).

Subsequently, publication bias was assessed using a Funnel Plot. Visual inspection of the funnel plot did not suggest a relevant risk of publication bias (Fig. 3). On the other hand, a slight asymmetry is observed, with more articles to the left of the vertical line. However, they are not outside the diagonal line, and it should be noted that there are only five studies.

A Drapery plot was generated to complement the interpretation of confidence intervals across a range of *p*-values [26]. The pooled effect remained significantly greater than zero (Fig. 4).

In addition, a cumulative sensitivity analysis was performed, which showed stable effect estimates over time (Fig. 5).

Regarding the articles that expressed the result as linear regression, there were 4 that used the MMSE test and 2 that used 3MS.

Table 1
Main characteristics of the included studies.

ARTICLE	COUNTRY	NUMBER OF PARTICIPANTS	MEAN AGE (years)	PROPORTION OF WOMEN (%)	FOLLOW-UP PERIOD (years)	OUTCOME VARIABLE	COGNITIVE TEST USED	NEWCASTLE-OTTAWA	RESULTS (only significant)
Brenowitz 2019	USA	1810	70-79	51,8 %	10	Dementia incidence	3MS	8 (good)	HR 1,25
Alattar 2020	USA	1164	73,5 +- 9,3	64 %	4-10	Difference in cognitive tests	MMSE, TMT-B, VFT	8 (good)	Beta (MMSE) -0,08 Beta (TMT-B) 1,91
Armstrong 2020	USA	313	74 +- 8	55,5 %	2	Difference in cognitive tests	MMSE, TMT-B, DSST, DSF, DSB, CVLT, BVRT	7 (fair)	Beta (CVLT): -0,064 Beta (DSF): -0,074
Chang 2020	South Korea	382404	65 +- 11	47 %	5-9	Dementia incidence	N/A	8 (good)	HR severe hearing loss: 1,336 HR non-severe hearing loss: 1,312
Croll 2021	Netherlands	3590	65,2 +- 7,3	56,2 %	4,4	Difference in cognitive tests	MMSE, STI, WFT, LDST, 15-WLT, PPT	7 (poor)	Beta (LDST): -2,65
Ge 2021	USA	295	81,4 +-5	52,2 %	8	Difference in cognitive tests	TICS	7 (good)	Beta (TICS): -0,16
Chern 2022	USA	2110	73,5 +- 3	52,4 %	9	Difference in cognitive tests	3MS, DDST, CLOX1	8 (good)	Beta (3MS): -0,044 Beta (DDST): -0,054
ARTICLE	COUNTRY	NUMBER OF PARTICIPANTS	MEAN AGE (years)	PROPORTION OF WOMEN (%)	FOLLOW-UP PERIOD (years)	OUTCOME VARIABLE	COGNITIVE TEST USED	NEWCASTLE-OTTAWA	RESULTS (only significant)
Jiang 2022	USA	702	75 +- 8,3	54,8 %	0-7	Difference in cognitive tests	Lenguage: LFT, CFT, BNT Memory: CVLT Attention: TMT-A, DDST Executive: TMT-B, DSF, DSB Visual-spatial: CRT, BVRT	6 (poor) / 7 (fair)	Beta (global): -0,03 Beta (lenguage): -0,01 Beta (attention): -0,02 Beta (executive): -0,01
Mohammed 2022	USA	295	79,5 +-5,2	63 %	7,8	Dementia incidence	N/A	7 (poor)	HR mild hearing loss vs normal 1.67
Powell 2022	USA	2061	74 +- 2,8	52 %	9-11	Dementia incidence	MMSE	8 (good)	HR 1,42
						Difference in cognitive tests	3MS, DDST		Beta (MMSE: -0,18. Beta (DDST): -0,16
Myrstad 2023	Norway	7251	55,6 +- 6	55 %	21,7	Dementia incidence	N/A	8 (good)	RR hearing loss vs normal 1.36

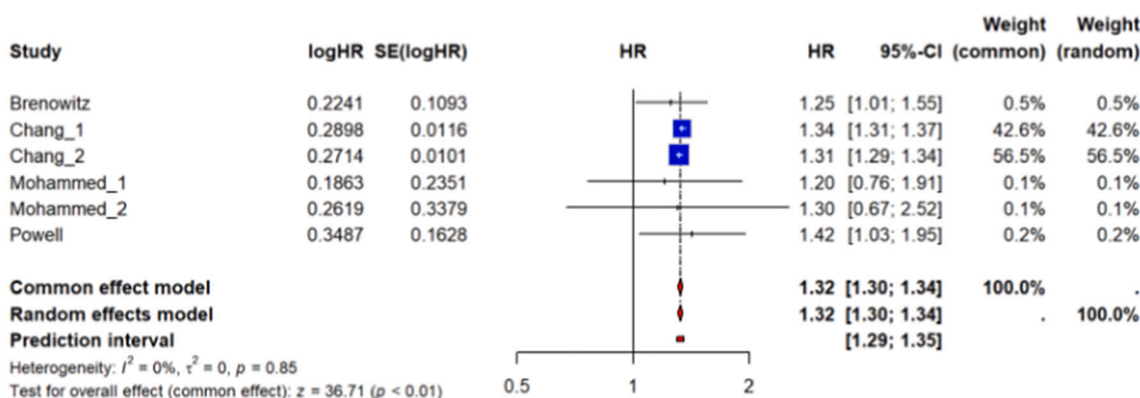


Fig. 2. Forest plot showing the hazard ratio (HR) for dementia incidence associated with hearing loss in the included studies.

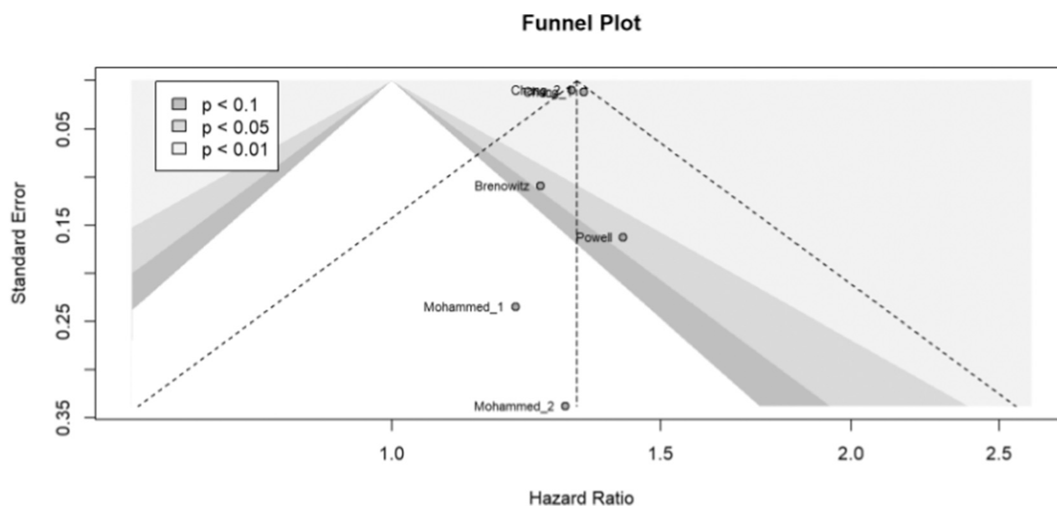


Fig. 3. Funnel plot assessing potential publication bias for the studies included in the meta-analysis of dementia incidence.

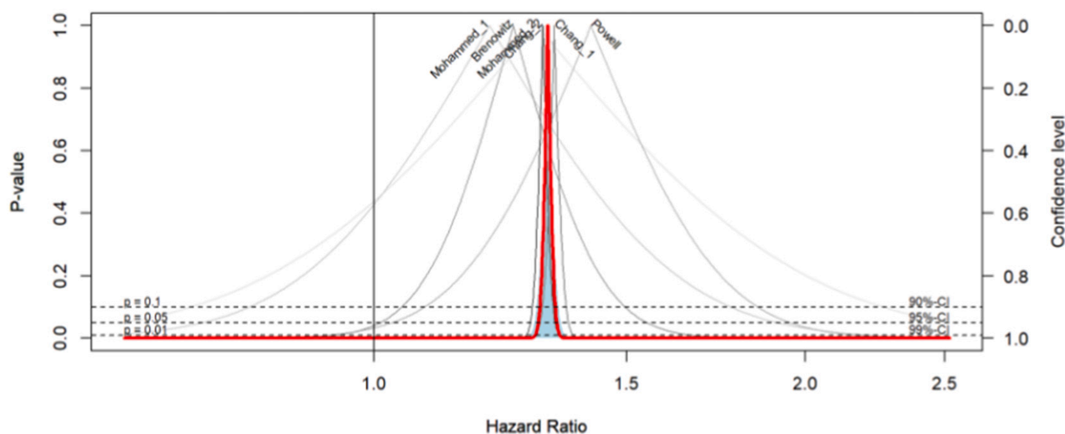


Fig. 4. Drapery plot displaying the distribution of p-values as a function of the effect size for meta-analysis of hazard ratios (HR).

Regarding the meta-analysis of the studies that used MMSE, an estimated beta of −0.2 was obtained, which was not statistically significant (p 0.101; −0.44 to 0.04) (Fig. 6). When analyzing the heterogeneity of the studies, heterogeneity was low to moderate ($I^2 = 26.4\%$; Q = 4.75, $p = 0.31$). The assessment of publication bias yielded mixed results (Fail-Safe N test *p*-value of 0.025; Kendall's Tau test p-value of 0.193; Eggers regression test p-value of 0.752), with no consistent evidence of publication bias (Fig. 7).

Regarding the meta-analysis of studies using 3MS, an estimated beta of −0.054 is obtained, with p 0.406 (Fig. 8); again, the effect is not statistically significant. The number of studies is very small, which may affect the precision of the estimate. No heterogeneity was observed ($I^2 = 0\%$; Q = 0.31, $p = 0.86$), indicating consistent effect estimates. All three publication bias assessments (Fail-Safe N, Kendall's tau, and Egger's regression) were non-significant, suggesting a low risk of publication bias (Fig. 9).

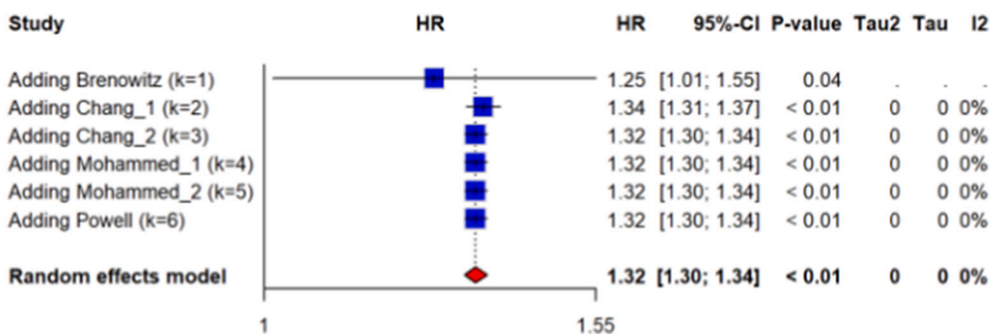


Fig. 5. Cumulative sensitivity analysis of the meta-analysis of hazard ratios (HR), showing the stability of the pooled estimate.

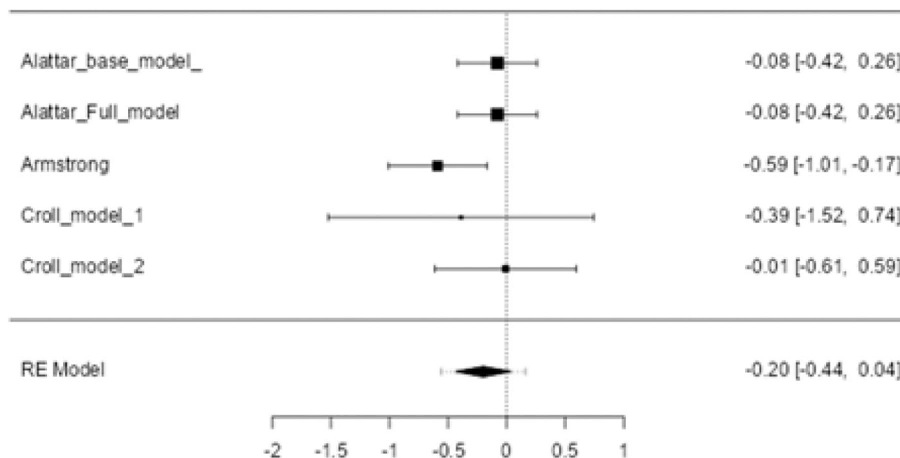


Fig. 6. Forest plot illustrating the association between hearing loss and cognitive decline measured by the Mini-Mental State Examination (MMSE)

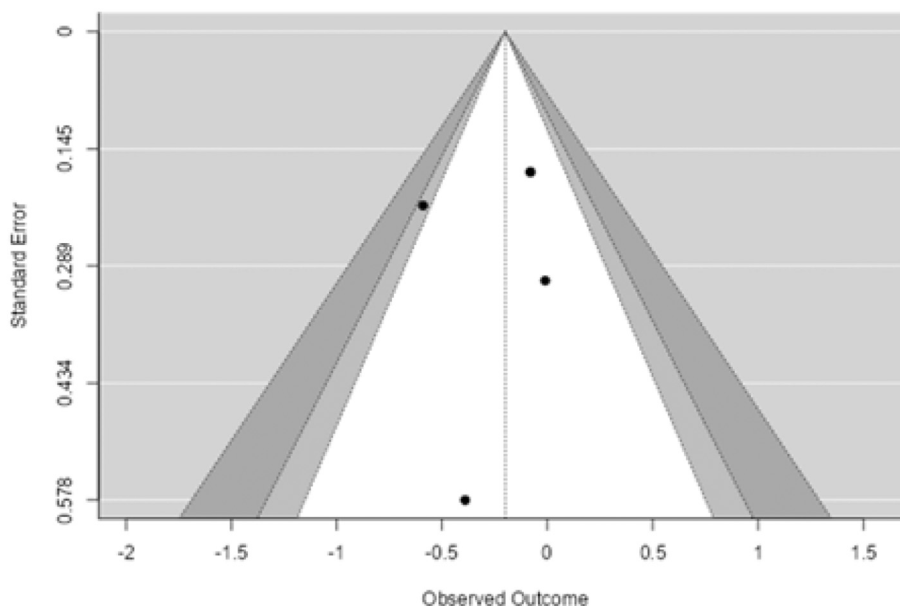


Fig. 7. Funnel plot assessing potential publication bias for the studies evaluating cognitive decline via the MMSE.

4. Discussion

We have found a clear relationship between the incidence of dementia and previous hearing loss: patients who have hearing loss at onset are 32% more likely to develop dementia in the future. This relationship is similar to many previous original studies: HR 1.21 (Amieva et al. 2018, but subjectively measured hearing) [27], HR 1.24 (Brenowitz et al. 2019) [20], HR 1.54 for severe dementia (Curhan et al. 2019, subjective tests) [28], HR 1.69 (Ford et al. 2018, although hearing diagnosis by database) [7], HR 1.69 (Golub et al. 2017, subjective hearing measurement) [29], HR 1.27 (Gurgel et al. 2014, subjective hearing measurement) [30], HR 2.32 (Lin et al. 2011) [31]. It is worth

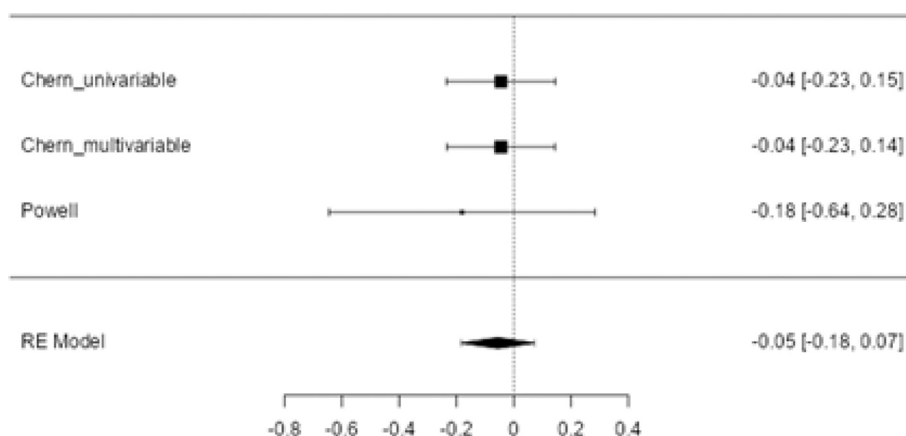


Fig. 8. Forest plot illustrating the association between hearing loss and cognitive decline measured by the Modified Mini-Mental State Examination (3MS).

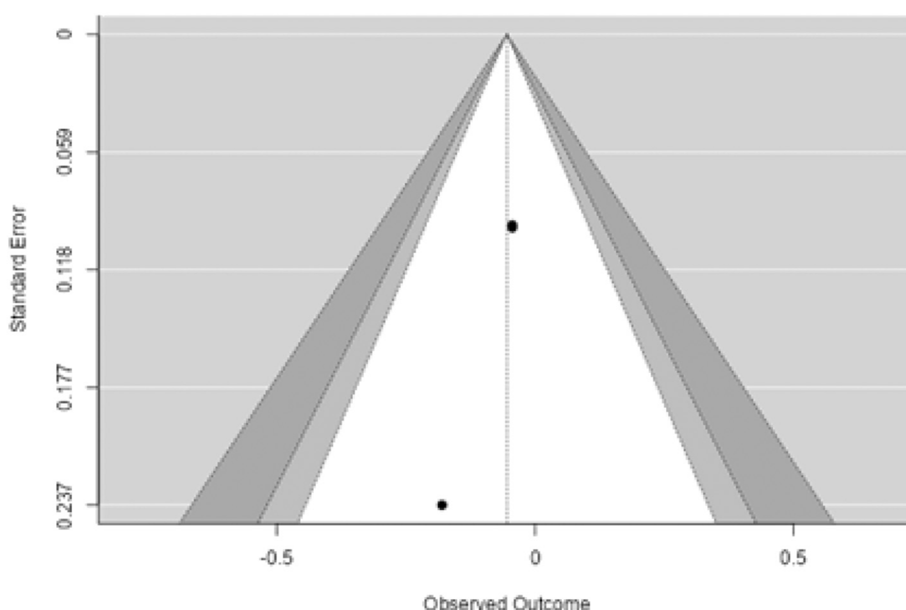


Fig. 9. Funnel plot assessing potential publication bias for the studies evaluating cognitive decline via the 3MS.

highlighting, Deal et al. (2016) [13], one of the best known and most cited studies in this field: from a cohort of 1800 Americans, they were measured at baseline with audiometry and followed for 9 years to see if they developed dementia. Even after controlling for multiple confounders in models, those with more severe hearing loss had an increased risk of dementia over 9 years: HR 1.55 (95% CI 1.10–2.19). Almost all studies have been conducted in Europe, North America, or Australia, but this statistically significant relationship also exists in other countries, such as Singapore, with an HR for dementia of 2.3 [32].

On the other hand, we found no relationship when we measured the difference between cognitive tests over a period of time, expressed as a linear regression (beta). However, it should be noted that the statistical analysis used is less reliable with small sample sizes. In previous literature, we found disparate data: Merten et al. (2020) [11] using the TMT test, border on statistical insignificance.; Deal et al. (2016) [13] found no relationship with the tests used; Gurgel et al. (2014) [30] found a 0.26-point worsening of the MMSE score with each passing year; and Lin et al. (2013) [9] found that both the 3MS and DDST scores worsen more rapidly when the patient has hearing loss.

If we look at meta-analyses with less strict study inclusion criteria (some also include case-control or cross-sectional studies, others do not use audiometry to measure hearing), similar results are found: such as Lau et al. (2022) [33] (RR 2.06 for mild cognitive impairment in patients with hearing loss, but significant statistical heterogeneity), Loughrey et al. (2017) [8] (HR 2.42 for dementia), or Yu et al. (2024) [34] (HR 1.35 for dementia). If we compare them with other meta-analyses with similar criteria to ours, the results are similar: a meta-analysis of five studies conducted by Lancet found an HR of 1.37 for dementia [35]; Liang et al. (2021) [36]found an HR of 1.69 for studies that used audiometry; however, significant publication bias was observed. Another good quality study worth mentioning is Dhanda et al. (2024) [37], which, going back much further (20 years from the date of publication), obtains an HR for dementia of 1.21. In the meta-analysis prepared by Ford et al. (2018) [7], if we look only at the part of studies measured with audiometry, an HR of 3.10 is obtained for dementia. In the meta-analysis by Conceição Santos et al. (2023) [38], using cognitive tests as the result of the difference, it is observed that there is no statistically significant relationship. If we analyze the review of systematic reviews available, also called umbrella review, Ying et al. (2023) [39], an RR for dementia of 1.59 is observed.

In summary, we can see that our results are generally similar to those of previous literature: when the outcome is the incidence of cognitive impairment/dementia, a relationship is found (Hazard Ratio), and when the outcome is expressed as linear regression—the difference over time

between cognitive tests—no relationship is found or it is very mild (Beta). This could be explained by the fact that for a patient to fall into the "dementia" category (either based on medical records, prescribed medication, or cognitive tests), their cognitive status must be very impaired, which would be equivalent to obtaining very low scores on diagnostic tests. If these patients in studies that employ HR or RR were examined using serial cognitive tests over time, they would probably show much steeper slopes of the linear regressions, and much more marked statistical alterations would occur. This doesn't happen, since we generally follow patients (in linear regression studies) who, when they repeat cognitive tests after a few years, obtain scores practically identical to their initial scores (slightly lower or similar). And the impact this minimal difference has on their cognitive function and performance is likely to be very minimal: they would need to be followed for much longer to be able to see significant changes in their performance on cognitive tests.

Among the strengths of our study, the main one is the strict inclusion and exclusion criteria. The fact that all studies use pure-tone audiometry lends objectivity to the measurement of hearing function. This accuracy provides internal validity and homogeneity to the statistical measures and allows for a much more precise and reliable meta-analysis: as has been shown, our heterogeneity measures are close to the null. We did not accept studies with other hearing measurements for several reasons. First, only some tests are validated, such as the HHIE-S [40] or the Whispered Voice Test [41]. Second, none of these validated tests are used in the reviewed studies: most simply use two simple dichotomous questions. On the other hand, the subjective report of dementia has not proven useful, as it is highly variable [42] and presents a fundamental problem: how does the interviewer know whether the difficulties they are perceiving are related to hearing or information processing? [30]. We felt it was important to exclude case-control and cross-sectional trials from our study, as we believe they severely limited the validity of the data due to their abundant biases. Furthermore, we present the results in two different forms: both as incidence of dementia and as a linear regression of the variation in cognitive tests. This provides us with two different and complementary perspectives.

Additionally, social isolation resulting from hearing loss may act as a potential primary factor in the progression of dementia, as suggested by previous studies on modifiable risk factors. Although our meta-analysis did not specifically address socialization parameters, this avenue warrants further investigation.

Within the limitations, we highlight the small number of studies included in the meta-analysis, which may limit the statistical power and precision of heterogeneity estimates. Most included studies did not consistently stratify participants according to the severity of hearing loss, nor did they systematically differentiate between sensory loss and sensorineural hearing loss, which may have contributed to unmeasured sources of heterogeneity.

Regarding the cognitive tests used, multiple ones were used: this has forced us to take those that look at global cognition as a reference for the meta-analysis, since they were the only ones repeated in all the studies. This implies that the linear regression meta-analysis loses some power, since instead of performing a joint one, two separate ones had to be performed. It is also important to keep in mind that hearing loss can make the administration of these tests difficult [28,43].

An additional consideration concerns the distinction between peripheral and central hearing. Central hearing, also known as central auditory processing, encompasses the neural mechanisms involved in the analysis, integration, and interpretation of auditory information within the central nervous system, especially during complex auditory tasks such as speech perception in noisy environments. Pure-tone audiometry, which was the main method used in the included studies, assesses peripheral hearing without taking into account more complex aspects such as central hearing, which is increasingly being considered [44]. We also did not consider other sensory impairments, which some studies have shown to increase overall cognitive decline [20].

5. Conclusions

There is a statistically significant relationship between hearing loss and the incidence of dementia, at least in those studies where the outcome is expressed as a Hazard Ratio: patients with hearing loss at baseline have a 32% higher risk of developing cognitive decline and/or dementia in the future. This relationship is attenuated or disappears when the outcome is measured as performance on cognitive tests over time.

As future lines of research, it would be interesting to conduct meta-analytical studies on central hearing loss, or to jointly assess these factors: other sensory impairments, mood at baseline and during the process, the presence of hearing aids, the patient's baseline cognitive reserve, and functionality (measured using geriatric scales) at baseline and during the process.

CRediT authorship contribution statement

Roberto Peribáñez García: Writing – original draft, Methodology, Investigation, Conceptualization, Data curation, Software. **Francisco Álvaro Rodriguez Rodriguez:** Writing – review & editing, Formal analysis, Project administration. **Blanca Ascaso Adiego:** Writing – review & editing, Investigation. **María Isabel Adiego Leza:** Writing – review & editing, Supervision, Methodology, Validation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

The authors wish to thank the Methodological and Statistical Support Service (SAME) of the IACS, specifically Daniel Bordonada, for conducting the statistical analysis of the study and answering any questions.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amjoto.2026.104799.

References

[1] Prince M, Wimo A, Guerchet M, Ali GC, Wu YT, Prina M. World Alzheimer Report 2015. The global impact of dementia an analysis of prevalence, incidence, cost and trends. Alzheimer's Disease International (ADI); 2015.

[2] Livingston G, Huntley J, Liu KY, Costafreda SG, Selbæk G, Alladi S, et al. Dementia prevention, intervention, and care: 2024 report of the Lancet standing Commission. Lancet 2024;404(10452):572–628.

[3] Rosenau C, Köhler S, Soons LM, Anstey KJ, Brayne C, Brodaty H, et al. Umbrella review and Delphi study on modifiable factors for dementia risk reduction. Alzheimers Dement 2024;20(3):2223–39.

[4] WHO. Global Estimates on Prevalence of Hearing Loss Mortality and Burden of Diseases and Prevention of Blindness and Deafness. 2012.

[5] Löhler J, Cebulla M, Shehata-Dieler W, Volkenstein S, Völter C, Walther LE. Hearing impairment in old age. Dtsch Arztebl Int 2019;116(17):301–10.

[6] Albers MW, Gilmore GC, Kaye J, Murphy C, Wingfield A, Bennett DA, et al. At the interface of sensory and motor dysfunctions and Alzheimer's disease. Alzheimer Dement 2015;11(1):70–98.

[7] Ford AH, Hankey GJ, Yeap BB, Golledge J, Flicker L, Almeida OP. Hearing loss and the risk of dementia in later life. Maturitas 2018;112:1–11.

[8] Loughrey DG, Kelly ME, Kelley GA, Brennan S, Lawlor BA. association of age-related hearing loss with cognitive function, cognitive impairment, and dementia: a systematic review and meta-analysis. JAMA Otolaryngol Head Neck Surg 2018;144 (2):115.

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

[10] Croll PH, Vinke EJ, Armstrong NM, Licher S, Vernooij MW, Baatenburg De Jong RJ, et al. Hearing loss and cognitive decline in the general population: a prospective cohort study. J Neurol 2021;268(3):860–71.

[11] Merten N, Fischer ME, Tweed TS, Breteler MMB, Cruickshanks KJ. Associations of hearing sensitivity, higher-order auditory processing, and cognition over time in middle-aged adults. Magaziner J, editor. J Gerontol A Biol Sci Med Sci 2020;75(3):545–51.
[12] Griffiths TD, Lad M, Kumar S, Holmes E, McMurray B, Maguire EA, et al. How can hearing loss cause dementia? Neuron 2020;108(3):401–12.
[13] Deal JA, Betz J, Yaffe K, Harris T, Purchase-Helzner E, Satterfield S, et al. Hearing impairment and incident dementia and cognitive decline in older adults: the health ABC study. Gerona 2016;72(5):703–9.
[14] Jafari Z, Kolb BE, Mohajerani MH. Age-related hearing loss and tinnitus, dementia risk, and auditory amplification outcomes. Ageing Res Rev 2019;56:100963.
[15] Hong T, Mitchell P, Burlutsky G, Liew G, Wang JJ. Visual impairment, hearing loss and cognitive function in an older population: longitudinal findings from the Blue Mountains Eye Study. Pan CW, editor. PLoS One 2016;11(1):e0147646.
[16] Myrstad C, Engdahl BL, Costafreda SG, Krokstad S, Lin F, Livingston G, et al. Hearing impairment and risk of dementia in the HUNT Study (HUNT4 70+): a Norwegian cohort study. EClinicalMedicine 2023;66:102319.
[17] Jiang K, Armstrong NM, Agrawal Y, Gross AL, Schrack JA, Lin FR, et al. Associations of audiometric hearing and speech-in-noise performance with cognitive decline among older adults: The Baltimore Longitudinal Study of Aging (BLSA). Front Neurol 2022;13:1029851.
[18] Mohammed A, Gibbons LE, Gates G, Anderson ML, McCurry SM, McCormick W, et al. Association of Performance on dichotic auditory tests with risk for incident dementia and Alzheimer dementia. JAMA Otolaryngol Head Neck Surg 2022;148(1):20.
[19] Chang YS, Rah YC, Lee MK, Park S, Kim B, Han K, et al. Association between the severity of hearing loss and the risk of dementia within the 2010–2017 national insurance service survey in South Korea. Sci Rep 2020;10(1):20679.
[20] Brenowitz WD, Kaup AR, Lin FR, Yaffe K. Multiple sensory impairment is associated with increased risk of dementia among black and white older adults. J Gerontol Ser A 2019;74(6):890–6.
[21] Alattar AA, Bergstrom J, Laughlin GA, Kritz-Silverstein D, Richard EL, Reas ET, et al. Hearing impairment and cognitive decline in older, community-dwelling adults. Newman A, editor. J Gerontol A Biol Sci Med Sci 2020;75(3):567–73.
[22] Armstrong NM, An Y, Ferrucci L, Deal JA, Lin FR, Resnick SM. Temporal sequence of hearing impairment and cognition in the Baltimore longitudinal study of aging. Newman A, editor. J Gerontol A Biol Sci Med Sci 2020;75(3):574–80.
[23] Ge S, McConnell ES, Wu B, Pan W, Dong X, Plassman BL. Longitudinal association between hearing loss, vision loss, dual sensory loss, and cognitive decline. J Am Geriatr Soc 2021;69(3):644–50.
[24] Chern A, Irace AL, Sharma RK, Zhang Y, Chen Q, Golub JS. The longitudinal association of subclinical hearing loss with cognition in the health, aging and body composition study. Front Aging Neurosci 2022;13:789515.
[25] Powell DS, Brenowitz WD, Yaffe K, Armstrong NM, Reed NS, Lin FR, et al. Examining the combined estimated effects of hearing loss and depressive symptoms on risk of cognitive decline and incident dementia. Taler V, editor. J Gerontol B Psychol Sci Soc Sci 2022;77(5):839–49.
[26] Infanger D, Schmidt-Trucksäss A. P value functions: an underused method to present research results and to promote quantitative reasoning. Stat Med 2019;38(21):4189–97.
[27] Amieva H, Ouvrard C, Meillon C, Rullier L, Dartigues JF. Death, depression, disability, and dementia associated with self-reported hearing problems: a 25-year study. J Gerontol Ser A 2018;73(10):1383–9.
[28] Curhan SG, Willett WC, Grodstein F, Curhan GC. Longitudinal study of hearing loss and subjective cognitive function decline in men. Alzheimers Dement 2019;15(4):525–33.
[29] Golub JS, Luchsinger JA, Manly JJ, Stern Y, Mayeux R, Schupf N. Observed hearing loss and incident dementia in a multiethnic cohort. J Am Geriatr Soc 2017;65(8):1691–7.
[30] Gurgel RK, Ward PD, Schwartz S, Norton MC, Foster NL, Tschanz JT. Relationship of hearing loss and dementia: a prospective, population-based study. Otol Neurotol 2014;35(5):775–81.
[31] Lin FR, Metter EJ, O'Brien RJ, Resnick SM, Zonderman AB, Ferrucci L. Hearing loss and incident dementia. Arch Neurol 2011;68(2).
[32] Heywood R, Gao Q, Nyunt MSZ, Feng L, Chong MS, Lim WS, et al. Hearing loss and risk of mild cognitive impairment and dementia: findings from the Singapore longitudinal ageing study. Dement Geriatr Cogn Disord 2017;43(5–6):259–68.
[33] Lau K, Dimitriadis PA, Mitchell C, Martyn-St-James M, Hind D, Ray J. Age-related hearing loss and mild cognitive impairment: a meta-analysis and systematic review of population-based studies. J Laryngol Otol 2022;136(2):103–18.
[34] Yu RC, Proctor D, Soni J, Pikett L, Livingston G, Lewis G, et al. Adult-onset hearing loss and incident cognitive impairment and dementia – a systematic review and meta-analysis of cohort studies. Ageing Res Rev 2024;98:102346.
[35] Livingston G, Sommerlad A, Orgeta V, Costafreda SG, Huntley J, Ames D, et al. Dementia prevention, intervention, and care. Lancet 2017;390(10113):2673–734.
[36] Liang Z, Li A, Xu Y, Qian X, Gao X. Hearing loss and dementia: a meta-analysis of prospective cohort studies. Front Aging Neurosci 2021;13:695117.
[37] Dhanda N, Hall A, Martin J. Does social isolation mediate the association between hearing loss and cognition in adults? A systematic review and meta-analysis of longitudinal studies. Front Public Health 2024;12:1347794.
[38] Conceição Santos De Oliveira D, Gomes-Filho IS, Araújo EM, Xavier Ramos MDS, Freitas Coelho JM, Marques AA, et al. Association between hearing loss and cognitive decline in the elderly: a systematic review with meta-analysis study. Fernandes TP, editor. PLoS One 2023;18(11):e0288099.
[39] Ying G, Zhao G, Xu X, Su S, Xie X. Association of age-related hearing loss with cognitive impairment and dementia: an umbrella review. Front Aging Neurosci 2023;15:1241224.
[40] Diao M, Sun J, Jiang T, Tian F, Jia Z, Liu Y, et al. Comparison between self-reported hearing and measured hearing thresholds of the elderly in China. Ear Hear 2014;35(5):e228-32.
[41] Pirozzo S. Whispered voice test for screening for hearing impairment in adults and children: systematic review. BMJ 2003;327(7421):967-0.
[42] Kamil RJ, Genther DJ, Lin FR. Factors associated with the accuracy of subjective assessments of hearing impairment. Ear Hear 2015;36(1):164–7.
[43] Gallacher J, Ilubaera V, Ben-Shlomo Y, Bayer A, Fish M, Babisch W, et al. Auditory threshold, phonologic demand, and incident dementia. Neurology 2012;79(15):1583–90.
[44] Gates GA, Beiser A, Rees TS, D'Agostino RB, Wolf PA. Central auditory dysfunction may precede the onset of clinical dementia in people with probable Alzheimer's disease. J Am Geriatr Soc 2002;50(3):482–8.