Internet Journal of Allied Health Sciences and Practice

Volume 22 | Number 1 Article 7

December 2023

Hearing Loss as a Risk Factor for Cognitive Decline in the Elderly: A Rapid Review

Natalie Large
Nova Southeastern University, nl856@mynsu.nova.edu

Nannette Nicholson
Norton Sound Health Corporation, nnicholson@nshcorp.org

Hearing Loss as a Risk Factor for Cognitive Decline in the Elderly: A Rapid Review

Abstract

Purpose: The aim of this rapid review was to identify and evaluate evidence exploring hearing loss as a risk factor for cognitive decline in the elderly population. **Methods:** A literature search was performed in three databases: CINAHL, Cochrane Central, and PubMed. The PRISMA template was used to record the search and selection process. Search criteria included older adults aged 65 and up with diagnosed or self-reported hearing loss and no previous diagnosis of dementia or Alzheimer's disease. Participants were excluded if they had been diagnosed with dementia or tested for it before the study began. Hearing loss was categorized using the pure tone average (PTA): normal (/= 25-40 dB), and moderate to severe impairment (> 40 dB). Selected research studies were critically appraised using the JBI checklist. A custom data extraction form was used to record inclusion/exclusion criteria, PICO data elements, risk of bias, and level of evidence. **Results:** Three longitudinal cohort studies met the inclusion criteria. The Joanna Briggs Institute evidence hierarchy was used to rate the level and quality of the studies. Results of the rapid review indicate the quality of studies a high or moderately high. A summary of the results for each study is provided. **Clinical Implications:** This review contributes to the growing body of literature suggesting that untreated hearing loss is a risk for cognitive decline. While there are various hypotheses on whether there is a definitive relationship between the two, many of the studies reviewed found that a hearing loss in older adults will result in a poorer change of cognitive ability or cognitive decline. Any patient aged 65 years or more indicating concern about hearing loss should be referred to an audiologist for a comprehensive hearing evaluation.

Author Bio(s)

Natalie Large, BA is a third-year student in the Department of Audiology, College of Health Care Sciences, Nova Southeastern University. She will be doing her 4th-year externship prior to graduation. Her research interests include adult diagnostics, intervention, and rehabilitation within patient-centered care in audiology.

Nannette Nicholson, Ph.D. was a professor in the Department of Audiology, College of Health Care Sciences, Nova Southeastern University. She has recently accepted a position at Norton Sound Health Corporation as the Director of Audiology. Her research interests include counseling based upon the principles of patient and family-centered care, aural rehabilitation, evidence-based practice, and interprofessional education.

IJAHSP™
The Internet Journal of Allied Health Sciences and Practice
Dedicated to allied health professional practice and education
Vol. 22 No. 1 ISSN 1540-580X

Hearing Loss as a Risk Factor for Cognitive Decline in the Elderly: A Rapid Review

Natalie Large
Nanette Nicholson

1. Nova Southeastern University
2. Norton Sound Health Corporation

United States

ABSTRACT

Purpose: The aim of this rapid review was to identify and evaluate evidence exploring hearing loss as a risk factor for cognitive decline in the elderly population. **Methods:** A literature search was performed in three databases: CINAHL, Cochrane Central, and PubMed. The PRISMA template was used to record the search and selection process. Search criteria included older adults aged 65 and up with diagnosed or self-reported hearing loss and no previous diagnosis of dementia or Alzheimer's disease. Participants were excluded if they had been diagnosed with dementia or tested for it before the study began. Hearing loss was categorized using the pure tone average (PTA): normal (</= 20 dB), mild impairment (>/= 25-40 dB), and moderate to severe impairment (> 40 dB). Selected research studies were critically appraised using the JBI checklist. A custom data extraction form was used to record inclusion/exclusion criteria, PICO data elements, risk of bias, and level of evidence. **Results:** Three longitudinal cohort studies met the inclusion criteria. The Joanna Briggs Institute evidence hierarchy was used to rate the level and quality of the studies. Results of the rapid review indicate the quality of studies a high or moderately high. A summary of the results for each study is provided. **Clinical Implications:** This review contributes to the growing body of literature suggesting that untreated hearing loss is a risk for cognitive decline. While there are various hypotheses on whether there is a definitive relationship between the two, many of the studies reviewed found that a hearing loss in older adults will result in a poorer change of cognitive ability or cognitive decline. Any patient aged 65 years or more indicating concern about hearing loss should be referred to an audiologist for a comprehensive hearing evaluation.

Keywords: hearing loss, hearing impairment, risk factor, cognitive decline, dementia, older adults

INTRODUCTION

Hearing loss is one of the leading disabilities in people aged 65 years and older all over the world. Predictions of hearing loss are expected to rise from an estimated 44.1 million adults in 2020 to 73.1 million in 2060.[1] Age related hearing loss is defined as a progressive, bilateral, symmetrical sensorineural loss, mainly seen in the high frequencies. It is the most preventable deficit in older adults.[1] Hearing loss impacts quality of life by interfering with physical, emotional, and social functions in daily life. Some authors suggest that there is an increase in isolation and depression among older adults with a diagnosis of hearing loss, causing the person to feel lonely.[2]

Cognitive decline is the experience of worsening or more frequent confusion or memory loss.[1,2] It is a form of cognitive impairment and one of the earliest noticeable symptoms of Alzheimer's disease and related dementias.[2-4] Cognitive decline includes dementia and Alzheimer's. [4] Dementia is a developing concern for the elderly population.[3,4] By 2050, the number of people that are affected by dementia is estimated to double to over 131 million.[5] Dementia takes a toll on a person's life and affects the way they function on daily living activities. Dementia comes with reduced quality of life and introduces a huge financial burden for the person affected and their families.[4] While two-thirds of dementia cases have been identified as genetic, there are approximately one-third of the cases that are due to preventable lifestyle measures.[4] If the onset of dementia could be delayed only just a few years because of lifestyle changes then this would significantly impact the path we take when it comes to diagnosing and treating dementia.[6]

Hearing loss may be a variable risk factor linked to dementia in later life.[1-6] As we get older, hearing loss is one of the most common conditions that occurs. We are also more at risk for developing dementia or Alzheimer's disease with age, heightening the issue from both conditions. Age-related hearing loss is severely undertreated, and many of the older adults do not seek out amplification even though it offers ample intervention options. Untreated hearing loss can lead to withdrawal from social interactions, depression, and reduced self-efficacy which are also risk factors of cognitive decline.[4] When the auditory system capabilities are damaged, this changes how the brain responds to cognitively demanding situations. Recently, hearing loss has been identified as potentially the most changeable risk factor leading to dementia.[7] Because there is no cure for dementia, risk factors must be identified and possibly treated.[7] Therefore, the purpose of this study was to explore, identify, and evaluate evidence linking hearing loss as a risk factor for cognitive decline.

METHODS

IRB Approval

A letter of determination was submitted to the Nova Southeastern University (NSU) Institutional Review Board (IRB) for approval. The Cochrane Rapid Review guidelines were followed.[8] This process was described in detail, which included the population, condition of interest, and as well as the objective of the research. Protocol #2022-23 was approved by the NSU IRB.

PECO Framework

The PECO Framework was used to formulate the research question.[9] PECO is the acronym for population, exposure, comparison, and outcome. In this review, the population was defined as adults older than 65 years of age. The exposure was hearing loss, compared to no exposure (normal hearing), and the outcome of interest was cognitive decline. The research question was: Is untreated hearing loss a risk factor for cognitive decline and/or dementia?

Search Terms and Search Strategy

Search terms were generated from the PECO Framework and are shown in Table 1. Search terms for the population included elderly, older adults, and geriatrics; for exposure, hearing loss, hearing impairment, and/or deaf were used. The term deaf was used because in some databases, that is how hearing loss is indexed. The outcomes of interest included cognitive decline, memory loss, and/or dementia. These terms were used to cast a wide net and to ensure that all peer-reviewed literature on the topic was captured. Those studies dealing exclusively with memory loss or dementia were screened out in the identification and selection process.

Table 1. PECO Framework

Acronym	Definition	Search Terms
P	Population	Elderly, Older Adults
E	Exposure	Hearing Loss, Hearing Impaired, or Deaf
C	Comparison	N/A
O	Outcome	Cognitive Decline, Memory Loss, or Dementia

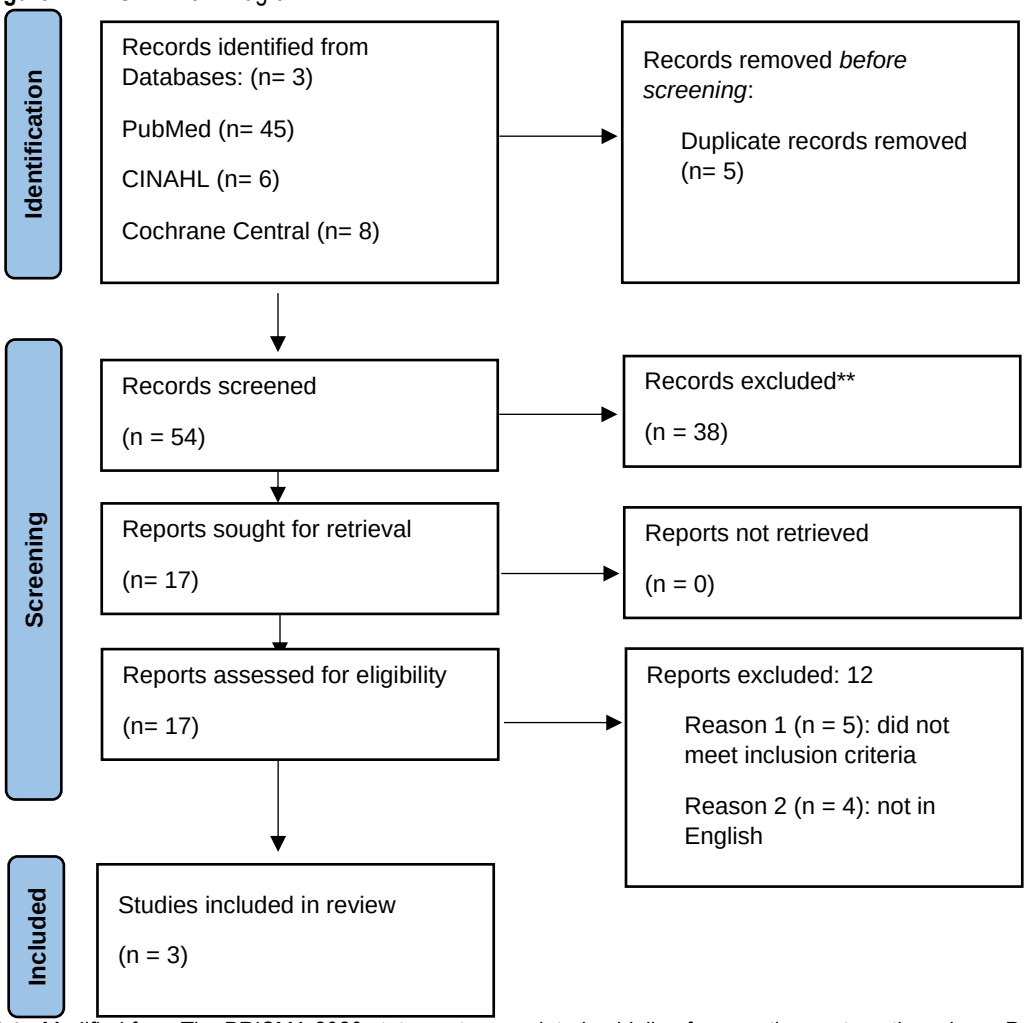
Note. P = population, E = exposure, C = comparison, O = outcome, N/A = not applicable

The search strategy was implemented on February 1, 2022, in three databases: CINAHL, and Cochrane Central, and PubMed (see Appendix A). Publications were limited to those published after 2010. This date was chosen to limit this review to current literature. Inclusion criteria restricted the population age to individuals 65 years and older who have hearing loss and had not been previously diagnosed with cognitive impairment or dementia. The identification, screening, and selection process was plotted on a PRISMA (Preferred Reporting Items for Systematic Reviews and meta-Analyses) Flow Diagram.[10]

PRISMA Flow Diagram

The PRISMA template was used to record the search and selection process (Figure 1). The process included an abstract and title screening, assessment for eligibility, selection for full review, and the final number of studies used.

Figure 1. PRISMA Flow Diagram



Note. Modified from The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. BMJ 2021;372:n71. https://doi.org/10.1136/bmj.n71

Inclusion and Exclusion Criteria

To be included, studies had to be published in a peer-reviewed journal, include participants aged 65 and older, be grouped by hearing level, and have no signs of cognitive decline or previous diagnosis of dementia/Alzheimer's. Pure tone average's (PTA) for participants in the studies were categorized as: normal (</= 20 dB), mild impairment (>/= 25-40 dB), and moderate to severe impairment (> 40 dB). Participants had to have been screened for normal cognitive function with re-assessment throughout the longitudinal years of study. Studies were limited to cohort studies published in English after 2010.

Data Extraction

A custom data extraction form was created (Appendix B). This is a standardized method of extracting the critical data elements. Critical elements included: the research design, PECO elements, inclusion/exclusion criteria, risk of bias, level of evidence, strength, outcome measures, and other components such as statistical analyses and significance of findings.

Risk of Bias Assessment

There are several published tools that can be used for critical appraisal. The Joanna Briggs Institute (JBI) published critical appraisal tools specific to each research design that can be downloaded from their website[11]. Since the studies selected for this review were limited to cohort studies, we chose to use a modified version of the JBI Checklist for Cohort Studies.[12] The level of evidence and strength was evaluated and assigned according to the JBI Levels of Evidence.[13] The JBI levels of evidence are ranked based primarily on the research design (e.g., 1a = systematic review of randomized controlled trials [RCT's], 1b = systematic review of RCT's and other study designs).[13] A modified JBI Checklist example is shown in Appendix C. The strength of evidence has four levels and is consistent with the Cochrane Rapid Review guidelines for methodology.[14]

RESULTS

The PRISMA Flow Diagram was used to track the selection process of the studies (Figure 1). There was a total of 6 studies identified in CINAHL, 8 in Cochrane Central, and 45 in PubMed. When duplicates were removed, a total of 54 records remained. The title and abstract screening process eliminated 38 due to irrelevancy. Seventeen records were retrieved for full text screening. Five did not meet inclusion criteria, 4 studies were not in English, and 3 used participants younger than 65 years of age. Three studies met the inclusion criteria and were subjected to critical appraisal and data extraction. Results are presented in Tables 2 – 4.

Author/Evidence Summary Tables

This review included 3 longitudinal cohort studies. The summary tables for this review are organized alphabetically by author and year and include the variables of interest pertinent to this review question. Table 2 shows the research design, population (sample size), exposure (number and degree of hearing loss), and outcomes (cognitive decline results) for each of the three longitudinal cohort studies. Table 3 displays the participants' demographics (i.e., number, age range, gender) for each research study used in this review. Table 4 illustrates the design, JBI level, and strength of evidence for each research study. The peer-reviewed cohort studies are summarized and described based on their method and outcome measures.

Table 2. Authors/Summary of Evidence with PECO Elements

Authors/Year	Research Design	Population	Exposure	Outcomes
Alattar et al., (2019)	Longitudinal Cohort Study	1,164	Normal (PTA ≤ 25 dB) Mild impairment (PTA > 25–40 dB) Moderate/Severe impairment (PTA > 40 dB)	MMSE Trail-Making Test Part B (Trails B) VFT
Deal et al., (2017)	Longitudinal Cohort Study	G1 HI and Dementia = 1,889 G2 HI and Cognitive Decline = 929	Normal hearing (≤25 dBHL) Mild (26–40 dBHL) Moderate/Severe (>40 dBHL)	MMSE SRT The Boxes Test and Digit Copying Test PCT LCT
Strutt et al., (2020)	Longitudinal Cohort Study	1,037	Likert-type scale 1= no hearing difficulties 2 = mild hearing difficulties 3 and 4 = moderate-severe hearing difficulties	MMSE Trail-Making Test Part A Bosting Naming Test Block Design Subtest RAVLT Controlled Oral Word Association Test

Note. MMSE = mini mental state examination, SRT = The Buschke Selective Reminding Test, PCT = The Pattern Comparison Test, LCT = Letter Comparison Test, ICD-9-CM = International Classification of Diseases, Ninth Revision, Clinical Modification, RAVLT = Rey Auditory Verbal Learning Test, HI = hearing impaired, HL = hearing loss

Table 3. Participant Demographics

Author/Year	Number	Age	Gender
Alattar et al., (2019)	1,164	≥ 65 years	N/A
Deal et al., (2017)	3,075	70-79 years	N/A
Strutt et al., (2020)	1,037	70-90 years	N/A

Note. N/A = not applicable

Table 4. Design, Level, and Strength of Evidence

Author(s)/Year	Research Design	Level of Evidence	Strength
Alattar et al., (2019)	Longitudinal Cohort Study	3.e	High
Deal et al., (2017)	Longitudinal Cohort Study	3.e	Moderately high
Strutt et al., (2020)	Longitudinal Cohort Study	3.e	Moderately high

Note. Level of evidence and strength based on the JBI Levels of Evidence (2014).

Hearing Loss as a Risk Factor

Alattar et al evaluated the association of hearing loss with long term cognitive decline among 1,164 older adults.[15] Five hundred and eighty had a mild hearing loss, 196 had a moderate/severe hearing loss compared to 388 with normal hearing. Study participants were followed for four years. They reported a significant difference between normal hearing and hearing loss for the Mini-Mental State Examination (MMSE).[16] The MMSE is a tool that is commonly used to assess mental status. Data for additional outcomes measures were also reported for this study; however, they are not relevant to the review question and were therefore not included in the summary tables or in this summary paragraph. For mild hearing loss p = .01 and for moderate/severe hearing loss p = .002. There was a relationship between degree of hearing loss and decline on the MMSE.

Deal et al compared two groups of individuals with hearing loss. Group 1 consisted of 1,889 individuals with hearing loss and dementia.[17] Group 2 included 929 individuals with hearing loss and cognitive decline. This study was included in our review because it was a longitudinal cohort study that met the inclusion criteria (i.e. population, age, hearing loss, cognitive decline, and publication date). MMSE data from the cohort enrolled in 1997-1998 were compared to outcome data collected during the years 2001-2002. Results for 786 individuals with normal hearing were compared to 716 with a mild hearing loss and 387 participants with a moderate/severe hearing loss. Comparisons were stratified by hearing levels and showed an increased risk of incident dementia for individuals in Group 1 over the 9-year period and no associations observed between hearing loss and cognitive decline for Group 2. MMSE scores were significantly different for Group 1 (dementia) hearing loss (p = .01) and hearing aid use (p <.01) versus Group 2 (cognitive decline) in which MMSE scores were not significant for hearing loss (p = .33), but was significant for hearing aid use (P <.01).

Strutt et al explored MMSE outcomes for 1,037 participants who were assessed every two years. The assessment included performance in six cognitive domains and a Likert self-report scale of hearing loss.[18] A Likert scale is used to rate a condition (e.g., attitude, belief, perception) on a continuum with two anchors. For this study, the participants rated their perception of hearing difficulty (e.g., 1 = the perception of no hearing difficulty and 4 = a perception of moderate to severe hearing difficulty). Six hundred and thirteen individuals reported no hearing difficulties, 297 reported mild hearing difficulties, and 127 reported moderate/severe. The MMSE was used as one of the baseline tests to categorize cognitive function. Cognitive performance for individuals with moderate/severe hearing loss was significantly worse than performance for those with normal and mild hearing difficulties. Furthermore, individuals with moderate/severe hearing loss reported significantly worse performance in two of the six cognitive domains: attention/processing speed and visuospatial ability.

Risk of Bias

This rapid review consisted of 3 longitudinal cohort studies. The design, level, and strength of evidence is shown on Table 4.[15-18] The studies were each rated as a JBI 3.e level of evidence. The strength of evidence was high for Alattar et al, and moderately high for Deal et al, and Strutt et al. Deal et al. and Strutt et al. were rated with a lower strength of evidence due to the lack of detailed reporting regarding drop-out rates and reasons for lack of follow-up. Additional risk of bias factors were explored (e.g., cohort group definitions, validity and reliability of the exposure measurement, identification of confounding factors, outcome measurement, and statistical analysis). The results of the critical appraisal using the JBI Checklist for Cohort Studies are shown in Table 5.

Table 5. Critical Appraisal

	Alattar et al., 2019	Deal et al., 2016	Strutt et al., 2020
1. Were the two groups similar and recruited from the same population?	Yes	Yes	Yes
2. Were the exposures measured similarly to assign people to both exposed and unexposed groups?	Yes	Yes	Yes
3. Was the exposure measured in a valid and reliable way?	Yes	Yes	Yes
4. Were confounding factors identified?	Yes	Yes	Yes
5. Were strategies to deal with confounding factors stated?	Yes	Yes	Yes
6. Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?	Yes	Yes	Yes
7. Were the outcomes measured in a valid and reliable way?	Yes	Yes	Yes
8. Was the follow up time reported and sufficient to be long enough for outcomes to occur?	Yes	Yes	Yes
9. Was follow up complete, and if not, were the reasons to loss to follow up described and explored?	Yes	No	No
10. Were strategies to address incomplete follow up utilized?	Yes	No	No
11. Was appropriate statistical analysis used?	Yes	Yes	Yes

Note. Modified from Joanna Briggs Institute Reviewers' Manual, Chapter 7 Systematic reviews of etiology and risk. Moola, S., Munn, Z., Tufanaru, C., Aromataris, E., Sears, K., Sfetcu, R., Currie, M., Qureshi, R., Mattis, P., Lisy, K., Mu, P. F. The Joanna Briggs Institute, 2017. Available from https://reviewersmanual.joannabriggs.org/

DISCUSSION

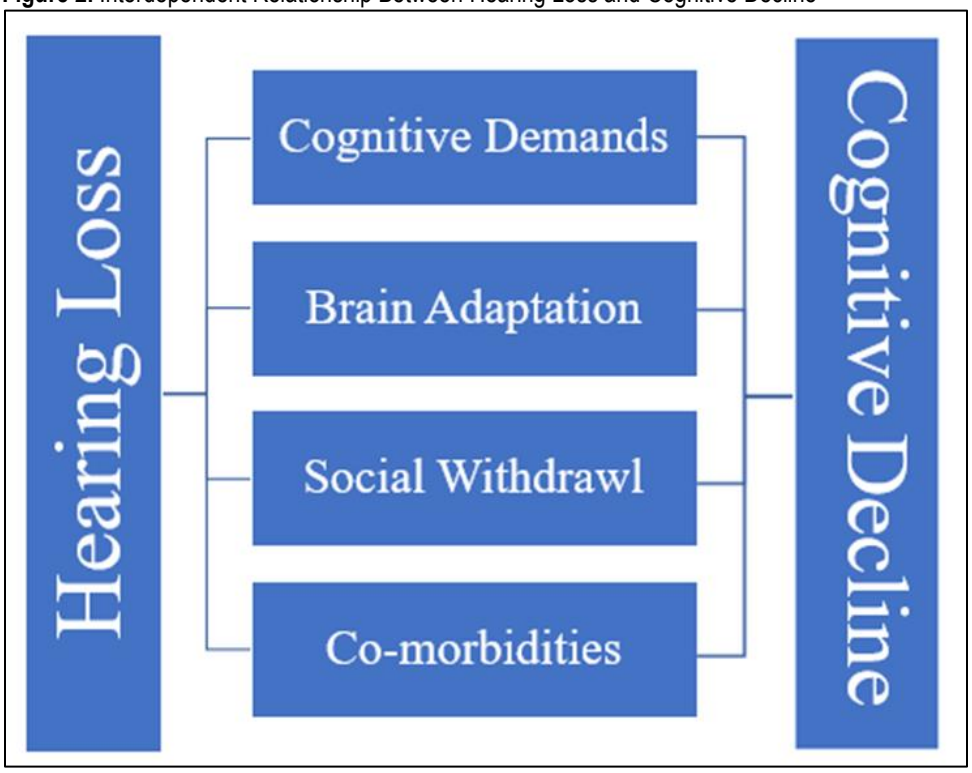
The main findings of this study indicate that hearing loss serves as a risk factor for cognitive decline. With changes to the auditory system, the brain adapts how it responds to cognitively demanding situations.[19] The association between hearing loss and cognitive decline was consistent across all research studies included in this rapid review. The consensus was: the greater the hearing loss, the greater the risk for cognitive decline.

A recent systematic review on the relationship between hearing and cognitive impairment presented hearing loss as one of the most modifiable risk factors for cognitive decline.[16] Underlying theories explaining the epidemiology and pathophysiological interactions of hearing loss and cognitive decline are shown in Figure 2. [19, 20] In this model, hearing loss influences the way the brain responds and adapts to cognitive demanding situations with changes in the auditory system. If left untreated, social disengagement often occurs leading to isolation. Co-morbidities (e.g., diabetes, hypertension, multiple sclerosis, metabolic disease) further complicate the relationship by contributing to hearing loss and to social isolation. There is a growing body of literature indicating hearing loss as a causal factor for cognitive decline.[20]

Some authors report that older adults with hearing loss are 4 times as likely to report memory loss than those without.[1] An article published in 2020 by The Lancet Commissions identified 12 modifiable risk factors for dementia, one of which was treatment for hearing loss.[7] Among the specific action items listed in this publication to minimize the risk of dementia were increased use of hearing aids and reduction of noise exposure. Livingston et al. suggest that treatment of hearing loss would reduce the prevalence of dementia by 8%. [7] A 24-month clinical trial to explore whether the treatment of hearing loss will result in decreased cognitive decline is known as the HearCog Trial.[21] The study will randomize 180 adults with hearing loss and mild cognitive impairment to an experimental and control group.[21] Results of this proof-of-concept trial provide valuable information to guide clinical-decision making in audiology. The authors anticipate the results will provide information to older adults about the use of amplification to prevent cognitive impairment and improve the quality of life for those at risk for dementia. [17]

Currently, there are no randomized clinical trials clearly demonstrating a direct relationship between the use of amplification and cognitive decline. The studies included in this review were cohort studies that did not explore the use of hearing technology to minimize the impact or progression of cognitive impairment. Limitations of these studies included lack of detail in reporting factors contributing to loss-to-follow up.

Figure 2. Interdependent Relationship Between Hearing Loss and Cognitive Decline



Limitations

This review was not without limitations. Although an information specialist was consulted regarding the search strategy, the specialist did not develop, peer-review, and execute the search strategy. In addition, the search was limited to 3 databases. The possibility exists that additional literature relevant to the topic could have been overlooked. Rapid Review guidelines developed for systematic reviews conducted with limited time and resources were followed[7]. One reviewer completed the search, screening, and selection process, two completed the critical appraisal for risk of bias, and two developed the manuscript.

Clinical Implications

This study contributes to the evidence linking hearing loss and cognitive impairment. It is imperative that audiology clinicians become aware of and knowledgeable about this relationship to better serve their patients. It is apparent that the more hearing loss a person has, the more susceptible they are to cognitive decline. By identifying hearing loss as a modifiable risk factor, development and implementation of better early intervention strategies for hearing loss and cognitive decline are possible. The results of this rapid review have strong implications for clinical practice in audiology. The inclusion of a cognitive screening tool in the clinical protocol for adults aged 65 years or older is strongly recommended. This allows for an open discussion with the patient and/or family members about appropriate intervention options consistent with the principles of patient-centered care.

Future Research

Future research needs include further exploration about (a) hearing loss as a modifiable risk factor, (b) effectiveness of amplification as a treatment option specific to slowing the progression of cognitive decline, (c) development of patient reported outcome measures capturing the patient perspective relative to this topic, and (d) increased interprofessional collaboration among health care providers. Research surrounding this topic can be used to inform audiologists, primary care physicians, and other health care providers regarding the importance of amplification. If cognitive decline can be delayed for older adults who are at risk, we can significantly increase their quality of life.

References

1. National Academies of Sciences, Engineering, and Medicine. Hearing HealthCare: Priorities for Improving Access and Affordability. Washington, DC: National Academies Press; 2016. https://doi.org/10.17226/23446
2. Shukla, A., Harper, M., Pedersen, E., Goman, A., Suen, J. J., Price, C., Applebaum, J., Hoyer, M., Lin, F. R., & Reed, N. S. (2020). Hearing Loss, Loneliness, and Social Isolation: A Systematic Review. *American Academy of Otolaryngology-Head and Neck Surgery*, *162*(5), 622–633. https://doi.org/10.1177/0194599820910377
3. Hugo, J., & Ganguli, M. (2014). Dementia and cognitive impairment: epidemiology, diagnosis, and treatment. *Clinics in geriatric medicine*, *30*(3), 421–442. https://doi.org/10.1016/j.cger.2014.04.001
4. Neff, R. M., Jicha, G., Westgate, P. M., Hawk, G. S., Bush, M. L., & McNulty, B. (2019). Neuropathological findings of dementia associated with subjective hearing loss. *Otology & Neurotology*, *40*(9). https://doi.org/10.1097/mao.0000000000002381
5. Sarant, J., Harris, D., Busby, P., Maruff, P., Schembri, A., Lemke, U., & Launer, S. (2020). The effect of hearing aid use on cognition in older adults: can we delay decline or even improve cognitive function? *Journal of Clinical Medicine*, *9*(1), 254. https://doi.org/10.3390/jcm9010254
6. Rasmussen, J., & Langerman, H. (2019). Alzheimer's Disease – Why we need early diagnosis. *Degenerative Neurological and Neuromuscular Disease*, *9*, 123–130. https://doi.org/10.2147/dnnd.s228939
7. Livingston, G., Huntley, J., Sommerlad, A., Ames, D., Ballard, C., Banerjee, S., Brayne, C., Burns, A., Cohen-Mansfield, J., Cooper, C., Costafreda, S. G., Dias, A., Fox, N., Gitlin, L. N., Howard, R., Kales, H. C., Kivimäki, M., Larson, E. B., Ogunniyi, A., Orgeta, V., … Mukadam, N. (2020). Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. *The Lancet Commissions*, *396*(10248), 413–446. https://doi.org/10.1016/S0140-6736(20)30367-6
8. Garritty, C., Gartlehner, G., Nussbaumer-Streit, B., King, V. J., Hamel, C., Kamel, C., Affengruber, L., & Stevens, A. (2021). Cochrane Rapid Reviews Methods Group offers evidence-informed guidance to conduct rapid reviews. *Journal of Clinical Epidemiology*, *130*, 13–22. https://doi.org/10.1016/j.jclinepi.2020.10.007
9. Morgan, R. L., Whaley, P., Thayer, K. A., & Schünemann, H. J. (2018). Identifying the Peco: A framework for formulating good questions to explore the association of environmental and other exposures with health outcomes. *Environment International*, *121*, 1027–1031. https://doi.org/10.1016/j.envint.2018.07.015
10. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The Prisma 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*. https://doi.org/10.1136/bmj.n71
11. Joanna Briggs Institute (2020). *Critical appraisal tools*. https://jbi.global/critical-appraisal-tools
12. Moola, S., Munn, Z., Tufanaru, C., Aromataris, E., Sears, K., Sfetcu, R., Currie, M., Qureshi, R., Mattis, P., Lisy, K., Mu, P. F. Chapter 7: Systematic reviews of etiology and risk. In: Aromataris E, Munn Z (Editors). Joanna Briggs Institute Reviewer's Manual. The Joanna Briggs Institute, 2017. Available from https://reviewersmanual.joannabriggs.org/
13. Joanna Briggs Institute (2014). JBI levels of evidence. Retrieved from https://joannabriggs.org/sites/default/files/2019-05/JBI-Levels-of-evidence_2014_0.pdf
14. Gartlehner, G., Nussbaumer-Streit, B., Devane, D., Kahwati, L., Viswanathan, M., King, V. J., Qaseem, A., Akl, E., & Schuenemann, H. J.. (2023). Rapid reviews methods series: Guidance on assessing the certainty of evidence. *BMJ Evidence-based Medicine*, bmjebm-2022-112. https://doi.org/10.1136/bmjebm-2022-112111
15. Alattar, A. A., Bergstrom, J., Laughlin, G. A., Kritz-Silverstein, D., Richard, E. L., Reas, E. T., Harris, J. P., Barrett-Connor, E., & McEvoy, L. K. (2020). Hearing impairment and cognitive decline in older, community-dwelling adults. *The Journals of Gerontology. Series A*, *75*(3), 567–573. https://doi.org/10.1093/gerona/glz035
16. Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *Journal of psychiatric research*, *12*(3), 189–198. https://doi.org/10.1016/0022-3956(75)90026-6
17. Deal, J. A., Betz, J., Yaffe, K., Harris, T., Purchase-Helzner, E., Satterfield, S., Pratt, S., Govil, N., Simonsick, E. M., Lin, F. R., & Health ABC Study Group (2017). Hearing impairment and incident dementia and cognitive decline in older adults: the health ABC study. *The Journals of Gerontology. Series A, 72*(5), 703–709. https://doi.org/10.1093/gerona/glw069
18. Strutt, P. A., Barnier, A. J., Savage, G., Picard, G., Kochan, N. A., Sachdev, P., Draper, B., & Brodaty, H. (2020). Hearing loss, cognition, and risk of neurocognitive disorder: Evidence from a longitudinal cohort study of older adult Australians. *Aging, Neuropsychology, and Cognition*, *29*(1), 121–138. https://doi.org/10.1080/13825585.2020.1857328

19. Slade, K., Plack, C. J., & Nuttall, H. E. (2020). The effects of age-related hearing loss on the brain and cognitive function. *Trends in Neurosciences*, *43*(10), 810–821. https://doi.org/10.1016/j.tins.2020.07.005
20. Bisogno, A., Scarpa, A., Di Girolamo, S., De Luca, P., Cassandro, C., Viola, P., Ricciardiello, F., Greco, A., De Vincentiis, M., Ralli, M. & Di Stadio, A. (2021). Hearing loss and cognitive impairment: Epidemiology, common pathophysiological findings, and treatment considerations. *Life*. 11(10):1102. https://doi.org/10.3390/life11101102
21. Jayakody, D., Almeida, O. P., Ford, A. H., Atlas, M. D., Lautenschlager, N. T., Friedland, P. L., Robinson, S., Makate, M., Coetzee, L., Liew, A., & Flicker, L. (2020). Hearing aids to support cognitive functions of older adults at risk of dementia: the HearCog trial- clinical protocols. *BMC Geriatrics*, *20*(1), 508. https://doi.org/10.1186/s12877-020-01912-1

Appendix A

Search Strategies:

1. Geriatrics OR Elderly OR “Older Adult”
2. “Hearing Loss” OR “hearing Impaired” OR Deaf
3. “Risk Factor”
4. “Cognitive Decline” OR “Memory Loss” OR Dementia

CINAHL: 6
Cochrane Central: 8
PubMed: 45

Figure 1A – CINAHL

ID#		Search modes	
S7	S5 AND S6	Search modes - Find all my search terms	View Results (6) | View Details | Edit
S6	S1 AND S4	Search modes - Find all my search terms	View Results (13,205) | View Details | Edit
S5	S2 AND S3	Search modes - Find all my search terms	View Results (302) | View Details | Edit
S4	"Cognitive Decline" Or "Memory Loss" Or Dementia	Search modes - Find all my search terms	View Results (80,189) | View Details | Edit
S3	"Risk Factor"	Search modes - Find all my search terms	View Results (64,079) | View Details | Edit
S2	"Hearing Loss" OR "Hearing Impairment" Or Deaf	Search modes - Find all my search terms	View Results (32,908) | View Details | Edit
S1	Geriatrics OR Elderly OR "Older Adult"	Search modes - Find all my search terms	View Results (149,432) | View Details | Edit

Figure 2A – Cochrane Central

ID#		Search modes	
S7	S5 AND S6	Search modes - Find all my search terms	View Results (8) | View Details | Edit
S6	S1 AND S4	Search modes - Find all my search terms	View Results (7,040) | View Details | Edit
S5	S2 AND S3	Search modes - Find all my search terms	View Results (81) | View Details | Edit
S4	"Cognitive Decline" Or "Memory Loss" Or Dementia	Search modes - Find all my search terms	View Results (27,584) | View Details | Edit
S3	"Risk Factor"	Search modes - Find all my search terms	View Results (38,974) | View Details | Edit
S2	"Hearing Loss" OR "Hearing Impairment" Or Deaf	Search modes - Find all my search terms	View Results (4,104) | View Details | Edit
S1	Geriatrics OR Elderly OR "Older Adult"	Search modes - Find all my search terms	View Results (69,350) | View Details | Edit

Figure 3A – PubMed

History and Search Details — Download — Delete

Search	Actions	Details	Query	Results	Time
#6	•••	›	Search: **#1 AND #4 AND #5**	54	13:40:09
#5	•••	›	Search: **"cognitive decline" OR "memory loss" OR dementia**	250,432	13:39:46
#4	•••	›	Search: **#2 AND #3**	791	13:39:16
#3	•••	›	Search: **"risk factor"**	232,975	13:39:02
#2	•••	›	Search: **"hearing loss" OR "hearing impaired" OR deaf**	85,707	13:38:53
#1	•••	›	Search: **geriatrics OR elderly OR "older adult"**	5,805,294	13:38:20

Showing 1 to 6 of 6 entries

Appendix B
Data Extraction Form

- Article
  - Author(s):
  - Title:
  - Year:
  - Journal Publisher
- Research Design
  - PICO:
- Criteria
  - Does the article meet inclusion criteria?
  - Does the article meet exclusion criteria?
- Population
  - How many participants were used?
  - What was the age range of the participants?
- Issue
  - Hearing loss in people aged 65 and older
- Comparison
  - None
- Outcome measures
  - What was the outcome measure:
  - What was the statistical significance:
- Risk of Bias
  - Any type of bias?
  - Any limitations noted:
- JBI Checklist used
  - Level of evidence
  - Quality of study
- Include/Excluded from study
- Comments

Appendix C
Johanna Briggs Institute Levels of Evidence for Effectiveness

Level 1 – Experimental Designs
- Level 1.a– Systematic Review of Randomized Controlled Trials (RCTs)
- Level 1.b– Systematic Review of RCT sand Other Study Designs
- Level 1.c – RCT
- Level 1.d – Pseudo-RCTs

Level 2 – Quasi-experimental Designs
- Level 2.a – Systematic Review of Quasi-experimental Studies
- Level2.b – Systematic Review of Quasi-experimental and Other Lower Study Designs
- Level 2.c – Quasi-experimental Prospectively Controlled Study
- Level 2.d – Pre-test – Post-test or Historic/Retrospective Control Group Study

Level 3 – Observational – Analytic Designs
- Level 3.a – Systematic Review of Comparable Cohort Studies
- Level3.b – Systematic Review of Comparable Cohort and Other Lower Study Designs
- Level 3.c – Cohort Study with Control Group
- Level 3.d – Case – Controlled Study
- Level 3.e – Observational Study Without a Control Group

Level 4 – Observational – Descriptive Studies
- Level 4.a – Systematic Review of Descriptive Studies
- Level 4.b – Cross-sectional Study
- Level 4.c – Case Series
- Level 4.d – Case Study

Level 5 – Expert Opinion and Bench Research
- Level 5.a–Systematic Review of Expert Opinion
- Level 5.b – Expert Consensus
- Level 5.c – Bench Research/ Single expert Opinion

Note. From Joanna Briggs Institute (2014). JBI levels of evidence. Retrieved from https://joannabriggs.org/sites/default/files/2019-05/JBI-Levels-of-evidence_2014_0.pdf