Hearing Aid Intervention and Cognitive Decline in Older Adults with Moderate-to-Severe Sensorineural Hearing Loss: A Systematic Review

Alexander Segal

SAERA. School of Advanced Education, Research and Accreditation

ABSTRACT

This systematic review examined the relationship between moderate-to-severe sensorineural hearing loss (≥40 dB HL) and cognitive decline in adults aged 70 and over, and the role of hearing aid intervention. Evidence from randomised controlled trials, cohort studies, and meta-analyses published between 2010 and 2025 was reviewed. Untreated hearing loss of ≥40 dB HL was consistently associated with faster cognitive decline, with dementia prevalence 61% higher than in normal-hearing peers. Hearing aid intervention was associated with up to a 48% reduction in cognitive decline among high-risk older adults. Three interacting mechanisms were identified: increased cognitive load, social isolation, and neurological change. The findings support timely audiological intervention as an important component of dementia prevention in this population.

Keywords: *sensorineural hearing loss, cognitive decline, dementia, hearing aid intervention, older adults, auditory rehabilitation*

1. INTRODUCTION

Dementia is one of the most significant public health challenges of the twenty-first century. An estimated 55 million people worldwide are currently living with the condition, and this figure is projected to exceed 150 million by 2050 as populations continue to age (Tomida et al., 2024; Yu et al., 2024). The economic burden is equally striking, with global dementia-related costs currently estimated at approximately one trillion US dollars per year (Livingston et al., 2024). As disease-modifying treatments remain limited, attention has shifted increasingly toward identifying modifiable risk factors that could be addressed through early intervention.

Among these risk factors, hearing loss has attracted growing interest over the past decade. Age-related hearing loss, known clinically as presbycusis, affects approximately two-thirds of adults over the age of 70 and is the most prevalent chronic sensory condition in older populations (Huang et al., 2023). The 2024 Lancet Commission on Dementia Prevention, Intervention, and Care continues to identify hearing loss as one of the largest modifiable risk factors for dementia, estimated to account for around 7% of global dementia cases (Livingston et al., 2024). This contribution places it among the most significant modifiable risk factors, ahead of many other well-established contributors such as depression, social isolation, and traumatic brain injury. A 2024 meta-analysis drawing on data from over 1.5 million participants across 50 studies confirmed that adult-onset hearing loss is independently associated with increased risk of cognitive decline, mild cognitive impairment (MCI), dementia, and Alzheimer's disease (AD), with each 10 decibel (dB) worsening of hearing linked to a 16% increase in dementia risk (Yu et al., 2024).

Sensorineural hearing loss (SNHL) arises from damage to the cochlea, the auditory nerve, or the central auditory pathways, and it is the most common form of permanent hearing loss in older adults. Unlike conductive hearing loss, which results from problems in the outer or middle ear and can often be treated medically or surgically, SNHL is generally irreversible and is managed through amplification. In older adults, SNHL most commonly presents as presbycusis, a gradual and progressive loss that typically begins in the higher frequencies and later affects the frequencies essential for understanding speech. This progressive nature means that many older adults are unaware of the extent of their hearing loss until it has become moderate or severe, by which point communication in everyday situations, particularly in the presence of background noise, has often become markedly difficult. The population of interest in this review, adults aged 70 years and over, is precisely the group in which SNHL is most prevalent and most functionally significant, and in which the cumulative effects of untreated hearing loss on communication, social participation, and cognition are most likely to become apparent.

Cognitive decline refers to a measurable deterioration in one or more domains of cognitive function, including memory, attention, executive function, language, and

processing speed. It exists on a continuum that ranges from the subtle changes associated with normal ageing, through mild cognitive impairment (MCI), in which deficits are greater than expected for age but do not yet interfere substantially with daily life, to dementia, in which cognitive impairment is severe enough to compromise independence. In research settings, cognitive function is assessed using validated instruments such as the Mini-Mental State Examination (MMSE) and the Montreal Cognitive Assessment (MoCA), or more comprehensive neuropsychological batteries that examine individual domains in greater detail. The trajectory of cognitive decline is of particular importance in the context of hearing loss, because if untreated hearing loss accelerates the rate of decline, then any intervention that slows this trajectory, even modestly, could have meaningful consequences at both the individual and population level given the scale of the ageing population.

Hearing aid intervention is the primary management strategy for SNHL and forms the central intervention of interest in this review. Modern hearing aids amplify and process incoming sound to improve audibility and speech understanding, and best-practice fitting involves programming the device to prescriptive targets based on the individual's audiogram, verified using real-ear measurement. Effective audiological rehabilitation, however, extends beyond the device itself to include orientation to device use, communication strategy training, and ongoing support to encourage consistent, long-term use. The hypothesised mechanism by which hearing aid intervention may protect against cognitive decline is that, by restoring access to auditory information, amplification reduces the cognitive effort required for listening, supports continued social engagement, and maintains stimulation of the auditory and cognitive pathways that may otherwise deteriorate under conditions of sensory deprivation (Karawani et al., 2016). Whether this translates into a measurable slowing of cognitive decline, and for whom the benefit is greatest, is the central question this review seeks to address.

The focus of this review on adults aged 70 years and over reflects the particular vulnerability of this population. It is in this age group that the prevalence of both hearing loss and cognitive decline rises most sharply, and in which the two conditions most frequently coexist. Older adults with moderate-to-severe hearing loss often face a combination of challenges, including reduced independence, social withdrawal, and an increased likelihood of depression, all of which may compound the effect of hearing loss on cognition (Tomida et al., 2024). At the same time, this is the population for whom timely intervention may offer the greatest benefit, since addressing a modifiable risk factor before irreversible cognitive change has occurred represents a genuine opportunity for prevention. Given that the number of adults in this age group is growing rapidly worldwide, even a modest protective effect of hearing aid intervention on cognitive decline could translate into a substantial reduction in the population burden of dementia. It is against this background that the present review examines the evidence linking moderate-to-severe sensorineural hearing loss to cognitive decline, and evaluates whether hearing aid intervention

offers a means of protecting cognitive health in older adults.

Despite this growing body of evidence, an important gap remains. Most existing research has examined hearing loss broadly, without separating findings by severity. Individuals with moderate-to-severe sensorineural hearing loss (SNHL), defined as a pure tone average (PTA) of ≥40 dB HL in the better-hearing ear, represent a distinct clinical group. They experience greater difficulties with communication, higher levels of listening effort, and more pronounced social consequences than those with mild loss, yet they remain underrepresented in systematic reviews. While landmark trials such as the Aging and Cognitive Health Evaluation in Elders (ACHIEVE) study have shown that hearing intervention may slow cognitive decline by up to 48% in high-risk older adults (Lin et al., 2023), it is not yet clear how generalisable these findings are to adults specifically defined by moderate-to-severe hearing loss and aged 70 years and over.

Need of the Study

This gap is particularly important given the scale of under-treatment in this population. Although hearing aids are the primary treatment for SNHL, uptake remains low, and many older adults who would benefit from amplification either never seek help or delay doing so for years. A range of factors contribute to this, including the gradual and often unnoticed onset of age-related hearing loss, the stigma associated with hearing aids, the cost of devices in systems where they are not publicly funded, and the mistaken belief that hearing loss is simply an inevitable and untreatable part of ageing (Knudsen et al., 2010). The consequence is that a large number of older adults live with untreated moderate-to-severe hearing loss for extended periods, which is precisely the situation that the mechanisms linking hearing loss to cognitive decline would predict to be most harmful. If hearing aid intervention does reduce cognitive decline in this group, then the current pattern of under-treatment represents a significant missed opportunity for dementia prevention at a population level.

This systematic review was designed to address that gap. Its aim was to bring together available evidence on the relationship between untreated moderate-to-severe SNHL and cognitive decline in adults aged 70 and over, and to evaluate what the current literature says about the role of hearing aid intervention in this population. Particular attention was given to the mechanisms through which hearing loss may drive cognitive decline, and to the factors that may influence how well hearing aid treatment works.

2. Objectives

The primary research question guiding this review was: Does hearing aid intervention reduce the rate or severity of cognitive decline in adults aged 70 years and over with moderate-to-severe sensorineural hearing loss (≥40 dB HL), compared to no intervention?

Four specific objectives were used to structure the review. The first was to examine evidence on the association between untreated moderate-to-severe SNHL (≥40 dB HL) and cognitive decline in adults aged 70 and over. The second was to

evaluate whether hearing aid intervention is effective in reducing the rate or severity of cognitive decline in this population. The third was to identify and explore the mechanisms that may link hearing loss to cognitive impairment, including increased cognitive load, social isolation, and neurological changes. The fourth was to compare cognitive outcomes between individuals who received hearing aid intervention and those who did not, and to identify any factors that may influence how well the intervention works.

The null hypothesis (H_0) was that hearing aid intervention has no significant effect on cognitive decline in adults aged 70 and over with moderate-to-severe SNHL (≥40 dB HL). The alternative hypothesis (H_1) was that moderate-to-severe SNHL accelerates cognitive decline in this population compared to those receiving hearing aid intervention.

METHODS

Aim of the study

This thesis adopted a systematic review design, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to ensure methodological transparency. A systematic review was considered the most appropriate approach given the volume of available literature and the heterogeneity in study designs and populations across the field. The aim of the review was to identify, appraise, and synthesise the available evidence on the relationship between moderate-to-severe SNHL and cognitive decline in adults aged 70 and over, and on the effectiveness of hearing aid intervention in this population, in order to address the research question and objectives set out above.

Search strategy

A systematic search was conducted in the PubMed/MEDLINE electronic database. The search was limited to publications between January 2010 and June 2025, and to articles published in English, in order to capture recent, methodologically rigorous evidence while remaining broad enough to include foundational longitudinal studies. Reference lists of all included articles were hand-searched to identify any additional studies not returned by the database search.

The search used Boolean combinations across three term clusters. Hearing-related terms included: sensorineural hearing loss, hearing impairment, presbycusis, moderate hearing loss, severe hearing loss, hearing aid, amplification, and hearing intervention. Cognition-related terms included: cognitive decline, dementia, Alzheimer's disease, mild cognitive impairment, cognitive function, neuropsychological outcomes, and cognitive ageing. Population terms included: older adults, elderly, aged 70, geriatric, and ageing population.

Inclusion criteria

Studies were included if they involved older adults, with a primary focus on those aged 70 years and over with moderate-to-severe SNHL, defined as a PTA of ≥40 dB HL, or if age-stratified or severity-stratified data were available for this subgroup. Studies needed to examine the relationship between hearing loss or hearing aid intervention and cognitive outcomes, using validated tools such as the Mini-Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA), or

a composite cognitive battery. Only peer-reviewed English-language publications were included, and acceptable study designs were RCTs, cohort studies, cross-sectional studies, and published systematic reviews or meta-analyses.

Exclusion criteria

Studies were excluded if they focused on conductive or mixed hearing loss without a sensorineural component as the primary sample, if participants were under 70 without available age-stratified data, or if hearing status was assessed only through self-report without audiometric verification. Studies not available in English, and those that did not report a measurable cognitive outcome, were also excluded.

Procedure

Data was extracted using a standardised form capturing study design, participant characteristics, hearing loss severity and audiometric classification, intervention type and duration, cognitive outcome measures, follow-up period, and key findings. The primary method of synthesis in this review was narrative, with the findings of the included studies integrated qualitatively and greater interpretive weight given to higher-quality evidence. To support this appraisal, the methodological quality of the included observational studies was additionally assessed using the Newcastle-Ottawa Scale (NOS), with scores presented in the Appendix. As the NOS applies to observational designs, the included randomised controlled trials and meta-analyses were not scored using it. Given the heterogeneity in outcome measures and population definitions across studies, a narrative synthesis was used as the primary method of evidence integration, organised around the four research objectives. Where data were sufficiently homogeneous, pooled effect sizes from published meta-analyses were drawn upon to support interpretation.

The study selection process followed the standard PRISMA stages. Records identified through the database search were first screened by title and abstract against the inclusion and exclusion criteria, and obviously irrelevant records were removed at this stage. The full texts of the remaining records were then retrieved and assessed in detail for eligibility. Studies that met all inclusion criteria were carried forward into the synthesis, while those that did not were excluded with the reason recorded. Particular attention was paid to whether each study reported data specific to the moderate-to-severe severity range or to adults aged 70 and over, since this determined how directly its findings could be applied to the population of interest. Where a study reported on a broader population but included a relevant subgroup, the subgroup data were extracted in preference to the overall results.

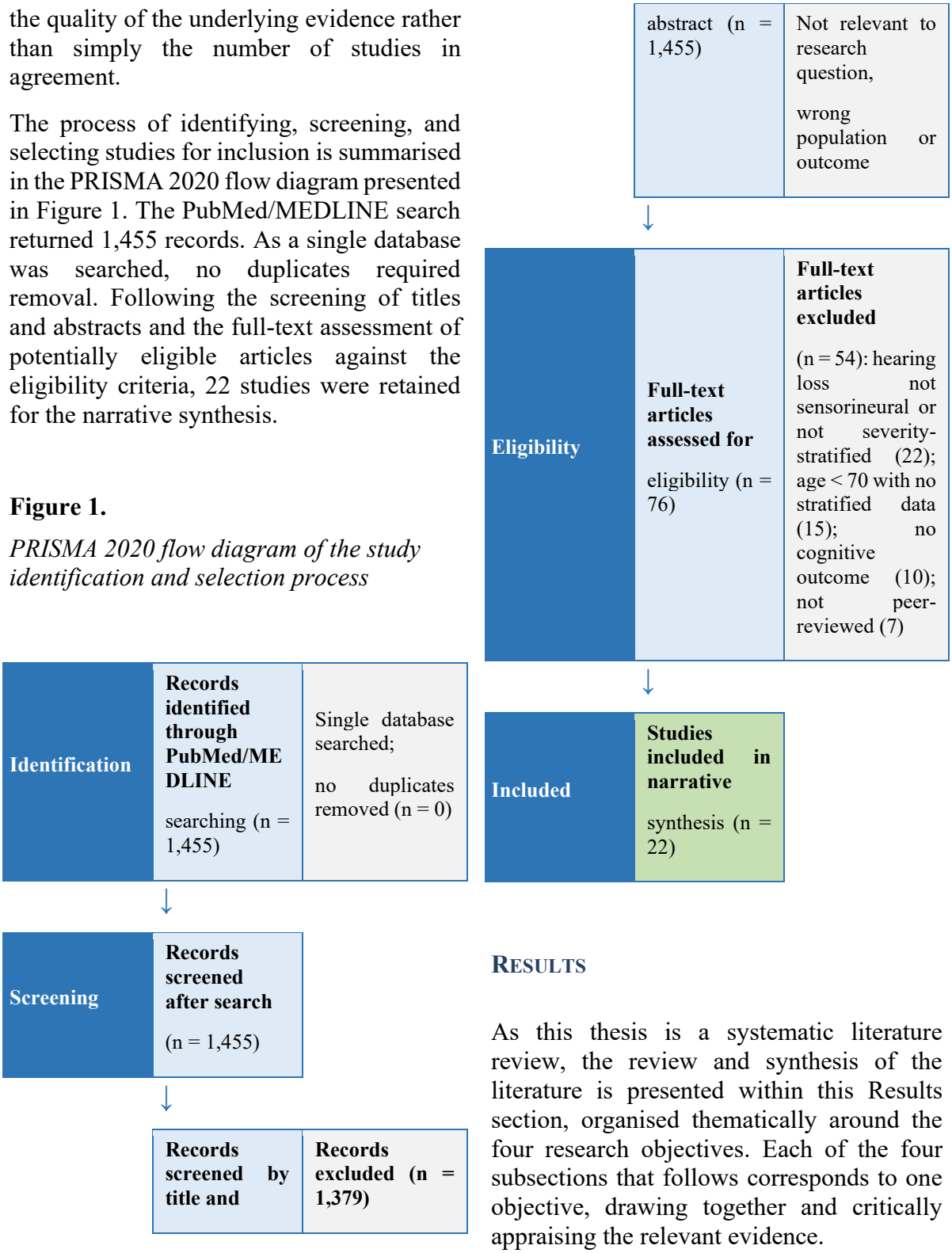
Because the included studies varied considerably in design, ranging from large randomised controlled trials to cross-sectional analyses, the synthesis gave greater interpretive weight to higher-quality evidence. Findings from randomised controlled trials and well-conducted longitudinal cohort studies were treated as more reliable than those from cross-sectional or retrospective designs, and this hierarchy informed the conclusions drawn in each thematic subsection. This approach is consistent with established principles of evidence-based practice, in which the strength of a recommendation should reflect

the quality of the underlying evidence rather than simply the number of studies in agreement.

The process of identifying, screening, and selecting studies for inclusion is summarised in the PRISMA 2020 flow diagram presented in Figure 1. The PubMed/MEDLINE search returned 1,455 records. As a single database was searched, no duplicates required removal. Following the screening of titles and abstracts and the full-text assessment of potentially eligible articles against the eligibility criteria, 22 studies were retained for the narrative synthesis.

Figure 1.

PRISMA 2020 flow diagram of the study identification and selection process



RESULTS

As this thesis is a systematic literature review, the review and synthesis of the literature is presented within this Results section, organised thematically around the four research objectives. Each of the four subsections that follows corresponds to one objective, drawing together and critically appraising the relevant evidence.

The characteristics of the principal empirical studies included in this review are summarised in Table 1, which sets out the study design, sample size, population, cognitive outcome measure, and main finding for each. The studies span randomised controlled trials, longitudinal cohort studies, cross-sectional analyses, and systematic reviews, reflecting the breadth of the evidence base synthesised in the sections that follow. Of the 22 studies included in the review, the 12 most directly relevant empirical studies, namely those providing primary quantitative data on the association between hearing loss or hearing aid intervention and cognitive outcomes, are summarised in Table 1. The remaining 10 studies, which contributed supporting or contextual evidence (for example, on mechanisms, prevalence, or moderating factors), are discussed within the narrative synthesis but not tabulated.

Table 1.

Characteristics of the key empirical studies included in the review

Study	Design	Sample (n)	Population & age	Outcome measure	Key finding
Lin et al. (2023), ACHIEVE	RCT	977	Adults 70–84, untreated HL	Global cognitive composite	No effect in total cohort; 48% slower decline in high-risk ARIC subgroup over 3 years
Pike et al. (2025)	RCT secondary analysis	977	Adults 70–84	Predicted-risk cognitive model	61.6% slower decline in highest-risk quartile with hearing intervention
Sarant et al. (2024), ENHANCE	Prospective cohort	160 vs 102	Mean age 73.5, mild–severe HL	Cognitive battery (Cogstate)	Hearing aid group remained cognitively stable while controls declined over 3 years
Yeo et al. (2023)	Systematic review / meta-analysis	137,484	Older adults, 8 studies	Long-term cognitive decline	Hearing devices linked to 19% lower hazard of cognitive decline
Yu et al. (2024)	Systematic review / meta-analysis	>1.5 million	Adults with adult-onset HL, 50 studies	Dementia, MCI, AD incidence	Each 10 dB worse hearing raised dementia risk by 16%
Huang et al. (2023)	Cross-sectional (NHATS)	2,413	US adults 70+	Dementia prevalence	Dementia 61% more prevalent in moderate-to-severe HL vs normal hearing
Alattar et al. (2020)	Longitudinal cohort	1,164	Mean age 73.5, not using aids	MMSE, Trail Making	Steeper decline in moderate-to-severe (>40 dB) than mild group

Study	Design	Sample (n)	Population & age	Outcome measure	Key finding
Myrstad et al. (2023), HUNT4	Prospective cohort	Community sample	Norwegian adults 70+	Incident dementia	Hearing impairment linked to incident dementia; weaker in oldest old
Marinelli et al. (2022)	Prospective cohort (MCSA)	1,200	Mean age 79, audiometric testing	Incident dementia	No significant association at follow-up (null result)
Bucholc et al. (2021)	Longitudinal retrospective	2,114 (MCI)	Adults with MCI at baseline	Conversion to dementia	Hearing aid users had 27% lower hazard of dementia conversion
Cantuaria et al. (2024)	Population cohort (Denmark)	573,088	Adults 50+	Incident dementia	7% higher dementia risk with HL; lower among hearing aid users
Samelli et al. (2025), ELSA-Brasil	Longitudinal cohort	Cohort sample	Adults, 8-year follow-up	Global cognitive decline	HL independently associated with faster cognitive decline

Association between untreated moderate-to-severe sensorineural hearing loss and cognitive decline

Evidence from multiple large-scale studies consistently shows a significant association between untreated hearing loss and accelerated cognitive decline, with a clear pattern of increasing risk at greater hearing loss severity. One of the most striking findings comes from a 2023 analysis of the National Health and Aging Trends Study (NHATS), a nationally representative dataset of United States Medicare beneficiaries, which found that dementia prevalence among participants with moderate-to-severe hearing loss was 61% higher than among those with normal hearing (Huang et al., 2023). These data directly support the clinical relevance of examining this severity subgroup as a distinct and high-risk population.

Supporting this, a 2024 meta-analysis by Yu et al., incorporating 50 cohort studies and more than 1.5 million participants, found that each 10 dB worsening of hearing threshold was associated with a 16% increase in dementia risk, confirming a dose-response relationship across the spectrum of hearing severity. Given that moderate-to-severe hearing loss involves substantially higher thresholds than mild loss, the cumulative risk elevation in this population is considerably greater. The same analysis confirmed associations with incident dementia, MCI, and AD across multiple study populations. The Norwegian HUNT4 70+ study, which conducted prospective audiometric testing and cognitive assessment in community-dwelling adults aged 70 and over, also found a significant association between objectively measured hearing impairment and incident dementia over a follow-up period of more than 20 years, with the strongest associations in adults aged 70–84 (Myrstad et al., 2023).

Longitudinal data from the ELSA-Brasil study further supported the association. Over 8 years of follow-up across three study waves, hearing loss was independently associated with faster global cognitive

decline across memory, verbal fluency, and executive function, even after controlling for sociodemographic, lifestyle, and clinical variables (Samelli et al., 2025). This cohort included middle-aged as well as older adults, and the authors concluded that preventing hearing loss earlier in life could contribute to slowing cognitive decline (Samelli et al., 2025). The robustness of this association across multiple continents and healthcare contexts, with replication in Polish, Brazilian, Canadian, Japanese, and French cohorts, suggests that the link between hearing loss and cognitive decline is not context-specific (Yu et al., 2024).

A population-based longitudinal study by Alattar et al. (2020), which followed 1,164 community-dwelling older adults (mean age 73.5 years) not using hearing aids for up to 24 years, is particularly relevant because it categorised participants using the same severity bands applied in this review: normal (PTA ≤ 25 dB), mild (PTA > 25–40 dB), and moderate-to-severe (PTA > 40 dB). The study found that hearing impairment was associated with steeper decline on the MMSE, and importantly, the effect was greater in the moderate-to-severe group ($\beta = -0.08$, $p = .002$) than in the mild group ($\beta = -0.04$, $p = .01$). A further finding was that higher education appeared to buffer the cognitive effect of mild hearing loss but not of moderate-to-severe loss, suggesting that once hearing impairment becomes more severe, cognitive reserve alone may be insufficient to offset its impact. These results provide direct evidence that the cognitive consequences of hearing loss intensify with severity, reinforcing the clinical importance of the ≥40 dB HL population examined here. A Polish cohort study within the PURE investigation similarly found MCI present in nearly 50% of participants with hearing loss, compared to 26% of those without, with hearing loss increasing the odds of MCI by 34% (OR = 1.34; 95% CI = 0.93–1.93) (Yu et al., 2024).

Not all studies found consistent associations. The HUNT4 70+ study reported weaker relationships in adults aged 85 and over, which may reflect competing health risks in the oldest old, survivor bias, or the increased prevalence of comorbidities that confound the relationship at very advanced age (Myrstad et al., 2023). A prospective study within the Mayo Clinic Study of Aging, which used formal behavioural audiometric testing rather than self-report, found no statistically significant association between baseline hearing threshold and incident dementia over the follow-up period (Marinelli et al., 2022). These inconsistencies are likely attributable to differences in how hearing and cognition were measured, the age range of the samples, and how confounders were handled across studies, rather than representing genuine evidence against the association. Indeed, the 2024 Lancet Commission incorporated several of these newer cohorts, including the Marinelli study, and still arrived at a pooled hazard ratio indicating a 37% increased risk of dementia in individuals with hearing loss, suggesting that the overall weight of evidence remains firmly in favour of a positive association despite individual null results (Livingston et al., 2024).

Taken together, the evidence reviewed under this objective provides strong and consistent support for the conclusion that untreated moderate-to-severe SNHL is associated with accelerated cognitive decline in adults aged 70 and over. The association is observed across cross-sectional, longitudinal, and

meta-analytic designs; it persists after adjustment for major confounders; and it follows a dose-response pattern in which greater hearing loss severity is linked to greater cognitive risk. Thus, this pattern is particularly important for the population examined in this review, since individuals with PTA ≥40 dB HL sit toward the higher end of the severity spectrum, where the cognitive consequences appear to be most pronounced.

Effectiveness of hearing aid intervention on cognitive outcomes

The most significant recent development in this area has been the publication of the ACHIEVE trial (Lin et al., 2023), the first large-scale RCT designed specifically to test whether hearing intervention can reduce long-term cognitive decline in older adults. The trial enrolled 977 community-dwelling adults aged 70–84 years with untreated mild-to-moderate hearing loss who were free from substantial cognitive impairment at baseline. Participants were randomly assigned to either a best-practice hearing intervention (which included hearing aid fitting, auditory rehabilitation, and communication counselling) or a health education control. In the primary analysis of the total cohort, no significant difference in 3-year cognitive decline was found between the two groups. However, in a pre-specified subgroup of 238 participants drawn from the Atherosclerosis Risk in Communities (ARIC) cohort, who were older, had lower baseline cognition, and carried greater cardiovascular risk, the hearing intervention slowed cognitive decline by 48% over 3 years (Lin et al., 2023). It should be noted that ACHIEVE enrolled participants with a better-ear four-frequency pure-tone average of ≥30 and <70 dB HL. This range overlaps the moderate-to-severe population examined in this review but also extends below the ≥40 dB HL threshold that defines it, so the trial was not confined to, and does not specifically represent, the moderate-to-severe group. As no relevant randomised controlled trial was found upon research that targeted the moderate-to-severe population specifically, the ACHIEVE findings represent the closest proxy evidence available for this cohort, and should be interpreted with this in mind.

A secondary analysis of ACHIEVE data published in 2025 took this further by modelling baseline cognitive decline risk across the full cohort. Among participants in the top quartile of predicted risk, cognitive decline in the hearing intervention group was 61.6% slower than in the control group (95% CI: 33.7%–94.1%) (Pike et al., 2025). This finding is particularly relevant to the population examined in this review, given that adults aged 70 and over with moderate-to-severe SNHL are likely to sit in higher-risk strata by virtue of both their age and the severity of their peripheral hearing impairment.

Broader meta-analytic evidence is consistent with these findings. A systematic review and meta-analysis by Yeo et al. (2023), published in JAMA Neurology and comprising 137,484 participants across eight observational studies with follow-up periods of 2–25 years, found that the use of hearing restorative devices was associated with a 19% reduction in the hazard of long-term cognitive decline. A large Danish population-based cohort study by Cantuaria et al. (2024), which followed more than 573,000 people over an average of almost 9 years, found that hearing loss was associated with a 7% increased risk of dementia, with

the risk greater in those with more severe hearing loss and lower among hearing aid users. Although this effect was smaller than that reported in some earlier studies, the authors suggested this may partly reflect the high baseline rate of hearing aid use in Denmark, and the finding nonetheless reinforces both the severity gradient and the potential protective role of hearing aids.

Evidence specifically examining the transition from MCI to dementia has added further support. Bucholc et al. (2021) found in a large longitudinal retrospective analysis that MCI participants who used hearing aids were at significantly lower risk of converting to all-cause dementia compared to non-users (HR = 0.73; 95% CI: 0.61–0.89). The TACT pilot RCT, conducted in London memory clinics with adults who had MCI and untreated hearing loss, demonstrated that randomising people with mild cognitive impairment to a personalised hearing intervention is feasible and has the potential to improve hearing aid use in this group, providing a foundation for a fully powered multicentre trial to test whether such intervention can mitigate cognitive decline (Yu et al., 2025). The ENHANCE study (Sarant et al., 2024), a 3-year prospective longitudinal study, compared 160 first-time hearing aid users (mean age 73.5 years) with mild-to-severe hearing loss against 102 community-living older adults from the Australian Imaging, Biomarkers and Lifestyle study. Hearing aid users demonstrated better cognitive performance at follow-up, with the authors concluding that hearing intervention may delay the onset of cognitive decline and dementia in older adults with hearing loss.

Whilst the majority of studies in this area enrolled participants across the mild-to-moderate severity range, rather than specifically targeting moderate-to-severe loss, this does not diminish the consistency of their direction of effect. Observational studies are also prone to healthy user bias, since individuals who seek out and consistently use hearing aids may already be healthier and more engaged in their own care than those who do not. These limitations do not negate the directional consistency of the evidence, but they do mean that firmer conclusions about the specific benefit for adults with ≥40 dB HL loss require more targeted research.

Overall, the evidence reviewed under this objective points consistently in the same direction: hearing aid intervention is associated with reduced cognitive decline, and the benefit appears greatest in those at highest baseline risk. The strongest single piece of evidence, the ACHIEVE trial, demonstrates this in a randomised design, while the observational and meta-analytic literature provides convergent support across much larger and more diverse populations. The consistency of findings across very different study designs, each with different strengths and susceptibilities to bias, strengthens confidence that the association reflects a genuine protective effect rather than an artefact of any single methodology. What remains less certain is the precise magnitude of benefit achievable specifically in adults aged 70 and over with moderate-to-severe loss, which the existing studies do not isolate as a distinct population.

Mechanisms linking hearing loss to cognitive impairment

Three main pathways have been proposed and supported in the literature through which SNHL may contribute to cognitive decline.

These are not mutually exclusive, and in practice they likely interact and reinforce one another, particularly in individuals with greater degrees of hearing impairment.

The first and most widely studied pathway is increased cognitive load. When the peripheral auditory system is damaged, as in SNHL, the brain must work harder to decode speech, even in quiet listening conditions. The Ease of Language Understanding (ELU) model helps explain this: when the auditory signal is degraded, the brain cannot automatically match incoming sounds to stored phonological representations and instead must rely on effortful working memory processes to fill in the gaps (Karawani et al., 2016). Over time, this sustained cognitive effort may deplete cognitive reserve and accelerate measurable decline. Neuroimaging evidence supports this pathway, showing greater activation of frontal brain regions associated with working memory and attention in older adults with hearing loss during speech perception tasks, reflecting a compensatory neural effort that may not be sustainable over the long term (Karawani et al., 2016).

The second pathway involves social isolation. Moderate-to-severe hearing loss creates real barriers to communication, which often leads to withdrawal from social activities, reduced participation in conversations, and increasing loneliness. Tomida et al. (2024) demonstrated that the combination of hearing impairment and social isolation was associated with significantly greater dementia risk than either factor alone in a Japanese longitudinal cohort, with isolated individuals with hearing impairment showing the highest rates of incident dementia. A systematic review and meta-analysis by Dhanda et al. (2024) confirmed a dose-dependent association between hearing threshold (40 dB HL or greater) and later cognitive impairment or dementia, although it concluded that the current evidence is not yet sufficient to establish social isolation as a formal mediator of this relationship. Research has shown that socially isolated individuals carry approximately a 50% higher relative risk of developing dementia compared to those who remain socially engaged (Azeem et al., 2023). Social interaction is cognitively stimulating and helps maintain neural reserve in older adults. Its absence, driven in large part by communication difficulties, appears to accelerate the cognitive effects of hearing loss.

The third pathway involves direct neurological and structural changes. Evidence from neuroimaging studies suggests that hearing loss is associated with reduced grey matter volume in the auditory cortex and hippocampus, regions critical for memory and learning, and that these structural changes are correlated with hearing threshold severity (Griffiths et al., 2020). Other proposed mechanisms include cortical reorganisation, whereby auditory regions are gradually recruited for non-auditory processing, and shared vascular pathology or common risk factors such as cardiovascular disease and diabetes, which may contribute to both hearing loss and cognitive decline. Animal models involving cochlear hair cell damage have demonstrated downstream changes in neurotransmitter expression and synaptic connectivity, providing biological plausibility for a direct neurodegeneration pathway (Azeem et al., 2023). Genetic analyses using UK Biobank data have further shown that a higher

polygenic risk for AD is associated with greater likelihood of speech-in-noise difficulty, raising the possibility of some shared genetic vulnerability between auditory and cognitive decline (Azeem et al., 2023).

A particularly influential account of the neurological pathway was proposed by Griffiths et al. (2020), who reviewed the candidate brain mechanisms linking hearing loss to dementia and put forward a novel explanation centred on the medial temporal lobe. This region, which includes the hippocampus, is essential not only for memory but also for the auditory cognitive processes involved in analysing complex sound patterns and holding auditory information in working memory. Griffiths et al. (2020) argued that when hearing is impaired, the medial temporal lobe is required to work harder to make sense of degraded auditory input, and that this increased activity may interact with early Alzheimer's pathology in this same region, potentially accelerating the disease process. This account is significant because it offers a specific neural mechanism through which the effortful listening associated with hearing loss could translate into measurable structural and pathological change, rather than treating cognitive load and neurodegeneration as entirely separate pathways. It also helps explain why the medial temporal lobe, one of the earliest regions affected in Alzheimer's disease, appears so consistently implicated in the hearing-cognition relationship. Importantly, Griffiths et al. (2020) noted that the effect of hearing intervention on cognitive outcomes is likely to depend on which mechanism predominates, which has direct implications for predicting who is most likely to benefit from hearing aid treatment.

These three pathways are therefore unlikely to operate in isolation. In an individual with moderate-to-severe SNHL, increased cognitive load, social withdrawal, and underlying neurological change may all be occurring simultaneously and may reinforce one another. For example, the effort of listening may lead a person to avoid social situations, which in turn reduces cognitive stimulation and may hasten the structural changes already underway. This interaction is clinically significant, because it suggests that a single intervention, such as hearing aid fitting, may produce benefit through several mechanisms at once. These include reducing listening effort, enabling renewed social participation, and restoring auditory input that may help preserve the integrity of the auditory and memory networks. The degree to which any one pathway can be reversed, however, remains uncertain, and is likely to depend on how early intervention occurs relative to the onset of irreversible neurological change.

Factors moderating treatment efficacy

The evidence reviewed suggests that the cognitive benefit of hearing aid intervention is not the same for all individuals, and that several factors influence how much benefit a person is likely to receive.

The most consistently identified factor is baseline cognitive risk. The ACHIEVE trial found that the cognitive benefit of hearing intervention was concentrated in participants who were already at higher risk at baseline, with no significant effect in the lower-risk community volunteer group (Lin et al., 2023). A secondary analysis of ACHIEVE

data confirmed that benefit scaled with predicted risk, with the top quartile of risk showing the greatest reduction in cognitive decline (Pike et al., 2025). Such evidence suggests that hearing aid intervention may be most valuable as a targeted strategy for individuals who already show markers of cognitive vulnerability, such as lower baseline cognitive scores, advanced age, or cardiovascular risk factors, rather than as a blanket preventive measure for all hearing-impaired adults.

Hearing aid adherence is another critical factor. Consistent, regular use is generally considered important for realising any cognitive benefit, since the proposed mechanisms, such as reduced listening effort and sustained auditory stimulation, depend on the device actually being worn. However, the precise relationship between duration or consistency of use and cognitive outcome has not been firmly established (Munro & Dawes, 2025). Cognitive impairment itself can also reduce a person's ability to manage hearing aids, since device insertion, battery replacement, and maintenance can become difficult for individuals with MCI or early dementia (Hooper et al., 2024). Thus, a difficult cycle is created where those most likely to benefit from hearing aids are also least able to use them independently. This highlights the importance of caregiver involvement and practical device support as part of any rehabilitation programme targeting older adults with cognitive vulnerability

Socioeconomic factors including education, income, and access to audiological services were also found to moderate outcomes. Higher educational attainment is associated with greater cognitive reserve, which may both buffer against hearing-related cognitive decline and improve the ability to benefit from rehabilitation (Karawani et al., 2016). Conversely, financial barriers can reduce hearing aid uptake and long-term use, particularly in systems where devices are not publicly funded (Knudsen et al., 2010). Other factors that may influence treatment response, including sex, the presence of comorbid vision impairment, and whether intervention was initiated before or after MCI onset, may also play a role, though the evidence for these moderators was less consistent and would benefit from further investigation in prospective studies.

DISCUSSION

Summary of principal findings

This systematic review brings together evidence on the relationship between moderate-to-severe SNHL and cognitive decline in adults aged 70 and over, and on the role of hearing aid intervention in modifying that relationship. Four main findings emerge from the reviewed literature. First, untreated moderate-to-severe SNHL is consistently associated with significantly accelerated cognitive decline across multiple populations, study designs, and cognitive domains, with dementia prevalence elevated by 61% in this severity category relative to normal-hearing peers (Huang et al., 2023). Second, hearing aid intervention is associated with meaningful reductions in cognitive decline, particularly in individuals at elevated baseline risk, among whom 3-year cognitive decline may be reduced by 48% to 62% (Lin et al., 2023; Pike et al., 2025). Third, three interacting pathways (cognitive load, social isolation, and neurological change) link hearing loss to

cognitive impairment, each of which may be at least partially addressed through effective hearing rehabilitation. Fourth, treatment response is influenced by baseline cognitive risk, hearing aid adherence, and socioeconomic factors, suggesting that outcomes are likely to be best when intervention is targeted and well-supported rather than delivered in isolation.

Interpretation of findings

The findings of this review align with the conclusions of recent systematic reviews and meta-analyses in the field. Yeo et al. (2023) reported a 19% reduction in long-term cognitive decline associated with hearing devices; this review builds on that finding by situating it within the specific context of adults aged 70 and over with moderate-to-severe loss, and by exploring the mechanistic and moderating factors that prior meta-analyses have not examined in depth. The ACHIEVE trial (Lin et al., 2023) remains the most methodologically robust evidence available, and its null result in the total study cohort requires careful interpretation. Whilst the absence of a significant effect across the full sample might at first appear discouraging, it does not undermine the positive finding in the high-risk subgroup. Rather, it reflects the fact that the effect is heterogeneous and concentrated in those who have most to gain. Presenting the ACHIEVE trial as simply a negative study would therefore misrepresent what the data actually show.

It should be noted, however, that not all authors interpret the current evidence as strongly. Munro and Dawes (2025) caution that there is not yet convincing evidence that hearing interventions reduce dementia risk in the general population, and that the strength of the association is often overstated. This more cautious perspective is an important counterpoint, and it reinforces the need to interpret findings such as those of ACHIEVE as indicative of benefit in specific higher-risk groups rather than as proof of a universal protective effect. If hearing intervention helps preserve cognitive function, it may simultaneously improve the capacity to manage hearing aids effectively, creating a reinforcing cycle of benefit. Conversely, cognitive decline that is left unchecked may progressively reduce a person's ability to engage with hearing rehabilitation. Such a dynamic makes the timing of intervention particularly important, and supports the argument that earlier fitting, before significant cognitive decline has occurred, is likely to produce better and more durable outcomes.

The mechanistic evidence reviewed here strengthens the biological plausibility of a causal relationship between hearing loss and cognitive decline, and of hearing aid intervention as a means of interrupting it. By improving auditory signal quality, hearing aids reduce the cognitive effort required for listening, thereby freeing resources for memory and executive function. By enabling greater communicative participation, they help maintain social engagement and the cognitive stimulation that comes with it. Evidence from the auditory training and neuroplasticity literature further suggests that sustained auditory stimulation may support more efficient cortical processing over time, a principle that is plausibly applicable to hearing aid use as well as formal training programmes (Brouns et al., 2011; Morais et al., 2015).

However, an important caveat must be drawn from the work of Griffiths et al. (2020): the

extent to which hearing intervention can reduce cognitive decline depends critically on which underlying mechanism is operating. If cognitive decline is driven primarily by reversible factors such as cognitive load and social isolation, then restoring auditory input through hearing aids would be expected to produce meaningful benefit. If, however, hearing loss and dementia share a common underlying pathology, such as vascular damage or neurodegeneration affecting both the auditory system and the medial temporal lobe, then treating the hearing loss alone may have limited effect on the cognitive trajectory, because the intervention does not address the shared cause. This distinction may help explain why the evidence for hearing aid benefit is stronger in some populations than others, and why the ACHIEVE trial found benefit concentrated in higher-risk participants. It also reinforces the argument that hearing intervention should be viewed as one component of a broader cognitive health strategy rather than as a standalone solution. Because the reversible mechanisms are most likely to be modifiable before irreversible neurological change has occurred, this mechanistic uncertainty further supports the case for early rather than delayed intervention.

Clinical implications and feasibility plan of action

The evidence synthesised in this review therefore has practical implications for audiological practice and health policy. A feasibility plan of action for implementing audiological rehabilitation as a cognitive protection strategy in adults aged 70 and over with moderate-to-severe SNHL should address the following areas.

First, systematic audiometric screening of adults aged 70 and over should be integrated into primary care and geriatric assessment pathways. Hearing loss is frequently under-identified in this age group, partly because communication difficulties are incorrectly attributed to cognitive decline rather than hearing impairment. Routine screening using validated tools such as pure-tone audiometry and the Hearing Handicap Inventory for the Elderly (HHIE) would enable earlier identification and referral, creating opportunities for intervention before significant cognitive deterioration has occurred.

Second, hearing aid fitting for adults in this group should be treated as a clinical priority, not merely a quality-of-life enhancement. Audiological rehabilitation programmes for older adults with moderate-to-severe loss should extend beyond device fitting to include structured auditory counselling, communication strategy training, and support for caregivers in managing devices on behalf of individuals with cognitive difficulties. The ACHIEVE trial protocol, which combined fitting with structured rehabilitation components, appears to have been a more effective package than device provision alone, and this approach should inform clinical practice (Lin et al., 2023).

Third, structural barriers to hearing aid access should be addressed at a policy level. In many healthcare systems, hearing aids are not universally funded or are available only with limited subsidy, and cost remains a significant barrier for older adults from lower socioeconomic backgrounds (Knudsen et al., 2010). Given the evidence that hearing intervention may reduce dementia incidence, with its associated healthcare and social care costs, a health

economic argument can be made for expanding access that policymakers and commissioning bodies should consider.

Fourth, there is a clear need for future research that specifically targets adults aged 70 and over with moderate-to-severe SNHL (≥40 dB HL) as a primary population. The current evidence base is strongest for mild-to-moderate hearing loss, and well-powered, long-term RCTs enrolling participants with PTA ≥40 dB HL would substantially strengthen the case for targeted intervention in this group.

Limitations

Several limitations of the reviewed literature, and of this review itself, should be acknowledged. Most included studies did not specifically target adults with moderate-to-severe SNHL as their primary population; the majority recruited across a range of hearing loss severities, with severity-stratified data not always separately available. This limits how precisely conclusions can be drawn about this specific group, and underlines the case for severity-stratified primary research. Observational studies are also prone to healthy user bias, since individuals who seek out and consistently use hearing aids may be healthier and more socially engaged overall, which could inflate the apparent cognitive benefit of hearing aid use. The ACHIEVE trial, while the most methodologically rigorous evidence available, was conducted entirely within the United States and enrolled a predominantly white sample, which limits generalisability across different healthcare systems and ethnic populations (Lin et al., 2023). A further key limitation when applying the ACHIEVE findings to the present review is that the trial's eligibility range (a better-ear four-frequency pure-tone average of ≥30 and <70 dB HL) overlaps but extends below the ≥40 dB HL threshold that defines the moderate-to-severe population targeted here; its results therefore serve as the closest available proxy evidence for this population rather than direct evidence, and this gap should be addressed by future trials enrolling participants with PTA ≥40 dB HL. Finally, variation in cognitive outcome measures across studies, ranging from brief screening tools to comprehensive neuropsychological batteries, makes direct comparison between studies difficult. A further methodological limitation concerns the search strategy itself: the formal search was confined to a single database, PubMed/MEDLINE. While this database provides broad coverage of the biomedical and audiological literature, the searching of additional databases such as Scopus, CINAHL, or Web of Science might have identified further eligible studies, and this should be borne in mind when interpreting the completeness of the evidence base.

Conclusions

The evidence reviewed in this thesis consistently supports the conclusion that untreated moderate-to-severe SNHL (≥40 dB HL) is associated with substantially accelerated cognitive decline in adults aged 70 years and over, and that hearing aid intervention is associated with meaningful reductions in that decline, particularly in individuals at elevated baseline cognitive risk. Three interacting mechanisms (increased cognitive load, social isolation, and neurological change) offer a biologically plausible account of how hearing loss contributes to cognitive deterioration, and

each is potentially addressable through effective audiological rehabilitation.

On the basis of the reviewed evidence, the null hypothesis, which states that hearing aid intervention has no significant effect on cognitive decline in this population, is not supported. The alternative hypothesis, which states that moderate-to-severe SNHL accelerates cognitive decline compared to those receiving hearing aid intervention, is supported, particularly for individuals at elevated baseline risk, by consistent epidemiological data, the findings of the ACHIEVE trial in high-risk subpopulations, and the broader meta-analytic literature demonstrating reduced long-term cognitive decline in hearing aid users.

For audiologists working with older adults who present with moderate-to-severe SNHL, these findings suggest that timely hearing aid fitting, combined with structured auditory rehabilitation, should be understood not only as a communication intervention but as a potentially important strategy for supporting cognitive health. The opportunity for hearing-based cognitive protection is greatest in the period before significant cognitive impairment has developed, which reinforces the clinical importance of early identification and intervention.

Looking ahead, the most pressing research priorities are large-scale RCTs specifically enrolling adults aged 70 and over with PTA ≥40 dB HL, longer-term follow-up studies examining whether cognitive protection is sustained beyond 3 years, investigations into the neural mechanisms through which hearing aid use affects brain structure and function, and health economic analyses examining the cost-effectiveness of systematic audiological intervention as part of a wider dementia prevention strategy.

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APPENDIX

Table 2.

Newcastle-Ottawa Scale quality appraisal of included observational studies

Study	Design	Selection (/4)	Comparability (/2)	Outcome (/3)	Total (/9)
Alattar et al. (2020)	Longitudinal cohort	3	2	2	7
Sarant et al. (2024)	Prospective cohort	2	1	2	5
Marinelli et al. (2022)	Prospective cohort	4	2	2	8
Bucholc et al. (2021)	Retrospective cohort	2	1	2	5
Cantuaria et al. (2024)	Population cohort	4	2	3	9
Myrstad et al. (2023)	Prospective cohort	4	2	2	8
Samelli et al. (2025)	Longitudinal cohort	3	2	2	7
Huang et al. (2023)	Cross-sectional	3	2	2	7

Appraisal was based on the information reported in each study's abstract and available text; points were not awarded where a criterion could not be confirmed