HCIA

DEMENTIA, HEARING LOSS AND HEARING CARE:

Saving Australia's Minds

The compelling peer-reviewed evidence for early hearing care intervention to prevent dementia

WHITE PAPER
MARCH 2021

Dementia, Hearing Loss and Hearing Care:
Saving Australia's Minds.

The compelling peer-reviewed evidence for early hearing care intervention to prevent dementia

A White Paper prepared by
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for the **Hearing Care Industry Association, Australia**

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About the Author

Mark Laureyns' professional career spans 40 years in hearing health care. He is the current co-chair of the World Hearing Forum 'Make Listening Safe Workgroup' an initiative of the World Health Organisation. He is the elected President of the European Association of Hearing Aid Professionals, a position he has held since 2014. He is the Director of the Global International CRS (Amplifon Centre for Research and Studies) in Milan, Italy. Mark lectures in Hearing Aid Fitting at the Thomas More University College, Department of Audiology in Antwerp. His field of research spans the relationship between hearing and cognition, central auditory processing, safe listening practices, the added value of hearing aid signal processing, hearing and burnout, diabetes and hearing loss, and quality professional hearing care – and was well-placed to review the international research into the relationship between hearing and dementia. He is a highly experienced and qualified Audiologist and Speech Pathologist.

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Foreword

This white paper covers the most current research into hearing loss, hearing care and dementia. Every research article quoted in this paper has been published in a peer-reviewed journal in the last four years. It has been commissioned by the Hearing Care Industry Association of Australia (HCIA). In the context of World Hearing Day 2021, it aims to draw the attention of policy makers to the urgency in addressing age-related hearing loss to avoid much greater healthcare burdens – specifically dementia. The Royal Commission into Aged Care Quality and Safety also raised the increasing challenges faced by the Aged Care sector in relation to Dementia.

Dementia is now the second leading cause of death in Australia and the leading cause of death among women. It is a highly visible disease, with over 472,000 people with dementia in Australia. This number is expected to grow to 590,000 in the next seven years and pass 1,000,000 in 2058. It is also currently estimated that over half of all aged care residents in Australia have dementia. The process of ageing need not be associated with decreased quality of life, depression or cognitive decline to a point of dementia.

Hearing loss in mid-life is the largest modifiable risk factor for age-related dementia.

This white paper highlights the scientific link between hearing loss and cognitive decline, and the positive impact early intervention through access to appropriate hearing aids and associated services can have on reducing the risk of dementia. This data presents policy makers with a critical choice relating to early hearing treatment intervention and reducing the impact of dementia.

Deferring hearing care treatment until well into old age is often too late. The cognitive decline and deficit are often well established, and they result in greater difficulties for an aged person to effectively and confidently adapt physically and psychologically to any hearing care support. An aged care resident with a hearing aid languishing in a drawer is a travesty and sadly, a common occurrence.

Within the context of an ageing population and increasing costs of providing aged care, now is the time to seize the opportunity for a preventative hearing health strategy that will address the link between age-related hearing loss and dementia.

Australia has an opportunity to lead the world in life-long hearing health care by actively funding those in mid-life (40-64 years) to have their hearing tested and when appropriate, access to hearing aids and associated services.

The HCIA thanks Mark Laureyns for his contribution to this important public policy issue.

Mr Ashley Wilson AM
Chair, HCIA

Introduction

When Dr Richard Uhlmann and colleagues from the University of Washington published their article, "Relationship of Hearing Impairment to Dementia and Cognitive Dysfunction in Older Adults" in 1989 (ref 100), it did not attract a lot of interest. Only when Dr Frank Lin and colleagues from The Johns Hopkins School of Medicine in Baltimore published their findings, "Hearing Loss and Incident Dementia" in 2011 (ref 95), did the topic of the relationship between hearing loss and dementia start to gain attention in academic and health care systems as well as mainstream media. Interestingly, the findings from Uhlmann and Lin were very comparable, although the methodology was different. In the Uhlmann case control study, a matched design was used (100 subjects), while in the Lin study was longitudinal in design (690 subjects were followed between 2008 and 2011). These studies both concluded that the risk (odds to hazard ratio) of developing dementia increased significantly with increasing hearing loss.

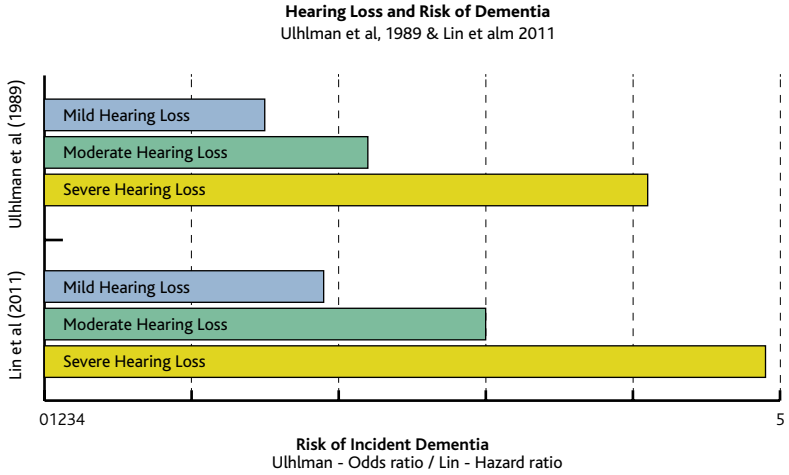
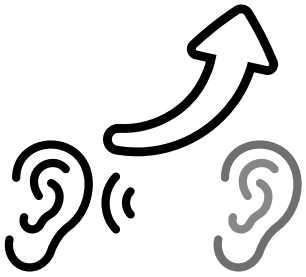


Fig 1. The risk to develop dementia related to the level of hearing loss. On the left pane, the data is based on Uhlmann et al, 1989 and on the right pane, the data is based on Lin et al, 2011. Notice that for both studies, there is a significant increase of the odds ratio between "Mild Hearing Loss" (blue), "Moderate Hearing Loss" (green) and "Severe Hearing Loss" (yellow).

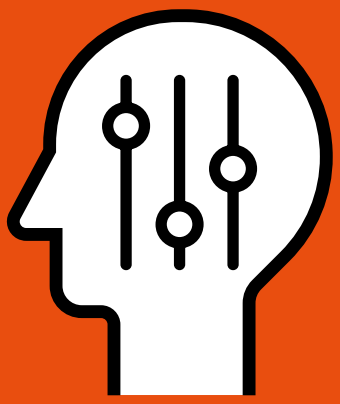
Since 2011, many studies have followed. This whitepaper focuses on research that has studied the various aspects of the relationship between hearing loss and dementia, and has been published in peer reviewed scientific journals from 2017 to March 2021. In total, 90 publications met the inclusion criteria for review in this whitepaper (see references).

Dementia is now the second leading cause of death in Australia

1 in 10 over 65's have dementia costing the economy more than $15 billion

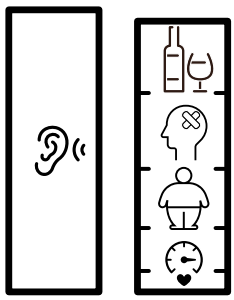


The risk of developing dementia increases significantly with increasing hearing loss



Hearing loss in mid-life is the largest modifiable risk factor for age-related dementia

The benefits of reducing the symptoms of dementia relative to the total cost of hearing aids is a ratio of around 30:1



Unaddressed hearing loss was identified as responsible for more dementia among older adults than other risk factors including alcohol overconsumption, traumatic brain injury, obesity and hypertension combined

Key themes in Research

The research has focused on four key areas, as follows:

- The relationship between hearing loss and cognitive decline.
- The physiology and biology of this relationship.
- The impact of hearing treatment on cognitive decline.
- The economic impact.

The following section will focus on the findings in these critical areas of hearing loss and cognitive decline.

Relationship between Hearing Loss and Cognitive Decline

Following on from the initial work of Dr Richard Uhlmann and colleagues (ref 100) and Dr Frank Lin (ref 95), substantial effort has gone into further understanding this critical relationship between hearing loss and cognitive decline. In the 90 peer reviewed research papers we have collated, we will highlight the findings of six studies that explore this relationship, as follows:

- Hearing loss is positively associated with risk of Mild Cognitive Impairment (MCI) and dementia (ref 66) and this correlation has been established in an Australian population based study. (ref 55)
- The impact of severity of hearing loss on dementia incidence has been established. (ref 13)
- The risk of cognitive decline increases with a younger age of hearing loss onset. (ref 13)
- The risk is especially prevalent in patients aged 45 – 64 years. (ref 66)
- The role of a marginal hearing loss (or subclinical hearing loss) in increasing the risk of cognitive decline has been identified (ref 24) supporting further consideration of treating marginal hearing losses.
- The risk of dementia was higher among patients with sudden hearing loss onset. (ref 37)
- The role of other comorbidities, specifically diabetes, with hearing loss, is associated with a higher risk of incident dementia. (ref 56)

This body of work substantiates the positive association between hearing loss and higher risk of cognitive decline or dementia.

The Physiology and Biology of the Relationship between Hearing Loss and Cognitive Decline

As part of the process of understanding the association and the possible effective treatments to reduce this association, the research assessed the physiological and biological models and markers of this relationship. Initially the research studied animal models and found:

- Specific biomarkers for Alzheimer's disease were related to cognitive impairment after hearing loss in a rat-model. (ref 45)
- Hearing loss may act as a risk factor for cognitive impairment in Alzheimer's disease due to indications that hearing loss may cause a part of the brain (hippocampal synapses) to be more vulnerable to a bio marker (Amyloid-ß (Aß) for Alzheimer's disease. (ref 59)

These results were replicated and further understood in human brain tissue, as follows:

- Hearing loss is associated with higher levels of ß-amyloid, a key biomarker for Alzheimer's disease. (ref 45)
- Age related hearing loss (presbycusis) causes reduced auditory nerve responses, which is associated with slower processing speed and brain structural changes in temporal and parietal regions. (ref 19)

This evidence provided an impetus to understand the effect of treating hearing loss to reduce the risk of cognitive decline.

The impact of Hearing Treatment on Cognitive Decline.

The most effective, and therefore most common mode of hearing loss treatment or intervention is hearing aids and/or hearing implants (such as cochlear implants). This body of research focused on the benefits of hearing aids and/or implants and cognitive functioning, as follows:

- Well-fitted hearing amplification may promote more typical cortical organization and functioning and provide cognitive benefit. (ref 22)
- Treatment of hearing loss with hearing aids may delay cognitive decline. (ref 13)
- Although hearing loss and cognition are linked, untreated hearing loss drives this association. For subjects with hearing loss, using hearing aids, there was no difference compared to subjects with no hearing loss. (ref 73)
- Providing hearing aids or other rehabilitative services for hearing impairment much earlier in the course of hearing impairment may stem the worldwide rise of dementia. (ref 80)
- Cognitive decline associated with age-related hearing loss is probably preventable by early rehabilitation and increased opportunistic screening for the elderly. (ref 73)
- Self-reported hearing loss is associated with increased risk of disability, dementia, and also depression in men. Such increased risks were not evidenced in those older adults using hearing aids. (ref 1)

Further the positive mental health association with hearing aid and/or hearing implant was established:

- Hearing aid use was associated with fewer Neuro-Psychiatric-Symptoms, lower severity, and less severe depressive symptoms. (ref 35)
- Identifying and addressing hearing loss may be a promising, low-risk, non-pharmacological intervention in preventing and treating Neuro-Psychiatric-Symptoms. (ref 35)

The Economic Aspects of Hearing Care to Delay or Prevent Dementia

Currently research is emerging on the cost-benefit analysis of hearing aids in reducing the incidence and the severity of dementia. One study (ref 58) has assessed the total benefits of hearing aids to reduce the symptoms of dementia, finding that the majority of the benefits were direct benefits, at a cost-benefit ratio of approximately 30. The economists deduced that the role of hearing aids in mitigating the rise of dementia should be acknowledged.

Dementia Prevention and Hearing Care

The rising prevalence of dementia resulted in The Lancet Commission publishing two reports (2017 and 2020) on "Dementia prevention, intervention, and care". In both reports, hearing loss was identified as the modifiable risk factor for dementia with the highest positive impact in mid life (40-65 years of age).

Further, in the 2020 report The Lancet Commission noted the additional research on the association between hearing loss, hearing loss treatment and dementia risk (ref 1, 73 and 80), resulting in The Lancet authors recommending access to appropriate hearing services, that provides hearing aids and the help to wear the aids.

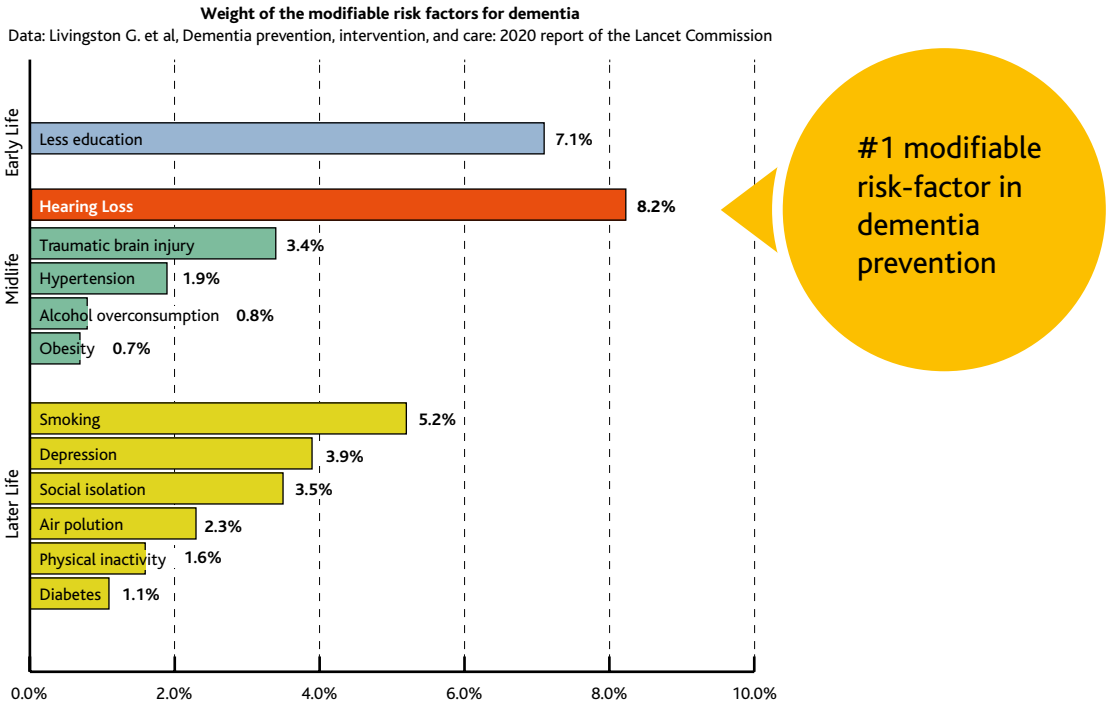


Fig 2. Weight of the modifiable risk factors for dementia. This graph is based on the data from "Livingston G. et al 2020". The risk factors for "Early Life" (blue), "Midlife" (orange & green) and "Later life" (red) are grouped yellow

World Health Organisation – "World Report on Hearing"

On the 3rd of March 2021 (World Hearing Day), the World Health Organisation (WHO) launched the "World Report on Hearing". The report[1] highlights the synthesis of the research in this area. The WHO concluded:

- Hearing loss is the largest potentially modifiable risk factor for age-related dementia.
- Adult hearing screening and early intervention becomes even more relevant given the links between hearing loss and dementia.
- Addressing hearing through hearing devices may have a positive influence on an individual's cognition.
- The use of hearing aids can also protect against cognitive decline and dementia.
- The use of hearing devices is shown to be cost-effective in different economic settings.

Conclusions

Dementia is now the second leading cause of death in Australia and the leading cause of death among women. It is a highly visible disease, with over 472,000 people suffering dementia in Australia. This number is expected to grow to 590,000 in the next seven years and pass 1,000,000 in 2058. It is also currently estimated that over half of all aged care residents in Australia have dementia. The process of ageing need not be associated with decreased quality of life, depression or cognitive decline to a point of dementia.

The peer reviewed published research has established the association between hearing loss and dementia; the positive impact of hearing intervention by means of hearing aids and/or hearing implants; and the economic impact of such intervention. The Lancet Commission crystallised this plethora of research with identifying hearing loss as the modifiable risk factor for dementia with the highest positive impact in mid life (40-65 years of age).

The recent WHO "World Report on Hearing" echoes the research, concluding for world leaders that hearing loss is the largest potentially modifiable risk factor for age-related dementia. Early intervention is warranted, it has a positive influence on cognition, reducing the risk of dementia and is cost-effective.

Further, in the near future, longitudinal interventional studies will become available on the impact of hearing care as a way to modify hearing loss as a risk factor for dementia.

The scientific community is in agreement and the consensus has been established on the role of hearing loss, hearing care and dementia. With the rising prevalence of dementia, and the devastating impact it has, the research will continue into this compelling public health area.

[1] This report is available at: https://www.who.int/activities/highlighting-priorities-for-ear-and-hearing-care

Appendix

The details, results and conclusions found in the most recent research.

Studies on the effect of hearing loss correction, with hearing aids and cochlear implants on the reduction of cognitive decline.

JOURNAL OF CLINICAL MEDICINE

Amieva H. et al. Death, Depression, Disability, and Dementia Associated with Self-reported Hearing Problems. 2020 (ref 1)

In this French PAQUID longitudinal epidemiological study, a community of 3,777 people in the region of Bordeaux was followed up for 25 years. Hearing loss and hearing aid use was based on self-reports (1,289 self-reported hearing problems and 2,290 self-reported having no hearing problems). Dementia was diagnosed in three steps. Initially, an interview was conducted by a psychologist who also filled out a checklist for dementia. When results were positive, the participants were seen by a neurologist or geriatrician to double-check the diagnosis; and finally, all the available data was checked by an independent panel of neurologists who specialised in dementia.

- *The subjects with self-reported hearing loss, had an increased risk of 1.18 (hazard ratio – p = 0.02) compared to subjects with self-reported normal hearing*
- *The subjects with self-reported hearing loss, not using hearing aids, had an increased risk (hazard ratio) of 1.21 (hazard ratio – p = 0.01) compared to subjects with self-reported normal hearing*
- *The subjects with self-reported hearing loss and using hearing aids, didn't have an increased risk (hazard ratio) of 0.86 (hazard ratio – p = 0.48) compared to subjects with self-reported normal hearing.*

The conclusions of this study: *Our study shows that self-reported hearing trouble is associated with increased risk of disability, dementia, and also depression in men. Such increased risks were not evidenced in those older adults using hearing aids. Because hearing impairment in older adults is both highly prevalent and treatable,* ***these results highlight the importance of formally assessing the consequences of treating hearing loss in elders in further RCT studies***. [emphasis added]

JAMA OTOLARYNGOLOGY – HEAD & NECK SURGERY

Ray M. et al. Association of Cognition and Age-Related Hearing Impairment in the English Longitudinal Study of Ageing – 2020 (ref 73)

This study was part of the English Longitudinal Study of Ageing (ELSA), in which 7,385 subjects, all living in the UK and in a community setting, met the criteria for this specific study. Hearing loss was evaluated with a hearing screener device (51.6% had hearing loss: 41.4% had mild hearing loss, with 10.2% with moderate-severe hearing loss). Hearing aid use was based on self-report (11% of the

total group and 22% of the group with hearing loss) and memory (recall of 10 uncorrelated words) and executive function (naming as many animals as they can in 60 seconds) were evaluated as measures of cognitive function.

- *For subjects with mild hearing loss, the mean memory assessment score is a 0.5 point (95%CI) lower than those with no hearing loss*
- *For subjects with moderate-severe hearing loss, the mean memory assessment score is a 1 point (95%CI) lower than those with no hearing loss*
- ***For subjects with hearing loss using hearing aids, there was no difference compared to subjects with no hearing loss.*** [emphasis added]

The conclusions of this study: *Although hearing loss and cognition are linked, untreated hearing loss drives the association. Social isolation is a mediating factor in the link for those who have untreated hearing loss.* ***Cognitive decline associated with ARHI is probably preventable by early rehabilitation and increased opportunistic screening for the elderly.***

JOURNAL OF THE AMERICAN GERIATRICS SOCIETY

Maharani A. et al, Longitudinal Relationship Between Hearing Aid Use and Cognitive Function in Older Americans – 2018 (ref 80)

The study was based on data from the Health and Retirement Study (HRS), a longitudinal study in the US in which 20,000 participants were followed since 1990. This specific study only selected subjects from Wave 3 or later, since they wanted to include the memory scores using 10 words, subjects aged 50 years or older, and those who started to use hearing aids for the first time between Wave 4 and 11 of the study. This resulted in a sample of 2,040 subjects which were followed for 18 years (from 1996 to 2014). Hearing aid use was self-reported and episodic memory was evaluated by a 10-word immediate recall and delayed recall test.

- *For all subjects, the results on the episodic memory test, reduced over time*
- *Before the subjects started using hearing aids, the slope of decline was ß = –0.11 (p <0,001)*
- *After the subjects started using hearing aids, the slope of decline was significantly smaller ß =–0.03 (p <0,001)*
- *The use of hearing aids resulted in a better episodic memory score of ß = 2.13 (p<.001)*

The conclusions of this study: *Hearing aids may have a mitigating effect on trajectories of cognitive decline in later life.* ***Providing hearing aids or other rehabilitative services for hearing impairment much earlier in the course of hearing impairment may stem the worldwide rise of dementia.***

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FRONTIERS IN NEUROSCIENCE

Glick H & Sharma A. Cortical Neuroplasticity and Cognitive Function in Early-Stage, Mild-Moderate Hearing Loss: Evidence of Neurocognitive Benefit from Hearing Aid Use. 2020 (ref 22)

In this study, 41 subjects participated (average age 64 years) and they were all native English speakers. The test group consisted of 28 subjects with Age-Related Hearing Loss (ARHL) and had never previously used hearing aids. The control group consisted of 13 subjects with normal hearing and the two groups were gender and age matched. Hearing loss was evaluated with tonal audiometry (the High Pure Tonal Average - HPTA was calculated) and a speech in noise test (QuickSin). The ARHL group was fitted with hearing aids after the intake (quality fitting with verification and follow up) and used them for six months; and were required to wear them for at least five hours daily. Since eight participants dropped out, the final test group consisted of 21 subjects. In this study, the "cross-modal re-organization" (CMR) was also evaluated. This is a form of cortical compensation observed in subjects with severe and moderate levels of hearing loss whereby the auditory cortex is re-organised to process stimuli from intact visual and somatosensory modalities. CMR was evaluated by measuring Cortical Visual Evoked Potential Latencies. (CVEP Latency)

- *The CVEP Latency P1 (ms) increased significantly with increasing hearing loss (HPTA in dBHL) (r=0.74/p<0.001)*
- *The CVEP Latency P1 (ms) increased significantly with poorer QuickSin – Speech in Noise in Test scores (dB SNR loss) (r=0.74/p<0.001)*
- *The CVEP Latency P1 (ms) improved significantly (=reduced in latency) post hearing aid fitting for the ARHL group (t=4.15/p<0.001)*

The conclusions of this study: *Following clinical treatment with hearing aids, a reversal in cross-modal re-organisation of auditory cortex by vision was observed in the Age-Related Hearing Loss group, coinciding with gains in speech perception and cognitive performance. Thus, beyond the known benefits of hearing aid use on communication, outcomes from this study provide* ***evidence that clinical intervention with well-fitted amplification may promote more typical cortical organization and functioning and provide cognitive benefit.***

THE AMERICAN JOURNAL OF GERIATRIC PSYCHIATRY

Kim A. et al, Association of Hearing Loss with Neuropsychiatric Symptoms in Older Adults with Cognitive Impairment. 2020 (ref 35)

The 101 participants (average age 76 years) who entered the study were recruited from the Johns Hopkins Memory and Alzheimer's Treatment Center in Baltimore (US). Hearing Loss was measured with Tonal Audiometry (PTA better ear at 0.5, 1, 2 and 4 kHz; 67 per cent had hearing loss and 22 per cent were using hearing aids), the Neuro-Psychiatric-Symptoms (NPS) were evaluated with the Neuropsychiatric Inventory Questionnaire (NPI-Q) and Depression was evaluated with the Cornell Scale for Depression in Dementia (CSDD). All these tests were part of the routine care these patients were receiving in the Treatment Center.

- *Hearing Loss (PTA) and the number of Neuro-Psychiatric-Symptoms (NPS) were positively related (b = 0.7/10 dB; 95% CI) – The more severe the hearing loss, the higher the number of NPS*

- *Hearing Loss (PTA) and the NPS severity score were positively related (b = 1.3 /10 dB; 95% CI) – The more severe the hearing loss, the higher severity score of the NPS*
- *Hearing Loss (PTA) and the depressive symptom severity were positively related (b = 1.5 /10 dB; 95% CI) – The more severe the hearing loss, the higher the depressive symptom severity*
- *The risk of dementia (hazard ratio) is 1.69 for subjects with (SHL) compared to those with normal hearing*
- *The use of hearing aids (HA-use) and the number of Neuro-Psychiatric-Symptoms (NPS) were negatively related (b = -2.09; 95% CI; p = 0.003) – "Hearing aid users" had a lower number of NPS compared to the "non-users"*
- *The use of hearing aids (HA-use) and the NPS severity score were negatively related (b = -3.82; 95% CI; p = 0.03) – "Hearing aid users" had a lower severity score of the NPS compared to "non-users"*
- *The use of hearing aids (HA-use) and the depressive symptom severity were negatively related (b = -2.94; 95% CI; p = 0.05) – "Hearing aid users" had a lower depressive symptom severity compared to the "non-users"*

The conclusions of this study: *Among patients at a memory clinic,* ***increasing severity of hearing loss was associated with a greater number of Neuro-Psychiatric-Symptoms (NPS), more severe NPS, and more severe depressive symptoms, while hearing aid use was associated with fewer NPS, lower severity, and less severe depressive symptoms. Identifying and addressing hearing loss may be a promising, low-risk, non-pharmacological intervention in preventing and treating NPS.***

NATURE RESEARCH - SCIENTIFIC REPORTS

Sarant J. et al. The Effect of Hearing Aid Use on Cognition in Older Adults: Can We Delay Decline or Even Improve Cognitive Function? Journal of Clinical Medicine. 2020 (ref 13)

This study was conducted in Australia by a researcher from the Department of Audiology and Speech Pathology in the University of Melbourne. Ninety-nine (99) subjects (mean age 72.5 years) were enrolled with confirmed hearing loss and no earlier diagnosis of cognitive impairment. Hearing loss was assessed with tonal audiometry, speech audiometry in quiet and in noise and the Abbreviated Profile of Hearing Aid Benefit (APHAB) questionnaire. Cognition was assessed with the Mini Mental State Examination (MMSE), the CogState Battery, the Groton Maze Learning Test (GML) for executive function, the Detection Test (DET) for psychomotor function, the Identification Test (IDN) for visual attention, the One Card Learning Test (OCL) for visual learning and the One Back Test (ONB) for working memory. All subjects were fitted with hearing aids, these were selected based on the hearing loss, patient preference and communication needs. All were fitted according the NAL-NL2 prescription rule and Real Ear Measurement Verification was used. They had follow-up sessions with fine-tuning and verification after 2 to 4 weeks, further reviews as seen appropriate with their managing audiologist and routinely after 12 and 18 months after fitting by a team audiologist.

Hearing aid use: After 18 months, 59% of the participants used their hearing aids at least 60%–90% of the time.

Results pre/post fitting (after 18 months) on the "CogState" battery for all subjects:

• *executive function*	*GML pre: 58.8 / GML post: 51 –*	*p= 0.001**
• *psychomotor function*	*DET pre: 2.6 / DET post: 2.6 –*	*p= 0.08*
• *working memory*	*ONB pre: 2.96 / ONB post: 2.04 –*	*p= 0.21*
• *visual attention*	*IDN pre: 2.8 / IDN post: 2.8 –*	*p= 0.87*
• *visual learning*	*OCL pre: 2.94 / OCL post: 2.96 –*	*p= 0.26*

One would expect a slow rate of decline with this aged group after 18 months, and the use of hearing aids keeps the cognitive test results stable or even improved for executive function.

The conclusions of this study: ***Relative stability and clinically and statistically significant improvement in cognition were seen in this participant group of older adults after 18 months of hearing aid use***, *suggesting that* ***treatment of hearing loss with hearing aids may delay cognitive decline***. *Given the small sample size, further follow up is required.*

Studies on the relationship between hearing loss and dementia

AGEING, NEUROPSYCHOLOGY, AND COGNITION

Strutt P. et al, Hearing loss, cognition, and risk of neurocognitive disorder: evidence from a longitudinal cohort study of older adult Australians. 2020 (ref 55)

This study used data from 1,037 Australian subjects who took part in the Sydney Memory and Ageing Longitudinal Study. Hearing Loss and the level of hearing loss was based on self-report (Likert type scale 1-4). From the total group, 424 (41%) mean age 79 years, self-reported hearing difficulties and 613 (59%) mean age 78 years, self-reported normal hearing. The cognitive domain was assessed with the "Trail-Making Test" and the "Digit–Symbol Coding Test" for "attention and processing speed", the Bosting Naming Test for "language", the Block Design subtest from the WAIS-R for Visuospatial ability, the Rey Auditory Verbal Learning Test (RAVLT) for "learning", recalling the items from the RAVLT and a story from the Logical Memory subtest from the WMS-III for "recall", the Controlled Oral Word Association Test, the total time taken to complete the Trail-Making Test Part B for "executive functioning", and for "Global Cognition", the results on the earlier items were pooled. An expert panel defined the level of Mild Cognitive Impairment and Dementia for each subject.

- *Mild hearing difficulties were not associated an increased risk for the neurocognitive disorder compared to subjects self-reporting normal hearing Hazard Ratio - HR = 0.93*
- *Moderate-severe hearing difficulties were associated an increased risk for the neurocognitive disorder compared to subjects self-reporting normal hearing Hazard Ratio - HR = 1.84*
- *For subjects with healthy cognition at baseline, significant hearing difficulties emerged as a significant risk factor for MCI during the follow-up period Hazard Ration - HR = 1.59*

The conclusions of this study: *This study provides further* ***evidence of the impact of hearing loss on cognitive abilities as well as risk for MCI and dementia in older adults.***

OTOLOGY AND NEUROTOLOGY

Lin CC., Lin HC. & Chiu HW. Increase Risk of Dementia in Patients with Sudden Hearing Loss: A Population-Based Cohort Study With 7-Year Follow-Up in Taiwan (2020) (ref 37)

This retrospective study used the Taiwan national health insurance (NHI) database to investigate the prevalence and risk of subsequent dementia in individuals with sudden hearing loss (SHL) compared to age and gender matched cohorts within a follow-up period of seven years. The study sample was comprised of 1,858 subjects with SHL and no associated risk factor who were above 40 years of age, and 9,290 control subjects. At the end of the seven-year period, a total of 89 subjects and 478 were still alive in the study cohort group and in the comparison cohort group, respectively.

- *The incidence of dementia was 20/1,000 for the group with sudden hearing loss (SHL) compared to 8/1,000 for the control group*
- *The risk of dementia (hazard ratio) is 1.69 for subjects with (SHL) compared to those with normal hearing.*

The conclusions of this study: This study revealed a relationship between sudden hearing loss and dementia in an Asian country. ***The risk of dementia was higher among patients with sudden hearing loss compared with matched cohorts during the 7-year follow-up period.***

NATURE RESEARCH - SCIENTIFIC REPORTS

Chang Y. et al, Association between the severity of hearing loss and the risk of dementia within the 2010–2017 national insurance service survey in South Korea – 2020 (ref 13)

This longitudinal study was conducted, using the data obtained from the nationwide South Korean National Health Information Database. The available patient data from 2010 to the end of 2017 were used. Hearing loss was determined by a tonal audiogram and the Pure Tone Average (PTA) was calculated at 0.5, 1, 2 and 4 kHz. For severe hearing loss, the PTA needed to be confirmed by Auditory Brainstem Response (ABR) or Auditory Steady State Responses (ASSR). Non-severe hearing loss was defined as a both-side hearing loss with at PTA between 60 and < 80 dB HL. Severe hearing loss was defined as both-side hearing loss with at PTA between 80 and up to ≥ 90 dB HL and speech disorder. Ipsilateral hearing loss was defined as hearing loss with at PTA at the worst ear ≥ 80 dB HL and ≥ 40 dB HL the other ear. Dementia was defined based on the medication that was prescribed.

For all age groups

- *The hazard ratio (HR) for all dementia types was 1.34 (95% CI) in the severe HD group*
- *The hazard ratio (HR) for all dementia types was 1.31 (95% CI) in the non-severe HD group*
- *The hazard ratio (HR) for all dementia types was 1.26 (95% CI) in the ipsilateral HD group*

For all age group younger than 65 years

- *The hazard ratio (HR) for all dementia types was 1.93 (95% CI) in the severe HD group*
- *The hazard ratio (HR) for all dementia types was 1.88 (95% CI) in the non-severe HD group*
- *The hazard ratio (HR) for all dementia types was 1.60 (95% CI) in the ipsilateral HD group*

For all age group ≥ 65 years

- *The hazard ratio (HR) for all dementia types was 1.23 (95% CI) in the severe HD group*
- *The hazard ratio (HR) for all dementia types was 1.28 (95% CI) in the non-severe HD group*
- *The hazard ratio (HR) for all dementia types was 1.30 (95% CI) in the ipsilateral HD group*

The conclusions of this study: *This study demonstrates that the **impact of hearing loss on dementia incidence is severity-dependent**, and the **risk increases in patients younger than 65 years of age**.*

JAMA OTOLARYNGOLOGY – HEAD & NECK SURGERY

Golub, J. et al, Association of Subclinical Hearing Loss with Cognitive Performance. (ref 24)

A total of 5,190 participants from both the Hispanic Community Health Study (HCHS) and 1,392 participants from the National Health and Nutrition Examination Study (NHANES) met the inclusion criteria (older than 50 years, no early onset hearing loss, audiometry and cognitive testing test results available) and were included in this cross-sectional study. Hearing loss was evaluated by pure tone audiometry and the 4 – frequency Pure Tone Average (PTA) was based on the better ear result at 0.5, 1, 2 and 4 kHz. Cognitive Performance was assessed by the Digit Symbol Substitution Test (DSST), Word Frequency Test, Spanish-English Verbal Learning Test (SEVLT) and the Six-Item Screener test.

The relation between hearing loss (PTA) and the Digit Symbol Substitution Test (DSST)

- *All subjects (HCHS & NHANES):–1.10 score difference per 10-dB Decrease in Hearing*
- *Normal hearing, ≤25 dB: –2.28 score difference per 10-dB Decrease in Hearing*
- *Hearing loss, >25 dB: –0.97 score difference per 10-dB Decrease in Hearing*
- *Normal hearing, ≤15 dB: –3.94 score difference per 10-dB Decrease in Hearing*
- *Hearing loss, >15 dB: –0.63 score difference per 10-dB Decrease in Hearing*

The conclusions of this study: *An independent association was observed between cognition and subclinical Hearing Loss. The association between hearing and cognition may be present earlier in Hearing Loss than previously understood. Studies investigating whether treating Hearing Loss can prevent impaired cognition and dementia should consider a lower threshold for defining Hearing Loss than the current 25-dB threshold.*

JOURNAL OF INTERNAL MEDICINE

Tomata Y. et al, Joint impact of common risk factors on incident dementia: A cohort study of the Swedish Twin Registry: Impact of risk factors on incident dementia. 2020 (ref 56)

In this cohort study, 9,017 subjects from the Swedish Twin Registry (mean age 72 years), who met the inclusion criteria at the time of the interview, were enrolled in the study (i.e. 60 years or older, no cognitive issues and information on the 9 risk factors available). The focus of the study was to evaluate 9 potential risk factors for incident dementia: low education, hearing loss, hypertension, obesity, smoking, depression, physical inactivity, diabetes and living alone. Hearing loss was evaluated by self-reporting. Dementia was assessed through patient records, prescribed medication, Mini Mental State Examination and a consensus diagnosis.

- *The hazard ratio (HR) of self-reported hearing loss for dementia was 1.29 (95% CI).*
- *The hazard ratio (HR) of diabetes for dementia was 1.33 (95% CI).*

The conclusions of this study: *The nine risk factors may have considerable impact as modifiable factors on incident dementia.* ***Hearing loss*** *and diabetes displayed* ***the higher Hazard Ratios*** *and were* ***statistically significantly associated with a higher risk of incident dementia.***

JAMA NETWORK OPEN

Liu C. & Lee C. Association of Hearing Loss with Dementia - 2019 (ref 66)

In this population-based cohort study, data were used from the National Health Insurance Research Database of Taiwan. In the test group, 8,135 patients with a new diagnosis of hearing loss in the years 2000 and 2011, were enrolled. They were matched (gender, age, residence and insurance fee) with 8,135 subjects with normal hearing in the control group.

- *Dementia incidence rate in the Test Group (HL) was 19.38 per 1000 person-year*
- *Dementia incidence rate in the Control Group (NH) was 13.98 per 1000 person-year*
- *The dementia incidence rate was significantly higher for the Test Group compared to the Control Group (95% CI)*

- *Patients with HL* *had a Dementia Hazard Ratio (HR) of 1.17 (95% CI)*
- *Female Patients with HL* *had a Dementia Hazard Ratio (HR) of 1.13 (95% CI)*
- *Male Patients with HL* *had a Dementia Hazard Ratio (HR) of 1.20 (95% CI)*
- *Patients 45-64y with HL* *had a Dementia Hazard Ratio (HR) of 2.21 (95% CI)*
- *Patients 65-74y with HL* *had a Dementia Hazard Ratio (HR) of 1.13 (95% CI)*
- *Patients ≥75y with HL* *had a Dementia Hazard Ratio (HR) of 1.07 (95% CI)*

The conclusions of this study: *In this study,* ***hearing loss was positively associated with a risk of dementia, especially in patients aged 45 to 64 years. Hearing protection, screening, and treatment may be used as strategies for mitigating this potential risk factor.***

Studies on animal models of the relationship hearing loss and dementia

CLINICAL AND EXPERIMENTAL OTORHINOLARYNGOLOGY

Mun S. et al, MicroRNAs Related to Cognitive Impairment After Hearing Loss. 2020 Clinical and Experimental Otorhinolaryngology - 2020 (ref 45)

In this rat-model, on 18 normal-hearing rats (confirmed by Auditory Brain Response ABR), amyloid-ß was administered to the brain, at a level that does not lead to cognitive decline but makes the brain more susceptible to risk factors. The group was divided in a test group which underwent surgery for cochlear ablation and a control group which also underwent surgery, but the cochlea was left intact. After 11 weeks, the rats were assessed on cognitive function by different tasks and microarray analysis of the miRNAs (biomarkers for Alzheimer's Disease) was conducted.

- *The relative quantification values (RQ) of miRNAs (biomarkers for Alzheimer's Disease) miR-376a-3p and miR-598-3p were significantly higher for the deaf group compared with the control group (**P<0.01)*
- *The results of cognitive tasks "object-in-place task (OPT)", "object location task (OLT)" and "Y-maze test" were significantly poorer for the deaf group compared with the control group (***P<0.001)*

The conclusions of this study: *These results indicate that the biomarkers for Alzheimer's Disease miR-376a-3p and miR-598-3p were related to cognitive impairment after hearing loss in a rat-model.*

BEHAVIOURAL BRAIN RESEARCH

Chang M. et al, Hearing loss as a risk factor for cognitive impairment and loss of synapses in the hippocampus. 2019 (ref 59)

This study was rolled out in two stages, in the first stage 10 seven-week-old male Wistar rats were studied and in the second stage 26 rats randomly assigned to 4 subgroups

• Normal Hearing – No subthreshold amyloid-ß	(NH-NA)	n=6
• Normal Hearing – Subthreshold amyloid-ß	(NH-SA)	n=6
• Deaf – No subthreshold amyloid-ß	(D-NA)	n=7
• Deaf – Subthreshold amyloid-ß	(D-SA)	n=7

The deaf subgroup had bilateral cochlear ablation surgery, the normal hearing group, had sham surgery. The subthreshold amyloid-ß, were receive an infusion with an Aß peptide solution for two weeks with a dose that does not lead to cognitive decline, but with the intention to create damage to make the brain more vulnerable to development dementia. Pre-surgery, Auditory Brainstem Responses have been measured on all rats, to ensure they were normal hearing. Cognitive performance was evaluated by the Y-maze test (related to working memory), object-in-place task (OPT) the object location task (OLT) and the novel object recognition task (NOR). All these tests were conducted,

before the surgery (baseline and respectively at 7-, 9- and 11-weeks post-surgery.

- *The Y-maze task results, were significantly poorer for the deaf SA group than for the nomal-hearing SA group 11 weeks after the surgery. (p=0.014) (no significant differences at 7 or 9 weeks)*

At 11 weeks after surgery:

- *The Y-maze task results were significantly poorer for the deaf SA group than for the 3 other groups: Deaf-NA (p= 0,036), NH-SA (p= 0.017) and NH-NA (p= 0.003)*
- *The object-in-place task (OPT) results were significantly poorer for the deaf SA group than for the 3 other groups: Deaf-NA (p= 0.003), NH-SA (p< 0,0001) and NH-NA (p< 0.0001)*
- *The object location task (OLT) results were significantly poorer for the deaf SA group than for the 3 other groups: Deaf-NA (p= 0,009), NH-SA (p< 0,0001) and NH-NA (p< 0.0001)*
- *There were no significant differences for the novel object recognition task (NOR)*

The conclusions of this study: *The present results suggest that* ***hearing loss may act as a risk factor for cognitive impairment in Alzheimer's disease****. Additionally,* ***the present findings indicate hearing loss may cause hippocampal synapses to be more vulnerable to subthreshold Amyloid-ß (Aß)-induced damage.***

Studies on human brain tissue, biomarker, changes in the relationship hearing loss and dementia

CLINICAL AND EXPERIMENTAL OTORHINOLARYNGOLOGY

Golub J. et al, The Association Between Early Age-Related Hearing Loss and Brain ß-Amyloid. Laryngoscope - 2020 (ref 45)

98 participants from the Northern Manhattan Study of Metabolism (New York) (mean age 65 years) were evaluated in this study on hearing loss and brain biomarkers of Alzheimer's disease. Hearing Loss was measured with pure tone audiometry and speech audiometry. The brain biomarkers were measured in vivo with PET scans and in this study the focus was one of the key biomarkers for Alzheimer's disease: whole brain ß-amyloid standardized uptake value ratio(ß-amyloid).

- *ß-amyloid increased 0,029 (95% CI]) for every 10 dB increase in pure-tone average (P = 0.030).*
- *ß-amyloid increased 0.061 (95% CI) for every 10% increase in word recognition score (P = 0.012).*

The conclusions of this study: *Hearing loss was associated with higher levels of ß-amyloid, a key biomarker for Alzheimer's disease.*

PLOS ONE

Delano P. et al, Reduced suprathreshold auditory nerve responses are associated with slower processing speed and thinner temporal and parietal cortex in presbycusis - 2020 (ref 19)

This prospective cohort study is part of the Auditory and Dementia study (ANDES) project in Chile. At the time of enrolment, the subjects need to be dementia free (based on the Mini-Mental State Examination), they can have different levels of hearing loss, but should not be using hearing aids. The audiologic evaluation consisted of pure tone audiometry (PTA), distortion product otoacoustic emissions (DPAOE) and auditory brainstem responses (ABR). Cortical thickness was measured as part of the morphometric analyses. 3T- magnetic resonance imaging (MRI) was performed to measure the volume and thickness of bilateral cortical regions.

The correlation between ABR amplitudes Wave I and cortical thickness *(we only list the 5 highest correlations)*:

- *Left hemisphere - Superior parietal:* *r= 0.26 p= 0.009**.*
- *Left hemisphere - Middle temporal:* *r= 0.26 p= 0.009**.*
- *Right hemisphere - Inferior temporal:* *r= 0.24 p= 0.02*.*
- *Left hemisphere - Inferior parietal:* *r= 0.23 p= 0.02*.*
- *Right hemisphere - Medial orbitofrontal:* *r= 0.23 p= 0.02*.*

The conclusions of this study: *These results evidence that* ***reduced suprathreshold auditory nerve responses in presbycusis are associated*** *with slower processing speed and* ***brain structural changes in temporal and parietal regions.***

OTOLOGY AND NEUROTOLOGY

Armstrong N. et al, Association of Speech Recognition Thresholds with Brain Volumes and White Matter Microstructure: The Rotterdam Study. 2020 (ref 02)

This study is part of the cross-sectional Rotterdam Study in which a total 14,926 subjects aged 45 years and older participated. For this specific study, 2,368 subjects (average age 65 years) who met the inclusion criteria (audiometric evaluation, cognitively normal, Magnetic Resonance Imaging results) were enrolled. Speech Recognition was assessed with a Digits in Noise Test. Brain volumes and White Matter Microstructure were assessed with Multisequence 1.5T MRI imaging and diffusion tensor imaging (DTI).

- There is a positive correlation between result on the Digit in Noise Test (SRT in dB) and parietal lobe volume (mL): difference in mL=0.24, 95% CI: 0.05. (Poorer central auditory speech processing was associated with larger parietal lobe volume)
- Degrees of auditory performance were not associated with brain volumes and white matter microstructure.

The conclusions of this study: ***Central auditory speech processing in the presence of both vascular burden and pure-tone average may not be related to brain volumes and white matter microstructure.*** *Longitudinal follow-up is needed to explore these relationships thoroughly.*

The economic aspects of hearing care to delay or prevent dementia

APPLIED ECONOMICS

Brent R. A cost–benefit analysis of hearing aids, including the benefits of reducing the symptoms of dementia – 2019 (ref 58)

The data used to estimate the benefits of Hearing Aids to reduce symptoms of dementia come from the National Alzheimer's Coordinating Center (NACC) in the United States. This NACC data set has been running since 2005 and includes demographic, clinical, diagnostic, and neuropsychological information on participants with normal cognition, mild cognitive impairment, and dementia who visited 32 US Alzheimer's Disease Centers (ADC). From the full data set, data on 37,544 subjects between 2005 and 2017 were extracted to be used for this study. Quality of Life (QoL) was evaluated with the Geriatric Depression Scale (GDS), short form.

- *The lifetime total benefits of purchasing and wearing Hearing Aids are:* *US$248,425.*
- *The lifetime Hearing Aid costs are:* *US$ 8,499.*
- *This results in a benefit–cost ratio of 29.*

The conclusions of this study: *Our results confirm the findings in the literature that* ***Hearing Aids reduce the symptoms of dementia****. As expected,* ***reducing the symptoms of dementia increases a client's quality of life,*** *as does improved hearing due to wearing Hearing Aids. We found that* ***the total benefits, mainly coming from the direct benefits, were around a quarter of a million dollars and very large relative to the costs, with a benefit–cost ratio of around 30****. However, the indirect benefits were sizeable in that, even if they were the only category of benefits, they alone would be sufficient to cover the Hearing Aids costs.* ***The capacity for Hearing Aids to reduce the symptoms of dementia needs to be acknowledged and added to the list of interventions helping to mitigate the spread of this increasingly prevalent disease.***

References

2020

1. Amieva H. & Ouvrard C. Does Treating Hearing Loss in Older Adults Improve Cognitive Outcomes? A Review. Journal of Clinical Medicine. 2020 Mar 16;9(3): Art. 805. P 1-12
2. Armstrong N. et al, Association of Speech Recognition Thresholds With Brain Volumes and White Matter Microstructure: The Rotterdam Study. 2020 Otology and Neurotology 41: p. 1202–1209.
3. Aylward A. et al, Left Ear Hearing Predicts Functional Activity in the Brains of Patients with Alzheimer's Disease Dementia. August 2020 Annals of Otology, Rhinology & Laryngology. doi:10.1177/0003489420952467. Online First p. 1-7
4. Aylward A., et al, Changes in the Auditory Association Cortex in Dementing Illnesses. Otology and Neurotology (2020): 41(10), 1327–33.
5. Beck et al. Hearing loss and cognition: a discussion for audiologists and hearing healthcare professionals - Journal of Otolaryngology-ENT Research - 2020;12(3):72-78.
6. Bonfiglio V., Umegaki H. & Kuzuya M. A Study on the Relationship between Cognitive Performance, Hearing Impairment, and Frailty in Older Adults. Dementia and Geriatric Cognitive Disorders 2020;49 (2): p. 156–162.
7. Bott A. et al, "It's Huge, in a Way." Conflicting Stakeholder Priorities for Managing Hearing Impairment for People Living with Dementia in Residential Aged Care Facilities. Clinical Gerontologist. 2020 Aug 18;1-15 Online ahead of print.
8. Brenowitz W. et al, Association of genetic risk for Alzheimer disease and hearing impairment. Neurology [Oct]. 2020;95(16): e2225-e2234.
9. Brenowitz W. et al, Clinician Judged Hearing Impairment and Associations with Neuropathologic Burden. Neurology. 2020[Sept 22];95(12): e1640-e1649. (we don't have the original article)
10. Brenowitz W., Kaup A. & Yaffe K. Incident dementia and faster rates of cognitive decline are associated with worse multisensory function summary scores. Alzheimer's & Dementia 2020 Oct;16(10): 1384-1392. (we don't have the article)
11. Brewster K. et al, Age-Related Hearing Loss, Late-Life Depression, and Risk for Incident Dementia in Older Adults - 2020 - The Journals of Gerontology: Series A, 2020; glaa242 p 1-8
12. Bucholc M., McClean P. & Bauermeister S. The impact of hearing loss on cognitive decline and risk of progression to mild cognitive impairment in healthy adults. Alzheimer's & Dementia. 2020;16(Suppl. 6): e044028. (we don't have the article
13. Chang Y. et al, Association between the severity of hearing loss and the risk of dementia within the 2010–2017 national insurance service survey in South Korea – 2020 - Nature Research - Scientific Reports Vol 10: Art. 20679 p 1-8
14. Chen L. & Zhou R. Does self-reported hearing difficulty decrease older adults' cognitive and physical functioning? The mediating role of social isolation. Maturitas 2020 Nov; 141: p. 53-58.
15. Chireh B. & Carl D'Arcy C. A comparison of the prevalence of and modifiable risk factors for cognitive impairment among community-dwelling Canadian seniors over two decades, 1991-2009. PLoS ONE Vol 15 2020 (12): e0242911. p. 1-20
16. Croll P. et al, Hearing loss and cognitive decline in the general population: a prospective cohort study. Journal of Neurology 2020 Sep 10 online ahead of print. (we don't have the article)
17. Croll P. et al, Hearing loss and microstructural integrity of the brain in a dementia-free older population. Alzheimer's & Dementia 2020 Nov;16(11):1515-1523. (we don't have the article)
18. Curhan S. et al, Longitudinal study of self-reported hearing loss and subjective cognitive function decline in women. April 2020 Alzheimer's & Dementia. Vol. 16 (4) p. 610-620
19. Delano P. et al, Reduced suprathreshold auditory nerve responses are associated with slower processing speed and thinner temporal and parietal cortex in presbycusis. 2020 PLoS ONE 15(5): e0233224 p. 1-15
20. Fields T. et al, Self-Reported Hearing Loss and Longitudinal Cognitive Function in a Cohort Enriched with Risk for Alzheimer's Disease. Journal of Alzheimer's Disease, vol. 78, no. 3, pp. 1109-1117, 2020.
21. Ge S. et al, Longitudinal Association Between Hearing Loss, Vision Loss, Dual Sensory Loss, and Cognitive Decline. Dec 2020 Journal of the American Geriatrics Society - ahead of print – p. 1-7
22. Glick H & Sharma A. Cortical Neuroplasticity and Cognitive Function in Early-Stage, Mild-Moderate Hearing Loss: Evidence of Neurocognitive Benefit From Hearing Aid Use. Frontiers in Neuroscience., February 2020, Vol 14, Art. 91, p. 1-22
23. Golub J. et al, The Association Between Early Age-Related Hearing Loss and Brain ß-Amyloid.
24. Golub, J. et al, Association of Subclinical Hearing Loss With Cognitive Performance. JAMA Otolaryngol Head Neck Surg. 2020;146(1):57-67.
25. Gray D. et al, Auditory Processing Deficits Are Selectively Associated with Medial Temporal Lobe Mnemonic Function and White Matter Integrity in Aging Macaques. Cerebral Cortex, Volume 30, Issue 5, May 2020, Pages 2789–2803. (we don't have the article)
26. Gregory S. et al, Experiences of hearing aid use among patients with mild cognitive impairment and Alzheimer's disease dementia: A qualitative study. March 2020 SAGE Open Medicine Vol. 8: p. 1–9
27. Griffiths T. et al, How Can Hearing Loss Cause Dementia? – Neuron Volume 108, Issue 3, 11 November 2020, Pages 401-412
28. Gyanwali B. et al, Hearing handicap in Asian patients with dementia. American Journal of Otolaryngology Vol. 41, (2), 2020, Art. 102377. p. 1-6
29. Ha J. et al, Hearing loss is associated with cortical thinning in cognitively normal older adults. 2020 European Journal of Neurology. Vol27 (6), June 2020 p. 1003-1009.
30. Häggström J. et al, Prognostic Value of a Test of Central Auditory Function in Conversion from Mild Cognitive Impairment to Dementia. Audiology and Neurotology 2020;25: p. 276–282.
31. Hwang P. et al, Dual sensory impairment in older adults and risk of dementia from the GEM Study. Alzheimer's & Dementia2020 Jul 7;12(1): e12054. p. 1-7
32. Jayakody D. et al, Hearing aids to support cognitive functions of older adults at risk of dementia: the HearCog trial- clinical protocols - BMC Geriatrics volume 20, Article number: 508 (2020) p. 1-8
33. Jia F. et al, Cognitive reserve, modifiable-risk-factor profile and incidence of dementia: results from a longitudinal study of CFAS Wales. Aging & Mental Health 2020 [Oct 20]; p. 1-7.
34. Johnson J. et al, Hearing and dementia: from ears to brain – December 2020 Brain, awaa429, p 1-11
35. Kim A. et al, Association of Hearing Loss With Neuropsychiatric Symptoms in Older Adults With Cognitive Impairment. 2020 The American Journal of Geriatric Psychiatry Oct 14; S1064-7481(20)30510-8. Online ahead of print. (we purchased the article)
36. Koops E., de Kleine E. & van Dijk P. Gray matter declines with age and hearing loss, but is partially maintained in tinnitus. Nature Scientific Reports 2020 Dec 11; Vol 10 (1): Art. 21801 p. 1-12
37. Lin CC., Lin HC. & Chiu HW. Increase Risk of Dementia in Patients with Sudden Hearing Loss: A Population-Based Cohort Study With 7-Year Follow-Up in Taiwan. Otology and Neurotology (2020): 41(10), 1334–40.
38. Liski I. et al, How can dementia and disability be prevented in older adults: where are we today and where are we going? Journal of Internal Medicine. 2020 Dec 13 Online ahead of print. p. 1-21
39. Littlejohn J., Blackburn D. & Venneri A. Understanding the links between hearing impairment and dementia: development and validation of the Social and Emotional Impact of Hearing Impairment (SEI-HI) questionnaire. Neurological Sciences (2020) 41: p. 3711–3717
40. Liu Y. et al, Hearing loss is an early biomarker in APP/PS1 Alzheimer's disease mice. Neuroscience Letters 2020 January; Vol 717.
41. Livingston G. et al, Dementia prevention, intervention, and care: 2020 report of the Lancet Commission. Lancet 2020; 396: 413–46
42. Loughrey, D. et al, Social factors may mediate the relationship between subjective age-related hearing loss and episodic memory. Aging & Mental Health 2020 Feb 18; p.1-8
43. Mitchell B. et al, Exploring the genetic relationship between hearing impairment and Alzheimer's disease. Alzheimer's Dementia 2020 Sep 25;12(1): e12108 p. 1-10
44. Montero-Odasso M. et al, CCCDTD5 recommendations on early non cognitive markers of dementia: A Canadian consensus. Alzheimers Dementia 2020 Oct 17;6(1): e12068. p. 1-18
45. Mun S. et al, MicroRNAs Related to Cognitive Impairment After Hearing Loss. 2020 Clinical and Experimental Otorhinolaryngology ceo.2019.01382. Epub ahead of print p. 1-9
46. Nadhimi Y. & Llano D. Does hearing loss lead to dementia? A review of the literature. Hearing Research, 30 Jul 2020 108038. doi:10.1016
47. Nakahori N. et al, Association between self-reported hearing loss and low socioeconomic status in Japan: findings from the Toyama dementia survey. BMC Geriatrics volume 20, Article number: 275 (2020). p. 1-7
48. Regal P. & Lange P. Is hearing impairment by audiometry as much a cognitive score as cognitive domain batteries? European Geriatric Medicine 2020 Dec; Vol 11(6): p. 995-1001
49. Rockwood K. et al, CCCDTD5: Reducing the risk of later-life dementia. Evidence informing the Fifth Canadian Consensus Conference on the Diagnosis and Treatment of Dementia (CCCDTD-5). Alzheimers & Dementia. 2020 Nov 11;6(1): e12083. P. 1-12
50. Rolandi E. et al, Estimating the potential for dementia prevention through modifiable risk factors elimination in the real-world setting: a population-based study. Alzheimer's Research & Therapy volume 12, Arti.: 94 (2020) 1-9
51. Saji N. et al, Hearing impairment is associated with cognitive function in community-dwelling older adults: A cross-sectional study. November 2020 Archives of Gerontology and Geriatrics ahead of print. p. 1-7
52. Sarant J. et al. The Effect of Hearing Aid Use on Cognition in Older Adults: Can We Delay Decline or Even Improve Cognitive Function? Journal of Clinical Medicine. January 2020, Vol 9 (1), Article 254 p. 1-23
53. Sardone R et al. Age-Related Central Auditory Processing Disorder, MCI, and Dementia in an Older Population of Southern Italy. Otolaryngology–Head and Neck Surgery, 2020: 163(2), 348-355
54. Slade K., Plack C. & Nuttall H. The Effects of Age-Related Hearing Loss on the Brain and Cognitive Function. Trends in Neurosciences, October 2020, Vol. 43, No. 10 p. 810-821

55. Strutt P. et al, Hearing loss, cognition, and risk of neurocognitive disorder: evidence from a longitudinal cohort study of older adult Australians. Aging, Neuropsychology, and Cognition. 2020 Dec Vol 28; p. 1-18 ahead of print.
56. Tomata Y. et al, Joint impact of common risk factors on incident dementia: A cohort study of the Swedish Twin Registry: Impact of risk factors on incident dementia. May 2020 Journal of Internal Medicine 288(2) p. 1-14.
57. Wimmer del Solar J. et al, [Hearing loss as a risk factor for dementia] / Hipoacusia como factor de riesgo para demencia. Revista Médica de Chile 2020; 148: p. 1128-1138

2019

58. Brent R. A cost–benefit analysis of hearing aids, including the benefits of reducing the symptoms of dementia – 2019 - Applied Economics, 51:28, 3091-3103
59. Chang M. et al, Hearing loss as a risk factor for cognitive impairment and loss of synapses in the hippocampus. 2019 Behavioural Brain Research Vol. 372 Art. 112069 p. 1-7
60. Chern, A. & Golub, J. Age-related Hearing Loss and Dementia Alzheimer Disease & Associated Disorders: July–September 2019 - Volume 33 - Issue 3 - p 285-290
61. Dawes P. et al, Interventions for hearing and vision impairment to improve outcomes for people with dementia: a scoping review - International Psychogeriatrics, Volume 31, Issue 2: Issue Theme: Positive Psychiatry II, February 2019, pp. 203 – 221
62. Dawes P. Hearing interventions to prevent dementia – 2019 HNO volume 67, p. 165–171
63. Gaeta L. et al, Effect of Reduced Audibility on Mini-Mental State Examination Scores. J Am Acad Audiol 30:845–855 (2019).
64. Gosselin P. et al, Effect of Hearing Ability and Mild Behavioural Impairment on MoCA and Memory Index Scores. 2019 Sep Canadian Geriatrics Journal Vol 22(3): p. 165-170
65. Jafari Z. et al, Age-related hearing loss and tinnitus, dementia risk, and auditory amplification outcomes - December 2019 - Ageing Research Reviews - Volume 56, p 1-18
66. Liu C. & Lee C. Association of Hearing Loss With Dementia - JAMA Network Open. 2019;2(7) p. 1-15
67. Mamo S. et al, Relationship Between Domain-Specific Cognitive Function and Speech-in-Noise Performance in Older Adults: The Atherosclerosis Risk in Communities Hearing Pilot Study. December 2019 American Journal of Audiology. Vol. 28, p. 1006–1014
68. Michalowsky B. et al, Association Between Hearing and Vision Impairment and Risk of Dementia: Results of a Case-Control Study Based on Secondary Data - Frontiers in Aging Neuroscience, December 2019, Vol 11: Art. 363.p1-9
69. Morita Y. et al, Age-related Hearing Loss Is Strongly Associated With Cognitive Decline Regardless of the APOE4 Polymorphism. 2019 Otology & Neurotology 40: p. 1263–1267
70. Osler M. et al, Hearing loss, cognitive ability, and dementia in men age 19–78 years - European Journal of Epidemiology (2019) 34:125–130.
71. Panza F. et al, Sensorial frailty: age-related hearing loss and the risk of cognitive impairment and dementia in later life – 2019 - Therapeutic Advances in Chronic Disease -, Vol. 10: 1–17
72. Ralli M. et al, Hearing Loss and Alzheimer's Disease: A Review. International Tinnitus Journal. 2019;23(2): p. 79-85.
73. Ray M. et al. Association of Cognition and Age-Related Hearing Impairment in the English Longitudinal Study of Ageing. JAMA Otolaryngol Head Neck Surg. 2018;144(10):876-882.
74. Ray M. et al. Dementia and hearing loss: A narrative review - Maturitas. 2019 Oct; Vol 128: p. 64-69

2018

75. Amieva H. et al. Death, Depression, Disability, and Dementia Associated With Self-reported Hearing Problems: A 25-Year Study. The Journals of Gerontology: Series A, Volume 73, Issue 10, October 2018, Pages 1383–1389.
76. Cardon G. & Sharma A. Somatosensory Cross-Modal Reorganization in Adults With Age-Related, Early-Stage Hearing Loss. 2018 Frontiers in Human Neuroscience Vol. 12: Art. 172 p. 1-11
77. Karawani H., Jenkins K. & Anderson S. Restoration of sensory input may improve cognitive and neural function. Neuropsychologia- Volume 114, June 2018, Pages 203-213
78. Kim SY, Lim JS, Kong IG, Choi HG. Hearing impairment and the risk of neurodegenerative dementia: A longitudinal follow-up study using a national sample cohort. Nature Scientific Reports. 2018 Oct 15;8(1):15266.
79. Loughrey D. et al. Association of Age-Related Hearing Loss With Cognitive Function, Cognitive Impairment, and Dementia: A Systematic Review and Meta-analysis - JAMA Otolaryngology Head and Neck Surgery. 2018; 144(2): p. 115-126
80. Maharani A. et al, Longitudinal Relationship Between Hearing Aid Use and Cognitive Function in Older Americans – 2018 Journal of the American Geriatrics Society 66(6): p. 1130–1136
81. Mosnier I et al Long-term cognitive prognosis of profoundly deaf older adults after hearing rehabilitation using cochlear implants. 2018 Journal of the American Geriatrics Society 66(8): p. 1553–1561
82. Pereira-Jorge M. et al, Anatomical and Functional MRI Changes after One Year of Auditory Rehabilitation with Hearing Aids. Hindawi Neural Plasticity. Vol. 2018, Special Issue - Neurorehabilitation: Neural Plasticity and Functional Recovery 2018 - Article ID 9303674, p. 1-13

2017

83. Davies H. et al, Hearing Impairment and Incident Dementia: Findings from the English Longitudinal Study of Ageing. The Journal of the American Geriatrics Society 2017 65 (Suppl. 1) p. 1-7
84. Deal J. et al. Hearing Impairment and Incident Dementia and Cognitive Decline in Older Adults: The Health ABC Study - The Journals of Gerontology: Series A, Volume 72, Issue 5, 1 May 2017, p. 703–709
85. Golub J. et al. Observed Hearing Loss and Incident Dementia in a Multi-ethnic Cohort - The Journal of the American Geriatrics Society 2017 Vol 65 (8) p. 1691-1697
86. Heywood R. et al, Hearing Loss and Risk of Mild Cognitive Impairment and Dementia: Findings from the Singapore Longitudinal Ageing Study – Dementia and Geriatric Cognitive Disorders 2017;43:259–268
87. Livingston G. et al, Dementia prevention, intervention, and care: 2017 The Lancet Commissions Vol. 390, (10113), p. 2673-2734
88. Su P. et al, Age-related hearing loss and dementia: a 10-year national population-based study. European Archives of Otorhinolaryngology (2017) 274:2327–2334
89. Thomson R. et al, Hearing Loss as a Risk Factor for Dementia: A Systematic Review - Laryngoscope Investigative Otolaryngology – Iss 2: April 2017 – p 69-79
90. Wei J. et al. Hearing Impairment, Mild Cognitive Impairment, and Dementia: A Meta-Analysis of Cohort Studies – Dementia and Geriatric Cognitive Disorders Extra 2017;7: p.440–452

Articles before 2017

91. Amieva H. et al. Self-Reported Hearing Loss, Hearing Aids, and Cognitive Decline in Elderly Adults: A 25-Year Study. Journal of the American Geriatrics Society (2015) 63:2099–2104.
92. Dawes P. et al. Hearing Loss and Cognition: The Role of Hearing Aids, Social Isolation and Depression. Plos One (2015) 10(3):e0119616.
93. Eckert MA. et al. White matter hyperintensities predict low frequency hearing in older adults. Journal of the Association for Research in Otolaryngology (2013) 14:425-433.
94. Lin FR. et al. Association of hearing impairment with brain volume changes in older adults. Neuroimage (2014) 90:84-92.
95. Lin F. et al. Hearing loss and cognition among older adults in the United States. The journals of gerontology. Series A, Biological sciences and medical sciences (2011) 66:1131-1136.
96. Lin FR. et al. Hearing loss and incident dementia. Archives of Neurology (2011) 68:214-220.
97. Mosnier I. et al. Improvement of Cognitive Function After Cochlear Implantation in Elderly Patients. JAMA Otolaryngology–Head & Neck Surgery (2015) 141:442-450.
98. Peelle JE. et al. Hearing loss in older adults affects neural systems supporting speech comprehension. Journal of Neuroscience (2011) 31:12638-12643.
99. Taljaard DS. et al. The relationship between hearing impairment and cognitive function: a meta-analysis in adults. Clinical Otolaryngology (2016) 41:718-729.
100. Uhlmann RF. et al. Relationship of hearing impairment to dementia cognitive dysfunction in older adults. JAMA (1989) 261:1916-1919.

Dementia prevalence data, Dementia Australia accessed on 15 February 2021: www.dementia.org.au/information/statistics/prevalence-data

Dementia prevalence data, Dementia Australia accessed on 15 February 2021: www.dementia.org.au/information/statistics/prevalence-data

Now is the time to seize the opportunity for a preventative hearing health strategy that will address the link between age-related hearing loss and dementia.

The Hearing Care Industry Association is the peak industry body representing hearing healthcare providers in Australia. Its members provide access to hearing health care, hearing aids and assistive hearing technology to more than 50,000 consumers a month through almost 700 hearing clinics around Australia. For more than two decades, HCIA has been providing evidence-based inputs to policy makers as a key partner of Australia's health system.

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