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Hearing loss and the risk of dementia in later life

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ABSTRACT

Dementia is a major source of disability worldwide and there are currently no available disease-modifying treatments. Hearing loss may be associated with increased risk of dementia in later life and therefore could be a modifiable risk factor, given the availability of efficacious interventions. We investigated the association of hearing loss and dementia through two complementary approaches: a prospective, cohort study of 37,898 older men (mean age 72.5 ± 4.6 years) with a mean follow-up of 11.1 years, and a systematic review and meta-analysis of prospective studies. In our cohort, men with hearing loss were more likely to develop dementia (n = 6948, 18.3%) than men free of significant hearing impairment – adjusted hazard ratio 1.69, 95% CI = 1.54–1.85. In our review, the aggregated hazard of dementia was 1.49 (95% CI 1.30–1.67) in those with hearing impairment (14 included studies). Study quality, duration and dementia type did not alter the results considerably. We found an increased risk of incident dementia with hearing impairment in both our novel data and the meta-analysis. This is an important finding, particularly in light of recent suggestions that mid-life hearing loss may account for up to 9.1% of dementia cases worldwide, and efforts to reduce its impact should continue to be explored.

1. Introduction

Dementia is a leading cause of disability worldwide and affects approximately 6.5% of the population over the age of 65 [1,2]. There are, unfortunately, no current disease-modifying treatments available for people with dementia and a focus on risk factor reduction, particularly modifiable ones, is justified [3]. In fact, evidence is emerging of declining dementia incidence thought to be secondary to societal changes and improvements in living conditions and management of vascular risk [2]. This is encouraging, but as the world's population continues to age the number of people living with dementia is expected to increase and will put increasing demands on health services across the world [4].

Hearing impairment is a significant health issue with the World Health Organisation estimating that 5.3% of the global population suffers from disabling hearing loss [5]. The risk of hearing loss increases with age (age-related hearing loss – ARHL) and is estimated to affect up to 40% of those over the age of 65 [6] and in as many as 75% in those older than 80 years [7]. Age-related hearing loss is usually progressive, bilateral and leads to a reduction in one's ability to communicate. The aetiology is often multifactorial with a variety of environmental, medical and genetic determinants [8]. Untreated hearing loss can undermine a person's lifestyle and contribute to social isolation, loss of self-esteem, reduced quality of life and increased risk of psychiatric illness [9,10]. Management of ARHL is relatively straight-forward but hearing aids are expensive and only around a third of those who may benefit from hearing aids actually purchase them, but a significant proportion of these do not utilise them correctly [11].

Hearing loss has fairly recently been proposed as a risk factor for dementia [12] but the mechanisms linking hearing loss to dementia have not been established. Hearing loss may accelerate existing but subtle cognitive impairment by increasing cognitive burden and

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exhausting existing cognitive compensatory strategies [13]. Hearing loss could contribute to increase social isolation leading to poorer lifestyle practices (e.g. smoking, obesity, alcohol abuse) and increasing depressive symptoms [14]. It could also lead to volume loss in the auditory cortex and other areas of the brain and disrupt the integrity of central auditory white matter tracts and cortical reorganisation [15,16]. Further, hearing impairment appears to accelerate brain atrophy in the superior, middle and inferior temporal gyri and parahippocampus, areas of the brain commonly implicated in Alzheimer's disease [15]. Lastly, histopathological changes (degeneration, plaques and tangles) of the auditory system have been described in the brains of people with Alzheimer's disease [17].

It is important to clarify if hearing loss contributes to cause dementia, as efficacious management is widely available and could lead to a decline in the incidence of dementia among those at risk. Data from cross-sectional and case-control studies generally support the association between ARHL and cognitive impairment but the direction of causality is difficult to establish from these studies. For example, does hearing loss increase the risk of cognitive impairment or is cognitive impairment over-diagnosed in those with hearing impairment? Could they simply be two common overlapping conditions associated with increasing age [18]? The best way to establish a causal relationship between ARHL and dementia would be through sufficiently powered randomized controlled trials, but clearly this is not feasible or practical in this population. Therefore, the next best approach is to examine the association of ARHL with incident dementia through large prospective cohort studies in populations free of dementia at baseline.

The aim of the present study was to investigate the association between hearing loss and incident dementia in the older age demographic that is at highest risk for both of these conditions. In order to examine our hypothesis that hearing impairment increases the risk of developing dementia in later life, we used two complementary approaches. First, we undertook a prospective, longitudinal study in a large cohort of older, community-dwelling men recruited as part of the Health in Men Study (HIMS) [19]. Second, we performed a systematic review and meta-analysis of relevant prospective studies investigating the association between hearing loss and incident dementia.

2. Methods

2.1. The health in men study

2.1.1. Study population

The HIMS recruited a community-representative sample of older Australian men living in the metropolitan region of Perth, Western Australia, between April 1996 and November 1998 [19]. The follow-up of participants for the current study closed on 31 December 2013.

We used the electoral roll (voting is compulsory in Australia) to retrieve the contact details of 49,801 men aged 65–85 years in the mid 1990s (1996–1998–wave 1). Of these, 1839 had died by the time the study started and another 9482 were not selected because they were living outside the Perth metropolitan region. Of the remaining 38,480 men, 307 were excluded because they were younger than 65 years (these men were invited in error), and a further 275 because they had a recorded diagnosis of dementia (see below), leaving a total study sample of 37,898 older men without dementia.

The Ethics Committees of the University of Western Australia and of the Department of Health of Western Australia approved the study procedures. Similarly, the Legal Data Custodian of Western Australia approved the conduction of the study – the Data Custodian is responsible for ensuring that all data are de-identified and used for the purposes of the approved medical research only. In addition, the Legal Data Custodian is responsible for ensuring that named investigators alone have access to the data.

Table 1
Clinical characteristics of a community-representative sample of older men without cognitive impairment and with hearing loss (data retrieved between 1996 and 1998).

		Population N = 37,898 n (%)	Hearing loss N = 1420 n (%)	Odds Ratio (95% CI)
Age (years)	65–69	13,359 (35.2)	297 (20.9)	1 (Reference)
	70–74	13,048 (34.4)	463 (32.6)	1.61 (1.40, 1.88)
	75–79	8604 (22.7)	441 (31.1)	2.38 (2.05, 2.76)
	≥80	2887 (7.6)	219 (15.4)	3.61 (3.02, 4.32)
Cardiovascular diseases		16,688 (44.0)	829 (58.4)	1.82 (1.64, 2.03)
Cancer (except of the skin)		6774 (17.9)	322 (22.7)	1.36 (1.20, 1.55)
Chronic respiratory diseases		8096 (21.4)	414 (29.1)	1.54 (1.37, 1.73)
Gastrointestinal diseases		18,535 (48.9)	846 (59.6)	1.57 (1.41, 1.74)
Renal diseases		774 (2.0)	48 (3.4)	1.72 (1.28, 2.32)

95% CI: 95% confidence interval of the odds ratio.
Cardiovascular diseases: included recorded medical history of myocardial infarction, angina or stroke.

2.1.2. Outcome measure: dementia

Dementia was the primary outcome of interest of the study. We used the Western Australian Data Linkage System (WADLS) to retrieve relevant clinical information about participants. Briefly, WADLS links health service data from inpatient and outpatient mental health services, hospital morbidity data, community aged care services, as well as cancer and death registries [20]. WADLS uses the International Classification of Diseases (ICD) system for the coding of clinical diagnoses and procedures: ICD-8 from 1st January 1966 to 31st December 1969, ICD-9 from 1st January 1970 to 30th June 1999, and ICD-10 from the 1st July 1999. WADLS records also show the date when the occasion of service started and finished.

We used the following codes to establish the diagnosis of dementia among participants: ICD-8 code 290; ICD-9 codes 290, 294.1, 294.2, 331.0, 331.1, 331.2, 331.82; ICD-10 codes F00-F03, G30, G31.0, G31.1, G31.83. As indicated before, men with a diagnosis of dementia prior to the date of enrolment (1996–1998) were excluded from this study.

2.1.3. Exposure: hearing loss

We used WADLS to retrieve information about diseases of the ear leading to hearing loss among participants according to the following codes: ICD-8 and ICD-9 codes 388.12 (hearing loss induced by noise), 388.2 (unspecified sudden hearing loss), 389 (hearing loss, conductive or sensorineural); ICD-10 codes H90 (conductive and sensorineural hearing loss) and H91 (hearing loss due to other causes).

2.1.4. Other study measures

We also retrieved from WADLS data on cardiovascular events, cancers (except skin cancer), chronic respiratory diseases, gastrointestinal and renal diseases using the following codes:

- cardiovascular diseases ICD-8 and 9 codes 390–398, 401, 402, 403, 404, 410–429, 430–434, 436–438, 440–448, and ICD-10 codes I00-09, I10, I11, I12, I13, I20-51, I60-69, I70-78;
- cancers ICD-8 and ICD-9 codes 140–209, and ICD-10 codes C00-C97;
- respiratory diseases ICD-8 and ICD-9 codes 490–496 and 507–519, and ICD-10 codes J00-09, J20-39, J40-47 and J60-99;
- gastrointestinal diseases ICD-8 and ICD-9 codes 520–537, 540–543, 5550-553, 555–589, and ICD-10 codes K00-K99;
- renal diseases ICD-8 and ICD-9 codes 580–589, and ICD-10 codes N00-07, N17-19 and N25-27.

We calculated the age of participants (in years) by subtracting the date of birth from the date of enrolment into the study.