

# Alzheimer's Disease and Hearing Loss among Older Adults: A Literature Review

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**Abstract** Older adults with hearing loss are more likely to develop Alzheimer's disease (AD) or dementia compared to those with normal hearing. Hearing loss can be consecutive to presbycusis and/or central auditory dysfunction. The current study reviewed the literature concerning the relationship between hearing loss and AD among older adults. Articles included in this review were identified through a search of the databases PubMed, Medline, Scopus, Google Scholar, and Scientific Information Database (SID) using the search terms Alzheimer's disease, dementia, presbycusis, hearing loss, and hearing impairment. The literature search was restricted to the years 1989 to 2018 and to articles published in the English language. Of 54 primary articles, 38 potentially eligible articles were reviewed. Although cognitive decline has been shown to be slowed by the use of hearing aids in older adults, a few studies have investigated the effects of other factors such as presbycusis-related tinnitus and length of use of hearing aids by older adults. High-quality clinical trials are needed to determine whether AD can be delayed or prevented in older adults. Moreover, it seems to be very important to evaluate hearing status (peripheral and central) in older adults to diagnose hearing impairment early and initiate the use of hearing aids.

**Keywords** Alzheimer's disease, Hearing loss, Presbycusis, Tinnitus, Older adults

## 1. Introduction

Population aging is a phenomenon resulting in some health-related problems all over the world, and consequently, the prediction and preparation of health services for them requires a comprehensive measurement of their care needs [1]. As age increases, organic and physiological changes occur in the auditory system [2]. The World Health Organization (WHO) has reported that age-related hearing loss (ARHL), or presbycusis, commonly affects individuals above the age of 65 years [3]. Rashedi et al. reported that the 'Hearing Loss' (68.3%) and 'Hearing Impairment' (10.4%) were the most prevalent types of disability that occurred among older adults [4]. Presbycusis involves the cochlea and leads to impairment in the transduction of acoustic signals. This impairment is progressive and accelerates with each passing decade of age [5]. In addition to peripheral auditory system, the central auditory pathway is also involved in presbycusis [6]. People

with central auditory processing disorder (CAPD) have difficulty hearing in noisy environments [7, 8]. With normal peripheral hearing, it is possible for only the central auditory system to show dysfunction [9].

Alzheimer's disease (AD) is a neurodegenerative disease prevalent among older adults. It is the main reason for dementia [10], and one frequent cause of cognitive decline among older adults is dementia due to Alzheimer's [11]. Dementia affects nearly 6.5% of individuals over the age of 65 years [12]. Several risk factors have been reported for AD [13]. More recently, it has been suggested that hearing loss may increase the possibility of AD [10].

The WHO has reported that 278 million people worldwide suffer from tinnitus, which causes its sufferers to perceive annoying noises that have no external source. The prevalence of tinnitus grows with increasing age [14].

In this review, the researchers aimed to determine whether early treatment of hearing loss (peripheral and/or central) can decrease the risk of Alzheimer's disease. Other factors associated with presbycusis are also outlined, such as tinnitus and its relation with Alzheimer's disease.

## 2. Methods

The current literature review involved searches of the

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databases PubMed, Google, and clinicaltrials.gov. The search strategy for PubMed was ("Presbycusis" [MeSH Terms] OR "Presbycusis" [All. - Fields]) OR ("Alzheimer's disease" [MeSH Terms]). The primary author reviewed the abstracts of all studies identified by this search strategy. We also considered whether other factors related to presbycusis, such as tinnitus, are risk factors for Alzheimer's disease. The literature search was restricted to the years 1989 to 2018 and to articles published in the English language.

### 3. Results

Of 54 primary articles, 38 potentially eligible articles were reviewed. Although the relation between cognitive decline and the use of hearing aids has been shown in older adults, a few studies have investigated the effects of other factors such as presbycusis-related tinnitus and length of use of hearing aids by older adults.

#### 3.1. Relation between ARHL and AD

Alzheimer's disease in its advanced stages spreads to the auditory cortex and higher-level auditory centers (inferior colliculi and medial geniculate bodies) [10]; however, cochlear nuclei remain normal [15]. Thus, patients with AD may have their own auditory pattern with symptoms of CAPD. Therefore, screening for central auditory processing is very important in older adults, especially in the AD populations. One study demonstrated that no significant difference in peripheral hearing impairment existed between older adults with and without AD [16]. The need to perform central auditory tests is emphasized in those older adults with AD whose peripheral hearing system is normal.

In presbycusis with cochlea dysfunction and degeneration of hair cells, a high frequency of hearing loss is expected, and this type of hearing loss is usually progressive and bilateral [12]. With profound sensory neural hearing loss, the acoustic signal does not reach the higher centers for interpretation, and this leads to atrophy in the whole brain, especially the right temporal lobe [17]. One study showed a dose-response relationship between the amount of hearing thresholds and the probability of developing dementia [18]. Many older adults refuse to see an audiologist or visit one only when their degree of hearing loss is very high.

Given that presbycusis is progressive, early diagnosis of hearing loss and the fitting of hearing aids as soon as possible are very important in older adults. The high prevalence of hearing loss in older adults with memory disorders highlights the need for hearing evaluation [19]. It has also been shown that the disease progression of dementia is faster in individuals with hearing loss than in those without it. Gurgel *et al.* discovered per 10 dB of increased in hearing thresholds, the lower score was gained in the test of assessing executive function and psychomotor processing [20].

These results confirmed the positive relationship between

peripheral hearing impairment and clinical dementia rating (CDR) in patients with AD [21]. Both types of impairment (peripheral and/or central) left untreated can lead to isolation and withdrawal from community activities in older adults because of the inability to understand other people's speech [22, 23]. Afflicted people have no tendency to communicate with other people because of they usually find communication difficult and inability to enjoy the sounds; this facilitates the conditions for depression to develop, and depression is a risk factor for AD [3, 10].

Environmental factors such as simultaneous exposure to noise and industrial chemicals are reported to be risk factors for presbycusis [3]. Increases in population combined with the development of industry and technology have led to many problems. Workers in many industries are exposed to both noise and air pollutants in the workplace [24]. It can be concluded that these people who have a risk factor for presbycusis are also at high risk for developing AD in their older years. One theory proposed for the relation between presbycusis and AD in those individuals exposed simultaneously to noise and industrial chemicals is the formation of free radicals.

An increased presence of reactive oxygen species (ROS) in the inner ear has been implicated in the development of presbycusis [25]. The production of damaging free radicals in the inner ear is increased by simultaneous exposure to noise and industrial chemicals. Many studies have demonstrated that the level of free radicals in the cochlea is significantly higher in animals exposed to both noise and industrial chemicals compared to those exposed to noise only [26].

Therefore, hearing screening in people who are commonly exposed to noise and industrial chemicals simultaneously in the workplace is very important. Evaluation of the cochlea or peripheral auditory system with pure-tone audiometry and otoacoustic emission, assessment of ascending auditory function by auditory brainstem response, and speech-in-noise test are recommended techniques for measuring patients at high risk for AD [27].

Sometimes hearing loss in presbycusis is very complicated and is not limited to the outer hair cells of the cochlea; loss of spiral ganglion cells, stria atrophy, and basilar membrane stiffness or spiral ligament atrophy are also possible [28].

It cannot be said that pure-tone audiometry is the only way to evaluate the peripheral auditory system, because the brain should process and decode signals in order to perceive sound, and some cognitive decision-making is also involved in forming a response to the signal [29]. Assessing the auditory system should not rely only on PTA, because PTA is primarily a test of the peripheral auditory system. In presbycusis that involves cochlear neuropathy, normal PTA results may be obtained [28]. Therefore, assessing the long latency CAEPs (central auditory evoked potentials) is very important [30].

### 3.2. The Effect of Presbycusis-Related Tinnitus

In most cases, tinnitus is associated with presbycusis and may even be more difficult than troublesome caused by hearing loss [31]. Presbycusis is an essential risk factor for tinnitus, and tinnitus is more common in older adults aged 60 to 69 years [32]. Hypertension is a common risk factor in both presbycusis and AD [28], and one study found a significant correlation between tinnitus and hypertension [33]. About 70% of older adults with tinnitus have difficulty concentrating [32]. The intensity of tinnitus varies between individuals and may be related to the magnitude of hearing loss, how much attention a person gives the tinnitus, and the amount of annoyance caused by it. Tinnitus has negative effects on speech perception in elderly people [2]. Moreover, it has several negative psychosocial effects on an individual's life, such as difficulty in paying attention and concentrating, decrease in daily activity, and some of the researchers reported that it may lead to obesity. Ultimately, it may lead to anxiety and depression [33-37]. As mentioned in the previous section, depression is a risk factor for AD. If presbycusis is timely diagnosed, i.e. before it reaches advanced stages, the use of hearing aids may act to suppress tinnitus by decreasing psychosocial risk factors of AD in older adults [32].

### 3.3. The Effects of Hearing Aids

Several studies have shown cognitive decline to be slowed by the use of hearing aids in older adults [38]. Conversely, the results of one study showed no significant effect of the use of hearing aids in patients older than 65 years with AD and hearing loss [39]. These conflicting results could be explained by differences in the length of time older adults have used hearing aids. Follow-up on this item is very important, because despite having hearing aids, a large number of older adults do not use them for most of the time at home. Moreover, the use of hearing aids has positive effects on psychosocial factors, including improved mood, increased participation in communications, and increased physical activity [40]. One study has shown that physical activity affects brain plasticity in younger elderly people [41]. The use of hearing aids also induces secondary brain plasticity by amplifying acoustic signals. Hearing aids that amplify the acoustic signal lead to a decrease in the bothering sensations of tinnitus, increase in concentration, and improved mood in older adults [14]. Obviously, there is an indirect effect of hearing aids on AD in older adults. Despite this significant effect, only one third of older adults with hearing impairment use hearing aids [40]. One reason that older adults refuse to use hearing aids is an unwillingness to be seen wearing them. Perhaps if people know the effects hearing aids have on health outcomes, whether their hearing aids are seen or not would not be so important for them.

## 4. Conclusions

This review is highly suggestive of the importance of

performing annual comprehensive hearing assessments (peripheral and central) in older adults, especially in populations with a high risk of developing AD, such as workers that are exposed in the workplace to noise and air pollutants simultaneously. The role of an audiologist in diagnosing hearing loss and fitting hearing aids is very important.

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