

## Review Article

# Age related hearing loss and cognitive impairment - a current perspective

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**Received:** 12 November 2020

**Accepted:** 14 December 2020

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### ABSTRACT

Age related hearing loss (ARHL) is one of the commonest health conditions of the elderly people which have an important relation with the cognition. Long standing hearing deprivation leads to decline of the cognitive performance. This has impact on quality of communication and result in social isolation, depression and enhances the dementia. Cognitive decline may be misdiagnosed or over-diagnosed when the sensory abilities of the patients are not properly evaluated. Adequate intervention by use of hearing aid or cochlear implant improves the communication, cognitive function, social, emotion function and positively impact on the quality of life. With rise of the elderly population and concomitant increase of ARHL with associated cognitive impairment, it is imperative to discuss this morbid clinical entity in present scenario. Cognitive decline in elderly age have a profound impact on the affected person, on caregivers and society. The financial costs for cognitive impairment in ARHL are also major source of concern for the society. In this review article, we focus on the epidemiology, pathophysiology, hypotheses of etiological mechanisms between the ARHL and cognitive decline or impairment, impact of cognitive impairment on quality of life and prevention.

**Keywords:** Age related hearing loss, Cognitive impairment, Dementia, Social isolation

### INTRODUCTION

Age related hearing loss (ARHL) is defined as a bilateral, progressive and symmetrical hearing loss (HL) which hampers or lower down the communicative skills because of the age.<sup>1</sup> ARHL or presbycusis is characterized by gradual progression of high frequency hearing loss with associated poor speech discrimination.<sup>1</sup> ARHL is the most common sensory abnormality in the elderly age group and is ranked as a leading cause of the years lived with disability after diabetes and dementia.<sup>2</sup> In more than 90% cases of the hearing loss in older age is called as ARHL whereas few patients present with conductive or mixed variety of the hearing loss. ARHL is considered as a complex and multi-factorial disorder where both genetic and environmental factors play important role for the etiology of this clinical entity.<sup>3</sup> Daily lives of the elderly persons are often linked to the hearing abilities and so

ARHL usually affects the quality of the life including social relations, psychological aspects, motor skills, function and morphology in specific brain areas. ARHL is an independent risk factor for development of the cognitive impairment in the elderly age group. At the neural level, the long standing hearing loss cause reduced activation of the central auditory pathways, leading to compensatory increased activation of the cognitive control network, auditory-limbic connectivity dysfunction and deafferentation induced atrophy of the frontal region of the brain.<sup>4</sup> These pathological changes reduce the cognitive performance and enhance the risk of depression by lowering the cognitive reserve, increase the executive dysfunction and disruption normative regulation and activity. ARHL is associated with rapid progression of the dementia. So, hearing loss is an important risk factor which often underestimated in the clinical practice. Despite such relationship of the hearing loss with dementia, this

relationship is still controversial and is under investigation whether HL related to the etiological factor of the dementia or whether an independent factor for ARHL which enhances the chances of the dementia. The aim of this review article is to overview of the new insights of this new challenging clinical topic of age related hearing loss and cognitive impairment.

## **METHODS OF LITERATURE SEARCH**

For searching the published articles, we conducted an electronic search of the Google Scholar, Medline, Scopus and PubMed databases. The search term in the database included age related hearing loss, cognitive decline, dementia and depression. The abstracts of the published articles are identified by this search method and other articles identified manually from the citations. This review article focuses on the age related hearing loss and its impact on cognition. This review article presents a baseline from where further prospective trials can be designed and help as a spur for further research in this commonly encountered clinical entity where not many studies are done.

## **EPIDEMIOLOGY**

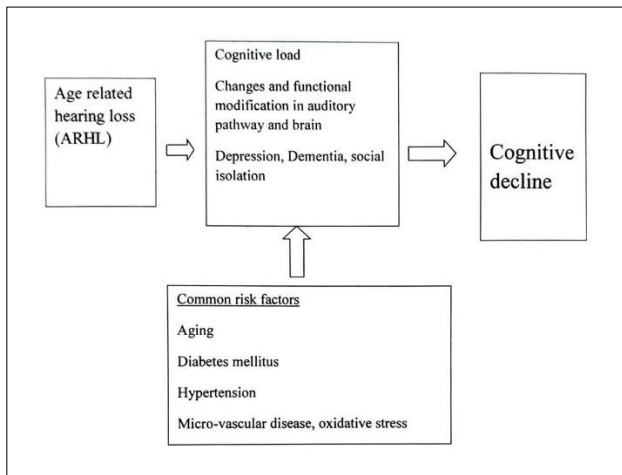
The World Health Organization (WHO) estimates that more than 328 million elderly persons experience hearing disabilities which not only impair interpersonal communication and also health, well-being, independence, quality of life, daily functions and can manifests social isolation, depression and cognitive impairment.<sup>5</sup> As per the report from the most recent global burden of disease (GBD), hearing loss is the third leading etiology of years lived with disability (YLDs) and an important concern for global health, particularly in elderly age group.<sup>6</sup> ARHL affects approximately one-third of the elderly persons in the age group of 61 to 70 years and more than 80% of those older than 85 years of age. In older age, ARHL is the commonest health problem after hypertension and arthritis. As per the data of the United Nations, the global population will increase from 6.9 billion in 2010 to 9.3 billion in 2050.<sup>7</sup> The population of elderly aged persons above 60 years will nearly double during the same period, touching 21% of the total population in 2050 or approximately 2 billion of people in 2050.<sup>7</sup> Males show a higher incidence of ARHL with earliest onset in comparison with women. In European countries, ARHL found in Italy as 1 in 6 of people, 1 of 7 in Finland whereas 1 in 10 people in Denmark and Sweden. As per the WHO data, approximately 70 million people are affected with ARHL. Similar to ARHL, there is progressive loss of cognitive functions such as memory, information processing and attention. The hearing loss and dementia are both highly prevalent neurological entity found in elderly age group, each having considerable impact on the quality of the daily life. The prevalence of dementia is from approximately 5% in 71 to 79 years of age to approximately 37% in 90 years of age or above with an overall prevalence of approximately 14% in above 70

years of age.<sup>8</sup> In case of dementia in elderly age group, it increases from approximately 5% at 71 to 79 years to approximately 37% in the age of 90 years and above and the overall prevalence of dementia above 70 years of age is approximately 14%.<sup>9</sup>

## **PATHOPHYSIOLOGY**

The association of ARHL and cognitive decline remains unclear. Identification of the exact etiopathology behind hearing loss and cognitive decline or impairment can help to intervene the cognitive dysfunction in ARHL. The underlying etiological mechanisms leading to the relation between these two are still not well understood. However, there are several epidemiological and basic science reports have been shown evidence regarding the hearing loss as an independent modified risk factor to cause cognitive decline. As the cognitive impairment like dementia or depression is one of the greatest global challenges for a clinical and social care in the communities with increased longevity so it is important to initiate the preventive measures against the cognitive decline and to scrutinize the etiological contribution of the ARHL. Healthy aging process is associated with micro-vascular and neurophysiological changes and this typically manifests simultaneous development of progressive age related sensorineural hearing loss and cognitive decline.<sup>10</sup> The pathophysiology of ARHL includes both degenerative changes to the inner ear structures (e.g. loss of outer and inner hair cells, deterioration of the spiral ganglion cells, atrophy of the stria vascularis) and alteration of the auditory neural processing. The cognitive decline in ARHL is attributable to common neurodegenerative changes in the brain. This hypothesis is supported by the parallel changes in different perceptual and cognitive domains in elderly persons e.g. reduced visual acuity and reduced cognitive decline.<sup>11</sup> In addition to this, atrophy of the brain found in both elderly age and ARHL.<sup>12</sup> These manifestations are due to biological ageing process which affects the global functions. There are several mechanisms for explaining the relation between the hearing loss and dementia including sensory deprivation or degradation, cognitive resource allocation or depletion and depression or social isolation.<sup>13</sup> There are three proposed theories for explaining the association between the ARHL and cognitive decline. In first one, neurophysiological studies supported by neuroimaging applied the cognitive load in reference to the brain activity required to understand the voice. The second theory explains the social isolation and negative perception towards own health and reduction of the daily activities. Third theory explains the role of the peripheral and central nervous system with aging process alter the neural anatomy and the synapses. These theories are not considered as mutually exclusive and these tend to overlap and can influence the general clinical condition of a person. If these theories give rise to an irreversible neural disorganization, this will decline the ability to understand the speech.<sup>14</sup> Certain clinical conditions like Alzheimer's disease, cardiovascular disease, long hospital stays and comorbidities may precipitate this trend.<sup>15</sup> The simplified

line diagram showing the ARHL resulting cognitive decline (Figure 1).



**Figure1: Line diagram showing the ARHL resulting cognitive decline.**

## HEARING LOSS AND COGNITIVE IMPAIRMENT

The attention to the ARHL has been increasing, not because of being one of the commonest clinical entity affecting the elderly age, but also from the perspective of its relation to the cognition. Hearing impairment is a sentinel developmental event which pushes a person off of a normal, healthy or normal aging trajectory towards high risk for depression and cognitive decline.<sup>16</sup> Long-term deprivations of the hearing inputs can lead to the impairment of the cognitive performance, decreasing of quality of the communication which leads to social isolation, depression and facilitates towards the onset of the dementia. On the reverse, the limited cognitive skills will decrease the cognitive resource available for hearing perception and the increased effects of the hearing loss. Hearing impairment and cognitive decline may reflect a common etiology on the hearing pathway and brain. The cognitive load in ARHL persons diverts the cognitive resources away from the cognitive process such as working memory. This can lead to cognitive decline. There is a grown speculation about the relation of ARHL and cognitive decline and the research pointing towards the hearing loss as an independent risk factor for cognitive impairment which can be measured by the mini-mental state examination.<sup>17</sup>

One study documented that the rate of the cognitive decline and risk of the cognitive impairment increased linearly with severity of the ARHL.<sup>18</sup> Similarly the risk of development of the dementia is also associated with severity of the hearing loss.<sup>18</sup>

This research also documented that mild, moderate and severe hearing loss was associated with two, three and five fold increased risk of progression of the dementia respectively.<sup>18</sup>

## ARHL AND COGNITIVE IMPAIRMENT ON QUALITY OF LIFE

ARHL is a common clinical problem found in elderly persons, causing communication difficulties, isolation and cognitive decline.<sup>19</sup> ARHL is associated with dementia which has the greatest global challenge for health and social perspectives. So, it is highly imperative to develop preventive measures against this dementia and find out the potential causal factors like age related hearing loss in the elderly age group. Study on older individuals with hearing loss had higher scores on depressive symptoms.<sup>20</sup> As in ARHL, there is progressive age related decline in cognitive processing along with speed of information processing, attention and memory. If patients of ARHL are untreated may develop several clinical conditions such as communication difficulties, depression, social isolation, tendency of falls, reduced physical functioning, decreased quality of life and even the declined cognitive function can be counteracted by hearing aid. A person with ARHL manifests verbal communication failure which severely limits social integration and reduces socialization, leading to the social isolation, loneliness, apathy and depression.<sup>21,22</sup> Social isolation is a risk factor for poor cognitive performance and speedy cognitive decline, negativity and depression.<sup>23</sup> Social isolation and depression can mediate the relation between the ARHL and cognitive impairment. Moreover, the cognitive decline decreases the social participation, depression and thus reduces the interest in hearing rehabilitation.

## ASSESSMENT OF THE ARHL AND COGNITION

Pure tone audiometry (PTA) is an ideal investigation for assessing the hearing loss. PTA is useful to quantify the severity of the hearing impairment in the elderly age group. PTA categorize the hearing loss into mild (25 to 40 dB), moderate (40 to 70 dB) and severe (>70 dB).<sup>24</sup> The stratification of the hearing loss gives information which is helpful for elucidating the relationship between the decreased hearings to dementia. The diagnosis of the cognitive decline or dementia with ARHL needs a multidisciplinary assessment, a battery of investigations and longer period of observation. Electroencephography (EEG) including brainstem and cortical potential is an important investigation to assess the patient with hearing loss and/or cognitive impairment. The alpha activity in EEG is useful to assess the central processing for differentiating the signals from the noise.<sup>25</sup> In healthy person, increased alpha activity is required in the selective attention given to the sound source in completion. This parameter can help to differentiate the peripheral/hearing from the central contribution/neurodegenerative to the cognitive defect in patient with hearing loss, particularly when associated with data on the auditory brainstem responses and tonal and speech audiological investigations. The mini mental state examination, the geriatric depression scale, the montreal cognitive assessment are also useful for evaluation of the cognition of the patient with ARHL. Hearing assessment is often not

enough for evaluation of the older people with several comorbidities. Along with hearing assessment, evaluation of the visual impairment, functional decline, balance disorders, urinary incontinence, malnutrition, cognitive impairment and depression are required for providing holistic treatment to the older persons.<sup>26</sup> The cognitive functions are usually measured by the simple tests of the memory and executive function. To assess the memory, the participants are allowed to read a list of ten unrelated words that they have to recall immediately and also with delay. The score in the memory assessment ranges from 0 to 20 and called as continuous variables with higher score indicates better cognition. The executive function test includes the participants naming as many animals as they can in sixty seconds. The score of this test ranges from zero to hundred with higher score suggest better function.<sup>27</sup>

### PREVENTIVE MEASURES

The life expectancy has been increased on a global scale and the burden of the ARHL and cognitive decline has become higher than ever. Hearing loss is considered as the largest potentially modifiable risk factor for causing dementia. Cardiovascular risk factors like hypertension, hyperlipidemia, diabetes mellitus and smoking are aggravating factors for developing the cognitive impairment. So, these factors should be controlled for preventing the cognitive decline in ARHL.<sup>28</sup> The Lancet commission documented that mid-life hearing loss if prevented, might eliminate the risk of the dementia by nine percent.<sup>29</sup> Timely rehabilitation will provide great benefits even in the very elderly age group. Hearing aids or cochlear implants are considered as the beneficial for ARHL but it is controversial for improving the cognitive decline. However, these rehabilitation measures such as hearing aids or cochlear implants are valid option even in the very elderly age and there are documented benefits in several literatures. The effective interventions with help of the cochlear implants or hearing aids may improve the emotional and social function, communication, cognitive function and add positive impact on the quality of life.<sup>30</sup> However, the evidence for demonstrating the impact of hearing aids or cochlear implants on cognitive function is inconsistent and limited. One study documented the significant improvement in cognitive functions after use of the hearing aids in comparison to the ARHL patients without hearing aids.<sup>31</sup> Use of the hearing aids or cochlear implants are associated with better cognitive functions. The elderly persons with moderate to profound hearing loss may lead to cascade of clinical situations like communication difficulties, depression, social isolation, falls and reductions of the physical functions, decreased quality of life and even the cognitive decline could be reversed by use of the hearing aids. The timing and average audiometric threshold at which hearing rehabilitation should be considered and beyond which, these measures are less effective. This hearing threshold could be set at 70 decibel in better hearing ear and the timing for use of hearing aid would be within a month of the hearing loss being diagnosed or suspected.<sup>32</sup>

### CONCLUSION

ARHL has a multi-factorial etiopathogenesis and considered as an inevitable hearing impairment along with reduction of the communicative skills in relation to the aging process. There is an increasing evidence of the cognitive decline and dementia linked with ARHL. ARHL with cognitive decline is an important public health concern and impact on economy of the country and social consequences. Age related hearing loss is a risk factor for cognitive impairment and dementia. Cognitive impairment or cognitive decline associated with ARHL is probably preventable with early rehabilitation and increased screening facilities for elderly persons. It is reasonable to assume that the cognitive impairment is common in elderly persons with ARHL. The association between ARHL and cognitive decline is now well established by different cross-sectional and longitudinal studies. However it often unquestionable that ARHL is more common in patients with dementia in healthy persons. Patients must use of hearing aids or cochlear implant for better cognitive performance.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: Not required*

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**Cite this article as:** Swain SK. Age related hearing loss and cognitive impairment - a current perspective. *Int J Res Med Sci* 2021;9:317-21.