

**Special Edition**  
"Hearing Loss which Solutions?  
Present and Future"

## Mini Review

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# A Mini Review: Ageing, Hearing Loss and Cognitive Decline

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### ABSTRACT

**Introduction:** Ageing has been linked to both hearing loss and cognitive decline. Several clinical implications such as increased cognitive load, social isolation, loneliness, and changes in the brain structure have been attributed to hearing impairment.

**Objective:** The aim of this article is to systematically review the available literature on the association between hearing loss and cognitive decline in ageing and the role of a few auditory rehabilitation devices for the improvement of the condition through this approach.

**Review:** There exists a link between hearing loss and cognitive decline. It has been documented that the risk of dementia increases with age-related hearing loss because of reduced input to the brain. Age-related hearing loss has been found to impact many other aspects such as physical mobility, social engagement, etc., in addition to cognitive dysfunction. Hearing aids and cochlear implants constitute a suitable choice of treatment for hearing loss in older patients with cognitive decline.

**Conclusion:** Cognitive abilities can be predicted well through sensory measures in older individuals. Hearing loss is considered to be a better predictor of intellectual abilities than assessed through other sensory functions. The effect of hearing loss on cognitive decline can be prevented with the use of many rehabilitative devices (i.e., hearing aids and cochlear implants). These rehabilitative devices can help to reduce social isolation, improve depression, improve working memory through auditory/speech training, improve self-control or self-confidence and help to preserve the function of peripheral and central synapses. A multidisciplinary approach is the best possible solution for geriatrics including the specific sensorineural investigation which emphasizes on the detailed assessment of the elderly with respect to cognitive abilities and conditions related to hearing loss.

**KEY WORDS:** Cognitive decline; Hearing loss; Cochlear implants; Hearing aids.

### INTRODUCTION

Ageing has been linked to both hearing loss and cognitive decline. Several studies have observed an association between hearing loss and cognitive decline.<sup>1</sup> Hearing loss has been found in one third of the adults aged between 61 to 70 years and more than 80% of the older population greater than 85 years of age. After arthritis and hypertension, it is considered as the most common health disorder affecting the older population.<sup>2</sup> Age-related hearing loss is characterized as bilateral, progressive and symmetrical hearing loss which can affect communication skills due to the influence of factors such as age and related factors associated with co-morbidity like environment and genetic factors. Cognitive impairment is defined by a wide range of clinical conditions ranging from mild to severe dementia with varying degrees of hearing impairment affecting the communicative skills and quality of life (QoL) of individuals.<sup>2</sup> Existing studies have suggested that in the daily lives of elderly people with age-related hearing loss, their social relations, psychological behavioral aspects, motor skills and QoL are compromised.<sup>2</sup> According to existing studies, many theories have been put forth to explain the association between hearing loss and cognition. The first theory emphasizes on the concept of cognitive load which refers to the brain activity, which helps to understand the voice and neural plasticity which plays a role

in compensating for the decline in hearing, and working memory in adults. Cognitive decline reduces the availability of cognitive resources which can be used for auditory perception thereby elevating the effects of hearing loss. When the inputs become poor through impaired perception or degraded stimuli, it puts an additional pressure on the available cognitive resources which are used for signal coding thereby demanding extra cognitive resources for its function which is referred to as 'cognitive load'. The second theory emphasizes on the concept of social isolation and negative perception which leads to a decline in the daily activities and well-being of the individual. The third amongst these theories emphasizes on the role of peripheral and central nervous system which tends to decline in its functions with the course of aging. These theories may overlap with each other. The consequences of these theories highlight the possibility of leading to neural disorganization and shooting up the process of decline thereby, affecting the ability to understand speech. The presence of other comorbid conditions (Alzheimer's disease, cardiovascular disease, etc.) may contribute to the severity of the existing situation.<sup>1</sup> Many studies have reported about the common etiology of cognitive decline and age related hearing loss.<sup>2</sup> Many morphological characteristics such as increased cognitive load, social isolation, loneliness, and structural changes in the brain can result due to hearing impairment.<sup>2</sup>

Considering the fact that ageing may be linked to both hearing impairment and cognitive decline it does not necessarily mean that 'cognitive decline' and sensory impairments always be present among the older people. Healthy ageing is always possible. Many procedures like implementing the use of hearing aids and cochlear implants which are the best possible treatment options for the younger population too, can support the rehabilitation for treating older patients.

## METHODOLOGY

Various databases like Medline (National Center for Biotechnology Information (NCBI), U.S. National Library of Medicine) (NLM), PubMed, Google and Google Scholar were searched for the terms ageing, cognitive decline and hearing impairment. The important findings were documented in a narrative manner.

## ROADMAP OF REVIEW

- Epidemiology of Hearing loss and Dementia;
- Relation between hearing loss and cognitive decline;
- Rehabilitation through cochlear implants and hearing aids.

## Epidemiology of Hearing Loss and Dementia

Hearing loss has been reported in one third of the adult population in the age group between 61 to 70 years and almost 80% of these older adults are above 85 years of age.<sup>1</sup> In a study, it was reported that age-related hearing loss was observed in 26.7 million adults more than 50 years of age and among them 3.8 million people use hearing aids.<sup>3</sup> Males demonstrate higher inci-

dence of presbycusis than females.<sup>2</sup> The epidemiological data on cognitive decline and hearing impaired people has been a major concern especially when considering adults aged between 65 to 75 years.<sup>1</sup> It has been reported that the prevalence of hearing loss increases with age and suggests that 1 in 3 people above 65 years of age have disabling hearing loss.<sup>1</sup> In a research undertaken to investigate the age-wise prevalence of dementia,<sup>2</sup> the clinical condition was reported in 8.5% of the patients above 59 years age, 10% of the patients above 65 years of age and 25-30% people aged above 85 years and more than 90% of the dementia patients showed hearing impairment.<sup>1</sup> The prevalence of dementia has been reported to be 35.6 million in 2010.<sup>1</sup> An increase in the population has consequently raised the number of instances of disability. At the same time, it has also been reported that hearing loss and cognitive decline does not go hand in hand, healthy elders can also be found in equal numbers. Age is naturally given but hearing loss can be modified with various treatment strategies.<sup>1</sup>

## Relation between Hearing Loss and Cognitive Decline

Several researchers have established a link between hearing loss and cognitive decline. It has been documented that the risk of dementia increases with age-related hearing loss because of reduced inputs to the brain.<sup>4-7</sup> Studies also reported that with every 10 dB increase in hearing loss over 25 dBHL, there was a 20% increase in the clinical incidence of dementia.<sup>4</sup> Grucel et al<sup>8</sup> reported in their study that the mean time for developing dementia was 10.3 years in those people affected with hearing loss whereas, it was 11.9 years in elders above 65 years of age who had no hearing impairment. Age-related hearing loss has been found to impact many other domains like physical mobility, social engagement, etc., in addition to cognitive dysfunction.<sup>9-11</sup> Scores of cognitive tests have also been found to be deteriorated with the increased level of hearing loss.<sup>5,6,12,13</sup> Also, the studies support the idea that cognitive tests—verbal and non-verbal—when performed on older patients with severe hearing loss show poor results.<sup>14-18</sup> In a study conducted by Jorgensen et al,<sup>19</sup> it was indicated that hearing loss was investigated in 13% patients in a primary care clinic affected by memory loss. In summary, there exists a link between age-related hearing loss and cognitive impairment in older adults.<sup>2</sup> On an interesting note, it has been reported on the basis of the findings from existing studies that age-related hearing loss affects the brain functioning and cognitive performance by elevating the risks of developing dementia thereby leading to brain injuries as a consequence of other disorders (e.g., microvascular disease and neurofibrillary tangles).<sup>1</sup>

As defined earlier, age-related hearing loss is a complex multifactorial disorder with both genetic and environmental factors (ototoxic drugs, diabetes, hypertension) contributing as a predisposing factor towards its etiology.<sup>2</sup> Experimental studies<sup>20-22</sup> have shown that the aged cochlea results in the degeneration of sensorineural epithelium, striavascularis, and neurons in the spiral ganglion and auditory cortex of the central auditory pathways that are related to exogenous factors. Studies have

highlighted the role of microvascular damage in the pathogenesis of age-related hearing loss with the evidence that spiral ganglion deafferentation is associated with altered dendritic architecture of the auditory pyramidal neurons.<sup>20,22</sup> In summary, the common factors that possibly underlie the correlation or link between hearing and cognition includes vascular risk factors, age and social factors (e.g., education).<sup>4-6,23</sup> Further, the mechanistic hypotheses highlights that association between age related hearing loss and cognitive decline is on account of increased social isolation and loneliness, changes in brain structure and increased cognitive load.<sup>24</sup>

### Rehabilitation through Cochlear Implants and Hearing Aids

Hearing aids and cochlear implants include a suitable choice of treatment for hearing loss in older patients experiencing cognitive decline.<sup>2</sup> Existing studies highlight that the risks of undergoing cognitive decline and dementia was reduced following auditory amplification.<sup>2</sup> It has been reported that untreated hearing loss varying from a moderate to profound degree may result in the development of a cascade of difficulties associated with them such as social isolation, depression, decline in physical functioning, decreased QoL, cognitive decline and communication difficulties. However, data from existing studies report that the prevalence of hearing aid users is often reported to be low due to noise in hearing aids, cost of the hearing aid and inadequate technical solutions available.<sup>2</sup>

Similarly studies on the usefulness of cochlear implants in older patients are many. Older adults have been found to benefit from cochlear implants particularly for understanding of speech based on the scores obtained through various tests as compared to regular amplification.<sup>2,25</sup> Further, the benefits with cochlear implants were noted in helping to bring about psychological changes, age at the time of implantation, reduced cognitive decline, hearing deprivation length and the influence of learning abilities in elderly patients.<sup>2</sup> In a study by Lin's Group<sup>2,26</sup> it was reported that the use of cochlear implants and hearing aids improved the mental health of older adults. In the same study, it was documented that the gain was twice as that of the mental component score with the use of cochlear implants as compared to hearing aid in a period of 6 months and 12 months after amplification.<sup>2</sup> Mosnier et al<sup>2,27</sup> in their prospective study conducted on the older population using cochlear implants found that hearing rehabilitation linked with cochlear implantation brought about an improvement of scores in the cognitive domain as early as 6 months after implantation in the elderly patients who previously had low scores.<sup>2</sup> Di Nardo et al in their study on two groups under and above 60 years of age, observed a high-level of significant improvement in auditory performance, QoL and communication abilities after cochlear implantation in the elderly population who had postlingual bilateral severe to profound hearing loss. Overall improvement was reported in the older population more as compared to the younger age group.<sup>25</sup> Also, there are equivocal studies which did not show much sig-

nificant difference with the use of cochlear implants. In 2015, Miller et al<sup>2,28</sup> in their review of 5,057 articles found that only 3 studies met the criteria of the accounted benefit of cochlear implantation. Further research is needed to evaluate the long-term benefits of the use of hearing aids and cochlear implantation and its effect on the affected older adults.

### DISCUSSION AND CONCLUSION

Cognitive abilities can be predicted well through sensory measures in older individuals.<sup>1</sup> Hearing loss is considered to be a better predictor of intellectual abilities than assessed through other sensory functions. It is considered that hearing loss is associated with greater cognitive impairment.<sup>6</sup> Hearing loss may enhance the speed of cognitive decline. Hearing impairment has become an important public concern due to the related social consequences.<sup>1</sup> Speech perception in noise can be a big challenge for the older adults experiencing cognitive decline. The link between intellectual and sensory abilities as a function of age has been found to originate in the brain. Although, this evidence needs to be strengthened and supported by further experiments and hypothesis. Existing literature supports the idea that sensory functioning affects cognitive aging, either directly or due to the influence of other factors such as mood improvement, etc. By boosting the sensory functions, higher-level cognitive abilities can also be improved. The effects of hearing loss on cognitive decline are quite evident as reported by many studies and its effects can be prevented with the use of many rehabilitative devices (i.e., hearing aids and cochlear implants).<sup>2</sup> These rehabilitative devices can help to reduce social isolation, improve depression, improve working memory through auditory/speech training, improve self-control or self-confidence and help to preserve the function of peripheral and central synapses.<sup>1,29-32</sup> Conventional procedures for medical evaluation of older people with multiple comorbidities has led to the development of a broader aspect of testing for geriatrics which includes hearing impairment, visual impairment, functional decline, balance disorders and malnutrition.<sup>1,33,34</sup>

Understanding pathophysiology and treatment of neurodegenerative disorders can further help to treat sensory deficits in cognitively impaired older individuals. This can change the viewpoint for physicians and surgeons who will try to treat these patients from the holistic way. In the end, a multidisciplinary approach is the best possible solution for geriatrics including the specific sensorineural investigations which emphasize on the detailed assessment of the elderly for their cognition and hearing loss. Also, further research is required to understand how the rehabilitative devices such as hearing aids and cochlear implants can change the natural history of these conditions and help improve communication, social isolation and QoL in older patients.

### CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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