

Review

Clinical concerns of hearing loss in old age: an Indian perspective

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Abstract

Background: Ageing is associated with hearing loss. With an increasing old age population in India, hearing loss in elderly population needs focussed attention. **Aims:** This review attempts to highlight the clinical concerns of age-related hearing loss (ARHL) or presbycusis, its prevention and management issues in the Indian scenario. **Methods:** Literature on the clinical and social aspects of ARHL among the elderly population was searched electronically through PubMed and individual study. Relevant articles were reviewed thoroughly and summarised. **Results:** National Sample Survey in India reported that over 62% and 56% of elderly in rural and urban areas respectively are suffering from ARHL. ARHL is a complex hearing disorder caused by several factors. Any significant impairment to the cochlear hair cells and auditory nerve can cause presbycusis, which is progressive in nature and irreversible. As some of the factors of ARHL are preventable, early detection and treatment slow down the process of deterioration. Awareness on ARHL issues can help to manage this public health burden. **Conclusion:** Research on ARHL in India is limited. There is a need for greater clinical assessment and treatment opportunities. Lack of awareness about it in the community suggests greater emphasis on public education.

Key words

Age-Related Hearing Loss, Elderly, India, Otological Disease, Presbycusis, Treatment

Introduction

Ageing is an inevitable biological phenomenon in human life. The progressive hearing loss as one of the sensory deficits in the elderly is concomitant to increasing life expectancy. Age-related hearing loss (ARHL), commonly known as presbycusis, is a silent, gradual process of sensory deficit that leads to hearing impairment and ultimately it may result in profound deafness. Elderly with ARHL become psychologically depressed, lose self-esteem, feel socially isolated; and thus, it affects their quality of life.

The ARHL prevalence in the elderly age group is increasing in South Asia, Asia Pacific and sub-Saharan

Africa.¹ Hearing loss is recognized as one of the top three chronic conditions of social burden among the elderly, next to arthritis and hypertension,² which needs immediate attention to reduce the social burden. The Indian demographic ratio of the elderly is growing consistently from 5.6 % (1961 census) to 8.6% (2011 census) during the last fifty years. This growth is projected to touch 19% by 2050.³ In regard to the rural and urban ratio, 71% of the elderly population reside in rural areas while 29% in urban areas. About 50% of rural-dwelling elderly belong to the poor socio-economic status group.³ It is reported that one-third of the population between age 65-74 and half of the population older than 75 have a type of hearing loss.⁴

The common causes attributed to hearing loss in elderly are noisy environment, cellular ageing, systemic and communicable diseases, nutritional deficiency and gene mutation.⁴ Loss of conduction of sound waves can occur in the external ear, middle ear and internal ear or cochlea; poor conduction of sound impulses through the auditory nerve and improper interpretation at central auditory processing unit (brainstem and cortex) contribute immensely to hearing loss in the elderly. Most of the presbycusis problems are irreversible but can be reduced or managed up to an extent by the use of hearing aids, nutritional supplement, medicine and surgical intervention as well.⁵

According to the National Sample Survey (NSS), hearing disability is considered as the topmost sensory disability in India.⁵ As the social structure in India has changed and nuclear families are fast becoming the norm rather than joint multigenerational families, many elderly people are living alone, having to support themselves. Health care dynamics of India has changed too, and the cost of the health care is not affordable for many, especially the poor. Similarly, environments have become noisier as if a sign of development.

The present study is aimed to review of clinical concerns of ARHL and its management in the Indian context. It is expected that the information may help clinicians, audiologists, and healthcare workers; it may increase awareness among elderly citizens and their caregivers, and policymakers to focus on the strategies to deal with the ARHL burden in communities.

Box 1: Grade of hearing loss or hearing impairment based on audiogram assessment in the better ear			
Grade	Audiometric value (dB)	Hearing characteristics	Remarks
Normal healthy hearing	0-25	Able to hear whispering at distance	No complaint of hearing
Grade 1 Hearing loss (Mild hearing impairment)	26-40	Able to hear the normal voice from 1 metre distance	Ear and hearing care can restore normal hearing.
Grade 2 Hearing loss (Moderate hearing impairment)	41-55	Able to hear the loud voice from a distance of 1 metre	The hearing aid is essentially required for uncompromised hearing.
Grade 3 Hearing loss (Moderately severe hearing impairment)	56-70	Able to hear only when shouted at ear	Hearing aids and body language improve the hearing and communication up to some extent.
Grade 4 Hearing loss (Severe hearing impairment)	71-90	Unable to hear even shouted at ear	Hearing aids and body language may help the understanding to a small extent.
Grade 5 Hearing loss (Profound hearing impairment)	>90	Unable to hear	Body language may help the understanding.

Methods

The literature on ear health problems among the elderly population was searched electronically through PubMed, and through individual study of cross references and related textbooks. Various keywords and their combinations were used for electronic literature search like India, elderly, ear health, age-related hearing loss, presbycusis, noise-induced hearing loss etc. Criteria included in this review are aetiology, prevention, treatment, early detection and awareness. Publications in the last 10 years were included; and those describing hearing loss in patients under the age of sixty were excluded. Search retrieved 52 related publications amongst which 38 were incorporated in this clinical review.

Result

The elderly population in India has been increasing consistently and it is projected to be 19% of total population by 2050. The age-related hearing loss (ARHL) or presbycusis is a complex hearing disorder caused by several factors. Any significant impairment to the cochlear hair cells and auditory nerve can cause presbycusis, which is progressive in nature and irreversible. As some of the factors of ARHL are preventable, early detection and treatment slows down the rate of further deterioration in the process of presbycusis. Awareness on ARHL issues can help to manage the social burden of presbycusis.

In this review clinical presentations, treatment and preventive aspects are discussed based on the observations from the Indian scenario.

Early sign and symptom of ARHL

ARHL is considered as a silent and slow progressive sensory deficit in the elderly. Initially, an elderly person

may not feel the onset of ARHL, but because of the decreased hearing they tend to speak louder. At this phase, elderly people cannot ascertain the location and direction of a sound source easily. ARHL may affect one ear or both the ears simultaneously. Many a time, some patients hesitate to disclose the problem of their hearing deficit to other family members. This ignorance or hesitance deprives them of the opportunity to address the issue in time.

National Institute of Hearing (NIH) enlisted the initial sign and symptoms of early onset of hearing loss.⁴ The hearing loss and degree of deafness are evaluated in pure tone audiogram, in the ranges from 250 Hz to 8000 Hz, and hearing level from -10 dB to 120 dB as classified by World Health Organisation (WHO).⁶ The degree of hearing loss (impairment) of each ear is measured separately and the reading of the better ear is considered for all the practical purposes. Goodman in 1965 classified the hearing loss/impairment on a scale of seven points and described the property of each category. Subsequently, an additional category was added as 'slight hearing loss' before the mild hearing loss. Grades of hearing loss are given in Box 1.

Etiology of ARHL

The presbycusis or ARHL generally appears around 55-65 years of age and gradually get worse. In a broad sense, the hearing loss can be classified as conductive hearing loss and sensorineural hearing loss (Box 2). Balasubramanian *et al.* expressed that the diseases which restrict the transmission of the sound wave to reach cochlea through the external ear, tympanic membrane, middle ear ossicles up to stapedio-vestibular joint are the causes of conductive hearing loss.⁷ The sensorineural hearing loss (SNHL) may occur due to any lesions in the internal ear (cochlea). SNHL again may be sensory or neural in nature in auditory nerve or central auditory pathways.⁶ Based on the pathological changes in the

cochlea of patient with presbycusis it can be described in four different categories such as:

- i) *Sensorial presbycusis* (epithelial atrophy and loss of hair cells as well as stromal cells in the organ of corti)
- ii) *Neural presbycusis* (neural cell atrophy in the cochlea and the central neural pathways)
- iii) *Metabolic presbycusis* (changes and atrophy of the stria vascularis)
- iv) *Mechanical presbycusis* (gradual thickening and subsequent stiffening of cochlear basilar membrane).

Box 2: Common etiologies of ARHL

A : Conductive hearing loss (CHL): sound wave is obstructed in external or middle ear

- Cerumin buildup
- Fluid accumulation
- Perforated tympanic membrane
- Lesions of auditory ossicles up to stapediostibular joint

B: Sensorineural hearing loss (SNHL): lesions in inner ear or auditory nerve

- Sensorial (damage of hair cells in the organ of corti)
- Neural (degeneration of cochlear nerve, loss of neuron in spiral ganglion)
- Strial (damage to stria vascularis)
- Cochlear duct impairment (transmission loss of sound wave in the endolymph)

These types of hearing loss are degenerately progressive and mostly irreversible unless otherwise specially intervened;⁸ whereas conductive hearing loss may be due to the common otological diseases and disorders like deposition of ear wax or cerumen impaction, accumulation fluid, perforated tympanic membrane and loss of flexibility in the ossicular chain (otosclerosis). WHO outlined the degree of hearing loss as mild, moderate and profound. The hard of hearing is the phase of hearing status up to profound phase but can perceive oral communication. The cause of presbycusis is complex. Several factors, such as genetic, environmental, nutritional, lifestyle, ototoxicity, etc., are found responsible collectively or individually. In this paper, all these factors are discussed under intrinsic and extrinsic headlines.

Intrinsic factors for hearing loss

Several studies revealed that more than 50% of the hearing impairment in the elderly that is due to inner ear ageing process is attributed to some genetic factors. About 70-80% of these factors are found as autosomal recessive, 15-25% is autosomal dominant. Only 1-2% is due to mitochondrial or X-linked genes.^{9,10} The genes related to the inner ear are categorised into six different families viz. transcription factors, cytoskeleton components, ion channels, transporter, extracellular

matrix molecules and genes for stria vascularis disorders.^{11,12}

The onset of ARHL at different age in elderly life may also be correlated with genetic inheritance factors with health comorbidities. When there is a family history of ARHL (maternal or paternal), hearing loss is repeated at a certain age it suggests the inheritance. Xiong *et al.*⁹ in a recent study, revealed that over 120 genes related to non-syndromic deafness had been mapped in the human genome but only a few of them are related to ARHL. Currently, it is understood that multiple genetic factors or potential gene groups are associated with auditory ageing, leading to presbycusis and presbystasis.⁸

Mitochondria provide adenosine triphosphate (ATP) for various functions of hair cells of the cochlea. Muted mitochondrial DNA affects the function of cochlear hair cells severely. Mutation of the mitochondrial genome builds up in the process of ageing, causes hair cell damage and hearing loss.¹³ It is also understood that functional loss in glutathione and superoxide dismutase genes can lead to presbycusis. Some changes in the coding region of the mtDNA have been attributed as the key factors in the progression of presbycusis. Recently, Falah *et al.* shows the significant differences in the frequencies of four nucleotide variants in the mtDNA of a progressive presbycusis patient.¹⁴

Extrinsic factors for hearing loss

Factors such as noisy environment, ototoxic medication, otological diseases, nutritional deficiency, lifestyle, trauma, etc. lead to the ARHL. Extrinsic factor-related hearing loss can be prevented up to some extent by keeping a person away from these factors with specific interventions.

Noisy environment

Noise-induced hearing loss (NIHL) contributes immensely to the elderly hearing disability. It is commonly defined as high-frequency hearing loss due to loud sound exposure of 3-6kHz.¹⁵ Elderly persons with continuous exposure to a high-frequency noisy workplace, engineering and construction industrial environment, war field activities, air traffic zone, amplified sound-based social recreation, etc., enhance the risk of developing NIHL. Sharp impulse noise of electromagnetic appliances, gunpowder or atomic explosion, thunders, etc., can also act as factors for NIHL in the elderly. Above exposures will ill the outer and inner hair cells of the inner cochlea and the stria vascularis. Incidences of tympanic trauma due to sharp impulse sound are not uncommon for NIHL.

Continuous exposure to sound more than 85 dB for short duration causes a temporary hearing loss known as temporary hearing threshold shift (TTS), which may come back to normal condition within a period of 10-15 days. If TTS persists it may lead to permanent threshold shift and degenerative changes.¹⁶ High-frequency noise exposure augments the oxygen uptake in the mitochondria of hair

cell and increases the level of reactive oxygen species (ROS) including other free radicals. Thus, the accumulated oxidative stress disrupts the intracellular redox homeostasis, which in turn leads to NIHL. Of course, the intrinsic antioxidant defences mechanism can resist the oxidative stress up to some extent. Systemic increase of antioxidant molecules in the Organ of Corti by endogenous antioxidant response or exogenous administration reduces the risk of NIHL.¹⁵

Otological diseases

Several chronic otological diseases like otomycosis, otitis media, suppurative otitis media, tympanosclerosis, otosclerosis, perforated tympanic membrane, fluid build-up in the labyrinth, demineralization of the otic capsule, vertigo, tinnitus etc., contribute to the aggregation of ARHL. Disease like vertigo and tinnitus appears as an episode may persist for hours to days together. Otosclerosis in the geriatric phase of life generally increases as a function of age. Rectification of conductive hearing loss may be intervened through stapedectomy, tympanoplasty and ossiculoplasty as the revision surgical procedure in older adults.¹⁷ Cerumen accumulation in old age also has a significant impact for conductive hearing loss. Besides, diseases like chronic viral infections, meningitis, syphilis, neoplasms etc., can also be linked to ARHL.¹⁸

Ototoxic medications

Any drug which has toxic effects to the structures and functions of the cochlea, vestibule, semi-circular canals, and otoliths are considered as ototoxic. Prolonged use of aminoglycoside-based antibiotics such as neomycin, tobramycin, kanamycin, streptomycin, amikacin, and gentamicin are proved to be ototoxic. Similarly, furosemide-based diuretics, quinine based antimalarial drugs, non-steroidal anti-inflammatory drugs (NSAIDs), and platinum-based chemotherapy, may induce the ARHL. The ototoxic effects of the drugs on ARHL may be reversible and temporary, or irreversible and permanent depending on their dose, duration of administration and co-administration of antioxidants and vitamins.¹⁹ Generally, ototoxicity is involved in the progress of ROS accumulation, and resulting apoptosis.¹⁷

Nutritional factors

High glycaemic index food and more carbohydrate intake levels are correlated with hearing loss. Similarly, high dietary intake of cholesterol is associated with an increased risk of hearing loss. However, regular intake of long-chain polyunsaturated fatty acid-containing food (cooking oils, linseed, soybean, sunflower, walnut, sea fishes, salmon, tuna, mackerel, etc.) seems to be protective in relation to ARHL. In a study it is found that intake of fish rich with omega-3 fatty acid reduced the risk of presbycusis up to 24%.²⁰ The cumulative effect of vitamins A, C and E with magnesium as dietary supplement help as good antioxidants to prevent NIHL. It is also reported that the incidences of presbycusis are increased due to lack of any single micro-nutrients, such as vitamins A, B, C, D and E, Zn, Mg, Se, iron and

iodine.²¹ Iron deficiency anaemia (IDA) has been correlated to ARHL through several means. One of the significant aspects is ischemic damage of the labyrinthine artery due to IDA, which reduces the cochlear efficiency.²²

Lifestyle

Hearing loss may lead to loneliness, isolation, depression, frustration, etc., as a consequence.²⁰ At the same time certain lifestyles and social behaviors of senior citizens may have a negative impact on the acoustic performance and progression of the presbycusis. Reduced physical activities and adiposity promote the metabolic presbycusis in the elderly. Smoking, tobacco chewing and use of tobacco paste are found to be the reason for some of the negative auditory function.²¹ It is also reported that chronic exposure to mid-day sun, as the source of ultraviolet radiation may be correlated with systemic oxidative stress and presbycusis.¹⁷ Chronic exposure to the electromagnetic field which is generated by the audiovisual appliances such as Wi-Fi, mobile phone, television, and many other radio devices may heighten the ARHL and tinnitus.¹⁹

Treatment of ARHL

The presbycusis is insidious in nature. Onset of presbycusis may not be felt by some people due to lack of awareness (Box 3). Some elderly neglect and delay the assessment of their hearing loss. This leads to a delay in choosing the type of intervention to manage the ARHL. The ARHL may be due to conductive hearing loss (CHL) or sensorineural hearing loss (SNHL) or due to super imposed otologic disorders. Untreated ARHL leads to several physical and psychological issues which adversely affect the quality of life.

Box3: How to recognize the onset of ARHL

- Generally confused with similar-sounding words and take the help of context to understand
- Difficult to hear in a noisy background
- Difficult to make out conversation when cross talked
- Often it is asked to people for repeating themselves
- The comfortable listening comes by raising the volume of TV, radio, mobile etc.
- Family members often ask the elderly to speak loudly.
- Elderly try to read the body language of others to understand oral communication

There are several clinical options to treat the ARHL. The treatment may effectively improve and/or reduce the progression of ARHL. Effective treatment of hearing loss also improves the emotional health and the quality of life of the patient.¹⁸ Some of these treatment options such as pharmacotherapy for extrinsic factors, hearing aids are commonly available in the usual clinical practice; and facilities for surgery and cochlear implantations also exist there these are indicated.

Surgical treatment

Cerumin deposition, collection of fluid, tympanosclerosis, otosclerosis and microbial infections are some of otologic diseases related to CHL. Generally, tympanotomy, stapedectomy, tympanoplasty, and ossiculoplasty of different types are considered as some of the major surgical interventions to treat the CHL. Some geriatric patients need only revision stapedectomy in addition to their earlier such surgical procedure. Geriatric patients can tolerate all these surgical procedures as it is done under local anaesthesia and within a short duration. However, before selecting a geriatric patient for otologic surgery one has to ascertain the hearing threshold, word recognition and air-bone gap of the patient. An air-bone gap may indicate conductive hearing problem in the outer or middle ear. Where the gap between air and bone conduction is negligible it gives a clue for cochlear problem. SNHL is further divided as sensory (cochlear) or neural (retro-cochlear). It is difficult to revive the damaged hair cells, but neural hearing loss caused due to tumours can be effectively treated surgically.¹⁸ Surgical procedures for geriatric and non-geriatric otology patients are same but the comorbidity, if any, must be taken into the consideration in the former group.

Antioxidant therapy

Oxidative stress accumulates reactive oxygen species (ROS) and reactive nitrogen species (RNS) in the hair cells which affect the endogenous ROS detoxification system. Administration of antioxidant molecules *viz.* Coenzyme Q10, N-acetylcysteine and D-methionine are proved to improve the NIHL condition.¹⁵ Several ototoxic drugs are used for the treatment of some serious infectious diseases, cancer and cardiovascular problems. Prolonged use of such drugs should be reviewed in view of ARHL.

Regenerative therapies

Regenerative therapies are new hopes to restore the SNHL. Transfer of exogenous or activation of endogenous stem cells may come to clinical practice in future for replacement of cochlear hair cells. Regeneration of hair cells by gene transfer therapy is also in trial.⁸

Hearing aids

Presently, hearing aids are universally accepted as one of the best therapeutic intervention for ARHL.⁸ Suitable hearing aids are suggested after clinical assessment of HL to improve the hearing ability in geriatric patients. The basic principle of a hearing aid is to amplify the sound at auditory path.

These aids are battery operated electronic devices consisting of a microphone, an amplifier, a receiver, an ear mould and custom tubing. The basic principle of a hearing aid is to amplify the sound and deliver at the auditory path. Several hearing aids types are available (Box 4), but the suitable aids are suggested after clinical assessment of HL to improve the hearing ability in

geriatric patients. Older adults with severe to profound hearing loss prefer both behind-the-ear (BTE) and in-the-ear (ITE) hearing devices. Whereas bone anchored hearing aid are found to be the choice of younger elderly.

Box 4: Some common hearing aids types used by the ARHL patients

- **Non-custom-amplifier:** Simple amplification systems, low cost, may not be comfortable for ARHL patients, clinically not recommended.
- **Body worn aids:** Comparatively larger in size, wide range of amplification, less in price, recommended for severe to profound HL, need to be pocketed in cloth, old style.
- **Behind-the-ear (BTE):** All the components of the equipment are embedded in a small crescent shaped plastic case, amplified sound reaches to ear through a custom tube, sits back on ear, recommended for severe to profound HL.
- **Receiver-in-Canal (RIC):** More or less similar to BTE hearing aids but a speaker is fitted to the custom tube inside the ear canal at the vicinity of tympanic membrane provides a better sound.
- **In-the-ear (ITE):** All the components of the equipment are lodged inside the ear mold shell, available in different forms (full-shell, half shell, in-the-canal (ITC), completely- in- the- canal [CITC]); recommended for moderate to severe HL.
- **Lyric:** Designed to wear in ear canal at near proximity to tympanic membrane, one can wear for 3-4 month constantly. A trained ear health personnel can only fit it properly; recommended for moderate to severe HL

Cochlear implant

Cochlear implant (CI) is a surgically implantable neuroprosthetic, recommended to the patients who have limited benefit out of hearing aids. An elderly can opt for CI intervention if the patient satisfies all the conditions necessary for CI. It is also studied that the benefit of CI in the elderly is comparable to that of CI of younger individuals.²³

Prevention of ARHL

Mostly prevention of ARHL means delay the onset or slow down the further deterioration rate. Hence some auditory impairment can be deferred by avoiding noise, restricted ototoxic medication with better diets and lifestyle. Sound levels more than 80 dB are harmful to the sensitive hair cells. Elderly people should keep themselves away from prolonged exposure to those sound sources as far as practicable. Short durations of exposure to noise prone area or impulse noise can be overcome by the use of noise protective devices such as earplugs, noise-reducing earphones and headphones, etc.¹ Use of some assistive listening devices *e.g.* captioned phones, amplified phones, FM systems, TV hearing devices, smartphone apps etc. can facilitate the easy listening in old age. It is also suggested to keep elderly away from the

persistent exposure to electromagnetic field such as mobile phone, Wi-Fi, radio, remote control systems and microwave oven.¹⁹

Diet containing omega three fatty acid, anti-oxidants, folic acid, zinc, vitamin C are proved to prevent or at least delay the onset of ARHL.¹⁹ Keeping the systemic diseases like blood pressure, diabetes, obesity etc., under control and stopping the habit of tobacco chewing and smoking are also recommended to delay the onset of ARHL. Elderly with ARHL not only need therapy but also expect some care and co-operation to improve their quality of life (Box 5).

Box 5: How to deal with a hearing-impaired elderly

- Identification of hearing loss onset and its treatment
- Identification of causes of the hearing loss and to address to the avoidable factors
- Provision of appropriate hearing aids, its maintenance and its regular use.
- Offering the support service to senior elderly to use the hearing aids.
- Protect the ears of senior citizen from the irritating noisy environment by suitable devices.
- Listen the hearing-impaired elderly with patience.
- Allow them to talk with a slow pace and in your close vicinity.
- Talk to them also in slow space and in clear voice
- If required repeat your oral communication versions
- Teach them how to read the lip movement and body language of the person who speaks.

Discussion

WHO defines deafness as the complete hearing loss in both the ears and is termed “profound hearing impairment” when showing hearing loss of more than 90 dB.²⁴ The Rehabilitation Council of India Act defined ‘hearing handicapped’ as when a person has acquired hearing loss of more than 70 dB. In this Act the segment of the “severe hearing-impaired” (hearing loss 61-70 dB), as per WHO classification is overlooked.²⁵ WHO opined that ARHL is an important social burden in India which is highly neglected.⁵ In a cross-sectional study hearing loss is found more acutely (67%) among elderly population over 60 years of age.²⁶ According to the report of National Sample Survey in India hearing disability at the age 60 and above was more prevalent in the rural (62%) than that of the urban areas (56%).⁵ Similar disparities in rural and urban ratio was also recorded by Garg *et al.*, in an epidemiological study.²⁷ This may be attributed to the poor socioeconomic status and low education level of rural population.^{26,28} According to WHO, lack of ear care manpower, speciality doctors and malnutrition are also equally responsible for the disparity.⁵ In India, a few hospital base studies are focused on the urban prevalence of presbycusis. The findings are mostly sensorineural in nature and are aggregated due to noise pollution, sedentary lifestyle (high body mass index and central obesity), and ototoxic medication. They also found that

middle economic groups in urban are the worst sufferer of ARHL.^{17,29}

Incidences of cerumen impaction and hearing loss among the elderly in India also reported by several cross-sectional studies.²⁷⁻²⁹ Mohanta *et al.* found more than 50% presbycusis instances with concomitant geriatric otological complaints.²⁸ Giri *et al.* reported that presbycusis incidences increased from 50% among age 60-64 to 56% among the age group over age 70.²⁹ Guleria *et al.* found that SNHL was more prevalent followed by infectious middle ear diseases in the elderly population in Himachal Pradesh.³⁰ SNHL is often reported at highest incidence, followed by CHL in India.²⁹ Most of the CHL cases are treatable. In fact, there is no such effective drug therapy to cure SNHL, but hearing aids improve the hearing ability. Hearing aids are portable electronic amplifying systems, available at varying affordable costs for ARHL rehabilitation of people in different socioeconomic status groups. Hearing aids for CHL is just a matter of amplification, but devices with more advanced technologies can target SNHL patients, helping them to hear sounds with greater ease.³¹ Many elderly ignore the use of hearing aid with a negative attitude, believing that they do not require the aids, nor they are convenient for them. The negative attitude and stigma are due to lack of awareness and motivation.²⁷

CI is one of the best options to treat extremely severe SNHL cases but may not be affordable for all.^{9,23} Keeping the cost factor in view, the Defence Research and Development Organisation (DRDO) is working on a low cost CI model to cater for the needs of the lower income groups of the country.⁵

Continuous exposure to sound more than 85dB can induce sensorineural problem in the cochlea.³² The industrial noise pollution in India is at a high level. A study in industrial areas in Haryana showed that 39% of workers who were exposed to noise level >87.3 dB for 8-12 h/day had substantial NIHL.³³ At this juncture country need a holistic hearing conservation programme, at least in the industrial areas, which should include noise assessment, hearing impairment assessment, awareness and rehabilitation campaigns as preventive measures.³³

Electromagnetic fields created by mobile phone, Wi-Fi, radio, remote control systems etc. contribute for SNHL.¹⁹ As common communication tools, the above devices are rampantly used in India by all age groups. In a cross-sectional study, Rameya *et al.* reported that the use of a mobile phone more than 30 minutes per day increases the hearing threshold significantly.³⁴

Common systemic diseases like diabetes, blood pressure, obesity etc. are linked with early onset of ARHL. According to the report of International Diabetic Federation, India is in the 2nd position in the global scenario of people with diabetes with over 70 million people as of 2019. Few cross-sectional studies of India show possible associations between chronic diabetes and hyperglycemic damage to the cochlear hair cells, causing significant SNHL among presbycusis group.³⁵ Krishnappa

and Naseeruddin recorded over 30% more incidences of presbycusis among diabetic subjects than the non-diabetic individuals.³⁶ Kumari *et al.* also reported a significant increase in otological diseases and SNHL among elderly diabetic patients.³⁷

The global burden of ARHL needs an assured management system and its easy clinical application. Regenerative therapy for SNHL is probably the next generation of research where different biotechnological tools like gene transfer system, exogenous stem cell supplement and activation of endogenous stem cells are going to restore the loss of hair cells and cochlear function *in situ*.³⁸

Conclusion

More than one third of elderly population suffer from ARHL. The prevalence is increasing due to various issues such as increased longevity, lack of awareness about the etiological factors, delay in detection of its onset, poor availability and utilisation of regular ear care services, negative attitudes for hearing aids and unaffordable cost of cochlear implant. Dearth of audiologists, otolaryngologists, and ear health carers is also partly responsible for slow progress in the ARHL management programmes in the country. At this juncture, the government should provide free hearing assessment services and hearing aids at least for those who cannot afford them, or at least in a subsidized price. There is a need to increase specially trained manpower. Currently all the management options available for ARHL have their own advantages and limitations. So, it is wise to delay the onset of ARHL by improving lifestyle as a preventive measure. The present thrust area of clinical research in this context is regenerative hair cell therapy, which should be given priority for next generation ARHL treatment.

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