World Health Organization

WORLD REPORT ON HEARING

The cover image is an artistic representation of a sound wave entering the cochlea. The sound wave in this image represents the musical notes of the 'Sound of Life', a song specially created for the WHO Make Listening Safe initiative by Ricky Kej. Download the song here https://youtu.be/EmXwAnP9puQ

WORLD REPORT
ON HEARING

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FOREWORD

Hearing loss has often been referred to as an "invisible disability", not just because of the lack of visible symptoms, but because it has long been stigmatized in communities and ignored by policy-makers.

Unaddressed hearing loss is the third largest cause of years lived with disability globally. It affects people of all ages, as well as families and economies. An estimated US$ 1 trillion is lost each year due to our collective failure to adequately address hearing loss. While the financial burden is enormous, what cannot be quantified is the distress caused by the loss of communication, education and social interaction that accompanies unaddressed hearing loss.

What makes this matter more pressing than ever is the fact that the number of people with hearing loss is likely to rise considerably in the coming decades. Over 1.5 billion people currently experience some degree of hearing loss, which could grow to 2.5 billion by 2050. In addition, 1.1 billion young people are at risk of permanent hearing loss from listening to music at loud volumes over prolonged periods of time. The *World report on hearing* shows that evidence-based and cost–effective public health measures can prevent many causes of hearing loss.

To guide future action, the *World report on hearing* outlines a package of interventions for Member States to adopt, and proposes strategies for their integration in national health systems to ensure equitable access to ear and hearing care services for all those who need them, without financial hardship, in accordance with the principles of universal health coverage.

The COVID-19 pandemic has underlined the importance of hearing. As we have struggled to maintain social contact and remain connected to family, friends and colleagues, we have relied on being able to hear them more than ever before. It has also taught us a hard lesson, that health is not a luxury item, but the foundation of social, economic and political development. Preventing and treating disease and disability of all kinds is not a cost, but an investment in a safer, fairer and more prosperous world for all people.

As we respond and recover from the pandemic, we must listen to the lessons it is teaching us, including that we can no longer afford to turn a deaf ear to hearing loss.

Dr Tedros Adhanom Ghebreyesus
Director-General, World Health Organization

When I travel to countries around the world, I meet girls who have struggled against poverty, child marriage and discrimination to stay in school and finish their education. These young women are from different backgrounds, practice different religions and speak different languages; but they share the same determination to pursue their dreams for the future.

With all the barriers to equality facing girls, women and other marginalized people, those who need hearing care are further disadvantaged and too often left behind. About 1 billion people around the world are at risk of avoidable hearing loss. WHO estimates that over 400 million, including 34 million children, live with disabling hearing loss, affecting their health and quality of life.

Because I have also suffered hearing loss, I know this doesn't need to be an obstacle to education. With access to health care, rehabilitation and technology, people with disabling hearing loss can participate equally in education, employment and their communities. Hearing loss doesn't keep them from reaching their full potential: poverty and discrimination do.

To address this global public health challenge, the *World report on hearing* offers evidence-based, equitable and cost–effective actions for ear and hearing care. Following the guidance in this report, WHO Member States can help prevent hearing loss and ensure that people with hearing loss can access the care they need.

I hope our leaders will work together to implement the recommendations in the *World report on hearing* – and give every person with hearing loss the chance to contribute to our shared future.

Malala Yousafzai
Nobel laureate and UN messenger of peace

From an early age, I knew I'd be involved music in some capacity because music was everything to me.

There are millions of people out there who share those same feelings. For the past forty-five years, I have been careful how I enjoy music. I'd like to use this *World report on hearing* to pass on this message:

"Music is everything, and so is your hearing."

Hearing loss doesn't just affect the young, it affects all age groups. The way we enjoy our music is what counts; volume can damage your hearing forever. So take care of your hearing with the level you listen to it.

Remember, if you lose your sense of hearing, it won't come back.

Keep rockin', be safe.

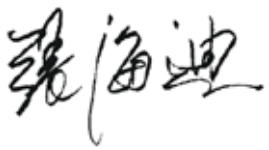
Bryan Adams
Musician

The ability to hear is a gift human beings are given to appreciate the amazing beauty of the world around us. It bestows aesthetics to life. It is also the medium for our learning and social interaction.

From my own personal experience as a child with a disability, I know the value of education and learning, which was not only my solace in the darkest hours of my life, but also the medium with which to achieve my full potential. Therefore, I find it unacceptable that even today millions of children in the world are deprived of their right to education and communication, thereby limiting them in their aspirations. It is even more so because hearing loss can both be prevented and can be addressed.

The WHO's *World report on hearing* shines a strong light on the needs of the nearly 450 million people that need rehabilitation services for their disabling hearing loss. It also provides great insights into how the services can be developed in an equitable manner across the world.

On behalf of Rehabilitation International, I appreciate WHO's ongoing commitment to this hidden disability and we are proud to be contributors to this important report. I sincerely hope that the release of this report will further promote the implementation of the "Prevention of deafness and hearing loss" resolution adopted by the World Health Assembly in 2017, so that all people, including those with hearing loss, can lead healthy and fulfilling lives. Rehabilitation International is fully committed to working together with the World Health Organization in this worthy endeavour.



Zhang Haidi
President of Rehabilitation International
Chairperson, China Disabled Persons' Federation

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ABBREVIATIONS

AABR	automated auditory brain response
ABR	auditory brainstem response
AOM	acute otitis media
APD	auditory processing disorder
APGAR	method of scoring to measure the physical condition of a newborn
ARHL	age-related hearing loss
ASHA	American Speech Language & Hearing Association
ASOM	acute suppurative otitis media
ASSR	auditory steady-state response
CART	communication access realtime translation
CCAC	Collaborative for Communication Access via Captioning
CDC	Centres for Disease Control and Prevention (United States)
CMA	community health aide/agent
CHW	community health worker
CMV	cytomegalovirus
CSOM	chronic suppurative otitis media
DALY	disability-adjusted life year
dB	decibel
dBA	A-weighted decibel
D/HH	deaf/hard-of-hearing
DLU	Deaf Link Uganda
DR-TB	drug-resistant tuberculosis
DST	dexamethasone suppression test
DTC	direct-to-consumer/customer
EHC	ear and hearing care

EHDI	early hearing detection and intervention
ENT	ear, nose and throat
FDA	Food and Drug Administration (United States)
FLIP	Family-centred Early Intervention Program (Austria)
FM	frequency modulation
FRESH	Focusing Resources on Effective School Health
GBD	global burden of disease
GDP	gross domestic product
GP	general practitioner
HHL	hidden hearing loss
HIV	human immunodeficiency virus
Hz	Hertz measurement of sound vibration frequency
ICF	International Classification of Functioning, Disability and Health
IPC-EHC	integrated people-centred ear and hearing care
ITU	International Telecommunication Union
MDR-TB	multidrug-resistant tuberculosis
MHMS	Ministry of Health and Medical Services (Fiji)
MoH	Ministry of Health
NGO	nongovernmental organization
NHSP	Newborn Hearing Screening Program (Israel)
NICU	neonatal intensive care units
NIHL	noise-induced hearing loss
NSOM	nonsuppurative otitis media
OAE	otoacoustic emission
OM	otitis media
OME	otitis media with effusion
OTC	over-the-counter
PCV	pneumococcal conjugate vaccine
PEHC	primary ear and hearing care

PEHC-TR	primary ear and hearing care training resources
PSAP	personal sound amplification product
PTA	pure tone audiometry
QALY	quality-adjusted life year
QOL	quality of life
RAHL	rapid assessment of hearing loss
RCT	randomized control trial
SDG	Sustainable Development Goal
SFHA	self-fitting hearing aids
SLT	speech-language therapist
SSNHL	sudden sensorineural hearing loss
STT	speech-to-text
STTI	speech-to-text-interpreting
STTR	speech-to-text-reporting
TEOAE	transient-evoked otoacoustic emission
UN	United Nations
UNCRPD	United Nations Convention on Rights of Persons with Disabilities
UNHS	universal newborn hearing screening
USA	United States of America
VA	Veterans Affairs (USA)
WHA	World Health Assembly
WHO	World Health Organization
WHF	World Hearing Forum
WISN	Workforce Indicator for Staffing Needs (WHO)
YLD	years lived with disability

Hearing care for all!

INTRODUCTION

> The *World report on hearing* envisions a world in which no individual experiences hearing loss due to preventable causes, and those with hearing loss can achieve their full potential through rehabilitation, education and empowerment.

Hearing is the sense with which we perceive the sounds around us; through hearing we engage with our environment, communicate with others, express our thoughts, and gain education. Globally more than 1.5 billion people experience some decline in their hearing capacity during their life course, of whom at least 430 million will require care.

Loss of hearing, if not identified and addressed, can have far-reaching consequences, adversely affecting language development, psychosocial well-being, quality of life, educational attainment and economic independence at various stages of life *(1–3)*. Unaddressed, hearing loss imposes a global cost of more than $ 980 billion annually, and potentially risks the global goal of United Nations Member States to end poverty and ensure that all people on this planet enjoy peace and prosperity by 2030 *(4, 5)*.

Many causes of hearing loss can be prevented. Common ear diseases, ear infections, vaccine-preventable illnesses, and exposure to noise and chemicals, endanger the hearing of many people at different ages. The World Health Organization (WHO) estimates, for example, that more than 1 billion young people put themselves at risk of permanent hearing loss, often unknowingly, by listening to music at loud intensity over long periods of time. Mitigating such risks through public health action is essential to addressing hearing loss.

Across the life course, people with ear conditions or hearing loss can benefit greatly from effective and available interventions. The past few decades have

seen game-changing advances in the field of hearing technology, diagnostics and telemedicine with innovations that enable ear diseases and hearing loss to be identified at any age and in any setting. Medical and surgical management, hearing aids, cochlear implants, rehabilitative therapy, sign language and captioning are solutions which can ensure that people with ear diseases or hearing loss access education and communication and thereby have the opportunity to fulfil their potential.

Despite the existence and effectiveness of these interventions, the vast majority of those in need do not have access to them. Most people with hearing loss live in low-income settings where human resources and services for ear and hearing care are not commonly accessible.

To address this, in 2017, the World Health Assembly adopted resolution WHA70.13 *(6)* which urges governments to integrate ear and hearing care into their national health system framework and instructs WHO to provide the evidence and tools for them to do this.

The *World report on hearing* was developed with the key purpose of promoting global action for equitable access to ear and hearing care in all settings across the world. The report provides clear evidence to target hearing loss as a global public health priority and outlines the H.E.A.R.I.N.G. package of interventions that countries should prioritize, taking into account their national circumstances. The many challenges facing countries in these endeavours are outlined in the report.

Challenges have further intensified during the COVID-19 pandemic, which has exposed the fragility of current health systems and focused attention on the need to invest in health care as a means to safeguard the world's populations in the future. As governments and public health agencies begin the task of building better, future-proofed health systems, lessons must be learnt, and the vision of universal health coverage realized. Public health action must take into account the ongoing demographic changes: a rise of more than 1.5-fold in hearing loss is anticipated in the coming decades. Through prioritizing hearing loss and integrating hearing care within the systems, WHO Member States can ensure that ear and hearing care services are accessible as part of universal health coverage, delivered through national health systems.

Definitive action is required to deliver not only on the mandate of resolution WHA70.13, but also the relevant Sustainable Development Goals (SDGs): SDG3 (good health and well-being); SDG4 (quality education); SDG8 (decent work and economic growth); and SDG10 (equality). In 2015, when countries adopted the new agenda for sustainable development in the form of 17 goals, they pledged to leave no one behind. They recognized that ending poverty must be supported by strategies to both build economic growth and to address a range of social needs including education, health, social protection and job opportunities.

Through the *World report on hearing*, the World Health Organization highlights the need for, and means of, promoting ear and hearing care to serve the SDG agenda and its relevance for everyone irrespective of age, nationality or hearing status. The report calls upon Member States to initiate affirmative action that both includes, and addresses, the needs of those living with ear diseases and hearing loss, as well as the populations at risk of these conditions. It also invites civil society, developmental public health agencies, professional societies, health-care providers and researchers to respond to this global call so that all people can enjoy good hearing as part of good health and well-being throughout their life course.

GOALS AND OBJECTIVES OF THE REPORT

The overarching goals of the report are to make ear and hearing care a global public health priority through presenting its relevance across the life course, and to define a public health approach for addressing this form of care from the prenatal stage to adulthood and into older age. The objectives outlined in the report include:

- establishing hearing loss across the life course as a public health priority among policy-makers;
- drawing attention to the existing solutions to prevent and rehabilitate hearing loss, as well as the challenges in their delivery and access;
- documenting scientific evidence and country experiences on the approaches to build integrated people-centred ear and hearing care services, delivered through national health systems; and
- making recommendations and setting targets that stimulate country-level action for improved access to ear and hearing care, through integration of the H.E.A.R.I.N.G. package of interventions as part of universal health coverage.

DEVELOPMENT OF THE REPORT

The *World report on hearing* was prepared through a consultative and evidence-based process; its structure, content and recommendations were guided by stakeholders in the field of hearing. After determining the structure, WHO identified information needs and engaged with a wider group of researchers to develop and review background papers based on reviews of literature. Information from these papers was used to inform and shape the text of the report. Estimations of prevalence, years lived with disability, and future projections were made in collaboration with the Global Burden of Disease study of the Institute of Health Metrics and Evaluation.[1] Data were collated from surveys from Member States and consultations held across all six WHO regions during the past two years. Economic analyses were also undertaken to better understand the financial implications of hearing loss and the benefits of ear and hearing care. Examples, case stories and photographs were sourced from, or contributed by, governmental and nongovernmental partners across the world. Member States were consulted through an open web-based consultation and their feedback sought on the final draft version.

The list of priority interventions was identified through a consultative process and further refined through extensive reviews of literature, assessment of effectiveness and cost–effectiveness. Development was carried out in close collaboration with different WHO departments and the final draft reviewed by the stakeholders. The quality of evidence was assessed and is documented in WEB ANNEX A of the report.

To ensure inclusivity of opinion, webinars were held to share information with all those interested; these were open to anyone who wished to attend. The entire process was aimed at developing a report based on evidence, while being grounded in reality and reflecting real-life experiences that are not always captured in peer-reviewed literature.

NEXT STEPS

Following the launch, the *World report on hearing*, will be widely disseminated to promote implementation of its recommendations by WHO Member States. WHO will provide technical support and where required, develop evidence-based guidance to facilitate Member States' response.

[1] See: http://www.healthdata.org/gbd/2019

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Societal change can mitigate the impact of hearing loss: a case study from India*

*Contributed by Anwesha Kolkatta. See: https://anweshakolkata.org/en_US/

As a deaf child I struggled a lot when I was in school. My mother tells me that despite the adjustment with hearing aids, going to therapy and learning to hear and speak, I managed quite well in the early years with the help from my teachers. But things became really tough when I had to start learning languages other than my mother tongue. I depend on my hearing aids and lip reading to understand what others say and trying to do so in three languages was nearly impossible. Even though the national Disabilities Act makes an exception for deaf children, this 'single language right' was not applicable where I lived. My parents did their best to support me in what seemed an impossible battle with my books.

Seeing my daily struggles and that of other deaf children, my mother, an active member of a parents' association decided to take action. Petitions were filed with the government and in courts, but the matter dragged on for years, while I finished schooling and joined university. I became a member of a youth self-advocacy group called 'Bondhu' and we decided to join our parents in this fight.

Once we spoke up for ourselves and explained our point of view, we noticed a new realization dawn among the officials. Finally, after five years of struggle, deaf children were granted the right of learning one language. Even though I cannot benefit from this, I know that this will help other deaf children continue their education and achieve their goals.

The experience made me realize the power of speaking out and that as people with hearing loss; we must ourselves become agents of societal change.

Sneha Das Gupta, PhD student, India

SECTION 1

THE IMPORTANCE OF HEARING ACROSS THE LIFE COURSE

> The sense of hearing is a key aspect of functioning at all stages of life: its loss, unless appropriately addressed, impacts society as a whole.

1.1 OVERVIEW

- Each individual has a unique hearing trajectory that is shaped by diverse influences experienced throughout the life course; these include genetic characteristics, and biological, behavioural and environmental factors.
- The course of the hearing trajectory determines a person's hearing capacity at any point during their life. Causative and protective factors influence hearing capacity.
- Although factors influencing hearing capacity can be encountered at different periods of a person's life, some factors are more likely to be experienced – or individuals may be most susceptible to their effects – at specific points in life.
- Section 1 describes the causative and protective influences encountered during the prenatal period through to older age, with emphasis placed on those most relevant to public health.
- Hearing capacity is commonly measured using pure tone audiometry and classified based on the audiometric hearing thresholds. Any decline in hearing capacity is referred to as hearing loss or hearing impairment[2] which may range in severity from mild to complete.

[2] In this report, the terms "hearing loss" and "hearing impairment" are used interchangeably.

- Globally more than 1.5 billion people experience some degree of hearing loss. Of these, an estimated 430 million have hearing loss of moderate or higher severity in the better hearing ear. Prevalence of hearing loss varies across WHO regions; the vast majority of people affected live in low- and middle-income countries of the world.
- The impact of hearing loss on a person is determined not only by the severity and profile of the loss, but also largely on whether the hearing loss is addressed by effective clinical or rehabilitative interventions, and the extent to which the environment is responsive to the person's needs.
- If unaddressed, hearing loss can negatively impact many aspects of life: communication; the development of language and speech in children; cognition; education; employment; mental health; and interpersonal relationships. Hearing loss can cause low self-esteem, is often associated with stigma, and can significantly impact the families and communication partners of those living with the condition.
- Globally, unaddressed hearing loss poses an annual cost of over $ 980 billion.[3] This includes costs related to health care, education, productivity losses, and societal costs. Many of these costs can be mitigated through the use of cost–effective interventions, as described later in the report.

Hearing is a key component of human intrinsic capacity; it is the sense most relied upon to communicate and engage with others. Any decline in hearing capacity at any point during the life course, if not addressed in a timely manner, can adversely affect day-to-day functioning *(1, 2)*. Section 1 highlights these factors and explores the impact of unaddressed hearing loss on those affected, their families and society as a whole.

[3] Unless otherwise specified, the use of "dollars" or "$" throughout the report refers to the International dollar.

> Multiple factors interact to determine the development of one's hearing trajectory across the life course.

1.2 HEARING ACROSS THE LIFE COURSE

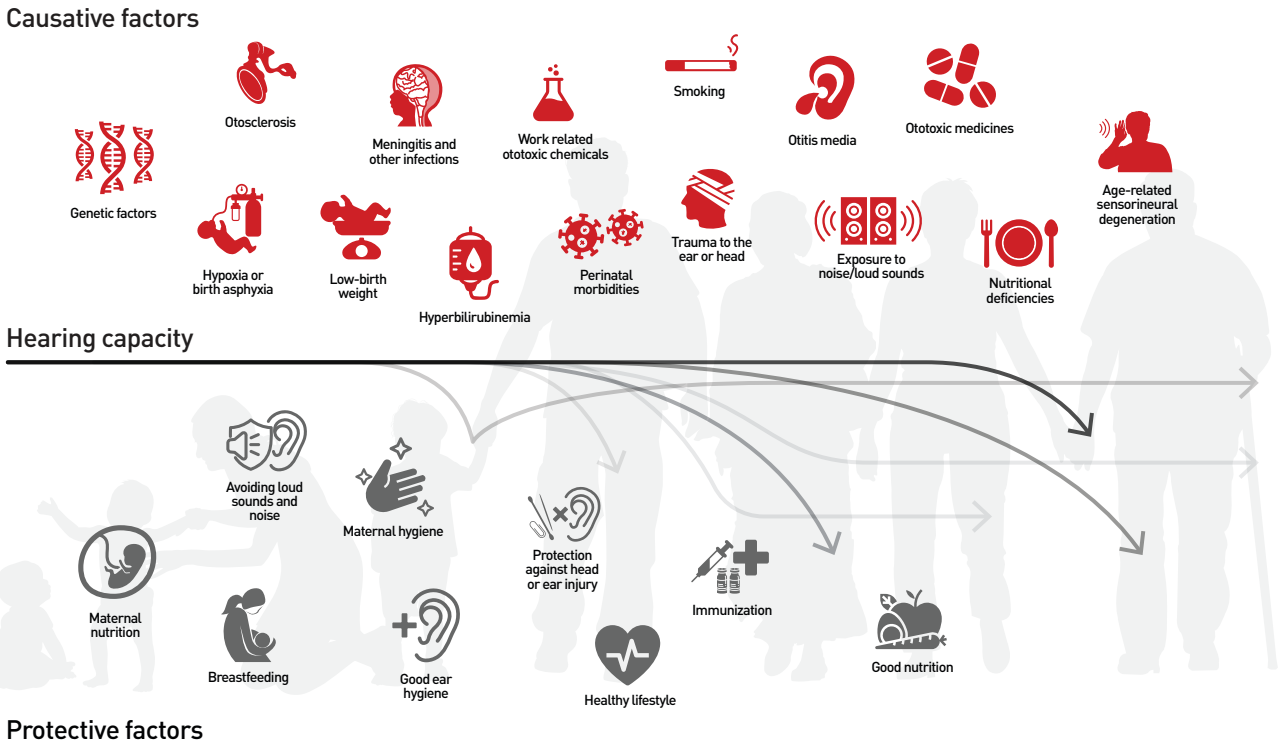
During the course of their lifetime, humans are exposed to multiple risk and protective factors that contribute to their overall hearing capacity *(3)*. The life course model for health development considers health as an emergent capacity that develops dynamically over time *(4, 5)*. This model considers health – including hearing – as being affected by multiple factors which range from genetic and biological to psychosocial and economic *(3, 5)*. Adopting a life-course approach allows the preservation of hearing to be viewed as an important goal, and hearing loss not as a single event or occurrence, but as an outcome of factors experienced from the prenatal period through childhood and adulthood *(3, 6)* and into older age.[4] This provides opportunities for intervention, in the form of prevention, identification, treatment and rehabilitation, across the life course,

An individual's hearing trajectory is determined by the baseline hearing capacity at birth along with the diverse causative and protective influences experienced throughout the life course *(3).*

Hearing throughout a person's life can be visualized in the form of a trajectory (the hearing trajectory), the course of which determines our hearing capacity at any point in time. An individual's hearing trajectory depends on the baseline capacity at birth, and the multiple risk or preventive factors encountered during the life course *(3, 6)*, as described in Figure 1.1. The mechanism by which hearing occurs in the ear is illustrated in Figure 1.2.

[4] The age ranges used in the *World report on hearing* are: perinatal period, 0–4 years; childhood and adolescence, 5–17 years; adulthood, 18–64 years; older adults, 65 years and above.

Figure 1.1 Hearing across the life course



1.2.1 DETERMINANTS OF HEARING CAPACITY

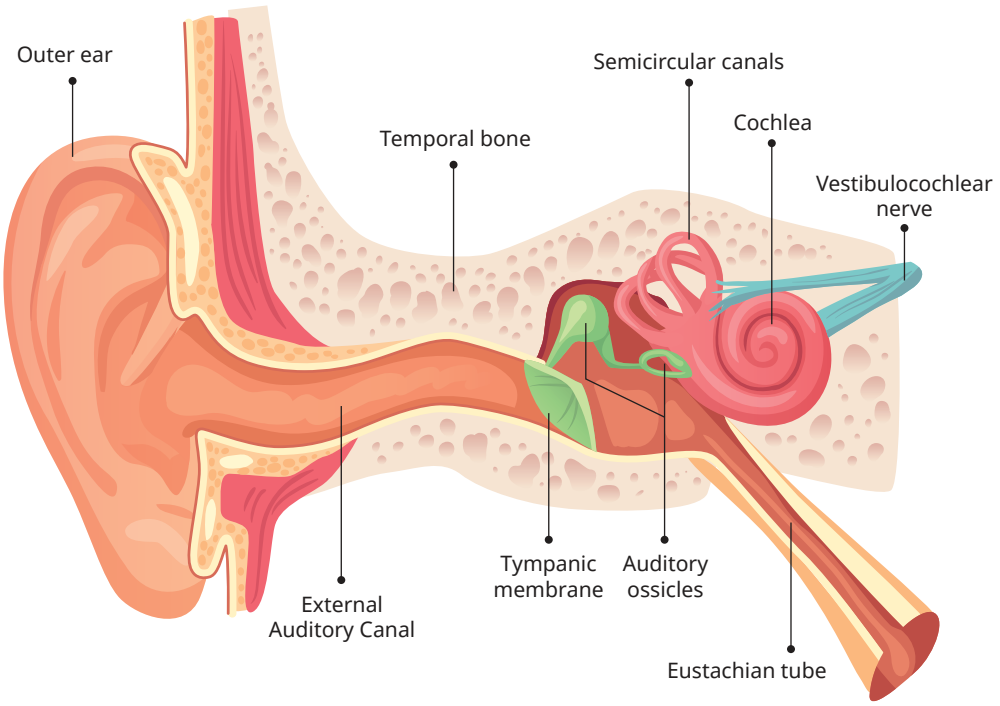
It is evident that many determining factors of the hearing capacity – genetic, biological, psychosocial and environmental – experienced at different stages of life, influence the ears and can either lead to hearing loss or protect against it. Many ear conditions, such as otitis media, are treatable, and many causes of hearing loss – nutrition, ear hygiene and loud noise, for example – can be avoided by taking preventive actions at a personal level. Both causative and preventive factors interplay to determine the occurrence, nature, severity and progression of hearing loss, thus the hearing capacity of an individual is determined by: *(3)*

1. Baseline hearing capacity at birth.
2. Exposure to, or presence of, causative factors (genetic, biological, behavioural or environmental).
3. Protective actions mitigating the risk factors.

1.2.2 CAUSATIVE FACTORS OF HEARING LOSS

Although these factors can be encountered at different periods across the life span, individuals are most susceptible to their effects during critical periods in life, such as before birth or in the first years of life – a period of physiological development and

Figure 1.2 The hearing mechanism



Sounds travel through the outer part of the ear to strike and set into vibration the tympanic membrane (eardrum). These vibrations are transmitted through the three ossicles (bones) in the middle ear to the cochlea in the inner ear. The outer and middle ears serve to amplify the sound vibrations setting into motion the fluid contained within the cochlea. This movement is transduced by hair (sensory) cells within the cochlea to an electrical, nervous impulse that is transmitted by the auditory nerve to the brain where it is perceived as sound *(7)*.

maturation for the hearing system and critical for language acquisition *(3)*. The impact of risk factors for hearing loss is also higher in older age groups when neurogenerative changes set in. However, the decline in hearing experienced at this age is not a simple, inevitable, degenerative process associated with growing old: it is the outcome of genetic influences, health conditions, lifestyle and environmental experiences that are embedded in the physiological system of hearing *(6)* and have influenced it during the course of life.

Factors that influence the hearing trajectory:

- **Genetic characteristics**
- **Biological factors – e.g. health conditions or diseases**
- **Behavioural factors – e.g. lifestyle choices**
- **Environmental factors**

Certain health conditions or environmental influences are more likely to be experienced at specific stages of the life course; these are detailed in the time period they are considered most relevant (Table 1.1). Factors that may be encountered at any point, or equally, at all stages of life are listed in Table 1.2 *(3, 8–10)*.

In addition to the information provided in the tables, three specific factors that can lead to hearing loss are highlighted: otitis media; exposure to loud noise; and age-related hearing loss. These are considered especially relevant from a public health perspective, mostly due to their high prevalence in the community or their well-established preventive and therapeutic mechanisms.

Table 1.1 Causative factors that lead to hearing loss across the life course

PRENATAL PERIOD

GENETIC FACTORS

These include 11 syndromes currently identified as being associated with hearing loss, including Usher's syndrome, Alport syndrome, Pendred syndrome among many others *(11)*.

> ***Consanguinity refers to marriage between close biological relatives, and may be associated with higher incidence of congenital problems*** *(12)*.

INFLUENCE ON HEARING

Over 250 genes are associated with syndromic and nonsyndromic types of hearing loss, which are commonly hereditary in nature. These include autosomal dominant, autosomal recessive and X-linked genes *(11)*.

IMPORTANT CONSIDERATIONS

Genetic hearing loss is encountered more frequently in children born to consanguineous parents *(12–15)*. Consanguineous marriages are a common tradition in many communities across the world, where such unions collectively account for 20–50% of all marriages *(12, 14, 16, 17)*.

Syndromic hearing loss is accompanied by additional clinical features in the visual, nervous system, endocrine and other systems *(18, 19)*.

RELATED STATISTICS

Genetic factors are responsible for over 50% of hearing loss encountered in neonates *(18)*, and account for nearly 40% of childhood hearing loss (*20*).

Syndromic factors account for 15% of neonatal hearing loss, while nonsyndromic hearing loss accounts for the remaining 35% *(18)*.

INTRAUTERINE INFECTIONS

Infections contracted by the mother during the intrauterine period which can lead to hearing loss. These include viral, bacterial and parasitic pathogens.

Congenital infections commonly associated with hearing loss include:

- Toxoplasmosis
- Rubella
- Cytomegalovirus (CMV)
- Herpes simplex virus type 1 and 2
- Human immunodeficiency virus
- Lymphocytic choriomeningitis virus
- Zika virus
- Syphilis

INFLUENCE ON HEARING

Most commonly associated with congenital sensorineural hearing loss which varies from moderate to profound and in some cases, with auditory processing disorders such as toxoplasmosis *(21–23)*.

At times, hearing loss may develop in the early months or years of life, as with, for example cytomegalovirus infection.

IMPORTANT CONSIDERATIONS

Presentation may be accompanied by other features of disease: Clutton's joints or Mulberry molars for example, in cases of congenital syphilis *(24)*; sequelae of congenital zika syndrome *(25)*; or cardiac or eye abnormalities associated with CHARGE syndrome in congenital rubella *(23)* depending on the cause.

RELATED STATISTICS

Viral infections cause up to 40% of all non-genetic congenital hearing loss *(22)*. Cytomegalovirus infection is a common cause, resulting in hearing loss in 14% of infants born to affected mothers. Of these infants, 3–5% have bilateral moderate to profound hearing loss *(26)*. Of infants with congenital zika syndrome, 6–68% have hearing loss. Hearing loss is the most common sequelae of congenital rubella infection, occurring in 12–19% of those affected *(22)*.

PERINATAL PERIOD

HYPOXIA OR BIRTH ASPHYXIA *(27–30)*

Lack of adequate oxygenation experienced at time of birth. This commonly manifests as a low APGAR score which is assessed in the minutes immediately following birth.

INFLUENCE ON HEARING

Severe hypoxia or anoxia experienced at the time of birth leads to irreversible cellular damage in the cochlea, with consequent sensorineural hearing loss.

IMPORTANT CONSIDERATIONS

The risk is higher in neonates that require assisted ventilation for neonatal respiratory failure.

RELATED STATISTICS

No available data.

HYPERBILIRUBINEMIA *(27, 31)*

An increase in the serum bilirubin levels, also commonly known as jaundice.

INFLUENCE ON HEARING

Neonatal jaundice is a frequent occurrence, and is mostly mild and transient, with no long-lasting sequelae. However, bilirubin-induced neurologic damage may occur in some infants and the auditory system is most sensitive to its effects. Such damage most commonly occurs within the auditory nerve or brainstem, often manifesting as an auditory neuropathy spectrum disorder.

IMPORTANT CONSIDERATIONS

Risk is greatest in infants with bilirubin levels higher than 20 mg/dL.

The hearing of premature infants is more susceptible to the toxic effects of bilirubin.

RELATED STATISTICS

No available data.

LOW-BIRTH WEIGHT *(18, 27, 32)*

A birth weight of below 1500 g, as a result of premature birth or maternal undernutrition.

INFLUENCE ON HEARING

Low birth weight is a well identified risk factor for hearing loss. It is likely that while low weight itself may not have an impact on hearing, it is commonly associated with multiple risk factors, such as ototoxic medicines, hypoxia and hyperbilirubinemia, that act synergistically leading to hearing loss.

IMPORTANT CONSIDERATIONS

Infants with very low birth weight may at times have conductive hearing loss due to transient middle ear effusion.

RELATED STATISTICS

No available data.

OTHER PERINATAL MORBIDITIES AND THEIR MANAGEMENT *(18 , 27, 29)*

Includes perinatal infections and use of ototoxic medicines.

INFLUENCE ON HEARING

Certain infections occurring in the newborn period may be due to pathogens that have a direct effect on the auditory system (e.g. CMV infection and meningitis). Hearing loss can also be the result of ototoxic medicines used to treat these infections.

IMPORTANT CONSIDERATIONS

It is observed that infants managed in neonatal intensive care units (NICU) have a significantly higher likelihood of developing hearing loss, mainly as a result of the underlying conditions (e.g. prematurity or hyperbilirubinemia); use of ototoxic medicines; and exposure to high noise levels in the NICU (where decibel (dB) levels may range to 120) *(33).*

RELATED STATISTICS

No available data.

OTITIS MEDIA* *(34–40)*

This includes a range of suppurative and nonsuppurative ear conditions characterized by inflammation of the middle ear.

INFLUENCE ON HEARING

Chronic otitis media is commonly associated with mild to moderate conductive hearing loss as a result of disruption in transmission of sound vibrations through the middle ear due to the accumulated fluid, ruptured ear drum or erosion of middle ear ossicles (bones). It may, at times, lead to sensorineural or severe hearing loss.

IMPORTANT CONSIDERATIONS

Otitis media is a leading cause for health care visits and morbidity, especially in children.

> ***Suppurative otitis media may be associated with life-threatening complications.***

RELATED STATISTICS

An estimated 98.7 million people or more, are affected by hearing loss (mild or greater) as a consequence of acute and chronic suppurative otitis media. *(41)*

*Further information is provided on page 23.

MENINGITIS AND OTHER INFECTIONS *(18, 42, 43)*

Infections common in childhood, such as measles, mumps and meningitis. Other pathogens that can lead to permanent hearing loss include:

- Borrelia burgdorferi
- Epstein-Barr virus
- Haemophilus influenzae
- Neisseria meningitidis
- Non-polio enteroviruses
- Plasmodium falciparum
- Streptococcus pneumoniae
- Varicella zoster virus

INFLUENCE ON HEARING

The mechanism has not always been well studied and could vary from middle ear effusion, caused by the infection, to auditory damage. In meningitis for example, it is likely that spread of inflammation to the inner ear results in labyrinthitis and cochlear cell damage. Damage to the auditory nerve due to inflammation or ischemia is another possibility.

IMPORTANT CONSIDERATIONS

Hearing loss varies in severity and nature and can be unilateral or bilateral.

Post-meningitic hearing loss can be unilateral or bilateral, severe or profound, and may deteriorate over time.

RELATED STATISTICS

Meningitis may be responsible for 6% of sensorineural hearing loss in children *(18)*.

Overall, an estimated 14% of those infected with these pathogens may suffer hearing loss, of which 5% can be profound.

ADULTHOOD AND OLDER AGE

CHRONIC DISEASES *(6, 8, 44, 45)*

Commonly encountered health conditions such as hypertension, diabetes and central adiposity.

INFLUENCE ON HEARING

It is not clear yet whether chronic disease denotes a possible causal relationship or only a correlation due to shared biological processes. Nevertheless, persons with these conditions are at greater risk of hearing loss.

IMPORTANT CONSIDERATIONS

Persons with chronic health conditions such as those enumerated need vigilance, with the aim of early identification and rehabilitation.

RELATED STATISTICS

Can contribute to the overall prevalence of hearing loss.

SMOKING *(46–49)*

Tobacco smoke, commonly inhaled through smoking cigarettes.

> ***Exposure to cigarette smoke clearly increases an individual's risk of hearing loss.***

INFLUENCE ON HEARING

Hearing loss could be due to the antioxidative and vascular effects of cigarette smoke; or the direct ototoxic effect that may affect neurotransmission of auditory stimuli.

IMPORTANT CONSIDERATIONS

Includes persons exposed to second-hand smoke.

It is noteworthy that the excess risk of hearing loss disappears in a relatively short period after quitting smoking.

RELATED STATISTICS

Can contribute to the overall hearing loss prevalence.

OTOSCLEROSIS *(50–52)*

Abnormal bone growth inside the ear of unknown cause, with possible genetic and environmental influences.

INFLUENCE ON HEARING

The abnormal bone growth commonly affects the Stapes (one of the ear ossicles), but in some cases also extends to the cochlea. It can cause conductive, mixed or sensorineural hearing loss.

IMPORTANT CONSIDERATIONS

Although not a common disease, otosclerosis can often be managed effectively through surgical and non-surgical means, including the use of hearing aids.

AGE-RELATED SENSORINEURAL DEGENERATION* *(6, 8, 53–57)*

Degenerative changes to the structures within the ear, associated with ageing.

> ***Over 65% of adults above 60 years of age experience hearing loss.***

INFLUENCE ON HEARING

Degenerative changes affect the ability of the inner ear and higher centres to process and discriminate acoustic signals, presented as difficulty in hearing some sounds and discriminating speech.

IMPORTANT CONSIDERATIONS

Age-related hearing loss is a multifactorial condition influenced by genetic factors that determine the rate and extent of neural degeneration, pre-existing ear conditions, chronic illnesses, noise exposure, use of ototoxic medicines and lifestyles.

RELATED STATISTICS

The Global Burden of Disease estimates for 2019 suggest that over 65% of persons aged more than 60 years of age experience some degree of hearing loss, and this is of moderate or higher grade in nearly 25% of this age group. Studies show that prevalence of hearing loss doubles in the USA during every decade of life from the second to the seventh decade *(58, 59)*, with the sharpest rises occurring in those aged more than 80 years *(6, 48)*.

*Further information is provided on page 28.

SUDDEN SENSORINEURAL HEARING LOSS (SSNHL) *(60, 61)*

Rather than being a cause for hearing loss, sudden sensorineural hearing loss is a unique presentation of hearing loss onset.

NON-MODIFIABLE RISK FACTORS *(45, 62, 63)*

Includes:

- Syndromes associated with progressive hearing loss, such as Usher's syndrome and neurofibromatosis; and neurodegenerative disorders e.g. Hunter's, Friedreich's ataxia
- Gene mutations that commonly manifest in later life (i.e. from childhood to old age)
- Gender
- Race

INFLUENCE ON HEARING

- The mechanism of genetic factors varies according to the gene affected and its expression or the relevant syndrome.
- Men are more prone to hearing loss, mainly due to their higher engagement in activities associated with noise-induced hearing loss *(64, 65)*, and because of the positive influence of estrogen on hearing functions among women. Since the hearing sensibility is correlated with the level of estrogen, women are more protected against hearing loss until menopause *(66)*.
- Racial differences in the cochlear pigmentation have been associated with hearing loss risk. Melanin pigmentation – significantly more abundant in the cochleae of African-Americans than those of Caucasians – underlies the decreased risk of age-related hearing loss in those of African origin Americans *(67)*.

IMPORTANT CONSIDERATIONS

More than 100 genes and their known mutations associated with hearing loss are described in literature. Many others are known to cause syndromic hearing loss.

Late onset, or progressive, hearing loss associated with some of these conditions, is commonly missed during early childhood screening.

RELATED STATISTICS

No available data.

CERUMEN IMPACTION (IMPACTED EAR WAX) *(68–71)*

Cerumen is a secretion produced by the ceruminous glands in the outer ear. It is sticky, waterproof and protective in nature, with bactericidal and fungicidal properties. Cerumen traps and removes dead skin cells, dust and other materials from the external ear. At times, the cerumen accumulates and dries, forming a hard plug of impacted wax in the external ear.

INFLUENCE ON HEARING

Cerumen can completely occlude the ear canal, leading to hearing loss due to the mechanical obstruction to sound waves. This may lead to small shifts (5–10 dB) in the hearing thresholds *(69)*.

The auditory effect of cerumen impaction is more marked in persons who already have an underlying hearing loss, as even a small additional impairment can cause significant problems in functioning *(69)*. Furthermore, hearing loss due to cerumen may worsen suddenly, if water is absorbed, e.g. during swimming or showering *(69)*.

IMPORTANT CONSIDERATIONS

Wax impaction is aggravated by the use of cotton-tipped swabs (e.g. Q-tips) that are commonly used to "clean" the ear canal. The use of aids may obstruct the normal movement and extrusion of wax, leading to its accumulation.

RELATED STATISTICS

The prevalence of wax impaction varies across age groups, from 7–35%. Prevalence is higher in older adults, with 57% possibly being affected, most likely as a result of increased skin dryness and shedding.

> ***Some 10% of children and 5% of adults have impacted cerumen. Over 50% of older adults may be affected.***

TRAUMA TO THE EAR OR HEAD *(72, 73)*

Hearing loss as a consequence of trauma to the ear and head. Such trauma may be accidental, intentional or iatrogenic (due to surgery of the ear or head).

INFLUENCE ON HEARING

The impact on hearing may be caused by:

- Disruption on the conductive mechanism of the ear: injury over the ear (e.g. slaps, falls on the ear, insertion of objects into the ear canal) can cause perforation of the tympanic membrane (eardrum), or dislocation of bones within the ear. This can lead to conductive type of hearing loss which can often be corrected through surgery.
- Cochlear or nerve injury: fractures of the temporal bone, or brain injuries, can result in trauma of the auditory nerve resulting in sensorineural type of hearing loss.

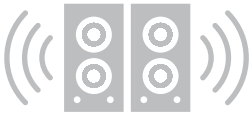
IMPORTANT CONSIDERATIONS

Traumatic hearing loss can be part of polytrauma.

Communicating with polytrauma patients with hearing loss requires special attention.

RELATED STATISTICS

No available data.



LOUD NOISE/LOUD SOUNDS* *(55, 64, 74–87)*

Exposure to loud noise or loud sounds, which include:

- Occupational noise
- Recreational sounds
- Environmental noise

INFLUENCE ON HEARING

Prolonged or regular exposure to loud sounds can cause permanent damage to the hair cells and other structures within the cochlea, resulting in irreversible hearing loss. The high frequency range is affected first. Continued exposure leads to progression of hearing loss.

IMPORTANT CONSIDERATIONS

In addition to hearing loss, noise exposure can lead to other noise-induced health problems such as insomnia or cardiovascular illnesses.

RELATED STATISTICS

It is estimated that approximately 16% (7–21% across different regions) of hearing loss in adults results from exposure to excessive noise in the workplace *(76)* which is responsible for over 4 million disability adjusted life years (DALYs).

Of persons aged 12–35 years, 50% are at risk of hearing loss due to exposure to unsafe levels of sounds in recreational settings.

*Further information is provided on page 25.

OTOTOXIC MEDICINES *(88–90)*

Drugs with the potential to cause ototoxicity (of which there are more than 600 categories). Those most commonly used in clinical practice include:

- aminoglycoside and macrolide antibiotics (e.g. gentamycin, streptomycin)
- quinoline antimalarials (quinine)
- platinum analog antineoplastics (e.g. cisplatin)
- loop diuretics (e.g. furosemide, acetylsalicylic acid)

INFLUENCE ON HEARING

Hearing loss may result from the cochleotoxic or neurotoxic effects of ototoxic medicines. In many cases, damage is to cochlear hair cells and results in sensorineural hearing loss, which is commonly permanent.

IMPORTANT CONSIDERATIONS

Ototoxic hearing loss onset and severity are commonly dose-dependent and cumulative, they are also affected by many other factors, such as age, gender, genetic susceptibility, comorbid conditions, alcohol intake, smoking, diet, exercise, stress, type of drug, route of administration, duration of therapy, exposure to other ototoxic chemicals, noise exposure, and pre-existing hearing loss.

RELATED STATISTICS

Incidence of ototoxic hearing loss is estimated to be 63% with aminoglycosides and 6–7% with furosemide.

Cisplatin has been shown to cause tinnitus and hearing loss in 23–50% of adults and up to 60% of children receiving it.

Up to 50% of those treated with injectable medicines (e.g. Amikacin and Streptomycin) for drug-resistant tuberculosis (DR-TB), could develop permanent hearing loss.

WORK RELATED OTOTOXIC CHEMICALS *(91, 92)*

Chemicals encountered in many occupations, especially those relating to printing, painting, boat-building, construction, glue manufacturing, metal products, chemicals, petroleum, leather products, furniture-making, agriculture, and mining. Commonly used chemicals include:

- aromatic solvents (e.g. toluene)
- non-aromatic solvents (e.g. trichloroethylene, a cleaning and degreasing agent)
- Nitriles (e.g. those used for preparation of melamine resins)
- Asphyxiants (e.g. carbon monoxide and hydrogen cyanide found in exhaust fumes)
- Metals and metal compounds (e.g. lead and mercury found in the manufacture of batteries, plastic, paint and petrol)
- Halogenated hydrocarbons (e.g. polychlorinated biphenyls found in coolant fluids)

INFLUENCE ON HEARING

As noted above, cochleotoxic and neurotoxic effects of these chemicals is the most likely cause of hearing loss.

IMPORTANT CONSIDERATIONS

Workers may be exposed to noise, multiple chemicals and vibrations at the same time, which act synergistically to cause hearing loss *(93)*. In addition, factors such as age, genetic susceptibility, co-morbid conditions, and alcohol intake, among others, may influence the effects of these agents.

RELATED STATISTICS

Limited data are available on this subject. However, it is estimated that in Europe, 11% of workers have reported exposure to solvents and thinners, while 14% reported handling chemical substances *(91)*.

NUTRITIONAL DEFICIENCIES *(94–99)*

Generalized undernutrition or deficiencies of certain macronutrients or micronutrients, including:

- Vitamin A
- Zinc
- Iron

INFLUENCE ON HEARING

Hearing loss may occur as a result of:

- Otitis media, as in the case of vitamin A and zinc deficiencies
- Effects on the central auditory pathways, as with iron deficiency

IMPORTANT CONSIDERATIONS

Nutritional deficiencies represent a modifiable risk factor for hearing loss with potentially major implications for low-resource settings, where the majority of the global burden of hearing loss is located.

RELATED STATISTICS

There is lack of data in this field, but emerging evidence points to a clear link between nutrition and hearing loss. A large cohort study in southern Nepal demonstrated that early childhood wasting, and stunting were consistently associated with a 1.8–2.2-fold higher risk of hearing loss in early adulthood.

FACTORS ACROSS THE LIFE SPAN

VIRAL INFECTIONS *(22, 42)*

Viruses such as such as Human immunodeficiency virus (HIV); Herpes simplex type 1 and 2; Ebola; Lassa virus; and West Nile virus.

INFLUENCE ON HEARING

Hearing loss may develop due to in utero exposure or exposure later in life. The underlying pathology and nature of hearing loss may vary and may be due to:

- Effects on the auditory pathway
- Associated chronic otitis media
- Treatment with potentially ototoxic medicines

IMPORTANT CONSIDERATIONS

These viral infections may occur at different stages across the life course. The type and severity of hearing loss associated with them varies, and depends on the nature of the underlying pathology.

RELATED STATISTICS

It is estimated that 14–49% of HIV patients could experience hearing loss as a consequence of the disease or treatment with potentially ototoxic medicines. Some 5.7% of Ebola survivors, and 8.5% of those with Lassa fever experience hearing loss.

OTHER EAR CONDITIONS

Meniere's disease, vestibular schwannoma, autoimmune diseases, and others, that are encountered in clinical practice and are causes of hearing loss.

INFLUENCE ON HEARING

Varies according to nature and severity of disease.

IMPORTANT CONSIDERATIONS

No available data.

RELATED STATISTICS

No available data.

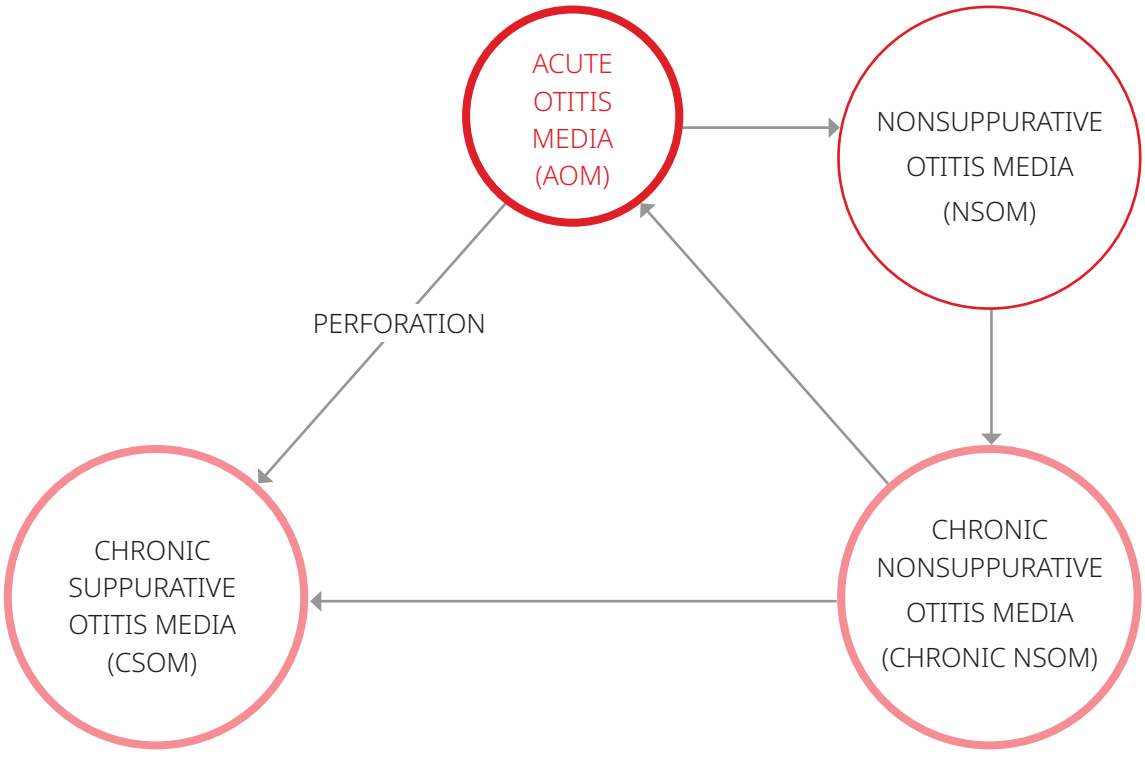
CAUSATIVE FACTORS:
Otitis media *(34–40)*

The term "otitis media" (OM) reflects a range of conditions, all characterized by inflammation of the middle ear. Although anyone of any age can develop otitis media, children are most commonly affected. The different forms of OM include:

- Suppurative otitis media (infective conditions):
  - Acute suppurative otitis media (AOM), including recurrent acute otitis media
  - Chronic suppurative otitis media (CSOM)
- Nonsuppurative otitis media (NSOM) including acute and chronic NSOM. NSOM is synonymous with otitis media with effusion (OME)

Acute otitis media (AOM) is a middle ear effusion accompanied by acute infection. Such an infection can result in a perforation of the tympanic membrane, with the possible development of chronic suppurative otitis media (CSOM). Incomplete resolution of AOM is often followed by a period with nonsuppurative otitis media (NSOM). At the same time, chronic NSOM may itself be a risk factor for AOM. Hence all conditions are interrelated and an individual with otitis media may experience its different forms at different times based on a variety of influences (Figure 1.3).

Figure 1.3 Types of otitis media and their interrelationship



Otitis media poses a major concern due to its:

Annually, acute middle ear infection affects over 700 million people, mostly children below the age of five years *(40).*

- **High incidence and prevalence**: Although infection can occur at any time throughout the life course, the highest incidence is encountered in children below the age of five years. Available data indicate an incidence rate of 10.85% of AOM *(40)* – i.e. more than 700 million cases each year, the majority of these being children in this age range. The incidence rate varies across regions and countries – from 3.64% in central Europe to more than 43% in parts of sub-Saharan Africa. The variation across countries and regions can be attributed to genetic predispositions as well as to modifiable risk factors such as allergy, upper respiratory tract infections, exposure to second-hand smoke, lack of sanitation, undernutrition, and low socioeconomic status *(36, 38, 100)*. The incidence rate of CSOM is 4.76% – i.e. more than 30 million cases each year, and an estimated point prevalence above 200 million cases globally *(40)*. Some 22.6% of the burden of CSOM occurs in children below five years of age. In terms of prevalence of NSOM, it is well documented that up to 80% children have experienced at least one episode by the age of four years *(35)*.

  In addition, certain Indigenous populations are predisposed towards otitis media *(38, 101–103)*. These include native Americans, Aboriginal populations in Australia and Indigenous populations in circumpolar regions such as Canada, Alaska, and Greenland. For example, the Government of Australia has documented that in Indigenous Australian children aged 0–5 years, the prevalence rate of otitis media is over 90%; and that over half of all Indigenous children experienced some degree of hearing loss *(104)*.

- **Association with hearing loss:** ear infections are one of the common causes of hearing loss in childhood *(20)*. Even though the prevalence of otitis media reduces with age, its impact on hearing is evident across the life course and hearing loss associated with otitis media persists into old age across all world regions *(40)*. It is estimated that globally, more than 3 in 1000 people have hearing loss due to otitis media *(40)* of varying severity.

  Cases of NSOM are usually associated with mild hearing loss, which is often the only symptom and may well go undetected. Despite the "mild" grade of hearing loss, the impact of NSOM on speech perception is significant, often leading to adverse educational outcomes *(105)*.

- **Potential to cause life threatening complications:** it is estimated that each year 21 000 people die as a result of otitis media complications, such as mastoiditis, meningitis and brain abscess *(40)*. Mortality is shown to be highest at the extremes of life – i.e. in the first five years of life and in those aged over 75 years. Geographically, mortality rates are lowest in high-income regions of the world; the highest rates are seen in Oceanic countries and in parts of sub-Saharan Africa.

CAUSATIVE FACTORS:
Exposure to loud sounds and loud noise

Exposure to loud sounds puts children and adults at risk not only of hearing loss, but other noise-induced health problems, such as insomnia and cardiovascular illnesses *(64)*. Typically, sound intensity[5] above 80 dB, heard for periods longer than 40 hours a week can lead to hearing loss by damaging the sensory hair cells within the inner ear *(82).* The higher the level of sound and the longer the duration, the greater the risk of hearing loss *(82, 106)*.[6]

Loud sounds can be encountered in the workplace, in the overall living environment, and are commonly experienced as part of recreational activities. Situations which present a risk of hearing loss include:

- **Occupational settings**: High levels of occupational noise remain a problem in all regions of the world *(77)*. In the United States of America (USA), for example, more than 30 million workers are exposed to hazardous noise *(87)*. The European Agency for Safety and Health at Work[7] estimates that 25–33% of the workforce in Europe is exposed to high-level noise at least a quarter of their working time *(75)*. In other parts of the world, data on noise-induced hearing loss are scarce, but available evidence suggests that average noise levels are well above the recommended levels *(77, 107)* and may well be rising due to increasing industrialization that is not always accompanied by protection.

  Workers in shipbuilding, the armed forces, the engineering industry, manufacturing, building and construction, woodworking foundries, mining, the food and drink industry, agriculture and entertainment are most likely to be exposed to high levels of sound *(74–76)*. Concurrent vibration or exposure to chemicals (e.g. solvents, lead) enhances the harmful effects of noise on hearing.

Noise in sporting events can reach levels as high as 135dB

- **Recreational settings**: Risk of hearing loss is also encountered when people expose themselves to loud levels of sound in recreational settings *(79).* Noisy leisure activities, especially the use of firearms, can cause the same damage to hearing as exposure to occupational noise *(74)*. Prolonged listening to loud music through personal audio devices (i.e. personal music players used

[5] Sound intensity is measured in decibels, represented as "dB".

[6] The equal energy principle states that the total effect of sound is proportional to the total amount of sound energy received by the ear, irrespective of the distribution of that energy over time and that the amount of energy doubles for every 3 dB increase in intensity of sound.

[7] See: https://osha.europa.eu/en.

with headphones/earphones) increases the risk of hearing loss and results in worsening of audiometric thresholds *(80)*. Listeners who regularly use portable audio devices can expose themselves to the same level of sound in 15 minutes of music at 100 dB that an industrial worker would receive in an 8-hour day at 85 dB. Given that the volume range of a typical listener is between 75 dB and 105 dB *(64)*, this presents cause for concern. WHO estimates that over 50% of people aged 12–35 years listen to music over their personal audio devices at volumes that pose a risk to their hearing. Among those who frequently visit entertainment venues, nearly 40% are at risk of hearing loss *(84)*.

- **Environmental factors** (other than occupational and recreational settings): Loud sounds are encountered routinely in the everyday environment. Common examples include the noise from traffic or home appliances. Overall, environmental exposure to noise is mostly lower than the levels required for development of irreversible hearing loss. However, people exposed to such levels of noise (not sufficient to cause hearing loss) can experience other health effects, including greater risk of ischaemic heart disease, hypertension, sleep disturbances, annoyance and cognitive impairments *(81, 82)*.

CASE STUDY

Loud sounds can cause lasting damage

Matt Brady, a 22-year-old University student suffered permanent hearing damage from listening to music at a very high volume while exercising on a treadmill.

It is estimated that in the USA, 21 million adults (19.9%) who reported no exposure to loud or very loud noise at work showed evidence of noise-induced hearing loss *(108)*.

Just as on a regular day, Matt was exercising and listening to music using his earphones when he experienced pain in his ears and head, followed by lasting hearing loss which affected his social and academic life. It took almost a year for multiple consulting doctors to understand the association between his hearing loss and his habit of listening to loud music. Matt now has permanent difficulty in listening and finds conversation challenging in situations with background noise.

Having learnt the hard way, Matt Brady is now a passionate advocate for safe listening behaviour as a way of ensuring others do not experience a similar impact to their hearing *(109)*.

- **Development of noise-induced hearing loss:** It is well established that noise damages the structures within the cochlea in a dose-response manner – i.e. the higher the amount of exposure, the greater the impact *(83, 84)*. Sometimes,

such damage may manifest only as difficulty in understanding speech in a noisy environment – a typical complaint associated with noise-induced hearing loss *(55)*. In addition, noise exposure is commonly associated with tinnitus – the sensation of ringing in the ear, and the phenomenon known as "hidden hearing loss" *(85)*.

- ***Tinnitus***: is derived from the Latin verb tinnire (to ring) and refers to the conscious perception of an auditory sensation in the absence of a corresponding external stimulus *(110)*. Tinnitus is commonly an outcome of noise exposure and may accompany or occur in the absence of clinically evident hearing loss *(85)*. Research shows that workers exposed to noise are more likely to experience tinnitus *(83)*.

  Tinnitus may also be caused by other auditory and nonauditory conditions. The onset, perception, and impact of tinnitus can be influenced by a number of psychological factors, such as anxiety and depression *(111)*. Prevalence in the general population ranges from 5.1% to 42.7%, while bothersome tinnitus is encountered in 3–30% of the population *(112)*.

- ***Hidden hearing loss****:* refers to the condition where an individual experiences common symptoms associated with noise-related auditory damage such as difficulty in hearing noise, tinnitus, and hyperacusis. However, as its name suggests, hidden hearing loss (HHL) is undetectable on pure tone audiometry, which shows normal hearing sensitivity at 250–8000 Hz. The condition is attributed to the destruction of synaptic connections between hair cells and cochlear neurons (cochlear synaptopathy) which occurs well before the hair cells are damaged and as a result of exposure to noise *(85, 113)*. It is likely that many people struggle with HHL and that it occurs in younger age groups due to increasing exposure to recreational noise *(85)*. It is also suggested that the changes caused by noise exposure, even early in life, make the ears significantly more vulnerable to ageing and hasten the onset of age-related hearing loss *(86)*.

  Irrespective of its presentation, the progression of irreversible noise-related auditory damage is relentless so long as the exposure continues.

CASE STUDY

Studying the long-term impact of sound exposure: The Apple Hearing Study*

To better understand long-term sound exposure and its impact on hearing health, a large-scale study was launched in 2019 through collaboration between the University of Michigan, USA and Apple.** The outcomes of this study will help guide public health policy and prevention programmes designed to protect and promote hearing health both in the USA and globally.

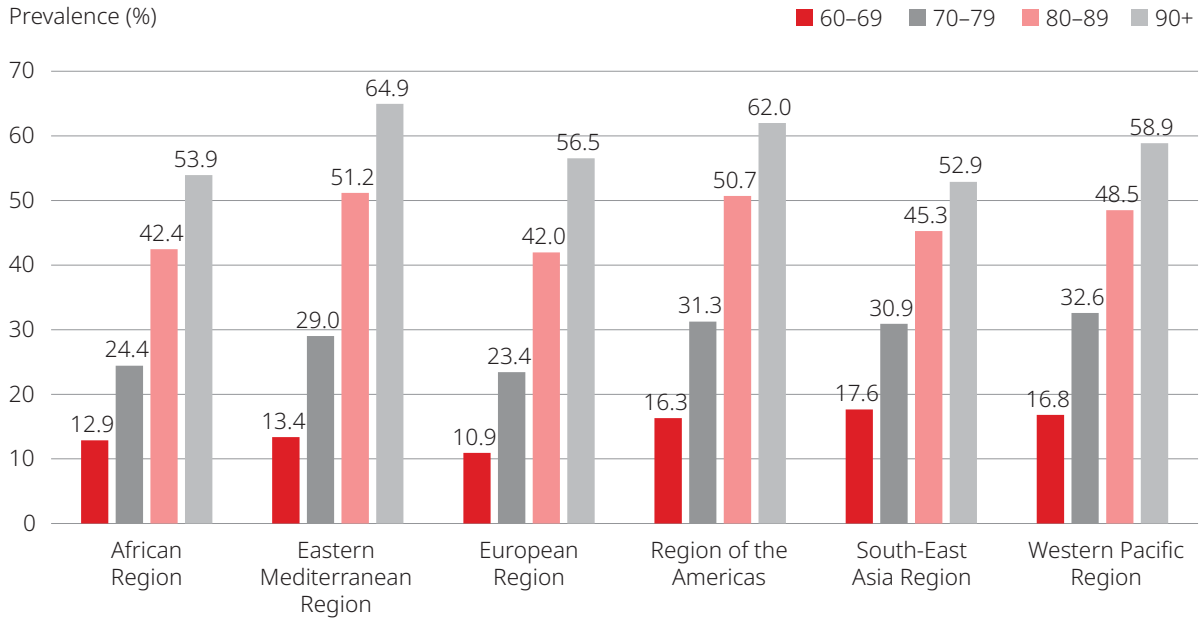
* https://sph.umich.edu/applehearingstudy/

**https://clinicaltrials.gov/ct2/show/NCT04172766

CAUSATIVE FACTORS:
Age-related factors

Given its high prevalence in the community, age-related hearing loss (ARHL) – also known as presbycusis – poses the greatest societal and economic burden from hearing loss across the life course and is expected to increase with the current demographic shifts (see Section 3). Current estimates suggest that over 42% of people with any degree of hearing loss are aged above 60 years. Globally, the prevalence of hearing loss (of moderate or higher grade severity) increases exponentially with age, rising from 15.4% among people aged in their 60s, to 58.2% among those aged more than 90 years. This trend is observed across all WHO regions. Figure 1.4 below shows a prevalence across regions of 10.9–17.6% among individuals aged 60–69 years, increasing to 41.9–51.2% among those aged 80–89 years, and reaching 52.9–64.9% in those aged above 90 years.

Figure 1.4 Prevalence of hearing loss (of moderate or higher grade) in older adults by decades



The development of ARHL can be attributed to physical and environmental insults, combined with genetic predispositions, and an increased vulnerability to physiological stressors and modifiable lifestyle behaviours experienced throughout the course of life *(6).* These factors include exposure to loud noise, ototoxic medications or chemicals, smoking, and dietary habits, as well as chronic conditions, such as cardiac disease. While factors causing ARHL in an individual cannot be separated, the additive nature of such insults, combined with biological susceptibilities, increase the risk of hearing loss. Adopting preventive behaviours, as outlined earlier, and making healthy lifestyle choices in the form of good nutrition, exercise and the avoidance of smoking, can reduce risk of hearing loss in older age.

The impacts of unaddressed adult onset hearing loss include social withdrawal, lost productivity from early retirement and the costs of informal care, mental and physical declines *(114–117)*. Without timely intervention, ARHL is associated with poorer quality of life as well as a broad range of negative effects on the communication partners of those affected *(118)*. Preventive efforts, as described below, are supported by strong public health strategies (outlined in Section 2) and can reduce the occurrence of ARHL. In addition, early detection of hearing loss, and appropriate interventions to address ARHL can mitigate many of the associated adverse effects *(119–121)*.

1.2.3 PROTECTIVE AND PREVENTIVE FACTORS OF HEARING LOSS

Various factors and interventions can either prevent or address the above-mentioned causes and thereby prevent onset of hearing loss or delay its progression. Detailed information on ear and hearing care (EHC) practices that can prevent ear diseases and maintain hearing capacity is provided below. The most relevant preventive actions that can be undertaken by individuals at a personal level across the life course to maintain their own hearing capacity is set out in Table 1.2 *(122–124)*. Preventive public health actions, not included in the table, are described in Section 2 of this report.

Table 1.2 Protective and preventive factors for hearing loss across the life course

FACTORS ACROSS THE LIFE SPAN

MATERNAL NUTRITION *(125–129)*

Balanced maternal nutrition during pregnancy.

PROTECTION AGAINST HEARING LOSS

Maternal nutrition influences the infant's birth weight as well as its overall health. Low birth weight and micronutrient deficiencies are linked with congenital hearing loss which can be avoided.

IMPORTANT CONSIDERATIONS

Maternal malnutrition can be minimized through appropriate dietary interventions that address these deficiencies.

MATERNAL HYGIENE *(130–132)*

Includes simple practices such as:

- frequent handwashing;
- thorough washing and peeling of fruits and vegetables;
- avoiding unprotected contact with soil and cat waste; and
- cooking food to safe temperatures.

PROTECTION AGAINST HEARING LOSS

Certain infections that lead to congenital hearing loss, such as (cytomegalovirus) infections and toxoplasmosis, can be prevented through good hygiene and care.

IMPORTANT CONSIDERATIONS

No available data.

BREASTFEEDING *(133)*

Early initiation of breastfeeding and exclusive breastfeeding during initial months of life, in line with WHO's recommendations *(134)*.

PROTECTION AGAINST HEARING LOSS

Offers significant protection against acute otitis media (AOM), especially during the early years of life *(133)*. Since chronic otitis media is commonly a sequelae of AOM, promotion of breastfeeding can help protect babies from CSOM with its consequent hearing loss and possible complications.

IMPORTANT CONSIDERATIONS

No available data.

GOOD EAR HYGIENE* *(123, 135, 136)*

Includes safe practices such as:

- avoiding use of cotton-tipped swabs for the ear;
- not inserting/instilling any objects or liquids in the ear;
- avoiding use of home remedies for common ear conditions; and
- seeking prompt medical attention to treat common colds, ear pain/discharge/bleeding or hearing loss.

PROTECTION AGAINST HEARING LOSS

Such practices can prevent the occurrence or aggravation of wax accumulation or otitis media.

IMPORTANT CONSIDERATIONS

> ***Most people do not need a regular schedule for prevention of earwax accumulation. Some may find it necessary to have a cleaning procedure performed occasionally. Earwax is formed naturally by the body and helps to protect the skin of the ear canal and to kill germs. A medical practitioner may find an excess of earwax at a regularly scheduled general check-up and perform a cleaning procedure*** *(71)*.

*Detailed information provided on page 33.

FACTORS ACROSS THE LIFE SPAN

AVOIDANCE OF TOBACCO

Avoidance of all forms of tobacco use, as well as exposure to secondhand smoke.

PROTECTION AGAINST HEARING LOSS

Given the relationship between tobacco consumption, chronic diseases, and hearing loss, avoiding tobacco can mitigate the risks associated with its use.

Secondhand smoke is associated with otitis media, especially in children, which can be avoided.

IMPORTANT CONSIDERATIONS

No available data.

PROTECTION AGAINST HEAD OR EAR INJURY *(137, 138)*

Common measures of protection, such as:

- Use of helmets while riding two-wheelers
- Avoiding slaps, especially over the ear

PROTECTION AGAINST HEARING LOSS

Since direct injury over the ear or head can result in hearing loss, avoidance is essential for mitigating this risk factor.

IMPORTANT CONSIDERATIONS

Slapping children is a form of punishment commonly practiced in many parts of the world. Besides the life-long psychological effects, slapping over the ear can also lead to perforated ear drums with potential for otitis media and hearing loss.

GOOD NUTRITION *(94, 127, 129, 139)*

The intake of a balanced diet, complete with essential macronutrients and micronutrients in proper concentration.

PROTECTION AGAINST HEARING LOSS

Balanced nutrition can reduce sensorineural degeneration associated with noise exposure and ageing, and protect against childhood purulent ear infections (e.g. otitis media).

IMPORTANT CONSIDERATIONS

Supplementation with omega 3 fatty acids, Vitamins A, C, E, and folic acid; as well as minerals such as magnesium, zinc and iodine is shown to be beneficial for the auditory system.

HEALTHY LIFESTYLE *(140, 141)*

Includes modifiable lifestyle factors, such as physical activity or exercise, diet, alcohol intake, smoking, substance abuse and recreation.

PROTECTION AGAINST HEARING LOSS

Adopting healthy lifestyle practices mitigate hearing loss by reducing the co-occurrence of chronic diseases and delaying the onset of age-related neural degeneration.

IMPORTANT CONSIDERATIONS

Higher educational attainment has been linked to a reduction in hearing loss, mainly through avoidance of modifiable lifestyle-related risk factors.

IMMUNIZATION

Vaccination, as recommended by global and national immunization programmes.

PROTECTION AGAINST HEARING LOSS

Timely immunization as protection against many diseases, including rubella, meningitis, mumps, measles and their associated hearing loss.

IMPORTANT CONSIDERATIONS

Further information on immunization is provided in Section 2 of this report.

AVOIDING LOUD SOUNDS AND LOUD NOISE

Includes practices to avoid exposure to loud sounds in professional and personal settings.

PROTECTION AGAINST HEARING LOSS

The importance of noise as a causative factor for hearing loss has been highlighted earlier. Minimizing this risk factor can reduce hearing loss occurrence and delay the onset of age-related hearing loss in older adults.

IMPORTANT CONSIDERATIONS

Further information on loud sounds and noise is provided in Section 2 of this report.

PROTECTIVE AND PREVENTIVE FACTORS:
Practicing good ear hygiene *(142)*

Practicing good ear hygiene can prevent many of the common conditions associated with hearing loss, as well as leading to early identification so that hearing loss can be prevented or reversed. Simple measures of ear hygiene include:

- **Avoiding the use of cotton buds** *(68, 143)*. It is important for people to understand that cleaning the inside of their ears is not usually necessary, and that wax is a normal ear secretion and harmless in most people *(70, 71)*. The common habit of cleaning the ears excessively with use of cotton-tipped buds irritates the skin of the ear canal, which may lead to infection, and even increase the chances of wax impaction *(71)*.
- **Not inserting or instilling any objects or liquids into the ear**. Unless their use is specifically recommended by a health-care practitioner objects or liquids should not be inserted into the ear. Different types of oils are commonly used; and foreign bodies such as cotton-tipped buds, matchsticks, feathers, pins, or pencils introduced to clean the inside of the ears are sometimes left in the ear canal causing further infection or harm *(70, 71)*. Their use can result in trauma to the ear canal, perforations of the ear drum and may aggravate cerumen impaction.
- **Not using home remedies**. The use of home remedies for common ear conditions (such as ear pain) is widespread and can cause harm rather give benefits *(144)*. Remedies such as ear candling *(71, 145)*, plant juice/hot oil instillation should not be used to treat ear diseases or conditions, nor should seeking care from untrained providers as is common practice in some parts of the world *(146)*.
- **Seeking prompt medical attention**. Seeking timely medical care for the treatment of common colds, ear pain, ear fullness, ear discharge, bleeding from the ear, or hearing loss, can help prevent or identify ear and hearing problems. These symptoms can indicate an underlying ear disease such as otitis media and commonly require a medical evaluation for diagnosis and management *(71)*. While ear fullness, pain and slight hearing loss may be due to cerumen impaction, it cannot be presumed to be the cause, and needs confirmation by a trained health-care provider.

CARE FOR YOUR EARS *(140)*

DON'T put anything in the ear. No cotton buds, clips, toothpicks, sticks or hopi candles.

DON'T ignore an ear that has any pus or fluid coming out of it.

DON'T treat any ear conditions with hot or cold oil, herbal or home remedies.

DON'T swim or wash in dirty water.

DON'T listen to very loud noises or music for long periods as this can cause hearing loss.

PROTECTIVE AND PREVENTIVE FACTORS:
Avoiding loud sounds and loud noise *(147)*

As noted in this section, the recommended level of sound exposure is below 80 dB for a maximum of 40 hours per week. Indications of noise being too loud is when, for example, voices need to be raised in order for conversation to be understood; when it is difficult for the listener to understand what a person is saying when at an arm's length distance; or when listeners develop pain or a ringing sensation in their ear(s). Hearing can be protected through adopting simple measures, such as:

- **Keeping noise volumes down**

  Sound exposure can be reduced when listening to personal audio devices by:

  - Keeping the volume of the personal audio devices (smartphones or MP3 players that are used with headphones/earphones) below 80 dB. This can be checked with the use of certain freely available smartphone applications (apps). Some devices provide this as an inbuilt feature. In the absence of these, the rule of the thumb for staying safe is to listen at a volume below 60% of maximum.
  - Using carefully-fitted and, where possible, noise cancellation earphones or headphones. Well fitted earphones and headphones allow music to be heard clearly at lower levels of volume. In addition noise-cancelling earphones and headphones cut down the background noise, so that users can hear sounds at lower volumes than otherwise needed. For example, frequent users of personal audio devices on trains or airplanes should consider using noise-cancelling earphones or headphones in these settings.

- **Protecting ears in noisy situations**

  In noisy workplaces and when frequenting nightclubs, discotheques, bars, sporting events and other noisy places, sound exposure can be limited by:

  - Regularly using earplugs as hearing protection. Well-inserted earplugs can help to reduce the level of exposure considerably. If inserted correctly, earplugs can reduce the exposure by 5–45 dB, depending on the type.
  - Maintaining a distance from the sources of sound, such as loudspeakers, can reduce the amount of sound energy a person is exposed to.

- **Minimizing the time spent in noisy environments**

  It is especially important to control the sound exposure for individuals who encounter loud sounds on a regular basis at their place of recreation or work. This can be achieved by:

  - Limiting time spent listening using personal audio devices. In addition, when listening to the devices, keeping the volume low, as indicated above.
  - Taking short breaks away from loud sounds. When in a noisy environment, trying to take regular breaks and moving to a quieter area. This could help the sensory cells to recover from the fatigue caused by noise exposure and reduce the risk of hearing loss.

- **Monitoring personal sound exposure**

  Knowing the level of sound being experienced can help a person set their own limits according to their own preference. This can be achieved by:

  - Using smartphone apps that monitor personal sound exposure. Apps are available that can help one to monitor exposure through the device and also in the external environment.
  - Using smartphones, currently available, that include inbuilt safe listening features. Use of these can assist people in making safe listening choices.

Use of earplugs in noisy places can reduce the risk of hearing loss significantly

More than 1.5 billion people experience some degree of hearing loss, which can significantly impact their lives, their families, society and countries.

1.3 DECLINE IN HEARING CAPACITY

1.3.1 DEFINITION AND TYPES OF HEARING LOSS *(148)*

A person is said to have hearing loss if their hearing capacity is reduced and they are not able to hear as well as someone with normal hearing. "Normal" hearing typically refers to hearing thresholds of 20 dB or better in both ears (see Table 1.3).

Those with a hearing threshold above 20 dB may be considered "hard of hearing" or "deaf" depending upon the severity of their hearing loss. The term "hard of hearing" is used to describe the condition of people with mild to severe hearing loss as they cannot hear as well as those with normal hearing. The term "deaf" is used to describe the condition of people with severe or profound hearing loss in both ears who can hear only very loud sounds or hear nothing at all.

Different types of hearing loss include:

- *Conductive hearing loss*: This term is used when hearing loss is caused by problems located in the ear canal or the middle ear which make it difficult for sound to be "conducted" through to the inner ear.
- *Sensorineural hearing loss*: This term is used when the cause of hearing loss is located in the cochlea or the hearing nerve, or sometimes both. "Sensori-" relates to the cochlea which is a "sense organ"; "neural" relates to the hearing nerve.
- *Mixed hearing loss*: This term is used when both conductive and sensorineural hearing loss are found in the same ear.

1.3.2 ASSESSING HEARING CAPACITY

Hearing capacity refers to the ability to perceive sounds and is commonly measured through pure tone audiometry (PTA) – considered the gold standard test of assessment. Audiometric threshold shifts help to define the nature of hearing loss, which may be conductive, sensorineural or mixed in type; and range from mild to complete in severity.

Assessment of hearing capacity through PTA is essential, both for epidemiological purposes and to guide rehabilitation. However, PTA assessment should not be the sole determinant for rehabilitation, mainly because audiometric shifts do not provide information on how sounds are processed by the central auditory system, and therefore offer only limited insight into "real-world" functioning *(149)*. For example, a person with an audiogram[8] test result of "normal" may face problems in difficult listening environments, such as in noisy situations *(85, 150)*. Even when hearing loss is mild and therefore may not be considered significant, a person may experience limitations in everyday functioning which would not be reflected through the sole assessment of an audiogram *(151, 152)*. Children and adults may have a normal audiogram but have a deficit in processing auditory information in the brain and limitations in hearing – referred to as central auditory processing disorder *(149, 153)*. Some of these limitations can be addressed through speech tests such as "speech discrimination" and "speech-in-noise" tests *(149)*. It is therefore important to take a holistic view of a person's audiological profile and hearing experiences to ensure that limitations in activity, participation in quiet and noisy environments, and communication needs and preferences, are all addressed *(8, 154)*. These considerations are elaborated in Section 2.

1.3.3 AUDITORY PROCESSING DISORDERS

Some children and adults may experience hearing difficulties in the absence of any substantial audiometric findings. These may have an auditory processing disorder (APD) – a generic term for hearing disorders that result from the poor processing of auditory information in the brain *(149, 153)*. This may manifest as poor hearing and auditory comprehension in some circumstances, despite normal hearing thresholds for pure tones. Prevalence estimates of APD in children range from 2–10% with frequent co-occurrence in children with other learning or developmental disabilities *(153, 155)*. APD can affect psychosocial development, academic achievement, social participation, and career opportunities. Age-related APD is also a common contributor to hearing difficulties in older age.

1.3.4 GRADES OF HEARING LOSS

To standardize the way in which severity of hearing loss is reported, WHO has adopted a grading system based on audiometric measurements. This system is a revision of an earlier approach adopted by WHO, and differs from the earlier system in that measurement of onset of mild hearing loss is lowered from 26 dB to 20 dB; hearing loss is categorized as mild, moderate, moderately-severe, severe, profound or complete; and unilateral hearing loss has been added. In addition to the classifications, the revised system provides a description of the functional

[8] Audiograms show the minimum intensity, in decibels, a person can hear at different frequencies of sound. This is typically depicted in graph form following a hearing test, as measured by an audiometer.

consequences for communication that are likely to accompany each level of severity *(148)*. This revised grading system is presented in Table 1.3 below.

Table 1.3 Grades of hearing loss and related hearing experience*

Grade	Hearing threshold‡ in better hearing ear in decibels (dB)	Hearing experience in a quiet environment for most adults	Hearing experience in a noisy environment for most adults
Normal hearing	Less than 20 dB	No problem hearing sounds	No or minimal problem hearing sounds
Mild hearing loss	20 to < 35 dB	Does not have problems hearing conversational speech	May have difficulty hearing conversational speech
Moderate hearing loss	35 to < 50 dB	May have difficulty hearing conversational speech	Difficulty hearing and taking part in conversation
Moderately severe hearing loss	50 to < 65 dB	Difficulty hearing conversational speech; can hear raised voices without difficulty	Difficulty hearing most speech and taking part in conversation
Severe hearing loss	65 to < 80 dB	Does not hear most conversational speech; may have difficulty hearing and understanding raised voices	Extreme difficulty hearing speech and taking part in conversation
Profound hearing loss	80 to < 95 dB	Extreme difficulty hearing raised voices	Conversational speech cannot be heard
Complete or total hearing loss/deafness	95 dB or greater	Cannot hear speech and most environmental sounds	Cannot hear speech and most environmental sounds
Unilateral	< 20 dB in the better ear, 35 dB or greater in the worse ear	May not have problem unless sound is near the poorer hearing ear. May have difficulty in locating sounds	May have difficulty hearing speech and taking part in conversation, and in locating sounds

* The classification and grades are for epidemiological use and applicable to adults. The following points must be kept in mind while applying this classification:

- While audiometric descriptors (e.g. category, pure-tone average) provide a useful summary of an individual's hearing thresholds, they should not be used as the sole determinant in the assessment of disability or the provision of intervention(s) including hearing aids or cochlear implants.
- The ability to detect pure tones using earphones in a quiet environment is not, in itself, a reliable indicator of hearing disability. Audiometric descriptors alone should not be used as the measure of difficulty experienced with communication in background noise, the primary complaint of individuals with hearing loss.

Unilateral hearing loss can pose a significant challenge for an individual at any level of asymmetry. It therefore requires suitable attention and intervention based on the difficulty experienced by the person.

‡ "Hearing threshold" refers to the minimum sound intensity that an ear can detect as an average of values at 500, 1000, 2000, 4000 Hz in the better ear *(148, 156, 157)*.

The classifications used in Table 1.3 follow the recommendations of the International Classification of Functioning, Disability and Health (ICF) proposed by WHO in 2001. As stated in the ICF, a person with the slightest reduction in hearing sensitivity has a potentially "disabling" condition. The ICF defines a person's state of health along three dimensions which are outlined in Box 1.1 *(158)*. According to the ICF, the disability experienced is determined not only by the individual's hearing loss but also by the physical, social and attitudinal environment in which the person lives, and the possibility of accessing quality EHC services. Therefore, a person with hearing loss who does not have access to hearing care, is likely to experience far greater limitations in day-to-day functioning and thus higher degrees of disability.

Box 1.1 International Classification of Functioning, Disability and Health *(158)*

The International Classification of Functioning, Disability and Health (ICF) is the WHO framework for measuring health and disability at both individual and population levels. The ICF defines a person's state of health across three dimensions:

(i) *Impairment*: which relates to the body-level function or shape (referred to as "hearing loss" in the case of hearing).

(ii) *Activity limitation*: which relates to personal level of function (formerly termed as "disability").

(iii) *Participation restriction:* which relates to psychosocial function (termed as "handicap" in earlier versions of the ICF).

The term "disability" encompasses all problems or difficulties a person with hearing loss may encounter when carrying out everyday activities or situations, such as self-care, or going to school or work. "Disability" in terms of hearing loss refers to the impairments, limitations and restrictions (physical, social, or attitudinal) experienced. As functioning and disability are influenced by context, the ICF also includes a list of environmental factors that contribute to the difficulities experienced by people with hearing loss.

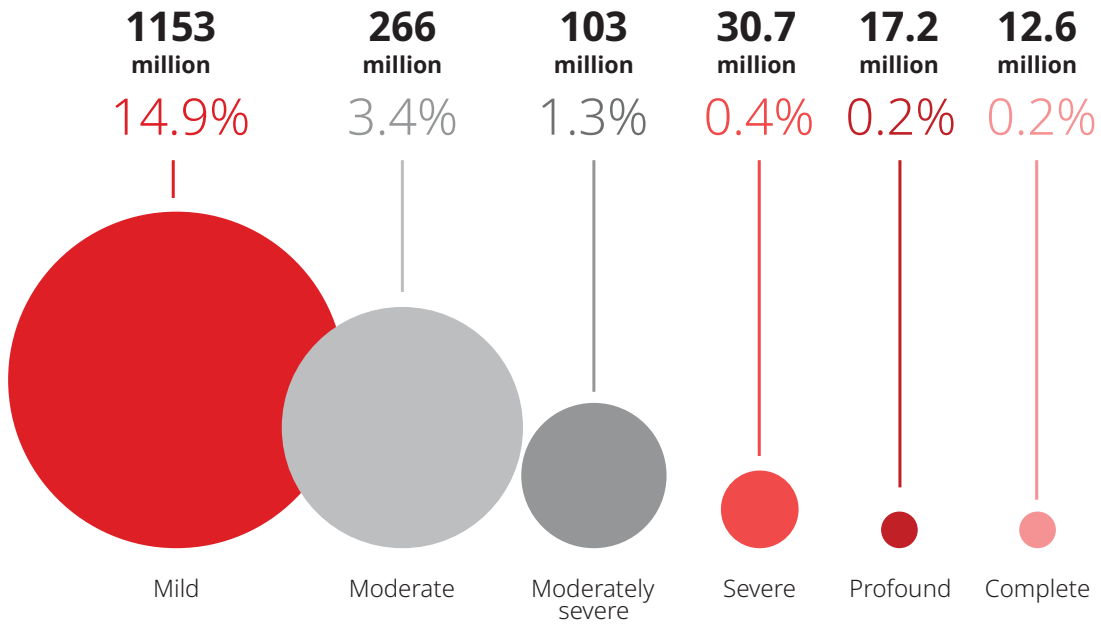
1.3.5 ESTIMATES OF HEARING LOSS[9]

Hearing loss currently affects more than 1.5 billion people or 20% of the global population; the majority of these (1.16 billion) have mild hearing loss. However, a substantial portion, or 430 million[10] people (i.e. 5.5% of the global population) experience moderate or higher levels of hearing loss which, if unaddressed, will most likely impact their daily activities and quality of life. More detailed information about the severity and distribution of hearing loss is presented in the following data.

HEARING LOSS ACCORDING TO SEVERITY

Besides the 1.16 billion people worldwide with mild hearing loss, about 400 million live with hearing loss that ranges from moderate to severe; nearly 30 million have profound or complete hearing loss in both ears (Figure 1.5).

Figure 1.5 Number of people and percentage prevalence according to grades of hearing loss



Globally 1.5 billion people live with hearing loss

[9] GBD 2019 Hearing Loss Collaborators. Hearing loss prevalence and years lived with disability, 1990–2019: findings from the Global Burden of Disease Study 2019. The Lancet. (2021). doi: 10.1016/S0140-6736(21)00516-X.

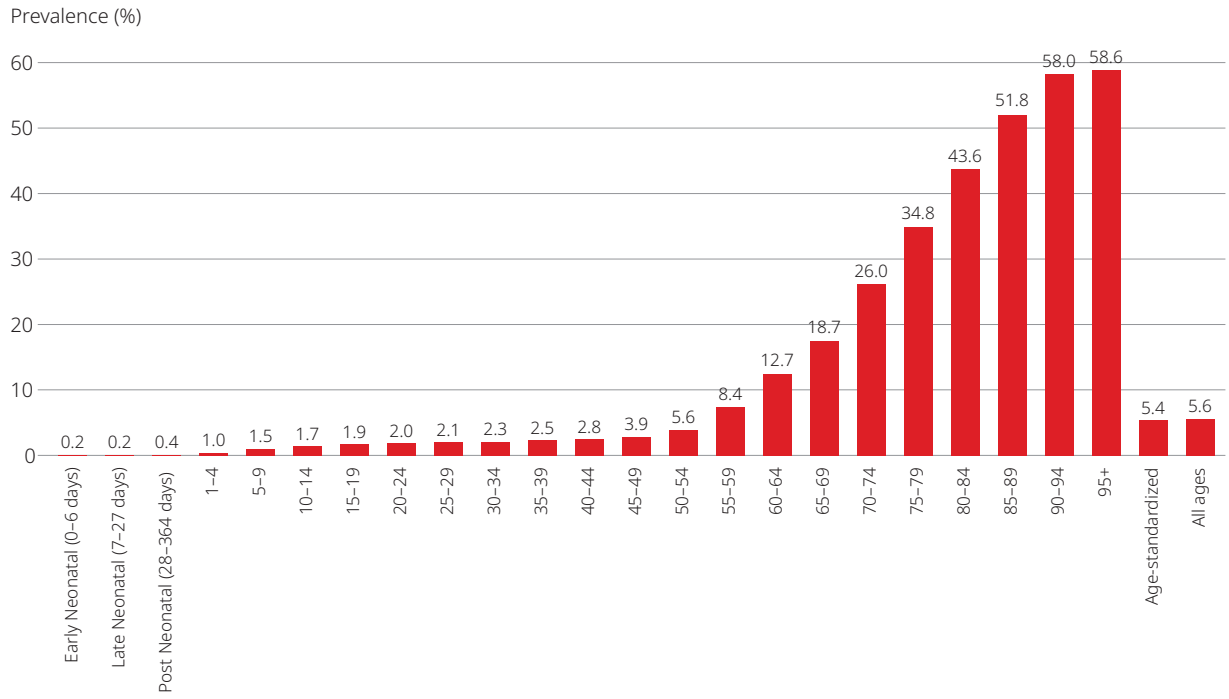
[10] Refers to number of people with hearing threshold higher than 35 dB in the better hearing ear.

AGE AND GENDER DIFFERENCES IN HEARING LOSS

The global prevalence of moderate or higher grades of hearing loss increases with age, rising from 12.7% at the age of 60 years to over 58% at 90 years (Figure 1.6). Notable is that over 58% of moderate or higher grade hearing loss is experienced by adults above the age of 60 years.

In terms of gender differences, global prevalence of moderate or higher levels of hearing loss is slightly higher among males than among females, with 217 million males (5.6%) living with hearing loss compared with 211 million females (5.5%).

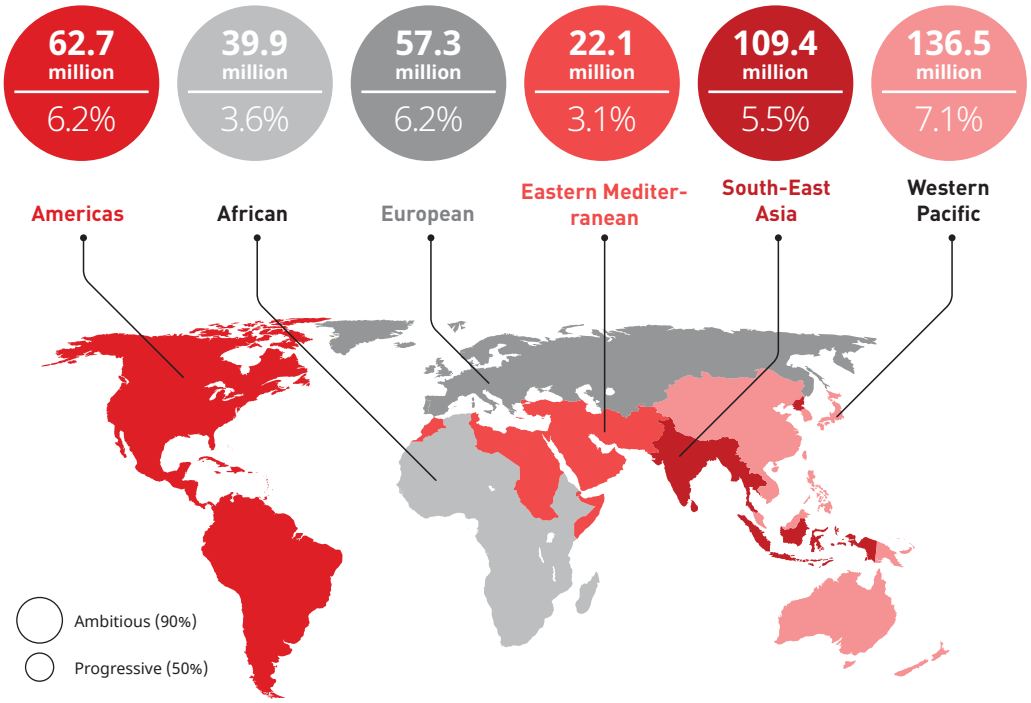
Figure 1.6 Global prevalence of hearing loss (of moderate or higher grade) according to age



DISTRIBUTION OF HEARING LOSS ACROSS WHO REGIONS

The prevalence of hearing loss varies across the six WHO regions, from 3.1% in the Eastern Mediterranean Region, to 7.1% in the Western Pacific Region. The maximum share is contributed by the Western Pacific Region, followed by the South-East Asia Region (Figure 1.7).

Figure 1.7 Prevalence of hearing loss (of moderate or higher grade) across WHO regions

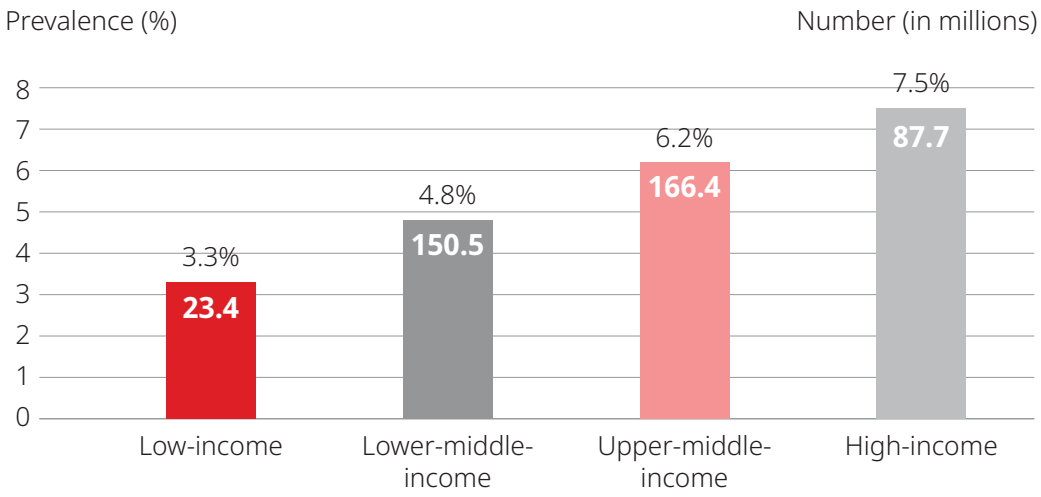


Note: This illustration represents WHO regions, not country boundaries.

PREVALENCE OF HEARING LOSS ACROSS INCOME GROUPS

The prevalence of hearing loss varies greatly across World Bank income groups worldwide, from 3.3% in low-income countries, to 7.5% in high-income countries. The maximum share of people with hearing loss is contributed by lower-middle-income and upper-middle-income countries (approximately 320 million). As a share of the total number of people with moderate or higher levels of hearing loss, nearly 80% live in low-income and middle-income countries of the world, as opposed to 20% in high-income countries (Figure 1.8).

Figure 1.8 Global prevalence of hearing loss (of moderate or higher grade) according to income group



Children with hearing loss are identified and included in an early intervention programme through newborn hearing screening conducted at national level by the CRRCHSI

> Early intervention is crucial to minimize the adverse impact of hearing loss on language and cognitive development.

1.4 THE IMPACT OF UNADDRESSED HEARING LOSS

In 2019, the global number of years lived with disability (YLDs) attributable to hearing loss was 43.5 million (95% UI 29.7–61.8). This number has increased by 73% since 1990 (25.0 million YLDs). Age-related hearing loss was the third largest source of global YLDs in 2019 and the leading source for adults older than 70 years of age.[11]

Sixty-five per cent of disability caused by hearing loss is attributed to moderate or higher grades of hearing loss. Irrespective of the severity of hearing loss or the audiological profile, the extent to which hearing loss impacts people's lives depends on whether it is addressed with effective clinical or rehabilitative interventions *(75, 123, 159)*, and the extent to which the environment is responsive to the needs of people with hearing loss *(75, 158)*. The impact can also be influenced by other co-existing functional limitations such as vision impairment, autism or developmental disabilities. Dual sensory loss in the form of deaf-blindness is estimated to affect as many as 0.2–2% of the global population at all ages *(159)*. Implications of its impact are highlighted in Box 1.2.

Box 1.2 Dual sensory loss: deaf-blindness *(160, 161)*

Deaf-blindness involves dual sensory loss of vision and hearing to varying degrees. Although affecting all ages, deaf-blindness occurs most commonly in elderly people. Thus, as the global population ages, it has become increasingly prevalent. Those with deaf-blindness commonly report an overall low quality of life. They often feel socially isolated due to communication difficulties and lack of public acceptance; have reduced participation in social events due to mobility challenges; have difficulties with daily functioning; experience feelings of loneliness, anger, frustration, depression, insecurity, uncertainty about the future; worthlessness; and face stigma on a daily basis. When compared with other disabilities, individuals with deaf-blindness are more likely to live in poverty and be unemployed, with lower educational outcomes.

[11] GBD 2019 Hearing Loss Collaborators. Hearing loss prevalence and years lived with disability, 1990–2019: findings from the Global Burden of Disease Study 2019. The Lancet. (2021). doi: 10.1016/S0140-6736(21)00516-X.

1.4.1 IMPACT AT THE INDIVIDUAL LEVEL

When unaddressed, hearing loss impacts many aspects of life:

LISTENING AND COMMUNICATION *(162)*

The greatest challenge for people with unaddressed hearing loss is in maintaining communication with others in their environment. The extent of the problem varies depending on the determinants listed above and may range from a person finding it difficult to listen to quiet speech or speech in noisy surroundings, to inability to hear even loud warning sounds including alarms. People with hearing loss often need to ask others to repeat themselves and may find it difficult to communicate in the workplace or to carry on a routine conversation. These difficulties have been further exacerbated as a result of the essential preventive measures against COVID-19 *(163)*. While masks and social distancing are undisputed allies in the fight against the virus, these create additional obstacles for people with hearing loss, who often rely on lip reading and other facial and physical clues to communicate *(163)*.

LANGUAGE AND SPEECH

The development of spoken language in children is directly related to their hearing ability. Most studies conducted on children with hearing loss show that they experience delayed speech and language development which are likely to continue into adulthood *(154, 164)*. The grade of impairment is proportionate to difficulties in speech perception and language deficits *(165)*. However, even mild or unilateral hearing losses, which are commonly overlooked, have an adverse impact on speech and language development in children *(154, 166–168)*. The language and speech outcomes of children with hearing loss are also greatly affected by the age at which intervention is commenced, with outcomes being more successful for children identified before six months of age and followed by prompt intervention *(169)*. The timing of intervention also affects developmental outcomes, as sensory deprivation in early years of life is commonly linked with developmental problems *(170)*.

A deaf child in Bangladesh keeps up with his education

Language is essential not only as a means for communication, but also as contributor for cognitive development, a tool for education, and the basis for social relationships. Hence, access to language is critical *(171)*; when deaf infants are unable to access language stimulation early in life, it poses a challenge for their overall development *(171)*.

Unaddressed hearing loss may be responsible for over 8% of cases of dementia among older adults *(173, 175),* with potentially a slightly higher risk contribution in high-income countries *(174),* and significantly increases the relative risk of dementia and cognitive impairment *(173, 176–180).*

A prospective cohort studied in Norway over three decades (the HUNT study) revealed that people with moderate to severe or mild hearing loss were about half as likely to achieve higher education as people without hearing loss *(181).*

In children (and also adults) that develop hearing loss after speech development, hearing loss can affect the quality of speech, which may be muffled and unclear if it is left untreated.

In those with sensorineural hearing loss, such as age-related hearing loss, a common tendency to speak loudly has been observed, which can create further difficulties within families *(154)*.

COGNITION

Language deprivation risks delayed cognitive development in children, which can be avoided if they receive suitable intervention during the initial years of life *(170, 172)*. Even unilateral hearing loss, occurring in children, affects the development of cognitive skills *(168)*. The impact on cognition is not limited to children but is clearly evident in adult-onset hearing loss as well. Hearing loss is the largest potentially modifiable risk factor for age-related dementia *(173, 174)*.

EDUCATION

Hearing loss can have a long-lasting impact on the academic outcomes of an individual. Unless addressed in a timely manner, those with hearing loss have reduced school performance, slower progression through the academic system, a greater risk of dropping out of school, and lower likelihood of applying for higher education, compared with their hearing peers *(181–183)*.

EMPLOYMENT

An association between hearing loss and employment in adults is evident. Students with hearing loss often demonstrate a lack of career-planning and decision-making which are required for success in the workplace *(182, 183)*. Overall, adults with hearing loss have increased odds of unemployment or underemployment *(184–186)*. In northern Finland, a longitudinal study showed that those aged 25 years, with clinically measured hearing loss, were twice as likely to be unemployed as those

of the same age with normal hearing *(182)*. When employed, people with hearing loss often earn lower wages and retire earlier than their hearing peers *(184, 187)*.

In northern Finland, people with unaddressed hearing loss are twice as likely to be unemployed as those with normal hearing *(182).*

SOCIAL ISOLATION AND LONELINESS

Hearing loss contributes to both social isolation and loneliness at all ages, more specifically in women and older adults *(188, 189)*, possibly because of decreased participation in activities, or by having a smaller social network. This is observed especially in places where access to ear and hearing care is limited *(190)*. The impaired ability to comprehend auditory information and maintain conversations *(191)* may lead to avoidance of potentially embarrassing social situations by the affected persons *(192)*. Hence, people with hearing loss, particularly those who do not use hearing aids, show elevated levels of loneliness *(188, 193, 194)*.

Social isolation and loneliness due to hearing loss can have important implications for the psychosocial and cognitive health of older adults. Lack of engagement and feeling lonely may mediate the pathway linking hearing loss and cognitive decline *(195, 196)*. Furthermore, both can contribute to worsened mental health, leading to experience of depression and distress *(189, 197, 198)*.

MENTAL HEALTH

Across the life course, people with hearing loss commonly have higher rates of depression and report lower quality of life compared with their hearing peers *(199–201)*. Social withdrawal and altered social interactions are frequently observed in persons with hearing loss, as well as feelings of embarrassment, rejection and anxiety *(162)*. Often, during conversation, their communication partners experience frustration and anger *(162)*.

RELATIONSHIPS

Over 90% of deaf children are born to hearing parents who most often have no fully effective means to communicate with their child *(202, 203)*. A number of studies report that parents have difficulties developing meaningful communication with their child with hearing loss, and in managing the child's behaviour, especially if they have other conditions such as autism spectrum disorders *(204)*. In adults, hearing loss can have a negative impact on personal relationships resulting in communication difficulties, misunderstandings and conflict *(162)*. The effect is evident both for the person with hearing loss as well as their communication partners.

CASE STUDY

Parents need support in addressing the needs of their deaf or hard-of-hearing children

Given the fact that the majority of deaf and hard-of-hearing children are born to hearing parents, who lack any experience with the implications of dealing with hearing loss, this affects families in many ways. For example, it leads to higher levels of stress among parents, especially when having to make decisions about the child's rehabilitation and education. The well-being of parents themselves has a significant influence of the audiological, cognitive and socioemotional outcomes of the child with hearing loss *(205)*. Hence, information, guidance, and support to parents whose child is diagnosed with hearing loss is crucial but not always available. In some parts of the world, well-organized efforts by groups of parents of deaf and hard-of-hearing children, such as "Hands and Voices" *(206)*, have taken leadership in providing family support and making available resources that increase parents' knowledge about addressing the needs of their children. This engagement has had a far-reaching impact on the knowledge of, and support received by, families with deaf or hard-of-hearing children in the places served. As one parent responded when receiving parent-to-parent support: "Thank you so much. I have been feeling like I am in a small boat in the middle of the ocean with no sight of land or vessel. You have thrown me a life preserver."*(206)*

IDENTITY AND STIGMA

Hearing loss among children, adolescents and adults is frequently linked with feelings of inadequacy and low self-esteem *(162, 207)*. People with hearing loss, even when it is addressed, may commonly reflect the stigma that is associated with hearing loss and the use of hearing devices *(162)* and try to hide their impairment. Many choose not to use hearing aids due to prejudiced mindsets and ageist stereotypes *(208)*.

1.4.2 IMPACT AT A FAMILY/COMMUNICATION PARTNER LEVEL

The majority of children who are deaf or hard of hearing are born to parents of normal hearing *(202, 203)*. In the USA, for example, only around 4% of deaf or hard-of-hearing infants have deaf parents; a further 4% have one parent with hearing loss. Parents with a deaf or hard-of-hearing child commonly experience higher levels of emotional and physical strain than other parents; their career may be compromised to take care of their child full time, and sometimes they may have to relocate to be closer to the required services *(204)*.

The impact on families, especially on communication partners, is also noteworthy, as they may experience reductions in social functions due to participation restrictions related to the partner's hearing loss; increased stress related to communication; and reduced satisfaction within the relationship *(118, 162)*.

1.4.3 ECONOMIC IMPACT *(210)*

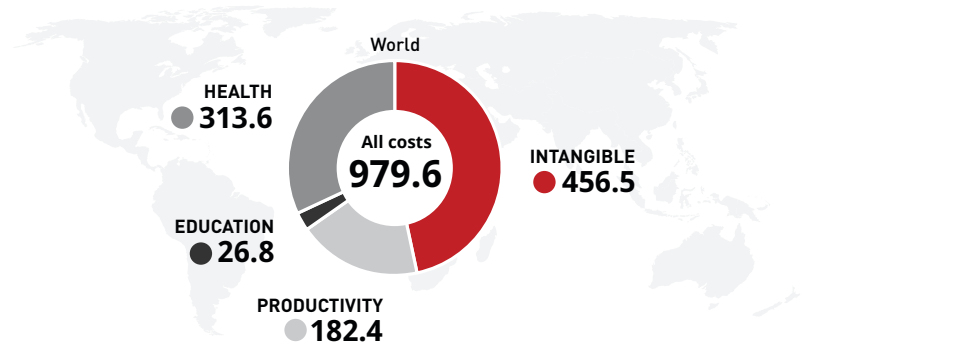
Beyond financial hardships at the individual level, hearing loss has a considerable economic impact on society as a whole. WHO data reveal that the overall global cost of unaddressed hearing loss is greater than $ 980 billion annually (see Figure 1.9). These include costs related to:

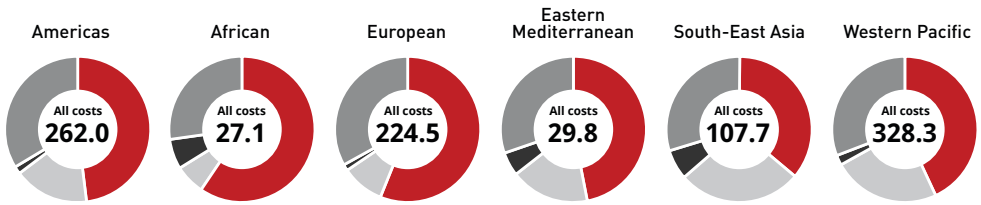
- *The health-care sector*: these are estimated to be around $ 314 billion and include health-care costs for children and adults posed by failing to address hearing loss. They do not include costs for the provision of services and rehabilitation.
- *The educational sector*: a conservative estimate of the cost for providing support to children (i.e. those aged 5–14 years) with unaddressed hearing loss is nearly $ 27 billion. This assumes that only children with at least moderately severe hearing loss (i.e. a hearing level greater than 50 dB in the better hearing ear) require educational support.
- *Loss of productivity*: costs related to unemployment and premature retirement among people with hearing loss is conservatively estimated as $ 182.5 billion annually.
- *Societal costs*: the result of social isolation, communication difficulties and stigma add a further $ 456.5 billion each year. These costs are calculated on the basis of the monetary value attached to avoidance of a year lived with disability and draw upon disability-adjusted life years (DALYs) attributed to hearing loss.

Unaddressed hearing loss costs the world $ 980 billion annually.

It is also important to note that 53% of all costs are attributed to low- and middle-income countries.

Figure 1.9 Illustrative combined direct, indirect and intangible costs of hearing loss (in billion dollars)*





	Americas	African	European	Eastern Mediterranean	South-East Asia	Western Pacific
HEALTH	88.6	7.3	74.5	9.0	32.2	101.8
EDUCATION	3.8	3.6	3.2	1.6	7.0	7.4
PRODUCTIVITY	44.1	3.5	21.1	5.2	29.7	78.5
INTANGIBLE	125.3	12.4	125.6	13.9	38.7	140.5

* All costs are calculated for moderate or higher degrees of hearing loss, i.e. hearing level greater than 35 dB in the better-hearing ear. The costs are estimated in 2015 International dollars (a unit of currency defined by the World Bank and represented simply as "$" in the table).

N.B. *The analysis takes no account of certain aspects of hearing loss, the costs of which are not well documented in literature, such as the costs of providing informal care, or pre-school learning and higher education for people with unaddressed hearing loss (201).*

These estimates focus only on unaddressed hearing loss and do not take into account the high costs posed by otitis media and its management. The costs attributed to the medical and surgical management of these potentially preventable diseases are high. In Australia, for example, treatment costs for cases of otitis media, excluding complications and comorbidities, were 100–400 million Australian dollars in 2008 *(211)*. In the Republic of Korea, a nationally representative study estimated treatment costs of otitis media as 497.35 million US dollars in 2012 alone *(212)*. In contrast to the data provided above, these costs refer to management of this group of conditions in certain countries. Nonetheless, their inclusion here is relevant since these costs could be mitigated by preventive actions as outlined in Section 2.

Hearing loss has the potential for adverse effects at all stages of life; however, the impacts described in this section can be mitigated if it is addressed in a timely and appropriate manner, as highlighted in the upcoming sections.

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Timely intervention benefits those with hearing loss and their families*

*Contributed by the Global Foundation For Children With Hearing Loss. See: https://childrenwithhearingloss.org/

My daughter, Nguyen Ngoc Bao Tran, was 11 months old when her hearing was tested and hearing loss diagnosed. My family could not afford the hearing aids necessary for her to develop listening and speaking skills. The doctor told us that time is of the essence. He told us that to have the chance to learn to listen and talk, children with hearing loss need to be identified as young as possible, fitted with appropriate hearing technology, and receive rehabilitation.

Thanks to the support of an international foundation, Bao Tran was fitted with a pair of high-quality hearing aids when she was 17 months old. I still remember the moment when I first called her and she turned her head to look towards me. It was the happiest moment of my life, to know that my child could hear and that I will be able to talk with her! Of course, I knew that the hearing aids were just the first step. There was a long road ahead and Bao Tran would need therapy for many years to make my hope a reality.

Now, after six years, my family and I are overjoyed each day to see her progress. Bao Tran goes to school proudly wearing her hearing aids, along with other children in our community. She is so talkative! I can't get her to stop. She has many friends, loves to sing and her teachers are very happy with her.

I hope that all deaf and hard-of-hearing children can get the same chances as my child, so that they have the opportunity to achieve their full potential."

Nguyen Thi Hong Loan, Bao Tran's mother

SECTION 2

SOLUTIONS ACROSS THE LIFE COURSE: HEARING LOSS CAN BE ADDRESSED

> Effective solutions can benefit all those at risk of, or living with, hearing loss.

2.1 OVERVIEW

- Many of the causes that lead to hearing loss can be avoided through public health strategies and clinical interventions implemented across the life course.
- Prevention of hearing loss is essential throughout the life course – from prenatal and perinatal periods to older age. In children, nearly 60% of hearing loss is due to avoidable causes that can be prevented through implementation of public health measures. Likewise, in adults, most common causes of hearing loss, such as exposure to loud noise and ototoxic chemicals, are preventable.
- Effective strategies for reducing hearing loss at different stages of the life course include:
  - immunization;
  - good maternal and childcare practices;
  - genetic counselling;
  - identification and management of common ear conditions;
  - occupational hearing conservation programmes for noise and chemical exposure;
  - safe listening strategies for the reduction of exposure to loud sounds in recreational settings; and
  - rational use of medicines to prevent ototoxic hearing loss.
- Common ear conditions, such as otitis media, can be treated medically and surgically; treatment lowers the rates of associated morbidity and mortality and can prevent or reverse the hearing loss attributed to such conditions.

- Changes in the modifiable risk factors encountered across the life course can help to maintain the hearing trajectory as a person ages and influence the extent of hearing loss experienced in later life.
- The adverse impacts of developing hearing loss or ear diseases at any stage during a person's life course can be mitigated through early identification followed by prompt and appropriate interventions.
- Early identification of hearing loss and ear diseases is key to effective management. Advancements in technology provide tools that can identify hearing loss at any age. To facilitate this process, it is important to implement programmes that target:
  - newborns and infants;
  - school-age children;
  - all those at greater risk of hearing loss due to exposure to noise, ototoxic chemicals and ototoxic medicines; and
  - older adults.
- Hearing assessment and ear examination can be conducted in clinical and community settings as well as field settings. Tools such as "hearWHO" and other technology-based solutions enable screening for ear diseases and hearing loss to be conducted in school and community settings with limited training and resources.
- Once hearing loss is identified, it is essential that it is addressed as early as possible and in an appropriate manner to mitigate any adverse impact. Such early intervention strategies must adopt a person-centred approach, taking into account the individual's communication needs and preferences, as well as available resources.
- Measures available to rehabilitate people with hearing loss include:
  - the use of hearing technology through hearing aids, cochlear implants and middle ear implants;
  - the use of sign language and other means of sensory substitution, such as speech reading, use of print on palm or Tadoma, signed communication; and
  - rehabilitative therapy to enhance perceptive skills and develop communication and linguistic abilities.
- The use of hearing assistive technology, and services such as frequency modulation and loop systems, alerting devices, telecommunication devices, captioning services and sign language interpretation, can further improve access to communication and education for people with hearing loss.

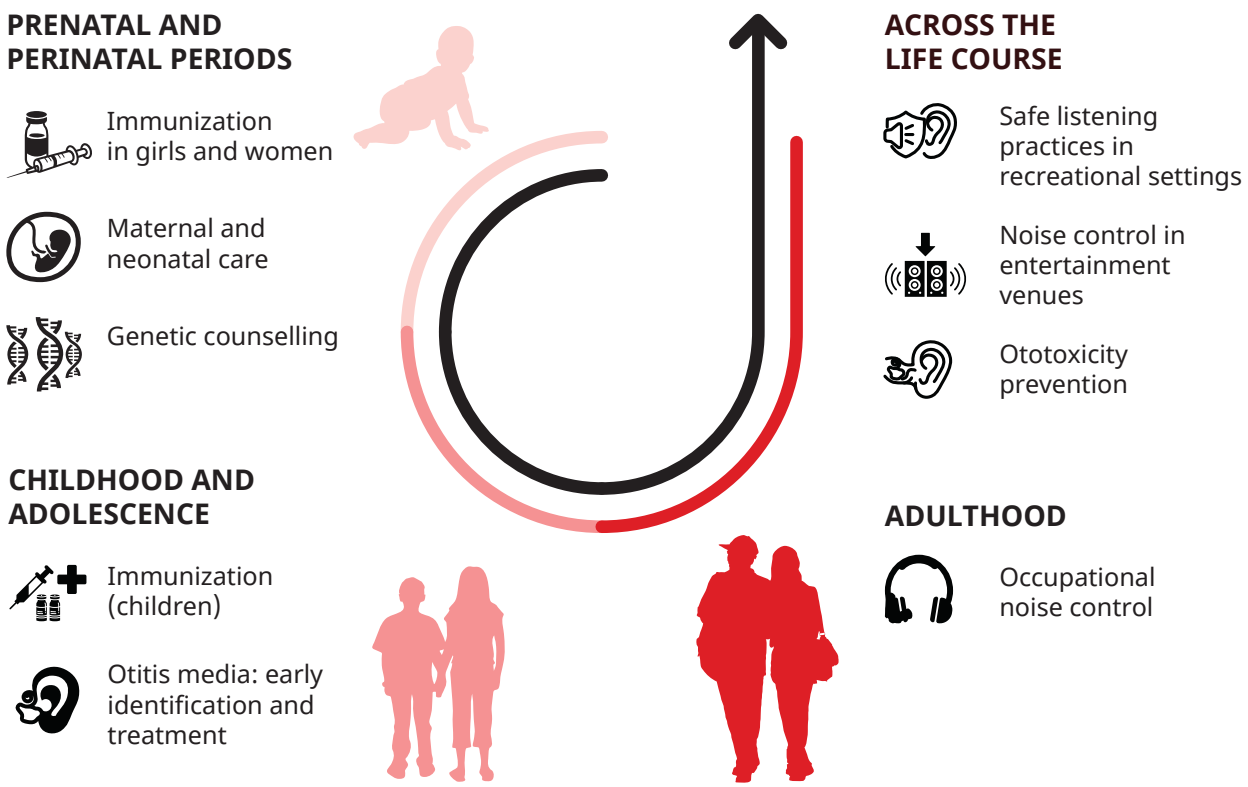
The hearing trajectory of an individual across the life course is influenced by multiple factors, including public health strategies implemented at a population level, as described in Section 1. Section 2 outlines solutions for preventing hearing loss and ear diseases through a population-based approach and presents means for identifying and addressing these conditions in a timely and appropriate manner. Additionally, Section 2 focuses on public health strategies as well as technological advances that can enable prevention, identification, treatment and rehabilitation of hearing loss and related ear diseases.

> Effective public health strategies and clinical interventions can, in many cases, prevent the occurrence or progression of hearing loss.

2.2 PREVENTION OF HEARING LOSS AND EAR CONDITIONS

Section 2.2 builds on the preventive actions to preserve hearing capacity that were outlined in Section 1 and focuses on actions to be taken at a population level to prevent hearing loss and ear diseases. Since certain health conditions or environmental influences are more likely to be experienced at particular stages of the life course, preventive strategies are designed to target these specific age groups. Many of these strategies, however, are applicable to multiple, or all, stages of a person's life (Figure 2.1).

Figure 2.1 Preventive strategies for hearing loss across the life course



2.2.1 PRENATAL AND PERINATAL PERIODS

It is estimated that nearly 60% of hearing loss in children is due to avoidable causes such as vaccine-preventable diseases, ear infections, birth-related causes and ototoxic medicines *(1)*. The prevention of congenital and childhood hearing loss during prenatal and perinatal periods include:

IMMUNIZATION IN GIRLS AND WOMEN

"Large-scale rubella vaccination in the past decade has practically eliminated rubella and congenital rubella syndrome in many countries. In 2015, the WHO Region of the Americas became the first in the world to be declared free of endemic transmission of rubella. As of December 2016, 152 out of 194 WHO Member States had introduced rubella vaccines, with coverage varying from 13% to 99%."*(5)*

Vaccination against rubella prior to, or during, reproductive age is extremely effective in preventing congenital rubella in offspring *(2, 3)*. Ongoing research into the prevention of cytomegalovirus (CMV) infection is also encouraging, although as yet a vaccine is not available *(4)*.

MATERNAL AND NEONATAL CARE

Antenatal maternal health and perinatal care are clearly linked with a child's hearing status. Evidence on the positive impact of improved antenatal and perinatal care on neonatal morbidity is unequivocal *(6)*. While there are no studies demonstrating a direct link between improved maternal care and hearing loss, it is clear that such improved outcomes would also apply to hearing loss *(7, 8)*.

In cases of mothers infected with syphilis, cytomegalovirus, toxoplasmosis or HIV, prompt management can mitigate the risk of congenital hearing loss associated with these conditions *(7, 9, 10)*. In addition, it is important to ensure that proper evidence-based protocols are followed for minimizing the ototoxic effects of the medicines on the mother and her infant. The availability and use of appropriate resuscitation measures along with perinatal care for the prevention and management of birth asphyxia, jaundice and perinatal infections, minimizes the adverse consequences of these risk factors *(11)*.

This contrasts with infants born in environments where health facilities are unavailable, or where health care is lacking, and who are thus at a greater risk for immediate or delayed effects on their hearing trajectories throughout life. Awareness among health professionals of these risk factors, their association with congenital hearing loss, and the common features that may indicate hearing loss in an infant, can assist in early identification.

GENETIC COUNSELLING

In families with a history of hearing loss, genetic counselling can prepare parents for hearing loss in their offspring, and provide guidance for early identification and rehabilitation. Genetic counselling refers to the provision of accurate information in a nondirective manner with the aim of offering medical, psychological and social support *(12)*. Such counselling services must always consider the beliefs and values of deaf communities *(13)*.

Awareness among health professionals regarding presentation of congenital hearing loss including features of common syndromes can assist in early identification of hearing loss.

Given the correlation between congenital deafness and consanguinity, raising awareness in this respect and ensuring access to preconception and premarital counselling services for consanguineous couples can help maintain and improve outcomes, including hearing loss prevention, identification and management *(14, 15)*.

2.2.2 CHILDHOOD AND ADOLESCENCE

Many of the risk factors for hearing loss and ear disease faced during early and late childhood can be prevented or addressed.

IMMUNIZATION IN CHILDREN AND ADOLESCENTS

WHO estimates that over 19% of childhood hearing loss could be avoided by immunization against rubella and meningitis alone *(1)*. Overall, vaccinations are highly effective in protecting against common illnesses such as measles, mumps, rubella and meningitis, and thus can prevent hearing loss that occurs as a complication *(16, 17)*. The vaccine for measles, mumps and rubella (MMR) is shown to be highly effective in prevention *(17, 18)*, and vaccines available for many of the strains that lead to meningitis has led to a significant reduction in meningitis incidence in many countries *(19, 20)*. Any reduction in the occurrence of these infections would mitigate the risk of hearing loss associated with them.

Vaccinations against common bacteria and viruses (e.g. influenza virus) associated with otitis media are also useful in reducing incidence *(21–23)* (see Box 2.1). It is important that countries consider these factors when planning for immunization coverage, and that effective immunization policies are implemented in line with global targets and national priorities.

Box 2.1 Vaccination to protect against otitis media

"The goal of the vaccines is to reduce or eliminate nasopharyngeal colonization of *S. pneumoniae*, non-typeable *H. influenzae* and *M. catarrhalis*. The seven-valent PCV (PCV7), became available in the United States and many European countries in 2000. PCV7 was associated with a 29% reduction in AOM caused by pneumococcal serotypes contained in the vaccine, a 6–7% reduction in overall AOM and a 20% reduction in the use of ventilation tubes for chronic recurrent OM. PCV13, available a decade later, has been associated with further reduction of AOM, mastoiditis and ventilation tube insertions." *(21)*

"In Korea, the economic burden associated with otitis media reduced from 530.11 million in 2004, before the PCV7 and PCV13 vaccines were introduced, to 497.35 in 2012, following the introduction of these vaccines." *(24)*

OTITIS MEDIA: EARLY IDENTIFICATION AND TREATMENT

Early identification and treatment of otitis media will prevent onset, or progression, of hearing loss. Since chronic suppurative otitis media (CSOM) commonly follows untreated acute otitis media (AOM), efforts should be directed towards the identification and management of AOM in order to prevent its recurrence and avoid chronic ear infections *(7, 25–27)*. Proper evaluation and management of persons with CSOM and nonsuppurative otitis media (NSOM) through medical and surgical means can prevent or reverse the auditory effects, while also mitigating the risk of recurrent infections *(25, 27)*. Key considerations when identifying and treating otitis media include:

An ENT surgeon and her team operates on a patient with chronic suppurative otitis media

- **Acute otitis media** – While the virtues of antibiotic use versus expectant observation approach are debated, it is important that in places where complications (such as mastoiditis) are still common and where there is no certainty of proper follow-up, antibiotics are recommended and made available to ensure effective resolution and to avoid complications *(26)*.
- **Nonsuppurative otitis media or otitis media with effusion** (OME) – These can be managed through the use of antibiotics, grommet insertion and adenoidectomy. The exact intervention must be determined based on indication and clinical needs *(21, 28–32)*. For this reason, it is important that persons with NSOM/OME receive care from a suitably qualified practitioner who can manage the condition or refer to an ear, nose and throat (ENT) specialist.

- **Chronic suppurative otitis media** – This must be addressed to ensure: (i) eradication of the infection responsible for morbidity and mortality associated with CSOM; and (ii) closure of tympanic membrane perforation, without which hearing loss due to re-infection of the middle ear may present a constant threat *(27)*. Eradication of infection is possible with proper care through aural toilet with or without use of local antibiotics or antiseptics *(33, 34)*. Surgical treatment for CSOM is required at times, either for removal of infection or for surgical repair of the tympanic membrane and middle ear structures. These surgical procedures, such as mastoidectomy, tympanoplasty and myringoplasty, are well established and highly effective in curing disease and reducing accompanying hearing loss *(21, 35–37)*. It is important to correctly evaluate every person with CSOM, and that any decision regarding surgical intervention is made in consultation with an ENT specialist. Information on treatment options for discharging ears, common in those with CSOM, is provided in Box 2.2.

Appropriate medical and surgical management of otitis media is crucial to cure these illnesses and to reduce the hearing loss associated with them.

Box 2.2 Discharging ears: medical and surgical management

Discharging ears and the hearing loss associated, can and should be addressed through access to high-quality ear care *(38)*. The purpose of treating discharging ears is to establish a dry ear, free of infection and to correct hearing loss. While in certain cases, medical treatments can control the discharge and improve hearing, surgical treatment is often needed to effectively remove infection and improve hearing over the long term. Most commonly applied treatments include:

Aural toilet *(38–40)*: Ear cleaning or aural toilet consists of cleaning discharge, pus, and debris from the ear using various techniques. Treatments can be performed by the individual, their family members, or a trained community health worker or primary care provider. Techniques include wicking, suctioning, and irrigating the ear. The benefit of aural toileting is that it can be performed frequently and requires minimal equipment and expertise. Nevertheless, aural toilet should not be considered a standalone treatment.

Note: It is essential that patients are taught to care for their discharging ears. The WHO training resources for primary ear and hearing care[12] provide guidance and information for health workers and patients.

[12] WHO primary ear and hearing care training resources https://www.who.int/pbd/deafness/activities/hearing_care/en/

Antibiotic use *(40)*: Antibiotics can be delivered as drops into the ear or the mouth. Antibiotic drops coupled with aural toilet is the most common form of treatment for draining ears.

Surgical treatments *(38, 40–44)*: Surgery conducted by trained ENT specialists is often the ultimate treatment required to halt the cycle of drainage and improve hearing over the long term. Surgery may include tympanoplasty, mastoidectomy, and ossicular chain reconstruction, or frequently a combination of techniques. Surgery for CSOM occurs across a range of resource settings and is considered cost–effective. Ear surgery performed on patients by surgeons with appropriate training is associated with long-term hearing improvements.

CASE STUDY

Otitis media is treatable: a case study from Nicaragua

Josue was six years old when his mother noticed a shift in his behaviour – from being a confident and softly spoken boy, to becoming irritable and distracted. His mother also noticed that Josue often had to raise the volume of the television set at home. But it was when his grades in school started to plummet that his parents took him to the village general practitioner (GP). When ear drops prescribed by the GP did not lead to any improvement, the family travelled to Esteli, their nearest city, to see an ENT specialist. The specialist diagnosed otitis media and referred Josue for ear surgery.

Since, at the time, specialized ear surgeries were performed only in Managua, the capital city, Josue's parents travelled across the country. Despite financial hardships, they were determined that their son should receive the treatment he so badly needed. Finally, at the age of eight years old, Josue received successful ear surgery. Post-surgery, Josue showed remarkable improvement in his symptoms and returned home. During the following months his hearing improved as did his mood and school performance. Today, he is once again on the honour roll of his class and enjoys making friends. He still needs to return to Esteli for regular check-ups, and his parents make sure that he never misses these.

EFFECTIVENESS OF EAR DISEASE PREVENTION AND MANAGEMENT

Medical and surgical means to manage common ear diseases such as ear wax and otitis media are effective and cost–effective in reducing the hearing loss and morbidity due to these conditions and their complications *(26, 30, 34, 45–53)*. Addressing ear diseases would lower the mortality rates associated with their neglect *(54)*.

CASE STUDY

In Australia, the Queensland government takes effective steps to address otitis media in children *(55)*

The children of Aboriginal and Torres Strait Islander populations have one of the highest global rates of otitis media in children – particularly for those living in rural and remote areas. To address this, Queensland government established the "Deadly Ears Deadly Kids Deadly Communities" Framework in 2009, targeting a significant reduction in the high rates of chronic suppurative otitis media in Aboriginal children. The Deadly Ears programme, which sits under this framework, delivers frontline services using a multidisciplinary team (including primary and ENT health, allied health and teaching professionals), and builds local workforce capacity in 11 partner locations across rural and remote Queensland. The programme team coordinates access to specialist services and rehabilitation programmes.

This model facilitates and streamlines the process of awareness, identification, diagnosis and management of otitis media, particularly for younger children, due to the implications of hearing loss on early childhood development and education. While the programme continues to evolve, the rate of children aged 0–4 years receiving ear and hearing care services has increased from 53% (2014) to 94% (2018).

2.2.3 ADULTHOOD AND OLDER AGE

Although the process of ageing is inevitable, the associated hearing loss cannot be considered unavoidable. It is now well understood that age-related hearing loss is a multifactorial condition, of which cochlear/neural ageing is only a part. Hearing loss is influenced by various determinants such as genetic factors *(56)*, existing ear conditions, chronic illnesses, and environmental factors such as noise exposure, use of ototoxic medicines and lifestyle choices. Changes in the modifiable risk factors can alter the course of a person's hearing trajectory and influence the extent of hearing loss experienced in the later years of life *(57)*.

2.2.4 FACTORS FOR HEARING LOSS ACROSS THE LIFE COURSE

LIMITING EXPOSURE TO DAMAGING LEVELS OF SOUND

Exposure to loud sounds has a damaging effect on the cochlear structures that are so vital for hearing. This risk factor can be mitigated by protecting a person's ears against such exposure *(58)* through:

- **Hearing conservation programmes in occupational settings**

  Hearing conservation programmes can reduce the daily exposure to noise encountered by workers and limit the impact on the cochlear hair cells and therefore on their hearing trajectory *(59)*. As depicted in Figure 2.2, occupational hearing conservation programmes comprise the following: *(58–61)*

  i. *Engineering and administrative controls for the reduction of noise levels and exposure:* These include reducing or eliminating the source of noise; changing materials, processes or workplace layout. Actions may involve purchasing quieter machinery; the segregation of noise sources; installing panels or curtains around the sources, and other such measures. Management policies may involve rotating workers between noisy and non-noisy areas, and ensuring availability of information and ongoing education in this respect.

  ii. *Noise monitoring:* Monitoring ensures that noise levels and exposure periods stay within the recommended levels. A level of 85 dBA[13] is the maximum permissible sound level for an 8-hour time period in occupational settings *(62, 63)*. If the noise level is higher, the time period needs to be reduced accordingly (based on a 3 dB exchange rate – see Box 2.3).

  iii. *The use of hearing protectors*: Use includes the provision of devices such as earmuffs and earplugs, as well as essential training in their correct use. Used correctly, hearing protectors can significantly attenuate noise reaching the ear.

  iv. *Education*: Key elements of a hearing conservation programme include education on the effects and control of noise, the impact of hearing loss and its prevention. Workers, especially those working in noisy areas, should be taught about hearing, hearing protectors and surveillance. Information on noise levels, exposure, risk and its mitigation, should also be conveyed through warning signs, information brochures and notifications.

  v. *Hearing surveillance:* Monitoring the hearing levels of exposed workers should be conducted through a baseline and regular audiometric evaluation. When an audiometric shift is detected and validated, it is important that suitable action to protect the worker from further exposure is initiated immediately. In addition to regular audiometric evaluation, daily noise exposure monitoring is effective in promoting safe practices.

[13] dBA refers to decibels of sound pressure level measured using the A-weighting that is commonly used for measuring occupational and environmental noise exposures.

Figure 2.2 Components of an occupational hearing conservation programme

Hearing conservation programmes were implemented in many European countries at the turn of the millennium. France, Italy, the United Kingdom of Great Britain and Northern Ireland (the United Kingdom), and the Czech Republic have all reported a decline in the incidence of noise-induced hearing loss (NIHL) in recent years. In France, the occurrence of physician-reported NIHL dropped by 17% between 2007 and 2012 *(64)*. Improved implementation of such programmes, along with strict legislation enforcement, can reduce noise levels in workplaces and thereby mitigate the adverse impact on the hearing trajectory of those exposed *(58, 60)*.

The prevalence of noise-induced hearing loss is declining in most industrialized countries, most likely due to the adoption of preventive measures *(65)*.

- **Safe listening practices in recreational settings**

  Unlike occupational exposure, people often voluntarily expose themselves to dangerous levels of sounds while listening through headphones, stereo systems, in live music events or concerts, nightclubs, sporting events, the recreational use of firearms and also in fitness classes *(66–68)*. Safe levels of exposure to leisure noise are described in Box 2.3.

Box 2.3 Limits of exposure for leisure noise

The maximum exposure level for leisure noise is the equivalent of 80 dB for 40 hours a week *(69)*. The equal energy principle states that the total effect of sound is proportional to the total amount of sound energy received by the ear, irrespective of the distribution of that energy over time and that the amount of energy doubles for every 3 dB increase in intensity of sound *(69, 70)*. Hence, a person may receive the same "noise dose" listening to music at 80 dB for 8 hours a day as listening to 100 dB for about 4 minutes.

Taking protective measures while enjoying preferred pastimes is an important factor in affecting a person's hearing trajectory. Safe listening practices that limit the amount of sound exposure through personal audio devices *(71)* and at concerts, for example through use of earplugs *(72)*, can help to prevent hearing damage occurring and thereby, potentially maintain hearing capacity over time *(66, 67)*. Specific public health measures can promote these protective behaviours through, for example:

i. *Development and implementation of school-based hearing conservation programmes:* Such programmes educate parents and children and should be based on the Health Belief Model[14] and aim to change the listening behaviours of young people who are commonly engaged in unsafe listening *(66, 67, 71)*. Programmes should focus on imparting knowledge of ear hearing, noise, hearing loss and modifiable risk factors; as well as developing skills for safe listening, such as use of hearing protectors; use of isolating earphones; prevention of overexposure through volume reduction *(66, 71)*. At the same time, the programmes should ensure that earphones or noise protectors do not interfere with personal safety.

ii. *Implementation of the WHO-ITU standard for safe listening devices:* Many users of personal audio devices have listening habits that put them at risk of hearing loss *(70, 71)*. Research in other areas related to health suggests that digital platforms, smartphone applications (apps) and mobile health tools can provide a useful means for improving healthy behaviours and lifestyles. Although evidence is currently scarce and uncertain, it is unanimous in acknowledging the potential of such digital platforms to promote healthy behaviours, especially when they are based on sound behaviour change theories; are user-friendly; culturally appropriate; accurate; and personalized *(73–78)*. The use of technology in hearing health and safe listening has not been studied systematically. Nonetheless, based on findings from other health areas, there are promising possibilities for using technology – for example smartphone apps, text messages, computers and the Internet – as a means

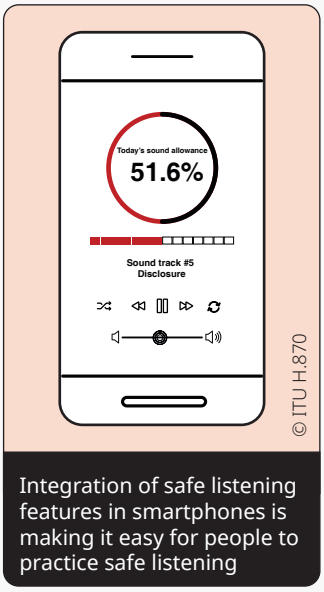
[14] The Health Belief Model derives from psychological and behavioural theory. It suggests that a person's belief in a personal threat of an illness or disease, together with a person's belief in the effectiveness of the recommended health behaviour or action, will predict the likelihood the person will adopt the behaviour (Rosenstock 1974). (I.M. Rosenstock. The Health Belief Model and preventive health behavior, Health Educ. Monogr., 1 (December (4) (1974), pp. 354–386).

for changing listening practices and behaviours *(57)*. To facilitate this, WHO, in collaboration with the International Telecommunication Union (ITU) and other stakeholders have made a series of recommendations regarding safe listening features that should be included in smartphones, MP3 players, ear/headphones and other devices used for listening (see Box 2.4). This global standard can be implemented voluntarily by manufacturers of the relevant devices and also mandated through government policies.

Box 2.4 The WHO-ITU H.870 Global Standard for safe listening devices and systems*

The WHO-ITU Global Standard aims to regulate exposure to loud sounds through personal audio devices/systems and mitigate hearing loss risk associated with their use. Recommendations state that:

1. Every device shall measure the listener's use of sound allowance, based on a choice of two modes of reference exposure:
   - Mode 1 for adults: 80 dBA for 40 hours a week
   - Mode 2 for sensitive users (e.g. children): 75 dBA for 40 hours a week
2. Each device should include options for volume limiting and parental volume control.
3. Each device shall provide the user with:
   - personal usage information
   - personalized messages and cues for action
   - general information on safe listening



Integration of safe listening features in smartphones is making it easy for people to practice safe listening

* See: https://www.who.int/publications-detail/safe-listening-devices-and-systems-a-who-itu-standard

- **Noise control in entertainment venues**

As outlined above, the implementation of noise control legislation in the workplace has been an important and effective strategy. Although occupational noise exposure cannot accurately be compared to the voluntary and pleasurable exposure undertaken as a means for recreation, there are lessons to be learnt from that field. Policies, regulations and their enforcement can influence a person's behaviour, and success through adopting such interventions is evident in several areas of public health. Examples include the mandatory graphic warnings on cigarette packages, and fines imposed for violating seatbelt-wearing laws *(79–82)*. In view of this, it is believed that the design and implementation of specific legislation that regulates sound exposure and management, while also raising awareness on the risks of loud listening can potentially be effective. It is

anticipated that as regulation becomes more widespread, and the number of compliant venues increases, it will increase the acceptability of protective hearing behaviours *(83)*. To this end, WHO is developing an evidence-based "Framework for control of sound exposure in recreational venues", with finalization due in 2021. Components of this global framework include:


sound level limits;


measurement of sound;


provision of hearing protection;


dissemination of information and warning messages;


quiet areas; and


sound distribution and management.

CASE STUDY

Switzerland takes steps to address hearing loss due to recreational sound *(84)*

Switzerland has the longest-standing active sound regulations for entertainment venues in the world. The Federal Office of Public Health of Switzerland published the first Sound Levels and Laser Ordinance in 1996, regulating those recreational venues where the audience is exposed to electroacoustically-generated or amplified sounds (e.g. in clubs, concert halls, bars, restaurants, festivals, discotheques).

The regulations have been developed and revised (the latest revision being in 2019) in close collaboration with the Swiss music industry. The regulations are now well accepted by all stakeholders including the venues where they have to be implemented.

The regulations direct venues to: (i) limit the average hourly sound levels to 100 dBA; (ii) measure and record sound levels; (iii) provide free ear plugs to the audience; (iv) prominently display information and posters on safe listening; and (v) provide "quiet areas" for events whose duration exceeds three hours.

Since implementation, each Swiss canton has enforced these regulations. As a possible consequence, 39% of attendees at festivals in Switzerland now wear hearing protection – a considerably higher percentage than reported in other countries.

EFFECTIVENESS OF NOISE REDUCTION MEASURES

- The adoption and strict implementation of legislation is effective in reducing noise levels in the workplace, and thereby limits exposure faced by workers and reducing hearing loss occurrence *(60, 64, 85, 86)*. For example, legislation directed at better compliance with the law regarding engineering and administrative control in the mining industry succeeded in reducing noise exposure in underground coal mines by 27.7% *(60)*.
- The use of properly fitted hearing protection devices is an effective measure, especially when accompanied by appropriate training in their use *(60, 87, 88)*.
- Limited research has been carried out to date on the effectiveness of programmes for promoting safe listening among youths; nonetheless, available data reinforces the importance of health promotion for changing listening behaviours and the role of technology in doing so.

CASE STUDIES

Raised awareness and policy measures can prevent hearing damage during work and leisure

1. An effectiveness analysis of a military hearing conservation programme in the USA showed such programmes to be both effective (workers were 28% less likely to acquire hearing loss) and economically viable. The programme reported an incremental cost–effectiveness ratio of US$ 10 657 per case of hearing loss prevented compared with no intervention. This is significantly lower when compared with the average compensation costs of US$ 64 172 for such occupational noise-induced hearing loss per individual *(89)*.
2. Preventive campaigns can be successful in altering attitudes towards noise in adolescents, leading to a more positive view of hearing protection, and increased intention to use them in a high-school population. The Flemish government undertook a campaign among high-school students, focusing on the harmful effects of recreational noise and the preventive use of hearing protection. The attitudes and practices of the students were assessed before and after the campaign and based on the model of the theory of planned behaviour. Results were very promising, with the use of hearing protection increasing from 3.6% prior to the campaign to a subsequent 14.3% *(90)*.

OTOTOXICITY PREVENTION

As indicated in Section 1, some commonly used medicines can seriously impact the auditory pathway and lead to permanent hearing loss. Prevention of such ototoxic hearing loss is possible through judicious use of these medicines and regular auditory monitoring during use, when necessary. Ototoxic hearing loss can also occur as a result of exposure to chemicals that are commonly encountered in industries such as printing, construction and manufacturing (see Section 1). Taking due care with their use, along with hearing surveillance, can mitigate the auditory risks posed to those exposed.

- **Chemical exposure in the workplace**

  It is possible to prevent the adverse effects of exposure in the workplace through taking concrete steps, including: *(91, 92)*

  - the initial identification of hazardous materials;
  - controlling exposure through substitution, where possible (if not possible, using engineering controls and administrative measures to minimize exposure);
  - the use of personal protective equipment, such as chemical-protective gloves, aprons etc. to reduce dermal exposure;
  - the labelling of chemicals that are known to be ototoxic and displaying warnings clearly; and
  - hearing surveillance (further information on noise-related hearing surveillance is provided in 2.2.4).

- **Appropriate use of ototoxic medicines**

  The risks posed by the unregulated use of ototoxic medicines for hearing are detailed in Section 1. While in many cases, the use of these medicines may be necessary and even life-saving, their judicious and regulated use is essential to ensure that people do not receive them unnecessarily. Wherever possible, safe and effective non-ototoxic treatment options should be sought and preferred over those likely to have a lasting negative impact on hearing *(93)*. Recent developments in the management of drug resistant tuberculosis (DR-TB) are an example of how this can be achieved. The recently updated WHO guidelines on DR-TB recommend the use of non-injectables such as Bedaquiline *(94)* in the treatment of tuberculosis, to protect against the high risk of hearing loss associated with the traditionally used injectables *(95)*. Where ototoxic medicines are essential, particularly in the management of cancer, tuberculosis, malaria and other diseases, audiological monitoring is crucial to optimize hearing-related outcomes *(93)*.

- **Monitoring ototoxicity**

  Ototoxicity is detected in an individual by regular audiometry to monitor the auditory response and thresholds, and to determine changes in auditory function or damage over the course of treatment.

  Ototoxicity monitoring assists with:

  - comparing the auditory test results during the course of drug therapy;
  - early identification of change in hearing;
  - need for potential alterations in therapy;
  - prevention of debilitating ototoxic-induced hearing loss if therapy is changed; and
  - auditory rehabilitation to minimize the negative impact of ototoxicity *(93)*.

Amikacin and streptomycin are to be considered only if high-quality audiometry monitoring for hearing loss can be ensured *(94).*

EFFECTIVENESS OF OTOTOXICITY PREVENTION MEASURES

- Audiological monitoring undertaken during the use of ototoxic medicines, such as those used for treatment of multidrug resistant tuberculosis, can help recognize the early signs of hearing loss. It can provide timely indication and opportunities for shifting to alternate treatment regimens as a means of conserving the individual's hearing capacity *(93, 96)*.
- The adoption and implementation of such protocols by professionals and governments cannot be considered as optional; given that these are essential in improving patient outcomes and quality of life, they should form the minimum standards of care in ototoxicity management *(97, 98)*.

CASE STUDY

South Africa takes steps to address ototoxic hearing loss*

Multi-Drug Resistant Tuberculosis (MDR-TB) is often treated with injectable agents that can cause permanent ototoxic hearing loss. A study conducted in South Africa, showed that within 3 months of in-hospital aminoglycoside therapy, 57% of patients developed high-frequency hearing loss. This gave cause for alarm given that South Africa is among countries with the highest burden of tuberculosis and HIV.

A person undergoes hearing testing to detect high-frequency hearing loss

To address this public health problem, the South African National Tuberculosis Control Programme (NTP) implemented the National Ototoxicity Prevention Programme to improve access to audiological monitoring with the aim of reducing incidence of ototoxic hearing loss. The objectives of the programme were to: conserve the hearing of DR-TB patients treated with injectables; ensure availability of portable audiometric services; and ensure rehabilitative care through appropriate care pathways for those who developed hearing loss.

Implementation was carried out in five phases: (i) exploration – conducting a situational analysis of the DR-TB cases and selecting audiometric devices; (ii) programme definition – developing an evidence-based ototoxicity monitoring protocol; (iii) execution – establishing an audiology network to support the programme and to secure funding; (iv) establishing and strengthening the referral patient-care pathway; and (v) implementation. As part of the implementation, NTP procured and distributed 183 portable automated audiometers to provide audiometric screening for monitoring ototoxic hearing loss. Training support was provided to strengthen and support screening and early identification of hearing loss in patients treated with aminoglycosides. Audiometers were distributed nationally to selected health facilities, which included government-run district hospitals, TB hospitals, community health centres and primary health-care facilities.

Baseline hearing assessments were undertaken at the start of therapy, and then at regular intervals during, and post, the injectable phase of DR-TB treatment among all DR-TB patients. In a resource-limited setting such as South Africa, the outcome of this intervention resulted in reducing the waiting time for patients to be screened and linked to rehabilitative audiological services. Between 2014 and 2019, 33 490 hearing tests were performed on DR-TB patients across South Africa among whom, 56% were identified as high-risk to develop permanent hearing loss. All patients were monitored on a monthly basis and received rehabilitation services.

The programme allowed South Africa to quantify the number of patients at risk of developing hearing loss due to aminoglycosides administration; this evidence contributed towards the introduction of an injection-free MDR-TB regimen in June 2018. Further, in noting the declining need for hearing screening among DR-TB patients, audiometers were re-allocated, particularly at primary health-care level. This transition served to strengthen universal access to hearing screening across the country. The programme provided many excellent health systems-based lessons which could be leveraged to mitigate against ototoxicity in oncology care, and requires urgent consideration *(99)*.

* *Source:* a report (unpublished) submitted to WHO by the Government of South Africa.

> It is possible to identify hearing loss at all ages and in all settings.

2.3 EARLY IDENTIFICATION OF HEARING LOSS

Early identification is the first step in addressing hearing loss. Since hearing loss is invisible, it often remains undetected. In the cases of infants and older adults, this can have negative consequences on rehabilitation outcomes and cognition. For this reason, it is important to establish special measures to screen for hearing loss at different stages across the life course, targeting those most likely at risk. As shown in Figure 2.3, those targeted include:

- newborns and infants;
- children, especially in pre-school and school settings;
- adults, especially older adults; and
- all who are at a higher risk of hearing loss across the life course, due to exposure to noise, ototoxic chemicals and ototoxic medicines.

Figure 2.3 Identifying hearing loss across the life course

ACROSS THE LIFE COURSE: Screening for hearing loss > Symptomatic testing

NEWBORN:	CHILDREN:	ADULTS:	OLDER ADULTS:
Newborn hearing screening	Pre-school and school ear and hearing checks	Hearing screening in high risk occupations	Regular hearing screening

Technological development and research has made it possible to undertake such screening, as detailed below.

2.3.1 IDENTIFICATION IN NEWBORNS

Given the important role of hearing in a child's development and learning, it is essential to address hearing loss at the earliest time possible *(100, 101)*. Early identification in newborns is made possible through screening.

THE IMPORTANCE OF SCREENING PROTOCOLS IN NEWBORNS

Hearing screening in newborns, when followed by prompt and appropriate interventions, is effective in ensuring that those born with significant permanent hearing loss do not experience the associated adverse impacts *(102–108)*. Screening generally follows one of two approaches: (i) universal screening, which covers all infants; or (ii) "at-risk" screening, which targets the 8–10% of newborns at risk of permanent hearing loss *(109)*; when neither strategy is feasible, screening can also be opportunistic (for example when a parent suspects hearing loss and takes their child to be screened). "At-risk" screening typically includes infants who have an identifiable risk factor for hearing loss. However, since only around 50–60% of infants with permanent hearing loss show risk indicators *(109)*, an unacceptably high proportion can be missed through this selective strategy; thus wherever possible, a universal approach is preferred *(110–112)* (see Box 2.5).

Box 2.5 Universal screening is the goal

A population study on the long-term outcomes of children identified with permanent hearing loss contrasted three screening programmes: a universal programme; an "at-risk" programme; and an opportunistic programme.

Results demonstrated the clear benefits of a universal programme, in terms of age of diagnosis; receptive and expressive language; and receptive vocabulary (in children without intellectual disability), when compared with the other two screening types *(113)*. Nonetheless, in environments with no screening programmes, and where resources are lacking, opportunistic screening could form a first step towards implementation of other more effective programmes.

AVAILABILITY OF TOOLS FOR EARLY IDENTIFICATION [114, 115]

Widespread hearing screening of newborns has been made possible by the development of portable, objective automated devices. Universal screening uses either automated transient-evoked otoacoustic emissions (TEOAEs), which assess

outer hair cell function; or automated auditory brain response (AABR) testing, which assesses the integrity of the auditory neural pathway to the auditory brainstem *(114)*. Such screening can be undertaken as early as the first day of birth. Accurate diagnosis can also be established within the first month of life by performing the Auditory Brainstem Response (ABR) testing or Auditory Stead State Response (ASSR) measurements *(116, 117)* as recommended by the Joint Commission on Infant Hearing Screening *(118)*.

Hearing screening must be accompanied by appropriate follow-up and interventions as the benefits of early detection are associated with early intervention rather than screening per se.

While screening in itself is an important part of an early intervention programme, it must be accompanied by appropriate follow-up and rehabilitation *(119, 120)*. There is ample evidence to demonstrate that children benefit significantly when newborn hearing screening is coupled with early intervention programmes (often referred to as early hearing detection and intervention (EHDI) programmes), and that effectiveness increases the earlier the child (and family) is identified and rehabilitation starts *(102–108, 121)*. An example of what is included in a high-quality EHDI programme is provided in Box 2.6.

Box 2.6 Early hearing detection and intervention

High-quality early hearing detection and intervention (EHDI) programmes include: *(122, 123)*

- universal newborn hearing screening;
- ongoing surveillance for newborns who are "at risk" of hearing loss but who passed the screening programme at birth;
- comprehensive diagnostic assessment to confirm and quantify the magnitude and type of the hearing loss;
- parental participation and family engagement;
- social, psychological and informational support for families of children diagnosed with permanent hearing loss;
- medical referral for etiologic investigation and management as indicated;
- assistive hearing technologies including hearing aids, cochlear implants, FM systems; adjunctive counselling, information, and training to support the technologies; and
- communication development options, including auditory-verbal therapy, sign language development, and other related interventions.

EFFECTIVENESS OF NEWBORN HEARING SCREENING PROGRAMMES

When followed by prompt and suitable rehabilitation, the screening of newborns brings significant advantages in terms of reducing the age of diagnosis and intervention, as well as improved language and cognitive development *(100, 124–127)*. These advantages translate into improved social and educational outcomes for infants who receive timely and suitable care.

A study undertaken in the USA *(110)* projected that the reduced costs of special education services could plausibly offset the cost of universal newborn hearing screening (UNHS) within a space of 10 years *(131)*.

In 2006, it was estimated that UNHS saves an estimated 4500 euros in Germany per hearing impaired child, per year *(125)*.

In Philippines, a UNHS being implemented since 2009 has resulted in considerable long-term savings *(132, 133)*.

Cost–effectiveness of newborn hearing screening is demonstrated in studies from high-income countries such as Australia, Netherlands, the United Kingdom, and the USA, as well as middle-income countries such as China, India, Nigeria and Philippines *(128)*. In China, for example, a long-term cost benefit ratio of 1:7.52 was reported *(129)*, and in India, a cost analysis revealed life-time savings (including societal costs) of over 500 000 International dollars per case identified *(130)*.

VALUE FOR MONEY!

WHO conservatively estimated a return on investment from newborn hearing screening in a lower-middle- and a high-income setting. Results, based on actual costs, estimated that in a lower-middle-income setting (taken as an example) there would be a possible return of 1.67 International dollars for every 1 dollar invested in newborn hearing screening. With a high-income country, this return was estimated to be 6.53 International dollars for every 1 dollar invested.

In addition, the lifetime value of DALYs averted in each individual would be 21 266 International dollars, and the net monetary benefit 1.21 dollars. In the case of a high-income setting, the value of DALYs averted would be 523 251 International dollars.

CASE STUDY

Implementing a national newborn hearing screening programme brings benefits to infants with hearing loss in Israel

The Israeli Newborn Hearing Screening Program (NHSP) was implemented on a national level in 2010, with the aim of ensuring that all infants were screened for hearing loss before 1 month of age; those with hearing loss were diagnosed no later than 3 months of age; and rehabilitation initiated by the time the child reached 6 months.

In 2019, a study evaluated the effectiveness of this programme and found that within 3 years of commencement, the programme had a high coverage, with 98.7% of the 179 000 infants born annually between 2014 and 2016 being screened through this programme. As a result, the average age of hearing loss diagnosis reduced from 9.5 to 3.7 months. Children with hearing loss started receiving intervention by a median age of 9.4 months (as opposed to 19 months before NHSP implementation).

In 2019, it was assessed that as an outcome of this programme, children received a cochlear implant at the relatively earlier age of 1.75 years, improving their consequent rehabilitation outcomes *(134)*.

2.3.2 IDENTIFICATION IN PRE-SCHOOL CHILDREN AND IN SCHOOL SETTINGS

Although, screening in newborns has improved the ability to identify and address congenital hearing loss, children who have experienced minimal hearing loss at birth, and those whose hearing loss is progressive or develops later in childhood (e.g. from middle ear disease), often remain unidentified and without care. Early identification of these conditions, especially ear diseases in children, and connecting them to care, is critical for the provision of effective hearing care.

SCREENING AS PART OF SCHOOL HEALTH INITIATIVES

Given that, worldwide, the vast majority of children go to school *(135)*, school screening represents a unique opportunity to conduct universal hearing screening. School screening programmes can be a useful tool in mitigating the effect of unaddressed hearing loss and ear diseases *(136)*; and for educating children regarding practices that help maintain their hearing trajectory (as part of overall health), such as safe listening (see section 2.2.4).

Positive experiences with respect to the overall impact of school health programmes have been reported by a number of international agencies such as WHO, UNICEF,

UNESCO and the World Bank *(137)* which, together, have developed a partnership: Focusing Resources on Effective School Health (FRESH). Given the importance of hearing in education; the frequency of ear and hearing problems in school-age children; and the need to inculcate safe listening behaviours at an early age, the inclusion of ear and hearing care in school health services and initiatives is essential.

TOOLS AND TECHNOLOGY-BASED OPTIONS FOR SCREENING AND TESTING

Several tools are available for facilitating hearing screening in school settings. Audiometric evaluation has been shown to be accurate in assessing hearing in school-age children *(138)*. However, the application of such screening is often limited in low-resource settings or remote areas due to several factors including the high cost of equipment; requirements for intensive training of screeners in audiometric principles; overreferrals; lack of environmental noise monitoring; and poor data capturing and management *(139, 140)*. Other technology-based options have recently emerged that have facilitated conduct of hearing screening in school settings. These include tools such as:

- mobile-based software applications
- automated hearing screening
- boothless audiometry
- telemedicine options.

These options are described in more detail in section 2.4.4.

Besides hearing assessment, other tests commonly used in a school ear and hearing screening service include:

i. *Otoscopic examination:*

   This examination identifies common problems of the outer or middle ear. Besides traditional otoscopic examination, other technology-based solutions, such as smartphone-based otoscopy apps, are available *(141, 142)*. Otoscopic examination can also be supported by telemedicine options *(142, 143)*.

ii. *Tympanometry:*

   This assesses middle ear function and diagnoses nonsuppurative otitis media *(138)*.

iii. *Otoacoustic emission testing (OAE):*

   This testing is relevant mostly in situations where children are unable to follow instructions, e.g. in pre-school-age children or children with special needs *(144)*.

EFFECTIVENESS OF SCHOOL SCREENING PROGRAMMES

To ensure the effectiveness of school screening programmes it is important that a referral system is in place and that children requiring further investigations and management should have access to services *(136, 145)*. It is essential to outline the

care pathway and follow-up mechanisms at the time of intervention planning so that full benefits can be realized.

- Children with progressive hearing loss may pass the newborn hearing screening, but later be identified through pre-school or school-based ear and hearing checks *(132, 135)*. Systematic screening in children, followed by appropriate care, can lead to timely identification and remediation of common ear diseases. Such programmes are especially useful where prevalence of common ear diseases and hearing loss is high.
- School hearing screening programmes represent an opportunity to reduce the health and economic burden of childhood hearing loss. However, to date, economic analyses performed on this topic are few in number and have mixed conclusions. While, overall, the studies have found school screening to be cost–effective, substantial uncertainty exists due to methodological differences; moreover, external validity of the available data is limited *(147–151)*.

An effective school health programme can be one of the most cost–effective investments a nation can make to simultaneously improve education and health. WHO promotes school health programmes as a strategic means to prevent important health risks among youth and to engage the education sector in efforts to change the educational, social, economic and political conditions that affect risk. *(146)*

A child in South Africa undergoes hearing testing using automated audiometry and noise-cancelling headphones

School screening programmes must be linked with ear and hearing services, so that children have access to required care, and undertake follow-up to ensure that they do so.

Further research in this area is urgently needed to create standards for cost evaluations and to develop generalizable, region-specific estimates that can be translated to countries considering implementing school screening.

CASE STUDY

Implementation of school hearing screening in Poland helped to identify children with hearing loss *(152)*

Between March and June 2008, a school hearing screening programme was implemented in the rural areas and small towns of Eastern Poland, reaching more than 92 000 children aged 7–12 years. In 2010, the programme was further implemented in the western part of the country, as part of the "Sensory organs examination" which included check-ups for ears, hearing and eyes. More than 71 000 first-graders were examined in 4041 schools, of whom nearly 14% were identified with hearing loss and referred for further care and treatment. Particularly concerning was that over 58% of parents of those identified with hearing loss did not realize that a problem existed for their child; 27% of children had never had a hearing check-up except as a newborn (newborn hearing screening programme); and 41% were not receiving any specialist care to address their hearing loss. Without the screening, it is likely that the majority of those with hearing loss would have remained unidentified.

2.3.3 IDENTIFICATION IN OLDER ADULTS

Given the global demographic trends *(153)*, the need for hearing care among the adult population is likely to continue to increase in the coming decades *(154)*. Global Burden of Disease estimates suggest that over 65% of the global population above the age of 60 years experiences some degree of hearing loss. Despite the functional limitations associated with hearing loss *(155)*, adults typically wait as much as nine to ten years before seeking any hearing care *(156, 157)*. To address this gap, it is essential to provide active screening services for older adults in an easy and accessible manner, followed by suitable interventions. Such screening can be undertaken by health-care providers, such as general practitioners, primary level doctors or health workers *(156, 158)*.

To support this, the WHO guidelines for integrated care of older persons recommends that screening, followed by the provision of hearing aids, should be offered to older people (see Box 2.7).

Box 2.7 Recommendation 4 of WHO guidelines for integrated care for older people *(155)*

Recommendation 4 states that screening, followed by provision of hearing aids, should be offered to older people for the timely identification and management of hearing loss.

Important considerations for implementation include:

1. Community awareness about hearing loss should be promoted, along with the positive benefits of audiological rehabilitation in older people through community case finding and outreach activities.
2. Health-care professionals should be encouraged to screen older adults for hearing loss by periodically questioning them about their hearing. Audiological examination, otoscopic examination, and the whispered voice test are also recommended.
3. Hearing devices are the treatment of choice for older people with hearing loss because they minimize the reduction in hearing and improve daily functioning.
4. Medications should be reviewed for potential ototoxicity.
5. People with chronic otitis media or sudden hearing loss, or who fail any screening tests, should be referred to an otolaryngologist.

EFFECTIVENESS OF HEARING SCREENING IN OLDER ADULTS

- In older adults, hearing screening, followed by prompt hearing aid provision, is associated with significant improvements in hearing-related health outcomes *(155, 159, 160)*.
- Adult hearing screening and early intervention become even more relevant given the links between hearing loss and dementia in older adults *(161)*, and that addressing hearing through these devices may have a positive influence on an individual's cognition.
- Hearing conservation programmes implemented for the reduction of noise-induced hearing loss in factories and military services have been shown to be cost–effective *(89, 162)*. Although the cost–effectiveness of hearing screening in older adults has not been studied extensively, limited available literature describes a positive improvement to the quality of life of older adults, as well as economic gains to society *(156, 163, 164)*.

VALUE FOR MONEY!

WHO made a conservative estimation of return on investment from hearing screening for adults aged above 50 years. Results based on actual costs estimated a possible return of 1.62 International dollars for every 1 dollar invested in hearing

screening among older adults in a high-income setting, and 0.28 International dollars in a middle-income setting, taken as examples.

In addition, the lifetime value of DALYs averted for 10 000 individuals screened would be 8 877 785 International dollars. In the case of a high-income setting, the value of DALYs averted would be 788 604 dollars for a similar population. Further details are provided in WEB ANNEX B.

CASE STUDY

Hearing screening in older adults is a cost–effective strategy

An economic model evaluated the financial implications and gains from an adult hearing screening followed by service provision as opposed by hearing care based on referrals made by general practitioners (GPs) in the United Kingdom. Costs considered included the full package of care, with assessment, hearing aid fitting, hearing aid device/s, follow-up and repair. The total cost of services increased significantly from £ 21 million to £ 38 million per 100 000 population. It also showed that up to 30 000 QALYs (quality-adjusted life years) could be gained per 100 000 cohort as a result of the screening programme, resulting in a justifiable cost per QALY ratio. Screening was shown to offer greater gains at greater costs compared with GP referral, with a favourable incremental cost–effectiveness ratio valued at £ 1000–£ 2000. It reached the conclusion that screening for bilateral hearing loss from the age of 55 years and above offered the best potential public health gain and is a cost–effective means of improving participation and quality of life for older adults *(163)*.

2.3.4 IDENTIFICATION OF THOSE AT HIGHER RISK

Individuals and populations at a greater risk of hearing loss commonly include those:

- exposed to noise or ototoxic chemicals at the workplace; and
- receiving ototoxic medicines.

Targeted hearing surveillance is an integral part of occupational hearing conservation programmes as well as ototoxicity prevention, as described earlier. Such surveillance not only provides a means for early detection, but also serves as an early warning. Preventive measures, if taken immediately upon identification, can reduce progression of hearing loss in those exposed to ototoxic influences.

Using the tools and strategies outlined above, early diagnosis of hearing loss is possible, even in resource-limited settings. Screening programmes targeting different risk groups can ensure that all persons with hearing loss have the possibility of being identified in time for them to benefit from rehabilitation services and avoid

the adverse impacts of hearing loss. For this reason, it is essential that all screening services are supported by appropriate diagnostic follow-up and rehabilitation.

2.3.5 INNOVATIVE SCREENING SOLUTIONS ACROSS THE LIFE COURSE

Hearing screening can be undertaken either through conventional screening audiometry or technology-based solutions tools *(156, 165)*; screening is facilitated by the development of mobile-based software applications *(142, 166, 167)* which provide tools that are cost–effective and easy to use. The range of tools include:

AUTOMATED HEARING TESTING *(142, 168–170)*

This reduces the need for training as the technology used can be programmed to provide the signal and analyse the individual's response.

DIGITS-IN-NOISE TEST *(171–173)*

This is based on speech recognition in noise and provides a functional measure as it relates to speech recognition abilities rather than pure tone averages. It is both accurate and quick; and can be administered online, through mobile applications, and in community settings *(172, 174–177)*. Based on the validated South African digits-in-noise test ("hearZa") *(177, 178)*, the World Health Organization has developed and launched the free smartphone applications "hearWHO" and "hearWHO*pro*" that can be used by individuals and health workers to check for hearing loss (Box 2.8).

Boothless audiometry makes hearing care accessible

Box 2.8 Smartphone applications developed by WHO

- The **hearWHO** app is based on validated digits-in-noise technology. It gives the general public access to a free, validated hearing screener to check their hearing status and to monitor it over time. The easy-to-use app clearly displays the users' results and keeps a personalized tracked record of their hearing status over time. It is available in both android and iOS formats.
- The **hearWHO*pro*** version can be used by health workers to screen people in the community for hearing loss and refer them for diagnostic testing if they fail the screening.

Other technology-based solutions include:

BOOTHLESS AUDIOMETRY

This is a means of testing without the need for a sound booth. As an example, audiometry can be done through the use of noise-cancellation headphones *(140, 167, 168, 179)*, which provide an effective adjunct for audiological testing in community settings, such as schools.

TELEMEDICINE SERVICES (139, 143, 180)

Telemedicine is the delivery of health-related services and information via telecommunications technologies. Teleotology and teleaudiology use telemedicine to provide otological and audiological services remotely. Audiological findings and otoscopic images are transmitted, commonly over the internet, from the point of contact with the individual to an expert at a remote location. The diagnosis (and where mandated management options) can be then transmitted back to the individual *(181, 182)*. These offer a valid solution to the discrepancies apparent in the need for health-related services and their limited availability.

Early diagnosis of hearing loss is possible using the tools and strategies outlined above, even in resource-limited settings. Screening programmes targeting different risk groups can ensure that all individuals with hearing loss have the possibility of being identified in time for them to benefit from rehabilitation services and avoid the adverse impacts of hearing loss. For this reason, it is essential that any screening service be supported by appropriate diagnostic follow up and rehabilitation.

> Addressing hearing loss requires a person-centred approach that takes a holistic overview of person's clinical profile, communication needs, preferences, environment, and fits the resources available.

2.4 CARE AND REHABILITATION

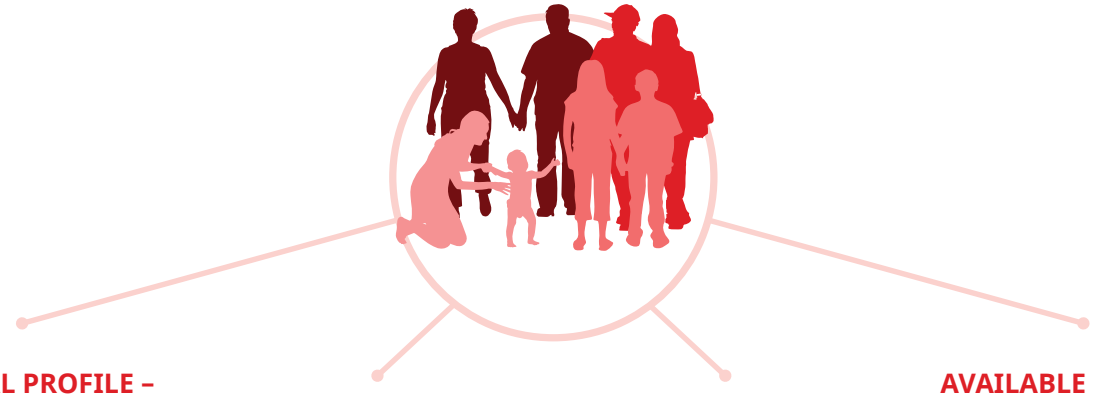
Once a person has been identified with an ear or hearing condition, he or she can benefit from a range of clinical, rehabilitative and environmental interventions currently available. The nature, degree and progression of hearing loss, along with any underlying or accompanying health conditions (e.g. otitis media, otosclerosis etc.), determine the clinical profile of an individual, although people with the same clinical profile can have very different everyday hearing care needs *(183)*. This is because the impact of hearing loss depends not only on the clinical profile, but also on contextual factors such as communication needs, environmental factors and access to rehabilitation *(10, 184, 185)*.

Two people with the same audiogram configuration can have very different everyday hearing-related difficulties and experiences.

2.4.1 A PERSON-CENTRED APPROACH TO EAR AND HEARING CARE AND REHABILITATION

Adopting a person-centred approach is essential for determining an individual's hearing care and rehabilitation needs. As illustrated in Figure 2.4, person-centred ear and hearing care involves an understanding in terms of their clinical profile, communication needs and preferences and the resources available.

Figure 2.4 Person centred ear and hearing care



CLINICAL PROFILE – WHICH INCLUDES:

Otological status

Audiological profile: degree; type; age of onset

Other functional limitations such as visual impairment; developmental disabilities e.g. autism

COMMUNICATION NEEDS – WHICH INCLUDE:

Hearing difficulties experienced

Communication requirements

COMMUNICATION PREFERENCES – SUCH AS:

Oral–aural

Visual/tactile

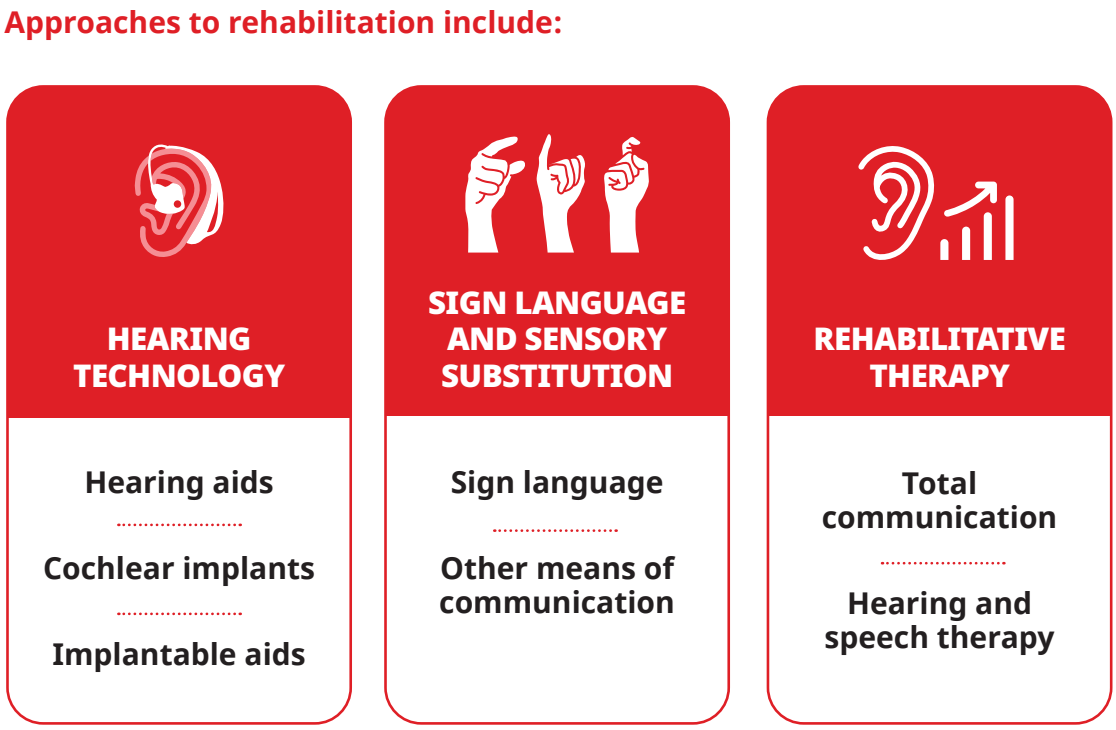
AVAILABLE RESOURCES

What resources are possible given the environment, health infrastructure and clinical services available

Rehabilitation aims to optimize everyday functioning of those with hearing loss to ensure that the person reaches the best quality of life at a physical, functional, social, emotional and economic level.

Hearing loss that accompanies ear diseases, such as otitis media or otosclerosis, can generally be treated through medicines or surgery (as described earlier in section 2.2). However, the majority of hearing loss is irreversible, and rehabilitation is required at all stages during the life course. Rehabilitation is essential to improve function, activity, participation and ultimately offer a better quality of life for people with hearing loss *(186)*. Figure 2.5 depicts the different approaches to rehabilitation adopted; these include: (i) hearing technology in the form of hearing aids, cochlear implants and implantable hearing aids; (ii) sign language and other sensory substitution such as Braille, Tadoma, print on palm, and speech-reading; and (iii) rehabilitative therapy, such as Total Communication and hearing and speech therapy.

Figure 2.5 Approaches to hearing rehabilitation



2.4.2 HEARING TECHNOLOGY FOR REHABILITATION

Hearing technology, to enhance or enable auditory perception, forms a key component of hearing rehabilitation. The use of such technology gives users increased access to information carried through sound and speech *(187)*. Although technology is a key part of rehabilitation, it is essential nonetheless to note that it forms only one part of a rehabilitation strategy. The different types of hearing technology include hearing aids and implants as described below.

HEARING AIDS

Hearing aids *(186, 188–191)* are a noninvasive, low-risk and effective option most frequently used to rehabilitate hearing loss *(192)*. (The different types of hearing aid are described in Box 2.9 below.) The vast majority of people with hearing loss are adults who experience mild to moderate degrees that pose difficulties in their day-to-day life. This level of hearing loss can be well addressed through the use of hearing aids that improve quality of life and listening ability. Even in cases of people with severe hearing loss, those with cognitive impairments *(193)*, and in children *(194, 195)*, hearing aid use can improve the ability to perceive sensory inputs and functional outcomes. These functional outcomes, however, are not merely the result of hearing amplification, but depend on other supportive interventions and factors.

Box 2.9 Hearing aids

Hearing aids are devices that amplify and deliver sound to the ear in order to improve auditory function. They can be analogue or digital.

Analogue hearing aids: pick up sound energy, change it to electrical signals which are amplified and delivered through the ear canal to the ear drum.

Digital hearing aids: perform the same key function as analogue hearing aids, but can be programmed to suit individual audiological needs. They commonly allow for many additional features and are generally the preferred option.

In determining which type of hearing aids to provide, countries should follow recommendations, outlined in the WHO's "*Preferred profile for hearing aid technology suitable for low- and middle-income countries*" *(196)*.

A health economic analysis showed an incremental cost–effectiveness ratio of $ 5759 per quality-adjusted life year gained for hearing aid use (versus no hearing aid use).

COCHLEAR IMPLANTS

Cochlear implants are electronic devices, especially useful when a conventional hearing aid has little or no benefit or cannot be used *(192)*. Typically, these devices bypass the middle- and inner-ear structures to stimulate the auditory nerve directly *(197)*, and can give a deaf person a useful representation of sounds in the environment, making it possible to understand speech. A description of how a cochlear implant works is provided in Box 2.10 and illustrated in Figure 2.6.

Their use in children with severe degree of hearing loss has brought substantial benefits to those implanted, and when accompanied by proper rehabilitation they lead to significant improvement in audiological status, overall functioning and speech perception skills *(198)*. Children with cochlear implants have greater likelihood of acquiring oral language, integrating into regular schools and being able to experience sounds along with better speech skills *(199, 200)*. Cochlear implants can also have a beneficial impact on learning and educational outcomes as well as the overall quality of life, though many factors other than implantation influence these results *(201–203)*. In recent years, the scope of implantation has been expanded to adults with severe to profound sensorineural hearing loss, who show improved speech perception and health-related quality of life with their use *(202, 204)*.

CASE STUDY

India takes steps to improve access to hearing technologies*

In 2006, the Indian government launched the National Programme for Prevention and Control of Deafness. In recent years, in some states of the country, the scope of this programme has been expanded to include cochlear implantation.

The Ministry of Social Welfare of India, through its scheme for assistance to people living with disability, has provided funding for the fitting of 500 cochlear implants each year. To facilitate this, the government has empanelled 172 centres, including government and private hospitals, to perform cochlear implant surgeries, along with more than 300 professionals to provide post-operative rehabilitation.

In the southern state of Tamil Nadu (with a population of over 67 million), the government has taken special heed of the high prevalence (0.6%) of congenital deafness in the state by including free cochlear implantation for children up to the age of six years, whose parents meet the economic criteria. In order to ensure successful rehabilitation of the implantees, the government has created a unique "hub and spoke" model of service provision with the creation of satellite service centres in underserved rural areas. Support in these centres is provided in person, by a trained workforce, as well as remotely through telemedicine. As a result, follow-up rates among implantees have jumped from 50% to 90%.

This unique approach addresses an immense need in the state, and provides a scalable model for other states of India, and other low- and middle-income countries, to adopt.

* *Source*: Sampath Kumar R, Kameswaran M. A sustainable model for cochlear implantation in the developing world: perspectives from the Indian subcontinent. Curr Opin Otolaryngol Head Neck Surg. 2018 Jun;26(3):196–9; and Government of India. Fifthy-fifth report: Standing Committee on Social Justice And Empowerment (2017–2018).

Cochlear implant is one of the most successful of all neural prostheses developed to date *(208)*.

While cochlear implants present remarkable potential in terms of their availability and the opportunities they create, their use is limited for many conditions and individuals *(205–207)*. In addition, the need for rehabilitation therapy and support services that must accompany cochlear implantation can be substantial. Cochlear implantation must therefore be undertaken only after thorough clinical evaluation to ensure the potential benefits, and only where supportive infrastructure for rehabilitation therapy exists.

Box 2.10 Cochlear implant: how it works *(208)*

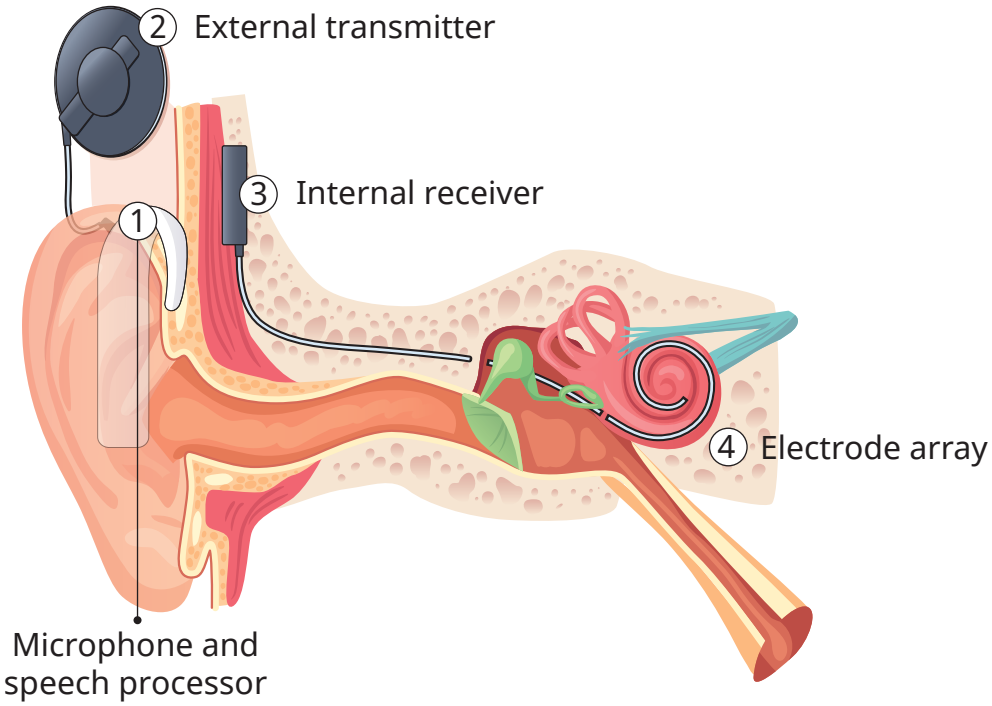
A cochlear implant is a surgically implanted device that works by transducing acoustic energy into an electrical signal, which is used to stimulate auditory nerve fibres. The implant has two components:

1. The external system which includes:
   - a microphone for sensing sounds;
   - a speech processor to transform the acoustic information into a sequence of electrical stimuli; and
   - an external transmitter for transmission of stimulus across the skin to the implanted system.

2. The implanted system which includes:
   - an internal receiver to process the stimuli received;
   - a multiwire cable to connect the receiver to electrodes; and
   - an electrode array that is inserted into the cochlea and directly stimulates neurons in the inner ear.

Direct stimulation of the auditory nerve bypasses the damaged or absent cochlear hair cells, making them a suitable form of intervention for individuals with a severe to profound sensorineural hearing loss.

Figure 2.6 Cochlear implant



BONE CONDUCTION AND MIDDLE EAR IMPLANTS

Bone conduction and middle ear implants represent another growing area of technological advancement in the field of hearing rehabilitation *(209–212)*.

- **Bone conduction implants** transmit sound to the inner ear through the bones of the skull, bypassing the middle ear.
- **Active middle ear implants** may be fully or partially implanted in the ear. They function by converting sound into kinetic energy which directly vibrates the middle ear ossicles or transmits the vibrations to the inner ear.

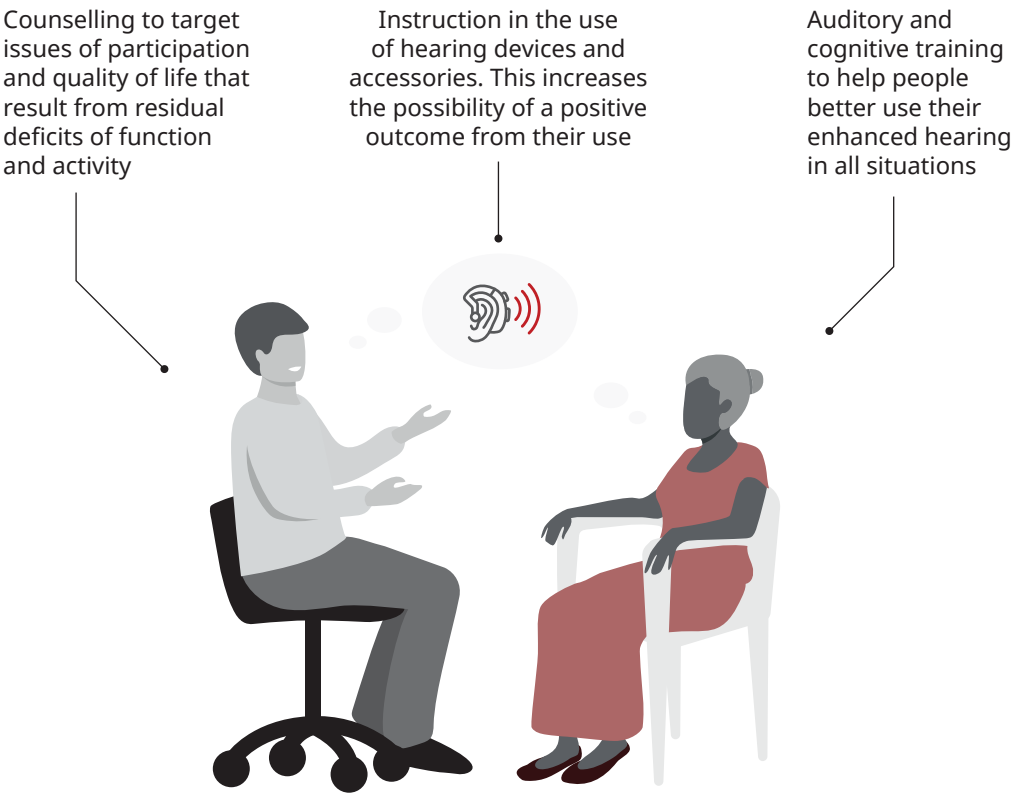
All individuals with conductive, sensorineural or mixed types of hearing loss can potentially use these aids; they do not require the external ear canal to be blocked and thereby reduce many of the problems associated with conventional hearing aids (e.g. wax impaction). The implants are also effective in those with middle-ear diseases and external ear malformations.

Whatever the technology used, complementary measures are necessary to ensure that these devices and implants benefit their users. As illustrated in Figure 2.7, this is achieved through a person-centred approach to care which involves the provision of: *(186, 187)*

- **Instruction in the use of hearing devices and accessories** which increases the possibility of a positive outcome from their use.
- **Auditory and cognitive training** to help people better use their enhanced hearing in all situations.
- **Counselling** to target issues of participation and quality of life that result from residual deficits of function and activity.

Person-centred care helps those with hearing loss achieve their full potential

Figure 2.7 Person-centred care for hearing aid users: factors to consider



EFFECTIVENESS OF HEARING AIDS AND IMPLANTS

- In children, timely intervention with hearing aids and implants leads to better hearing, spoken communication and quality of life, which further translates into better educational outcomes *(202, 203, 213–215).* The use of hearing aids can also protect against cognitive decline and dementia *(216)*.
- In adults, the use of hearing aids and cochlear implants improves listening abilities and quality of life *(186, 187, 190, 191, 193, 202, 214, 217).*
- The use of these devices is shown to be cost–effective in different economic settings *(202, 214, 215, 218–220)*.

Whatever the means of hearing amplification, complementary measures are necessary to ensure that these can bring benefit to their users.

VALUE FOR MONEY!

WHO made a conservative estimation of return on investment in unilateral hearing aids and cochlear implants in children. In terms of unilateral hearing aids,

estimations based on actual costs in a high-income setting showed a possible return of 1.84 International dollars for every 1 dollar invested, and a lifetime value of DALYs averted of 60 183 dollars for each individual. In the example of a lower-middle-income setting, the return on investment ratio was 1.62 with a lifetime value of DALYs averted of 3564 dollars.

With unilateral cochlear implants, estimations based on actual costs in a high-income setting showed a return of 2.59 International dollars for every 1 dollar invested, and a lifetime value of DALYs averted of 38 153 dollars for each individual. In the example of a lower-middle-income setting, the return on investment ratio was 1.46 International dollars with a lifetime value of DALYs averted of 6907 dollars. For an upper-middle-income setting, the return on investment ratio was estimated to be 4.09 International dollars with a lifetime value of DALYs averted of 24 161 dollars. Further details are provided in WEB ANNEX B.

Despite the effectiveness and cost–effectiveness of hearing amplification in rehabilitation, many challenges restrict their use and accessibility. These challenges and potential solutions to address their non-availability and non-use are outlined in Section 3. Nonetheless, game-changing developments, especially targeting adult-onset hearing loss provide a sound foundation for further improvements to accessing hearing technology and hearing-related services.

CASE STUDY I

Hearing aids improve the quality of life of their users

Five randomized control trials (RCTs) carried out between 1987 and 2017 in the USA and Europe, concluded that use of hearing aids in older adults led to improved health- and hearing-related outcomes. Those using the devices reported significant improvement in their ability to listen, in particular; and in their quality of life, in general. Along with reporting improved participation in community life, social and family spheres and recreational activities, users indicated that the barriers to employment and education opportunities were reduced when compared with no use of hearing aids *(189)*.

CASE STUDY II

Cochlear implants are cost–effective in Colombia *(221)*

In Colombia, Penaranda et al. assessed the lifetime investments made in 68 children who received cochlear implants at an early age. Taking into account the cost of the device and any other medical costs, follow-up, speech therapy, batteries, loss of parental income and travel, each child required an average investment of US$ 99 000 over the course of their life (assuming a life span of 78

years for women and 72 years for men). The analysis also assessed the return of investment for treating children through cochlear implants based on costs of treatment and benefits of using cochlear implants compared to hearing aids. The study concluded that for every dollar invested in rehabilitation of a child with cochlear implant, there was a return on investment of US$ 2.07.

CASE STUDY III

Age is no barrier to hearing rehabilitation

Hearing loss can occur at any stage during the life course, and can be addressed through timely interventions. Mollie Smith of Rugby in the United Kingdom became profoundly deaf in both ears at the age of 70, attributing the decline in her hearing to exposure to the sound of zeppelins as a child during World War II. With the full loss of her hearing, she learned to read lips, but eventually the additional loss of her vision left her able to communicate through touch alone. It was her vision loss that motivated Mollie to seek an assistive device, learning at the age of 99 years that she was a candidate to receive a cochlear implant. Through use of the cochlear implant, Mollie was once again able to communicate with her loved ones, thus greatly improving her quality of life.

Related links: https://katherinebouton.com/2017/02/22/how-old-is-too-old-for-a-cochlear-implant/
https://www.dailymail.co.uk/health/article-2604170/Deaf-great-grandmother-99-oldest-person-Europe-receive-cochlear-implant.html
https://www.coventrytelegraph.net/news/health/99-year-old-mollie-becomes-oldest-europe-6983622

GAME-CHANGING DEVELOPMENTS IN HEARING TECHNOLOGY

In recent years, the many developments in the field of hearing technology, its provision and related policies, offer the potential to expand access to the required devices in underserved populations. Examples of these include:

- **Developments in technology**

  i. *Self-fitting hearing aids/trainable hearing aids:*

  These aids have the potential to address accessibility and affordability of hearing health care, particularly in low- and middle-income countries *(222–225)*, by reducing the need for audiological support and equipment. A self-fitting hearing aid enables the user to perform both threshold measurements and fine-tuning, with the help of detailed instructions *(222).* Studies suggest that self-fitting of hearing aids is feasible and is more likely to be successful if the devices and interfaces are clear and well designed, and if the fitting process is clearly outlined *(222, 223, 225)*. However, research that targets diverse population groups and educational settings is required.

ii. *New hearing technologies:*

These include smartphone-connected hearing aids, smartphone hearing aid apps, personal sound amplification products (PSAP) and hearables which provide users with alternative options for amplification *(186, 226, 227)* (Box 2.11). Although the increasing availability of these could be the first step for people to seek hearing care *(228)*, the effectiveness, benefits and limitations need careful investigation *(226, 227, 229, 230)*.

iii. *Rechargeable batteries for hearing aids (including solar powered batteries):*

Hearing aids that use rechargeable batteries are effective in reducing the recurring costs associated with battery use. Rechargeable nickel-metal hydride or lithium-ion batteries paired with a solar charging device provide an alternative that can be useful in all settings, including environments where electrical supply is uncertain *(231–233)*. Rechargeable batteries and a recharger pose additional initial costs and must be affordable for this strategy to succeed. It is also important to test hearing aids with these rechargeable cells to make sure their electroacoustic characteristics and quality remain unaltered *(233)*.

- **Developments in service delivery**

i. *Direct-to-consumer devices:*

Many of the above-mentioned technologies are becoming available direct-to-consumer (DTC) including over-the-counter (OTC) hearing aids. Studies suggest that efficacious OTC models may increase accessibility and affordability of hearing aids for millions of older adults *(234)*. However, it is important that these products are accompanied by policy and regulatory efforts to ensure their safety and effectiveness *(235)* and that users have access to, and can fully benefit from, the required support and services delivered at community level[13] *(236)* (see Box 2.11).

ii. *Use of eHealth and mHealth[15] platforms for instructions and training:*

Given that amplification forms only one part of person-centred care for hearing, the lack of audiologist input must be compensated for by providing high-quality instructions *(227, 237)*. The use of eHealth and mHealth provides many opportunities that can enhance access, improve affordability, use, and convenience of hearing amplification *(238)*. Freely-available, evidence-based online multimedia materials can improve knowledge and impart the skills required for hearing aid handling. These would be particularly suitable if the materials were adapted to meet the specific needs of an individual *(186)*.

iii. *Training of locally available manpower in the fitting and maintenance of hearing aids: (151, 239, 240)*

[15] eHealth refers to the use of information and communication technologies (ICT) for health, (https://www.who.int/ehealth/en/). mHealth is a component of eHealth which includes medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices (https://www.who.int/goe/publications/goe_mhealth_web.pdf).

Training can improve access to hearing care, especially in environments where audiological manpower is in short supply. Section 3 provides further details on adopting a task-sharing approach to bridge human resource gaps for hearing care provision including hearing aids.

Box 2.11 Food and Drug Administration regulations

The Food and Drug Administration (FDA) of the United States of America states that:

1. A personal sound amplification product (PSAP) is a wearable consumer electronic product intended for consumers without hearing loss to amplify sounds in certain environments such as recreational activities.

2. A hearing aid is a wearable instrument or device designed for, offered for the purposes of, or represented as, aiding persons with, or compensating for, impaired hearing.

An over-the-counter (OTC) hearing aid is considered a direct-to-consumer product and thus does not require consultation with, or dispensing from, a hearing health-care professional. Nonetheless, the FDA requires that a person buying a hearing aid be examined to rule out certain red-flag medical conditions related to the ears, or that a medical waiver declining a medical evaluation be signed by the patient.

2.4.3 SIGN LANGUAGE AND OTHER MEANS OF SENSORY SUBSTITUTION FOR HEARING LOSS

The main concern relating to hearing rehabilitation for infants and children with hearing loss is ensuring the timely development of language. Language acquisition in children ensures optimal cognitive and socioemotional development *(241, 242)* and can be undertaken through non-auditory means.

Deaf schoolchildren in India can learn and communicate with the use of sign language

SIGN LANGUAGE

Access to communication through sign language learning provides a much needed stimulus for facilitating the timely development of deaf infants. Early access to sign language is beneficial for many deaf infants and children *(241–244)* including those:

i. who do not have access to hearing care services and hearing technology. When access to these is limited, the use of sign

language can ensure cognitive development and facilitate communication. It also enables children to gain education through sign language and have proper socioemotional development.

ii. who live in environments with access to hearing technology and speech learning. While taking steps to ensure that a child develops spoken language skills, learning sign language ensures that infants do not face any delay in language acquisition. Given the far-reaching consequences of linguistic deprivation in early childhood, it is essential to address this at the earliest stage possible. Sign language provides that possibility. Moreover, learning sign language does not hinder or delay the subsequent or simultaneous acquisition of spoken language skills.

iii. whose families prefer to use non-auditory communication through sign language instead of, or in addition to, auditory-verbal rehabilitation.

"Signed languages are natural human languages existing across numerous societies around the world. As with spoken languages, signed languages display phonetic, phonemic, syllabic, morphological, syntactic, discourse, and pragmatic levels of organization as expected of natural languages." *(241, 245)*

SPEECH READING

Speech reading, where a person understands spoken language solely by viewing the person talking, forms an important means of accessing communication for those with hearing loss. The underlying neurological processes are similar to those for auditory word recognition *(246)*. Lipreading is one of the most common means of speech reading and includes looking at teeth, tongue, facial expressions, body language and other visual cues to understand what a person is saying. This is an integral part of speech perception *(247)* and, since it requires training, needs to be considered in hearing and speech rehabilitation strategies *(248)*. Such training should further be supported by auditory training and use of cued speech *(248)*.

ALTERNATIVE METHODS OF COMMUNICATION

Alternative methods of communicating are especially useful for people with dual sensory loss such as deaf-blindness, where access to communication is further challenged. Such methods include:

- **Signing**: includes signed communication, signed supported languages, manually coded languages (e.g. Signed Supported English), Total Communication, Simultaneous Communication and Cued Speech. All are terms that cover communication where a spoken language is used with some visual support or cues.
- **Finger spelling**: involves spelling out words by finger shapes on the hand and can be used to support oral approaches.
- **Braille**: is a form of written language in which characters are represented by patterns of raised dots that are felt with the fingertips.
- **Tadoma**: involves the deaf-blind individual placing their thumb on the speaker's lips and their fingers along the jawline to feel the movements of the speaker as they talk *(249)*.

CASE STUDY

Sign language learning transforms lives in Uganda

In 2009, Orianda Martin heard about Deaf Link Uganda (DLU) through its Mobilisation Project – a project created to assess the educational needs of deaf children whose families require financial assistance for them to access education. Orianda was living in Kumi District, Eastern Uganda where fear and miseducation about his deafness and inability to communicate had led to him being abused by members of the community. DLU was able to identify a school for the deaf in Orianda's region and provided the necessary financial assistance for him to enrol. A subsequent assessment concluded that a vocational school for the blind and deaf would be more suitable for Orianda, as he had begun learning to farm before leaving home. He was enrolled at SIKRI Vocational Training Centre for the Blind and Deaf in Kenya and quickly began to thrive in his new setting. He learned to communicate using sign language and touch communication and eventually graduated with a degree in farming and weaving. Upon returning to Uganda, his community welcomed him and celebrated his success with heartfelt recognition that, in the past, they had misunderstood his deafness. A leader from DLU delivered a powerful message to all those who had come to celebrate Orianda's accomplishments: "Deaf people can do all the things you can do, and must be included."

Related weblinks: https://www.deaflinkuganda.org/project/educational-support/ ; https://www.youtube.com/watch?v=ksNLa3KJiAo

2.4.4 REHABILITATIVE THERAPY

Whether a person is born deaf or develops hearing loss during the early years, or in adulthood, rehabilitative therapy is essential. The aim of such therapy is to enhance perceptive skills and communication-linguistic abilities *(250)*.

PERCEPTIVE SKILLS

Perceptive skills allow the user to make best use of their residual hearing, if any; or to optimize the benefits of hearing technology. Making best use of residual hearing can be achieved through appropriate auditory training and other professional measures; these are key to improving auditory communication skills among people with hearing loss, at all ages *(186, 187, 251)*. At the same time, as described earlier, counselling and instructions are important to improving the use of technology.

A hearing-impaired child undergoes speech therapy in Viet Nam

COMMUNICATION–LINGUISTIC ABILITIES

Communication–linguistic skills aim to improve language capability to enable communication and facilitate education. This may be through a traditional oral approach, auditory verbal therapy, total communication, speech-reading, sign language or bilingual programmes *(252, 253)*. While much has been written on the effectiveness of rehabilitative therapy, especially in deaf children and their linguistic and educational outcomes, overarching contributory factors to individual outcomes include age at intervention; family-centred care; multidisciplinary team support; and care across the life course (see Box 2.12).

Decisions regarding rehabilitation must be taken with parental participation and family involvement. These are key determinants of rehabilitation outcomes, since the success of interventions depends not only on service provision, but is influenced significantly by how parents receive the interventions, parent satisfaction, and how the interventions "fit" the family *(107, 254, 255)*.

Box 2.12 Key factors for optimal rehabilitation outcomes in deaf infants

- **Family-centred care**: *(104, 121, 254–259)* the participation of parents and families in the care of a deaf child is a strong predictor of outcomes. Families must be involved at the outset and be a part of all decision-making and care provision. Professionals who provide care must be trained in family-centred communication; rehabilitation programmes should be "fit to the family".
- **Early intervention**: infants that are enrolled in intervention programmes within the first few months of life can maintain language and socioemotional development corresponding to their chronological age *(102–105, 107, 108, 121, 260, 261)*. For this to occur, infants must have their hearing impairment identified soon after birth, which is possible through newborn hearing screening programmes.
- **Multidisciplinary support team**: *(250, 259, 262)* the support of a multidisciplinary team in the care of a deaf child is ideal, and would include physicians (neonatologists, otolaryngologists, audiologists, family paediatricians, neuropsychiatrists), technicians, therapists, and social workers among others as required. The composition and skills of a multidisciplinary team depend on the needs of the child and family.
- **Strong tracking and follow-up mechanism**: *(262–264)* a strong follow-through mechanism and tracking system is required following a newborn screening programme to ensure its effectiveness.
- **Life-course approach**: *(265, 266)* while it is important for deaf infants to receive care and counselling through childhood, care must also be taken to provide appropriate support and guidance through adolescence and adulthood.

EFFECTIVENESS OF REHABILITATIVE THERAPY FOR HEARING LOSS

- Early intervention and therapy is effective in improving language development, psychosocial skills, quality of life and real-life functioning in children and adults *(187, 261, 268–273)*.
- Rehabilitative therapy is essential to ensure that people benefit from the use of their hearing aids and implants *(187, 274, 275)*. Such rehabilitation improves the acceptability, effectiveness and cost–effectiveness of these devices.
- Hearing rehabilitation with or without the use of hearing aids is beneficial for communication and quality of life in persons with cognitive impairments *(193)*.

"Though the health and economic issues in developing countries may create situations in which the development of early hearing detection and intervention (EHDI) programs could seem insurmountable, developing countries have some resources that are not easily available to those in the developed world. Developing countries often have well-organized communities in which members work together for the benefit of the individuals within their communities as well as a willingness to learn strategies that can improve the lives of individuals in their communities." *(267)*

CASE STUDY

Family-centred early intervention benefits children with hearing loss and their parents

A successful newborn hearing screening programme in upper Austria allows interventions to commence almost immediately after diagnosis of a hearing loss. Children diagnosed with hearing loss are commonly referred to the Family-centred Early Intervention Program (FLIP) Linz,* which provides home-based services for deaf and hard-of-hearing children. FLIP works through a multidisciplinary team including speech and language therapists, educationalists, social workers, parent-to-parent support providers (parent-peer) and deaf role models. Interventions are provided in the child's home by speech therapists who also educate and guide parents to make informed decisions regarding different communication modes and strategies. Families that decide to take the sign language route are supported through a deaf role model for integration of sign language into the daily life of the family.

Those who opt for the use of hearing technology are also supported in its use. Families also have access to a social worker who can aid with completion of the required applications and provide information regarding financial support. In addition, parent-peers help the child's parents find ways to process the understanding that their child has a hearing loss, as well as providing information on social and educational systems. Through this family-centred approach, the programme delivers an individually tailored education plan for each child in close cooperation with the parents.

Over years, hundreds of families have benefitted through this approach. One of the parents enrolled in this programme has stated: "We get great support from our speech therapist who coaches us in a way we had never expected. Another special point is the opportunity to talk to other parents who are facing the same challenges, who have walked a few more steps than we have."

*See: https://www.barmherzige-brueder.at/unit/issn/hoerbeeintraechtigung/babyskleinkinder

CASE STUDY

Veterans of the USA benefit from hearing care

Some 28 million Americans live with hearing loss, including more than half of adults over 75 years of age. Among American veterans, hearing problems are the most prevalent service-connected disability, and more than 933 000 veterans receive compensation for hearing loss. Moreover, only 1 in 5 of those in need of a hearing aid actually use one. To address this issue, Veterans Health Administration has initiated a Veterans Affairs (VA) Audiology Program to provide quality comprehensive hearing health care to all veterans in need. This programme allows veterans to receive comprehensive assessments and rehabilitation services including advanced hearing technology.

More than 1100 audiologists employed by VA offer care across 400 sites of care, along with 400 speech-language pathologists at 190 sites. According to an audiologist working for VA, these services have positively impacted the ability of veterans to function in their daily life and improved their quality of life by allowing them to remain active and socially engaged *(276, 277).*

2.4.5 HEARING ASSISTIVE TECHNOLOGY

In addition to rehabilitation, hearing assistive technology is useful in improving access to communication. By improving sound quality and speech discrimination, it supports a person's interaction with the environment. Hearing assistive technology includes both software and hardware that can be used in a variety of environments, including home, work, school, social gatherings, meetings, hospitals, places of worship, and theatres. The different types of hearing assistive technologies available include devices for enhanced listening that improve the signal to noise ratio for improved listening in a noisy surrounding; alerting devices; and telecommunication devices.

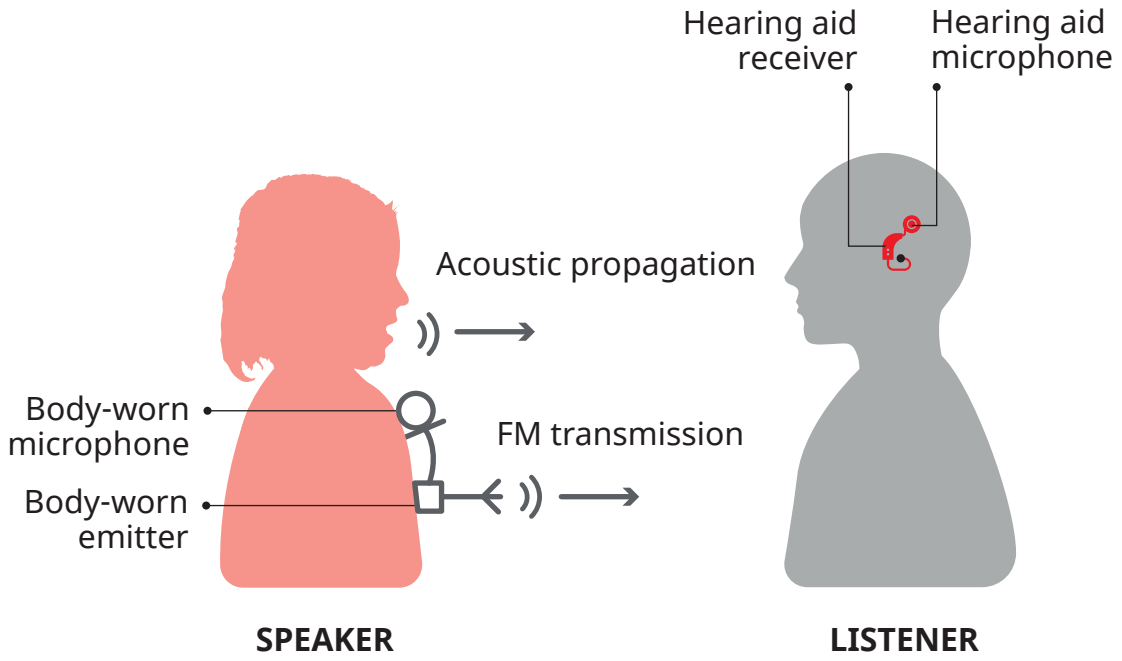
DEVICES FOR ENHANCED LISTENING

These devices enhance the use of hearing aids and cochlear implants, and can also assist those not using these tools. The speaker talks into a microphone and the sound is delivered directly into a receiver worn by the listener or integrated within his or her hearing aid or implant. By doing so, the system cuts off interference and masks the effects of environmental background noise, making speech easier to understand. Its use improves a person's ability to listen and therefore is useful in classroom settings. The system also makes it easier for people with hearing loss to carry out conversations in public spaces, health-care centres and in their home.

The common technologies used in enhanced listening devices include:

- **Frequency modulation (FM) systems** *(217)* – which convert sound into FM signals (see Figure 2.8).
- **Infrared system** *(278–280)* – which uses infrared rays to transmit sound.
- **Hearing induction loop** *(281)* – which transmits an audio signal directly into a hearing aid via a magnetic field.
- **Hardwired system** *(282)* – where sound is carried from the microphone to the receiver through a wired connection.

Figure 2.8 A frequency modulation system



A frequency modulation (FM) system typically has two or more components: the microphone, with or without a transmitter; and a receiver attached to the hearing aid or microphone. FM serves well in eliminating the effects of background noise and maintaining a constant speech input, irrespective of distance between speaker and listener.

ALERTING DEVICES

Alerting devices use sound, light, vibrations, or a combination of these, to catch the attention of a person who is hard of hearing or deaf. Examples of alerting devices include shaking alarms, pillow vibrators, bed vibrator, vibrating pagers, wrist vibrator, vibrating and shaking alarm clocks, motion signaller, motion signaller, fire and smoke signaller, and doorbell signaller *(283)*.

TELECOMMUNICATION DEVICES

Telecommunication devices transmit spoken messages in a written format. Examples include: (i) a teleprinter that works as a two-way typing telephone where someone types the message and responds to the teleconversation; and (ii) a captioned telephone where spoken words are converted into text.

CASE STUDY

Technology promotes inclusion

Recent technological aids have been developed to assist persons with hearing loss:

1. **Quiet Taxi**:* was launched by a leading car manufacturing company revealing technology that assists taxi drivers who have impaired hearing to have sustainable employment and ensures safety. Operated in Seoul, these taxis are equipped with vibration, text-to-speech, light signallers and alerts for safe driving.
2. **Loopfinder**: is a mobile app developed by the Hearing Loss Association of America, along with OTOjoy which helps people find hearing loop systems available in America. A person can locate where loop systems are available and also mark any place as having or needing a loop system.
3. **StorySign**: is a mobile application which facilitates reading in deaf children by translating text from selected books into sign language.

**Source:* https://tech.hyundaimotorgroup.com/video/the-quiet-taxi/

2.4.6 HEARING ASSISTIVE SERVICES

Hearing assistive services include measures such as captioning and sign language interpretation.

CAPTIONING

Captioning is the process of converting the audio content of a television broadcast, webcast, film, video, CD-ROM, DVD, live event, or other productions into text, and displaying the text on a screen, monitor, or other visual display system *(284)*. It is an important means of providing access to content for people with hearing loss who rely mainly on oral communication. Captions not only display words as the textual equivalent of spoken dialogue or narration, they also include speaker identification,

sound effects, and music description. Further information on captioning is provided in Box 2.13. Captioning typically is offered for:

- Live events that are held face to face, e.g. meetings, conferences, theatre performances or events streamed online such as webcasts, live social media events, television programmes.
- Pre-recorded content such as movies, television, video and audio material.

Box 2.13 Captioning services provide access to all

In different countries, captioning services can be referred to variously as: speech-to-text-reporting (STTR); speech-to-text-interpreting (STTI); Communication Access Real-time Translation (CART); or speech-to-text services. Users tend to be those who have difficulty hearing either with or without a hearing aid or implant. For example, a person using a hearing aid may function well in a one-to-one context, but may have difficulty in a meeting room among several people.

Services for captioning can be available either onsite where an event or recording is taking place, or offered remotely. In cases of remote captioning, the captioner is able to hear the person/s in another location via electronic means and captions are quickly and effectively transmitted to the viewers/listeners.

Provision of such captioning services is an important component in implementation of Articles 5 and 9 of the United Nations Convention on Rights of Persons with Disabilities *(285)*, ratified by 163 Member States. Captioning empowers its users, and ensures their inclusion in ongoing social, recreational and official activities.

Users frequently report that captioning is essential to them and empowers them. A survey carried out in 2013 by Collaborative for Communication Access via Captioning (CCAC) of 220 respondents, found that over 70% felt included, less stressed by their hearing loss, and more able to participate when they had captioning. Comments made by users include: *(286)*

"I BELONG. I am no longer an outcast because I cannot hear what is going on."

"STT [Speech-to-text] allows me to hear the conversation. Without it, I am lost."

CASE STUDY

Captioning promotes equal participation among hard-of-hearing people*

"Captioning is an invaluable means of access for many hard-of-hearing persons, myself included. I rely on captions every day to get news and information on television and to enjoy media programmes and movies. By reading the captions,

I am able to supplement my hearing so that I can understand the intended meaning in these mediums.

I also find captioning invaluable for large-scale meetings and group discussions. Although I wear hearing aids, they cannot pick up sounds at considerable distances; thus captioning reduces the hearing barrier. The use of assistive devices such as FM/Infrared systems and loops may also help in these settings. In small group discussions, which frequently seem to take place in noisy environments or rooms with poor acoustics, captions and assistive devices make it possible for me to understand the conversation and to participate as a group member.

The fact that the meetings of the World Hearing Forum at the World Health Organization are fully accessible with the provision of captions and the use of amplified sound through microphones has made it possible for me to contribute effectively to its work.

Without captioning and assistive devices I would be a "visitor" to these discussions, not a true participant and, therefore, not fully engaged. The removal of barriers to participation enables me to contribute to my full capacity as an equal member of society. As it does for me and others in my situation, it provides access and contributes to my self-development and self-esteem. I dream that this form of access is available for all persons with a hearing loss who require it at school, in the workplace, in churches, theatres, movie houses, transportation facilities, and venues for community and political participation, in short, in all areas of human endeavour."

**Source:* contributed by Ms Ruth Warick, President, International Federation of Hard of Hearing People

SIGN LANGUAGE INTERPRETATION

Sign language interpretation is the use of a sign language to convey the information contained in the programme audio (speech and other important sounds) to viewers who are deaf, and for whom sign language is their preferred language; it requires an interpreter who can translate the audible content into a sign language that is understood by the participants. Sign languages differ from country to country. Use of sign language interpretation services in health-care settings facilitates access to health services among sign language users *(287)*, and can also improve classroom learning among deaf students *(288)*. The provision of such services in countries is required by Article 9 of the United Nations Convention on the Rights of Persons with Disability *(289)*. An example of the value of sign language interpretation to education and health is provided in Box 2.14.

Box 2.14 Sign language interpretation improves access to education and health services*

A survey conducted in 2009 by the World Federation of the Deaf revealed that 68% of the 93 responding countries did not have access to professional sign language interpreters *(290)*, as is mandated by the United Nations Convention on Rights of Persons with Disabilities (UNCRPD). Ensuring the availability and quality of these services requires a system for training, certifying, and paying interpreters, none of which are in place on a global scale.

In Europe, there are an estimated 8491 professional sign language interpreters – i.e. 1 interpreter for every 162 users of sign language, although a wide variation is evident among countries, with ratios ranging from 1:8 in Finland to 1:6500 in Albania *(246)*. Professional interpreters have undergone training at various levels, ranging from vocational training to gaining a Masters degree. A survey conducted among sign language users in Europe showed substantial unmet demand in covering all interpreting needs – i.e. ranging from medical to educational to community and public sector *(291)*.

Professional sign language interpreters are even more scarce in developing countries, where many interpreters may have received no training whatsoever. In order to promote access to qualified and professional sign language interpreters, in 2017, the Ghana National Association of the Deaf, in partnership with the Danish Deaf Association, embarked on a diploma programme in sign language interpreting, in cooperation with the University of Cape Coast.‡ As of August 2019, a total of 60 sign language interpreters were certified through this programme, of which 34 have been employed at various governmental agencies and institutions. Other interpreters employed at major hospitals in Ghana have ensured equal access to health services for deaf people in those hospitals.

*contributed by Kasper Bergmann of the World Federation of the Deaf.

‡See: https://gnadgh.org.

Well-established, effective and evidence-based interventions, along with more recent developments, provide a range of options to address hearing loss across the life course. Sections 3 and 4 outline solutions to the challenges faced in using a public health approach, and in making these options accessible to all those in need.

2.4.7 ENVIRONMENTAL ADAPTATIONS

While there are many solutions designed for the individual with hearing loss, improving the acoustic environment can reduce hearing-related disability and increase accessibility to sound and communication. This is important across the life course in different settings: in learning situations, such as classrooms; in social and cultural environments where communication is highly valued (including restaurants,

church and activity halls, adult care homes), and in environments of daily living, such as supermarkets. Good acoustics are critical to learning for young children who have less well-developed phonological knowledge of the world than adults, and are thus less able to reconstruct degraded speech information *(292)*. Unsuitable acoustics present an even greater challenge for children with hearing loss or learning problems *(292)*. Open plan learning is becoming increasingly popular in some settings to enhance flexible teaching and learning practices; however, acoustic modifications to support this have often been overlooked, leading to poor perception of auditory information *(293)*.

For older adults with hearing loss, listening in challenging environments increases cognitive effort which is associated with fatigue and social withdrawal *(294, 295)*. Many restaurant and café dining areas are noisy, in part due to a lack of soft furnishings which increases acoustic reverberation *(296)*. Universal building design[16] maximizes accessibility *(297)* and benefits older adults; the principles of universal design are recommended in WHO's Age Friendly Cities initiative *(298)*. There is a growing interest in "soundscapes" in urban design; this concept considers the sound environment in combination with the human experience and behavioural response to it, rather than the noise level of the setting alone *(299)*. The Positive Soundscape Project *(300)* included older adults, and adults with hearing loss in the co-design of such spaces.

[16] Universal building design for accessibility refers to design of spaces and living environments, including their acoustic characteristics, such that they are usable by all people to the greatest extent possible without the need for adaptation.

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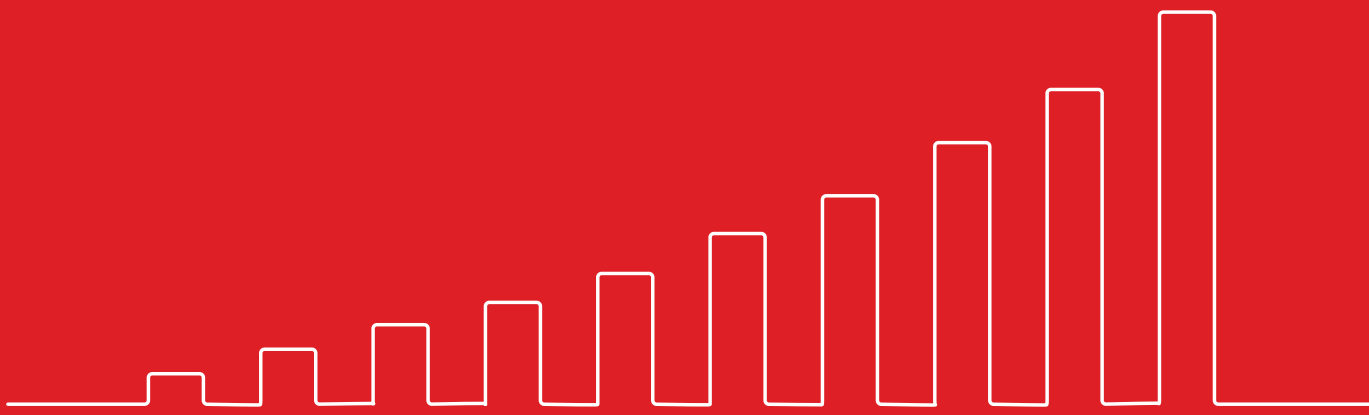
Facing the workforce challenge in Zambia

Ear and hearing care is a fairly new concept in Zambia. Following the World Health Assembly resolution of 2017 on hearing loss, the Government of Zambia adopted a plan to develop quality EHC services as close to people as possible. The major challenge in this effort came from the fact that there are only five ENT specialists and one audiologist for the 17 million people of Zambia, of whom 4–6% have hearing loss and many more suffer with ear diseases.

Using the national ENT Strategic Plan 2017–2021 as a guide and with support from the German and Scottish governments, we rolled out a pilot project to train nurses and clinical officers working in the country's national health service, on primary ear and hearing care. Through a systematic rollout of a cascade training plan which is based on the WHO primary ear and hearing care training manuals, 28 nurses, 43 clinical officers and 133 community health workers from 92 facilities have been trained over the last 18 months. With their support, 50 primary ear and hearing care services have been established at peri-urban and rural health centres across the country. The trained health workers themselves have also benefitted from the additional skills they have developed, which help them in addressing ear and hearing problems, which are so common in the community.

Over 15 000 Zambians, including those living in rural and underserved areas, have already benefitted from the services provided by the trained staff. As the programme continues to grow and expand, through the political commitment of the government and the dedication of its health cadres, the country is on track to realize the vision of 'making ear and hearing care accessible for all'.

Racheal Hapunda, EHC programme coordinator,
Ministry of Health, Zambia



SECTION 3

CHALLENGES FACING EAR AND HEARING CARE

> Health is an investment in the future: the cost of doing nothing is one we cannot afford.
>
> Dr Tedros Adhanom Ghebreyesus, WHO Director-General, 2020

3.1 OVERVIEW

- Key challenges facing the field of ear and hearing care (EHC) are grouped into three categories:

  1) Demographic and population trends.

  2) EHC literacy, and stigma associated with hearing loss.

  3) Health system related issues.

- Demographic and population trends reflect the high, and rising, global prevalence of hearing loss across the life course. By 2050, it is estimated that some 2.5 billion (1 in every 4) people will experience hearing loss, with nearly 700 million (1 in every 14) living with moderate or higher levels of hearing loss in the better hearing ear.

- Urgent public health action is needed to mitigate this projected growth. While people with hearing loss of all ages and across all population groups need care, special attention is needed for vulnerable populations to ensure they have access to ear and hearing care and other health services.

- The lack of accurate information, and stigmatizing mindsets surrounding ear diseases and hearing loss often limit access to care. Even among health-care providers, knowledge relevant to prevention, early identification and management may be lacking, thereby restricting the care they provide to those with ear and hearing needs.

- Challenges encountered in the delivery of hearing care services relate to the different building blocks of health systems: clinical services; human resources; access to devices; data and indicators; and governance and finance.
- Throughout the life course, clinical EHC services must be accessible, integrated within national health services, and delivered across all levels of care. Despite the high level of need for these services, they are commonly unavailable at the primary level of care and inconsistent at secondary and tertiary levels.
- Section 3 provides information and analysis of the overall availability of human resources for hearing care, by WHO region and income group, and shows the significant inequities across both. The impact of shortages on existing professionals is explored, the implications of real-life scenarios described, and solutions, such as task-sharing, in combination with other strategies to address the gaps and increase the EHC workforce, are proposed.
- Issues relating to worldwide accessibility of hearing aids and cochlear implants are highlighted, with estimates showing that only 17% of those who would benefit from using a hearing aid, actually use one. This gap ranges from 77% in the WHO European Region to a daunting 90% in the WHO African Region. Assessment reveals that the appropriate use of a hearing aid by every person who would benefit with this device, could reduce the years lived with disability (YLDs) associated with unaddressed hearing loss by 59%.
- Government leadership for EHC integration is often lacking, as evidenced by the lack of countries with strategic plans for integration and available financial resources to address ear diseases and hearing loss.
- Although seemingly insurmountable, challenges have been overcome in many parts of the world by countries adopting public health strategies. Section 3 proposes solutions for addressing these challenges and provides examples of implementation.

Despite the available range of effective interventions to prevent and address hearing loss, most of those who need hearing care still do not have access to it *(1)*. In order to chart a future course in the field of ear and hearing care, the situation must be addressed and the challenges faced.

The key challenges form three distinct categories: (i) demographic and population trends; (ii) EHC literacy and stigma; and (iii) health system challenges. Through acknowledging and understanding these, we can be better placed to address them. Section 3 outlines these challenges and highlights the opportunities to tackle them.

> By 2050, 1 in 4 people are projected to have a problem with their hearing.

3.2 DEMOGRAPHIC AND POPULATION TRENDS

Hearing loss is a widely prevalent health condition of diverse aetiology, affecting individuals across the life course. Prevalence of hearing loss is constantly increasing, driven by global demographic trends, and persistent and growing risk factors. The current and projected global prevalence is outlined below.

3.2.1 PROJECTED TRENDS IN HEARING LOSS

The main demographic shifts predicted for the coming decades are population growth and population ageing, both of which will greatly affect the epidemiology of hearing loss *(2, 3)*. As the world's population continues to grow – research estimates a global population increase from the current 7.7 billion, to almost 10 billion by 2050 *(2)* – it is anticipated that by 2050, nearly 2.5 billion people will have hearing loss of mild or higher severity in the better hearing ear.[17] Of these 2.5 billion, nearly 700 million are most likely to encounter loss of moderate or higher severity in the better hearing ear (Figure 3.1). Thus worldwide, by 2050, nearly 1 in every 4 people can expect to have some degree of hearing loss, and 1 in 14 (at least 7%) will require hearing care. All WHO regions can expect to experience this exponential rise, proportionate to their population profile. Whereas the maximum rise is likely to be seen in the Eastern Mediterranean and African regions where the number of people with hearing loss is predicted to more than double by 2050, the highest number of people in 2050 is likely to be found in the Western Pacific (approximately 760 million) and South-East Asia (approximately 660 million) regions (Figure 3.2).

The rising numbers depicted in Figure 3.3 are driven mainly by demographic population shifts, such as the global increase in ageing populations. However, hearing loss cannot be considered an inevitable consequence of living longer: several factors influence a person's hearing trajectory across the course of life (as outlined in Section 1). Prevention, through urgent public health action, can mitigate some of this projected growth. In addressing the needs of the growing numbers predicted to experience hearing loss in the coming years, countries should make preparations to ensure a well-functioning and productive society.

[17] McDaid D, Park AL, Chadha S. Estimating the global costs of hearing loss. Int J Audiol. 2021;16:1-9.

Figure 3.1 Projected increase in prevalence of moderate and higher grade of hearing loss, 2019–2050

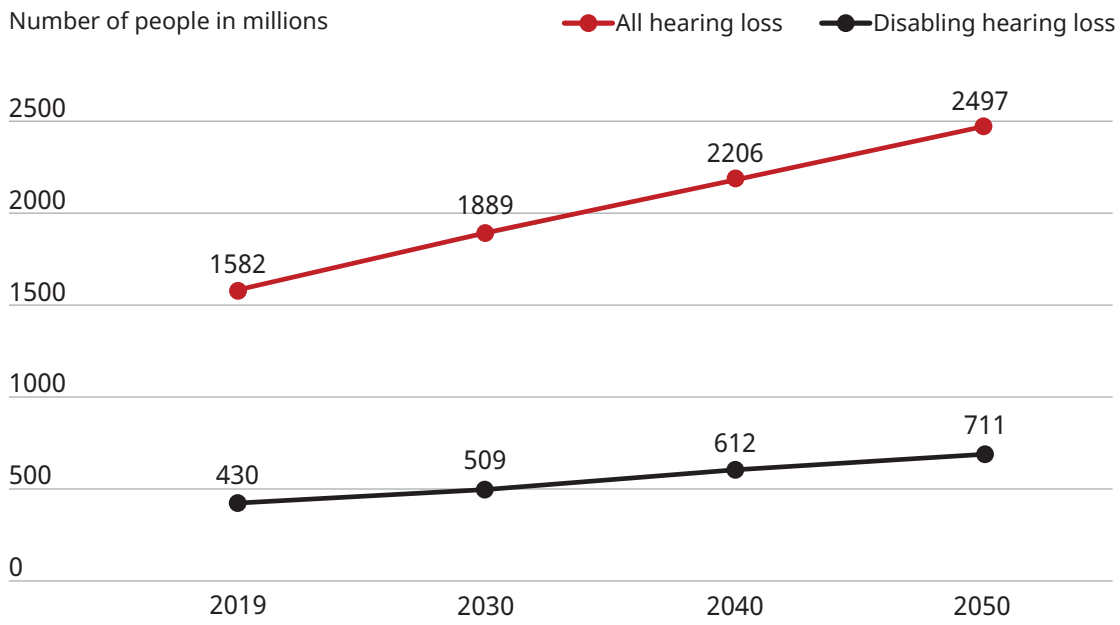


Figure 3.2 Projected increase in prevalence of all grades of hearing loss in WHO regions

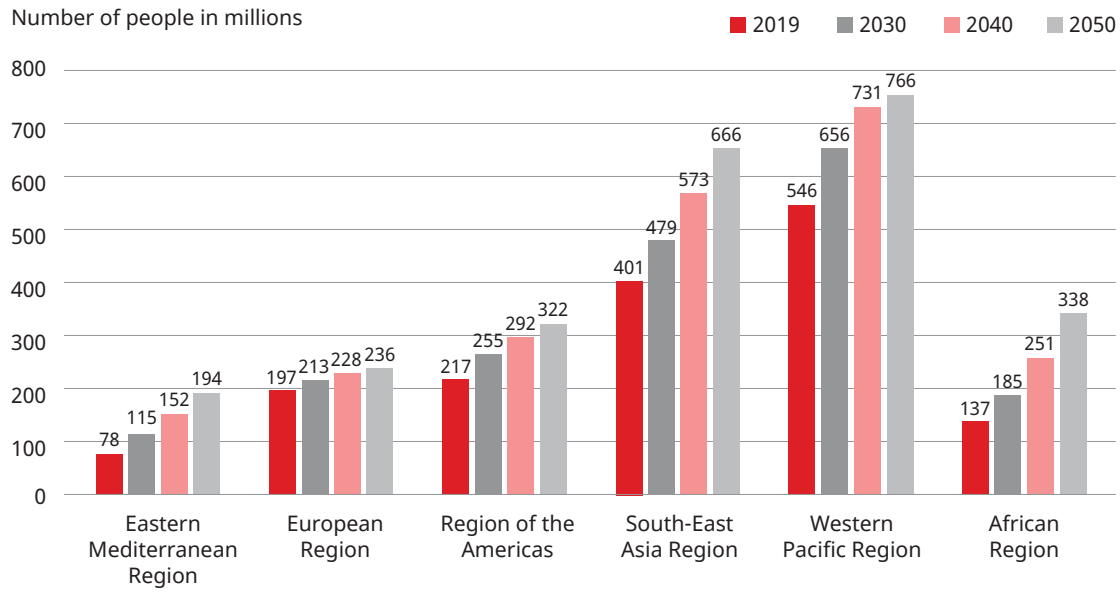
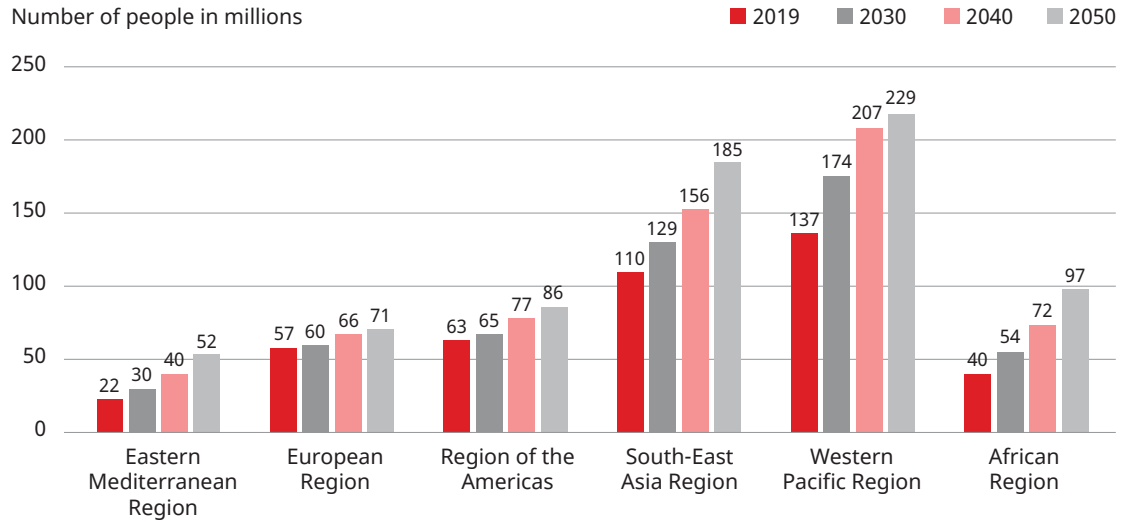


Figure 3.3. Projected increase in prevalence of moderate or higher grade of hearing loss in WHO regions



CHALLENGES CAN BE OVERCOME

- Preventive efforts need be strengthened, especially in the face of the projected growth. Such actions can succeed in controlling the projected growth trends and mitigate the associated costs *(3, 4)*. Large cohort studies conducted in high-income countries, such as the United States, Sweden and Norway, show a clear decline in age-specific prevalence of hearing loss during the past decades. Reduced exposure to occupational noise and decline in ear infections are considered responsible for this encouraging trend *(5–7)*. Nonetheless, the overall numbers continue to rise, mainly due to demographic changes.

CASE STUDY

Prevention works!

In 2002, rigorous implementation of a hearing conservation programme was undertaken in the Swedish Armed Forces, and its impact assessed after a few years. The results showed that the incidence of hearing loss in the affected population dropped to one third during a five-year period, having reduced to 2.3% from the earlier 7.9% – i.e. the same as the incidence rate in the non-exposed population. This was also reflected in a decreased rate of hearing loss cases in the occupational insurance system leading to benefits for the employer and employees *(8)*.

3.2.2 HEARING LOSS IN VULNERABLE POPULATIONS

Difficulty in accessing care, not only for hearing loss but for other issues of general health, is most marked in certain vulnerable populations. Typically, vulnerable populations include racial and ethnic minorities, children, older adults, socioeconomically disadvantaged people, people with health conditions, LGQTBI[18] persons, immigrants, those in war-torn and conflict areas, prisoners, and even families of persons with life-threatening health conditions *(9)*.

People with hearing loss are more likely to face challenges when seeking services, mainly due to communication difficulties *(10–13)*. Health promotion messages may be inaccessible to people with hearing loss unless attention is given to this *(12)*.

While these challenges existed before the advent of the COVID-19 pandemic, they have been further aggravated by the implementation of key preventive strategies, such as the use of face masks and need for social distancing. People with hearing loss commonly strain to hear, even when using hearing aids; the wearing of face masks increases their difficulties by distorting sound and concealing important visual cues *(14)*. Moreover, in hospitals, patients could be at greater risk of medical errors due to misunderstandings between them and the health-care providers wearing face masks *(10, 15)*. The wearing of face masks has particular relevance in classroom settings. In a survey undertaken by the Hearing Health Foundation to assess the impact of the pandemic on people with hearing loss, 85% of respondents reported that they were struggling due to their inability to read lips covered by face masks.

"Being able to hear from a distance of at least six feet, while the speaker is covering the bottom half of their face has been daunting, to say the least, for people with hearing loss."

Hearing Health Foundation Survey

CHALLENGES CAN BE OVERCOME

- When planning for health services, including hearing care services, each country should pay specific attention to the needs of vulnerable groups.
- Communication challenges associated with the wearing of face masks can be reduced by wearing clear masks which allow others to see facial expressions and read lips. As an example, the United States Centers for Disease Control and Prevention has recommended the wearing of clear face masks by teachers when interacting with children and young students with hearing loss. The wearing of clear masks is relevant in all settings and can improve accessibility for all people, not only those with hearing loss.

[18] LGQTBI: Lesbian, Gay, Queer, Transgender, Bisexual, Intersexual

CASE STUDY I

Coordinated multistakeholder action can address hearing care needs in times of war and strife

Following nearly nine months of relentless air strikes, mortar rounds and car bombs pounding the city of Mosul, thousands of residents experienced hearing problems ranging from tinnitus to profound hearing loss. Many civilians who were exposed to repeated blasts suffered bleeding from their ears and many developed profound sensorineural hearing loss, making it impossible for them to communicate with others and forcing children to drop out of school, even after the war had ended. To provide services to thousands in need, a specialized hearing impairment centre was opened through a collaborative effort of the city's leading hospital and a humanitarian organization. Within a year of its operation, the centre provided care to several thousands of people affected, including fitting 2000 hearing aids and referring many for cochlear implant surgery *(16)*.

CASE STUDY II

Accessible health promotion and services for deaf persons

People with hearing loss (and those with other disabilities) are often excluded, not only from HIV prevention education, but also from access to HIV testing and treatment *(12)*. To address this, voluntary counselling and testing (VCT) services for HIV/AIDS, sympathetic to those who are deaf, have been successfully established in Kenya. The VCT services were combined with an education programme targeting people who are deaf. Peer educators provided accessible information at places such as churches for deaf people, learning institutions, seminars and other environments where deaf people congregate. This strategy had been proved successful in promoting safer practices for HIV prevention as well as HIV testing *(17)*.

In another initiative to reduce risk of heart disease in the United States of America, community health workers were trained to enable better communication with people with hearing loss. This led to significant improvements in nutrition, psychological well-being/stress management, and enhanced physical activity *(18)*.

> The lack of accurate information and knowledge limits the population and health workers in their ability to address ear diseases and hearing loss, and perpetuates the associated stigma.

3.3 EAR AND HEARING CARE LITERACY AND STIGMA RELATED TO HEARING LOSS

The success of public health interventions depends not only on their effectiveness and availability, but also on how prepared populations are to receive them. The knowledge, attitude and practices of the population receiving such services are highly relevant, as are those of health-care providers who make these interventions possible. Current challenges in this context are summarized below.

3.3.1 LIMITED EAR AND HEARING CARE LITERACY IN THE POPULATION AT LARGE

Prevalent sociocultural norms commonly influence people's attitude towards loud music *(21, 22),* and govern their behaviour in loud surroundings *(23, 24).* High-intensity sound levels are often expected and accepted, and protective behaviours viewed with disfavour *(25).*

It is widely known that people – including those with major, possibly life-threatening conditions – frequently avoid seeking medical care, even when they suspect it may be necessary to do so *(19, 20)*. Few studies have been conducted to understand the reasons behind this; even fewer in the field of hearing care. Existing literature reveals that even when people are aware of the risk of hearing loss – such as when exposed to noise in occupational or recreational settings – and when they have protective means available to them (such as earplugs and earmuffs), they remain reluctant to use them. This could be attributed, in part, to several factors: discomfort caused by wearing the devices; underlying beliefs and sociocultural norms relating to noise exposure *(21, 22)*; a lack of appreciation of the threat posed; or lack of perceived benefit of their use.

A similar reluctance to seek care also exists around ear care and ear diseases which are often incorrectly addressed or ignored. The use of home remedies and potentially harmful practices, for example, is common in the context of ear and hearing care. Evidence of ear candling for cleaning ears is overwhelming *(26)*, as is the use of Q-tips or cotton buds, even

when these practices are shown consistently to lead to trauma, wax impaction or infection *(27–30)*. This is so despite relevant warnings being provided on most commercially available products. Different types of oils are often used, and other unsuitable materials, such as matchsticks, feathers, pins, or pencils introduced to clean ears *(29, 31)*. Not only can use of these products result in trauma to the ear canal, ear drum perforations and aggravate cerumen impaction, they can also lead to foreign bodies being left in the ear canal *(29, 31)* providing potential for infection or further harm. Even in cases where credible symptoms of ear pain and ear discharge are evident, people in many parts of the world choose to use home remedies, such as the instillation of plant juice and hot oil, or visit traditional healers, all of which can cause significant harm rather than benefit *(32, 33)*.

This lack of awareness and attention persists, even when people develop hearing loss; many remain unaware of their hearing loss, especially when it is mild or moderate in degree *(34)*. Despite living in well-resourced settings, some people wait for years before having a hearing test or seeking care *(34, 35)*. When hearing loss is identified and remedial interventions suggested, people often postpone their use to an undetermined future date claiming that there is "no need" for use, or that they "can manage for now" *(36)*. This attitude has translated into consistently low rates in the use of hearing services and uptake of hearing aids, even in high-income countries where these services and aids are available *(35, 37)*. Given the high impact of unaddressed hearing loss on mental health, the ability to continue working, and the quality of life and relationships, this gives serious cause for concern.

The early identification and management of children with hearing loss is critical. Parents are commonly unaware of the need and possibility of hearing screening, and parental education is important both for identifying risk factors *(38)* and for seeking attention to mitigate delayed language milestones in their child. Often when a child is identified

Schoolchildren in Kenya learn about ear and hearing care

Typically, those who are referred for hearing assessment recognize that they have had a hearing problem for around 10 years or more, are aged in their mid-seventies and have a substantial hearing problem. The older that people are when they present for assessment and intervention, the more difficult they find adaptation to and care of their hearing aids. It often takes 10 years for an individual to recognize that they have a hearing problem (but a shorter time for significant others) *(34)*.

Public health communication is the scientific development, strategic dissemination, and critical evaluation of relevant, accurate, accessible, and understandable health information communicated to, and from, intended audiences to advance the health of the public *(38).*

with hearing loss, parents require considerable guidance and information to make the most suitable communication choice for their family, and to ensure appropriate follow-up and care for their child *(39, 40)*. Such guidance may be unavailable and can result in delayed diagnosis and intervention. Inadequate and incorrect information can also lead to low satisfaction with rehabilitation efforts, and frustration in the use of hearing devices, especially when expectations regarding their performance are unrealistic *(34, 36, 39, 41, 42)*.

CHALLENGES CAN BE OVERCOME

While the obvious response to this issue is to raise awareness on the relevance and impact of, and solutions for, hearing loss, this objective is not easy to achieve. A number of measures are required to address the challenge:

- Providing accurate, relevant, accessible and understandable information, from a credible source and in a friendly manner, is essential. Good communication is key to effective public health *(43, 44)*.
- Implementing hearing screening programmes for different risk-groups can ensure that people do not face the adverse impact of hearing loss as a result of being unaware of their health condition *(34)*.

CASE STUDY I

Accurate and friendly information can bring lasting change

The school-based programme "Dangerous Decibels"* is an example of an effective strategy for promoting safe listening practices among school children during their formative years. Delivered as a single brief session, the programme was evaluated in the United States of America *(45)* and Brazil *(46)*. The studies demonstrated the programme's effectiveness at producing long-term improvements in knowledge, and positively influencing attitudes of fourth-grade students regarding loud sounds and hearing protection.

Implementation of such programmes in a culturally appropriate manner on a widespread scale could create a lasting impact on hearing loss trends in the future.

*See: http://dangerousdecibels.org/education/outreach-program-overview/

CASE STUDY II

Hearing screening is effective

A study undertaken in Washington, USA, evaluated the efficacy of hearing screening in older adults. The study compared hearing aid uptake in a population. Adults tested with three different screening modalities were compared against adults who underwent no screening.

Results clearly indicated that the rate of uptake in the screened population group was as much as double that of those with no screening. The study then evaluated patients' self-reported improvement in hearing and communication ability a year after the intervention. Significantly greater improvement was reported in the screened population compared with the unscreened population *(47)*.

3.3.2 EAR AND HEARING CARE LITERACY IN HEALTH-CARE PROVIDERS

General practitioners and health workers play a critical role in ensuring that children and adults with hearing loss are identified in a timely manner and receive the interventions they require *(35)*. However, health-care providers are commonly ill-informed about risk factor recognition which could help with identification *(35, 39)*. Knowledge relating to common ear problems, such as otitis media, can be lacking, as can the importance of addressing these conditions *(48–50)*. Even among staff involved in newborn hearing screening, critical gaps in knowledge relating to the causes of hearing loss, follow-up and referral of identified infants are frequently reported *(39, 51, 52)*. Without such knowledge, health-care providers cannot be expected to impart the required information and guidance that could ensure timely diagnosis and appropriate interventions to persons with hearing loss, as well as continued support for them and their families during rehabilitation. Moreover, due to a lack of necessary skills, medical staff commonly struggle to communicate well with those who are hard of hearing or deaf *(10–13)*; consequently, health needs among deaf populations often remain unmet.

CHALLENGES CAN BE OVERCOME

Training health-care providers enables them to:

- provide appropriate instructions for ear care and hearing loss prevention to people in their communities;
- recognize ear diseases and hearing loss with the aim of guiding people regarding their diagnosis and management; and
- provide scientifically-accurate and culturally-sensitive information and counselling to the community *(34, 39, 50, 53–55)*.

CASE STUDY

Training of community health workers brings benefits in the Region of the Americas*

In the WHO Region of the Americas, the Primary Ear and Hearing Care Training Resources (PEHC-TR) have been widely used to train general practitioners (GPs), nurses (both qualified and still in training), community health workers (CHWs), community workers, teachers, health planners and programme coordinators of nongovernmental organizations (NGOs). They have also been used to sensitize specialist cadres on PEHC, including ENT surgeons, audiologists, paediatricians, obstetricians, public health specialists and other health professionals.

Over a period of seven years (2006–2012), a total of 96 courses on PEHC (Basic, Intermediate and Advanced levels) were delivered in nine countries in the Region of the Americas: Bolivia, Cuba, Dominican Republic, El Salvador, Guatemala, Mexico, Nicaragua, Paraguay, and Peru with a total of 2330 persons trained.

The results of this experience show that without minimizing the importance of the need for increasing the number and strengthening the capacity of EHC professionals (e.g. ENT specialists and audiologists) in low- and middle-income countries, there is a very significant role for PEHC training resources in contributing towards task-sharing of certain EHC interventions. This is especially relevant for community and primary level health-care workers, for example with activities such as raising awareness, early diagnosis and management, and prompt referral to specialist services. This training is reaping benefits across the region. For example, in Bolivia, trained health workers examined the ears and hearing of over 10 000 people, of whom more than 2000 were treated. Many others were referred for further evaluation and received care at secondary level centres.

In a separate study, CHWs were trained in the provision of hearing care to children in parts of Brazil and the efficacy of the study assessed *(56)*. The assessment confirmed that training was effective in improving the knowledge of CHWs so that they were able to undertake a variety of health promotion and surveillance-related tasks, including motivation of families regarding hearing loss prevention and care; promotion of good hearing-care practices leading to improvement in community knowledge on hearing loss; identification of hearing loss, referral and follow-up; and support to families of children who were diagnosed with hearing loss or undergoing rehabilitation.

* *Source:* information contributed by Dr Diego Santana of CBM (and ref: 51)

3.3.3 STIGMA ASSOCIATED WITH HEARING LOSS

Stigma – due to hearing loss, the related communication difficulties, and the use of hearing devices – is perhaps the most critical impediment to hearing care *(39, 41)*, and is faced at all stages of the life course. Deep-seated cultural beliefs and myths about hearing loss persist in many communities of the world where a deaf child may be regarded, erroneously, as a bad omen who may bring misfortune upon the family. Such beliefs pose a challenge at every level. Since many families are reluctant to subject a child to a test that could indicate a disability, uptake of newborn hearing screening services can be hampered *(39)*. Such beliefs can be even more harsh and restrictive in cases of the dual sensory loss of deaf-blindness *(57, 58)*. Such negative societal views may limit the potential of, and opportunities available to, deaf and hearing impaired persons *(59)*.

While stigma directed at children may be considered to have the most far-reaching consequences, it is no less significant or debilitating when encountered later during the life course, for example with adults who develop hearing loss either at a young age or as they grow older. Behaviour resulting from experiencing stigma most commonly manifests as a denial of the difficulties in hearing and communication; choosing to self-isolate; or not wear a hearing device *(60)*. Since hearing loss is generally believed to be a natural accompaniment to ageing, a person using a hearing aid may be perceived as "old" *(56)*. Experiencing such "ageist" behaviour *(61)* can result in long periods of denial and concealment which in turn leads to mounting social stress and worsening hearing *(60)*.

Stigma related to hearing devices is the significant factor limiting their use; size and visibility of the device are reported as key features associated with user reluctance *(60, 63)*. Marketing strategies aim to improve hearing aid uptake by promoting those which are small and barely noticeable when worn. Perversely, such practices may strengthen the belief that hearing loss and use of hearing aids are stigmatizing and should be hidden *(60, 64)*.

In many cultures still, within the traditional paradigm, deafness may be attributed to causes such as blood impurities, sorcery, spirits, ancestors, and retribution for failure to perform certain cultural rites. Since the arrival of a newborn is both a joyous and an emotion-laden event for parents and the entire family, the idea of screening apparently normal babies for a possible hidden abnormality is not considered desirable *(39)*.

Ageism marginalizes older people within their communities; reduces their access to services, including health and social care; and limits appreciation and use of the human and social capital of older populations *(62)*.

CASE STUDY

Personal testimonials cited from Wallhagen 2010 *(64)*

"I guess young people have near-sightedness. But hearing loss seems to be affiliated with ageing … the fact of having a big hearing aid says: 'I don't care how you look otherwise, but you're old' … So I like to think that I'm not old. But then the hearing part says 'Wait a minute, you are old.' I mean, especially if you wear something that says, 'Hey guys, you know, I'm old! I'm an old man.'"

"I think even today there are some things that many people in society just recoil to some physical or mental disability. Human nature I guess. And … in my case, you know, if I have, in addition to weak eyes, if I have weak ears, oh my gosh! You know, it's another little bit of a handicap that, you know, that you don't like to talk about."

"I think loss of hearing is portrayed that way in movies, you know media … it's a common ailment, it just gets associated with ageing and loss of function and, you know, death [laughs], eventually. It starts to look like you're slipping …"

The lack of disclosure and associated actions may be attempts to escape societal stigmas associated with having a hearing loss *(65).*

CHALLENGES CAN BE OVERCOME

- The stigma associated with hearing loss, and use of hearing technology and sign language can be overcome through raised awareness within communities and by empowering people with hearing loss. The substantial challenges associated with stigma can be addressed by recognizing role models who are hard of hearing, deaf, or deaf-blind; by promoting associations of people with hearing loss; and by including people with hearing loss in policy dialogues.

CASE STUDY

Role models make a difference!

The Deaf Role Models programmes have played a significant role in early intervention services for families in many states across the United States. Normal hearing parents may need support to cope with the challenge of communicating with their deaf child. Deaf Role Models address this need and support parents by sharing experiences, career goals, and highlighting their child's potential. The programmes focus on communication and encourage family members in sign language learning to ensure that the child has access to a communication-rich environment for early language development.

This approach has resulted in improved language outcomes for deaf infants. It has also led to greater awareness on hearing loss, especially in affected families, and has helped families realize that hearing loss does not need to limit their child in any way *(66)*.

Talking about hearing loss can address the stigma related to it

Significant gaps in the capacity of health systems challenge the provision of ear and hearing care services across regions and income-settings.

3.4 THE CHALLENGES FOR HEALTH SYSTEMS AND POTENTIAL SOLUTIONS

Challenges encountered in the field of ear and hearing care extend to the health system level where the capacity to integrate this form of care is often limited. These, and other challenges based on the six building blocks of the health system are described below, with solutions proposed (Figure 3.4).

Figure 3.4 Strategies to strengthen health system for IPC-EHC

3.4.1 CLINICAL SERVICES

To ensure accessibility across the life course, EHC services must be integrated within national health services and delivered across all levels of care (community, primary, secondary and tertiary).

Despite the evident high need for these services, data from countries indicate a lack of provision across all health service levels. While interventions for the prevention, identification and management of ear diseases and hearing loss must be initiated at the community and primary levels, these are mostly unavailable in low- and middle-income countries. Even at secondary and tertiary levels, availability of EHC services varies across regions and income levels. The data compiled for this report, sourced from a relatively small number of countries, indicate that most countries have no EHC services at community and primary level, and availability is inconsistent at secondary levels across regions and income-groups. Only approximately 38% of the world's population is covered by newborn or infant hearing screening services, for example *(67)*, despite the effectiveness of this strategy in ensuring optimal rehabilitation of deaf and hearing impaired children (as described in Section 2). According to a recent study, nearly one third of countries have minimal or no newborn hearing screening services *(67)* (see Table 3.1).

Table 3.1 Global coverage of newborn and infant hearing screening*

Coverage of Screenings	Number of Countries	Percentage of Countries	Percentage of World Population	GDP (nominal) per capita, average
0% to < 1%	64	32.7	37.63	3.7
1% to 9%	14	7.1	7.42	3.9
10% to 49%	19	9.7	8.33	10.7
50% to 84%	17	8.7	6.72	14.4
85% to 100%	41	20.9	32.59	40.4
No/insufficient data	41	20.9	6.09	8.6
Sum	196	100	98.78	

Note: The entries do not add up to exactly 100% because of not listed dependent and disrupted territories. GDP = gross domestic product.

*reproduced with permission from the Journal of Early Hearing Detection and Intervention *(67)*

The provision of EHC services is often limited by the lack of required equipment and infrastructure in low-resource settings *(68–70)*, and clinical services are hampered by the distances people commonly need to travel to access them. This is most marked for those living in rural communities and is a significant issue for health-care services

in general, and hearing care services in particular. It is a problem encountered in both low- and high-income settings *(20, 71, 72)*.

Planning for these services is made complex due to the varied and often undetermined aetiology of hearing loss and the need for specialized skills to deliver them. For example, micro-ear surgery is often needed to address otitis media, prevent complications, and repair the hearing mechanism (see Section 2). Advanced surgical skills are needed for successful cochlear implantation and other implantable hearing devices; and audiological diagnosis, especially in infants, demands specialized knowledge.

Hearing rehabilitation often requires a multidisciplinary effort, with prolonged therapy, for children to develop linguistic skills, gain education and become independent *(73)*. Adults using hearing technology need instructions, auditory training, and counselling to ensure that they derive maximum benefit *(53)*.

In addition, the management of ear diseases and hearing loss is time sensitive. Delays in intervention aggravate the impact on health, communication and cognition; they may also adversely influence the final outcomes that can be achieved even when rehabilitation is initiated *(34, 74)*. These factors make it essential to adopt a person-centred approach to ensure beneficial results.

CASE STUDY

Hearing care access in Malawi *(72)*

"The distance to QECH [Queen Elizabeth Central Hospital] was perceived by most caregivers to be vast and a significant obstacle to taking up the referral. For example, one caregiver explained that their village was 100 km from Blantyre and, because of the challenging terrain, the journey would be at least 2.5 hours. It also required walking or cycling up steep hills to reach public transportation. Thus the journey was perceived to be challenging particularly for their children."

A caregiver described the challenges of making this journey:

"It's a long journey, imagine from here to Goliati you will ride a bike and in the hills you will be walking on foot. At Goliati we board another [minibus] to Limbe and then another to Queens. Its long journey and you might not be assisted the same day when you go." *(72)*

CHALLENGES CAN BE OVERCOME

- Adopting an evidence-based planning process can help countries prioritize and implement interventions most suited to their specific needs *(75)*. The WHO H.E.A.R.I.N.G. package of interventions (outlined in Section 4), and available WHO tools, provide concrete guidance for undertaking this.

CASE STUDY

Different needs, different strategies

Many countries, mainly (but not exclusively) in the higher-income group (e.g. Germany and the United Kingdom) have implemented newborn hearing screening programmes which have reaped significant benefits by minimizing the adverse impact of congenital hearing loss *(76–82)* and maximizing cost-savings *(77, 78, 82)*. Implementing such programmes has proved effective in reducing occupational noise-induced hearing loss *(83, 84)* and has benefitted the population at risk. Countries such as India have focused attention on otitis media as the priority issue and implemented tools and initiatives to train primary level workers in this effort *(85)*. Such prioritization is often essential to ensure the most effective use of available resources and must be undertaken by countries through review of evidence and stakeholder discussion.

- Training health workers and primary level physicians/family doctors who provide services and undertake heath promotion at community and primary levels, can help to improve the knowledge level of communities regarding good EHC practices. Training can also facilitate early identification of common problems *(50)*, and could help reduce the distance barrier by ensuring available basic services are nearby.

CASE STUDY

Primary Ear and Hearing Care (PEHC) training in Fiji improves knowledge and skills among health workers*

It is estimated that 9.6% of the population in Fiji are living with disabling hearing loss, while 6% of the children have chronic suppurative otitis media. The single dedicated ENT facility is based at the main hospital, the Colonial War Memorial Hospital, and provides specialist ENT service to the 900 000

Training develops knowledge and skills among primary level healthcare providers in Fiji

population of Fiji. Due to the limited access to specialist service, 90% of ear disease and hearing problems are managed by medical officers and nurse practitioners in nursing stations, health centres and subdivisional hospitals in 20 subdivisions. With the limited special training in ear and hearing care available to health practitioners, patients are often referred to a tertiary hospital for simple ear problems such as ear wax, ear infections, or a foreign body in the ear. This contributes to delays and complications for patients requiring urgent attention for ear infections who are on the ENT clinic waiting list. In order to address this issue and improve access to quality ear and hearing care in Fiji, the Ministry of Health and Medical Services (MHMS) made PEHC training available in the country.

A two-day training course is now undertaken by medical officers and nurses, using the WHO PEHC training resources, and facilitated by an ENT specialist. Training focuses on clinical skills development such as history-taking, ear examination, conduct of simple hearing tests and ear toileting. During a two-year period, 313 primary clinical health workers were trained and certified in PEHC by the MHMS of Fiji.

The outcome and impact of the training have been evaluated, and a significant increase in the knowledge and clinical skills of trainees is evident. The quality management rate increased from 5.4 to 7.3. Medical officers and nurses now feel empowered to diagnose and manage common ear diseases and identify hearing loss. Training has helped reduce the workload of the few available ENT specialists and has also helped improve levels of awareness of ENT care within the community.

*narrative contributed by Dr Oh Chunghyeon, CWM hospital, Fiji

- Using innovative measures, such as telemedicine, improves access to services, especially in remote or underserved communities. The potential of telemedicine has been further highlighted by the COVID-19 pandemic with physical distancing being an important preventive strategy *(86)*. A WHO survey conducted during the pandemic reported disruptions in services for all noncommunicable diseases in 75% of the responding Member States *(87)*. Among strategies being used to overcome the COVID-19 disruptions, the use of telemedicine to replace in-person consultations has been the most widespread, and undoubtedly is one of the most effective means of ensuring continuity of services while access to health-care facilities remains limited *(87)*. Through COVID-19, telemedicine has been shown to play a significant role in improving access to care in remote and hard-to-serve areas *(88)*. When applied effectively, telemedicine has the capacity to revolutionize the delivery of ear and hearing care and significantly improve the quality of health care by increasing accessibility and efficiency. Certain factors must be kept in mind to ensure the effective, safe and ethical use of telemedicine. These are summarized in Box 3.1.

Box 3.1 Telemedicine: principles and uses

What is telemedicine?

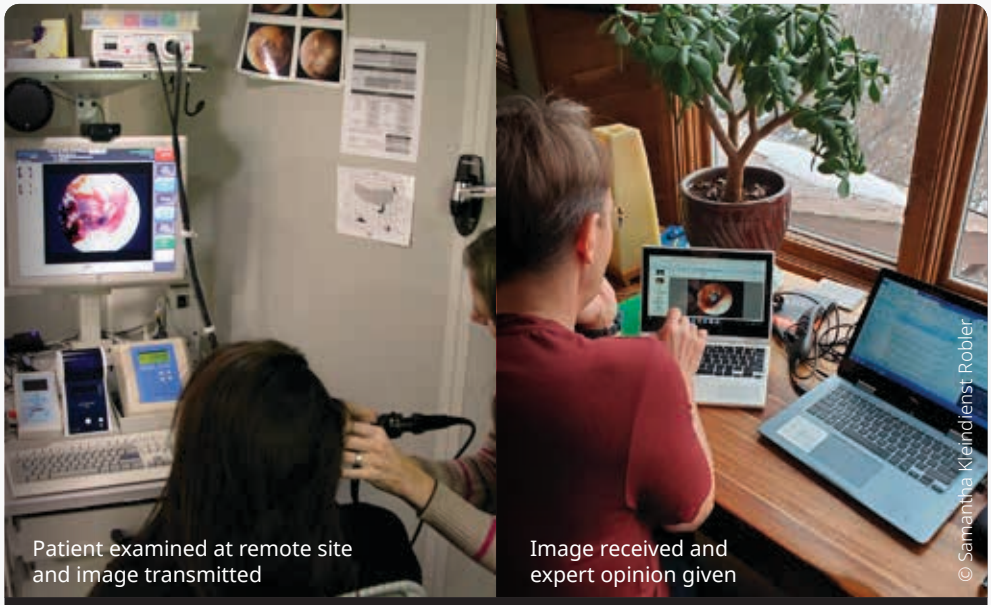
Telemedicine is the delivery of health-care services by health professionals in settings where distance is a critical factor. Telemedicine services use information and communication technologies for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health-care providers – all in the interests of advancing the health of individuals and their communities.

Key benefits

The principal services telemedicine offers in terms of remote assistance, include teleconsultations for remote diagnosis, treatment, follow-up, and monitoring. These are provided through the use of tools such as mobile or landline telephone, video, devices connected over the Internet, chat platforms, mobile apps or Internet based digital platforms (e.g. Skype or email) for telemedicine.

Beyond clinical service provision, telehealth services are also relevant for:

- distance learning for professionals to facilitate continuing education and training;
- evaluation and collaborative research networks to share best practices and build knowledge; and
- administrative management, for example billing services.



Ear and hearing care services reach the rural parts of Alaska through use of telemedicine

Key considerations

When developing telemedicine, it is important that the service should:

- respond to a clearly perceived need;
- put the patient at the centre of the service;
- have a clear, accountable governing structure, and ensure political commitment;
- engage national stakeholders in planning and setting priorities;
- elaborate and implement a strategic plan for integration into the overall national digital health vision, in line with the existing national digital health policy or strategy;
- establish collaboration with all participating organizations and scientific institutions;
- involve health professionals who will use the new service in its development;
- verify cultural predisposition towards telemedicine in the population served;
- ensure that the technology to be implemented is functional, user-friendly, accessible for all, including people with disabilities, and has the potential to be scaled up;
- ensure interoperability across systems to facilitate intergration with the health system and patient health records;
- guarantee effective reimbursement and capitation modalities;
- establish meticulous evaluation mechanisms;
- identify whether there are Accreditation Standards for telehealth that should be considered;[19] and
- ensure establishment of legal, ethical, privacy, and security regulations or frameworks and mechanisms for compliance.

CASE STUDY

Telemedicine brings EHC services to remote parts of Alaska*

Telemedicine has been successfully applied to address the barrier of distance between patients and providers in Alaska, the largest state in the United States *(89, 90)*. In this vast, remote state, 75% of communities are not connected to a hospital by road, necessitating travel by plane to be seen by a specialist. Population sparsity and a low ratio of doctors to residents further contribute to delays in care.

[19] In this context and where necessary, governments and other implementers can engage with the International Society for Telemedicine & eHealth (ISfTeH): https://www.isfteh.org/.

To address these challenges, tribally owned health-care systems across the state have developed a network of village health clinics where community health aides (CHAs) provide basic health care in remote communities that otherwise would not have direct access to doctors or nurses *(91)*. The Alaska telemedicine network, which spans over 250 communities across the state, supports CHAs with specialty triage for all types of health concerns. This system allows specialists to make treatment plans for patients remotely, directing care provided locally by CHAs and determining when travel to a regional or tertiary care hospital is required for an in-person visit, imaging, or surgery *(92, 93)*.

Most telemedicine encounters are completed asynchronously and thus require minimal bandwidth, an important feature in remote communities that may not have reliable Internet access. For ear and hearing care, otoscopic images, history, and basic testing are transmitted from village health clinics to specialists, who return a treatment plan to the CHA within hours. Telemedicine consultation for ear and hearing care has been validated as equivalent to in-person examination and has reduced average waiting times for specialty appointments by 8 weeks *(94–97)*. As a result, service provision by the CHAs with telemedicine support is now standard practice for ear and hearing care across the state, from management of middle ear disease to pre-operative planning and postoperative follow-up.

Most recently, the Alaska telemedicine network is being expanded from clinical care to include school-based preventive services. Telemedicine is used in prevention, to connect children who are referred through school hearing screenings to specialized triage to reduce loss to follow-up, a problem faced by screening programmes worldwide *(98)*. This is important for Alaska Native children who experience high prevalence of infection-related hearing loss *(99)*. These telemedicine-based models for clinical care and prevention have implications for remote communities globally, where specialists are often located in cities far from patients who need them.

**Source:* narrative contributed by Dr Susan Emmett, Duke University, USA

3.4.2 HUMAN RESOURCES

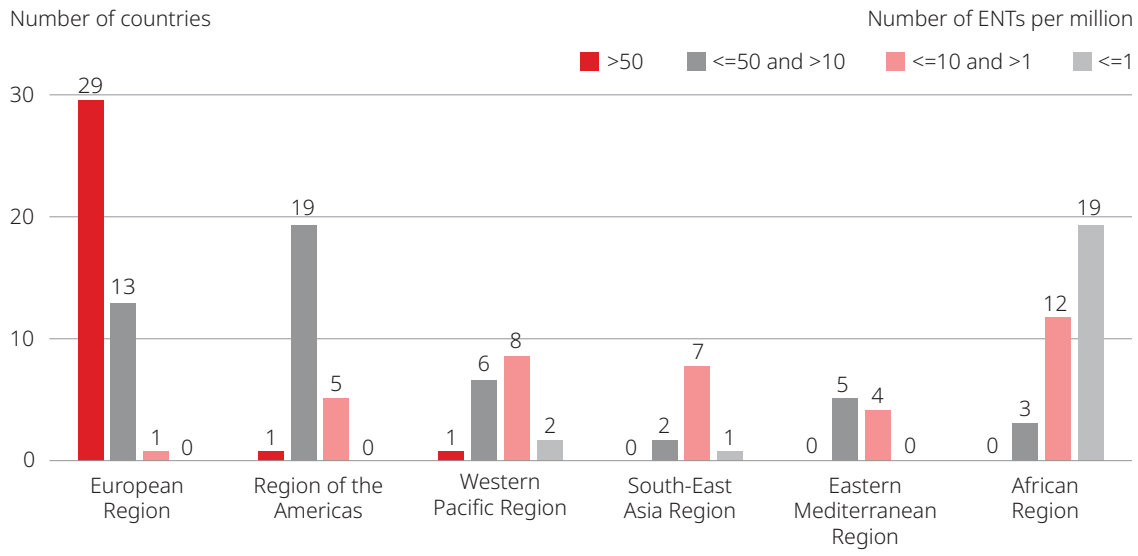
Ensuring equitable access to the required services depends on a trained health workforce that provides ear and hearing care for different ages and across all care levels. The lack of an appropriately trained workforce is a barrier to improving access to services. The WHO report, *Multi-country assessment of national capacity to provide hearing care*, published in 2014 *(100)* revealed substantial gaps in the availability of EHC professionals such as ENT doctors, audiologists and speech therapists. Updating the available information on the basis of published data and survey responses revealed no major changes in the situation. The results of these

analyses are shared below, with reference to some of the main service providers commonly engaged in diagnostic, therapeutic and rehabilitative services for people with hearing loss *(101)*.

EAR, NOSE AND THROAT SPECIALISTS[20]

ENT professionals provide specialist care in addressing ear disease, and are most commonly referred to for conditions affecting ears and hearing. Significant differences in the availability of ENT specialists are observed across WHO regions and income levels. As described in Figure 3.5a, approximately 56% of all countries in the African Region have fewer than 1 ENT specialist per 1 million population, in comparison with 67% of countries in the European Region which has more than 50 specialists per 1 million population. In terms of income level, 78% of low-income countries have fewer than 1 ENT specialist per 1 million, whereas 95% of high-income, and 69% of upper-middle-income countries have more than 10 ENT specialists per 1 million population (Figure 3.5b). The map presented in Figure 3.5c shows the availability of ENT specialists in all 138 countries for which data were available.

Figure 3.5a Density of ear, nose and throat (ENT) specialists among WHO regions



[20] "ENT specialist" (or otolaryngologist) refers to medical doctors who have received training in the management of diseases of the ear, nose and throat, through a recognized degree or diploma course.

Figure 3.5b Density of ear, nose and throat (ENT) specialists across World Bank income groups

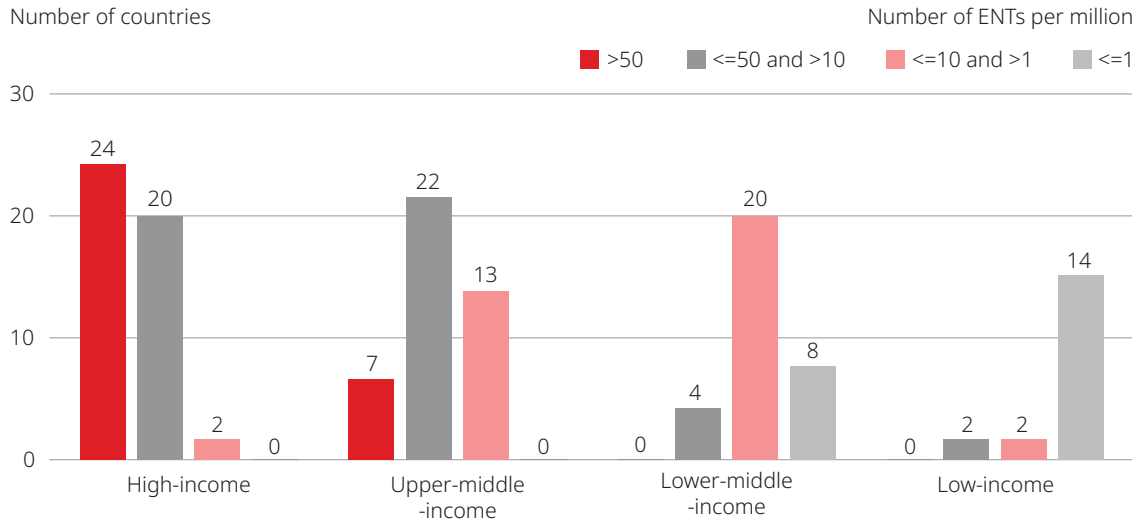
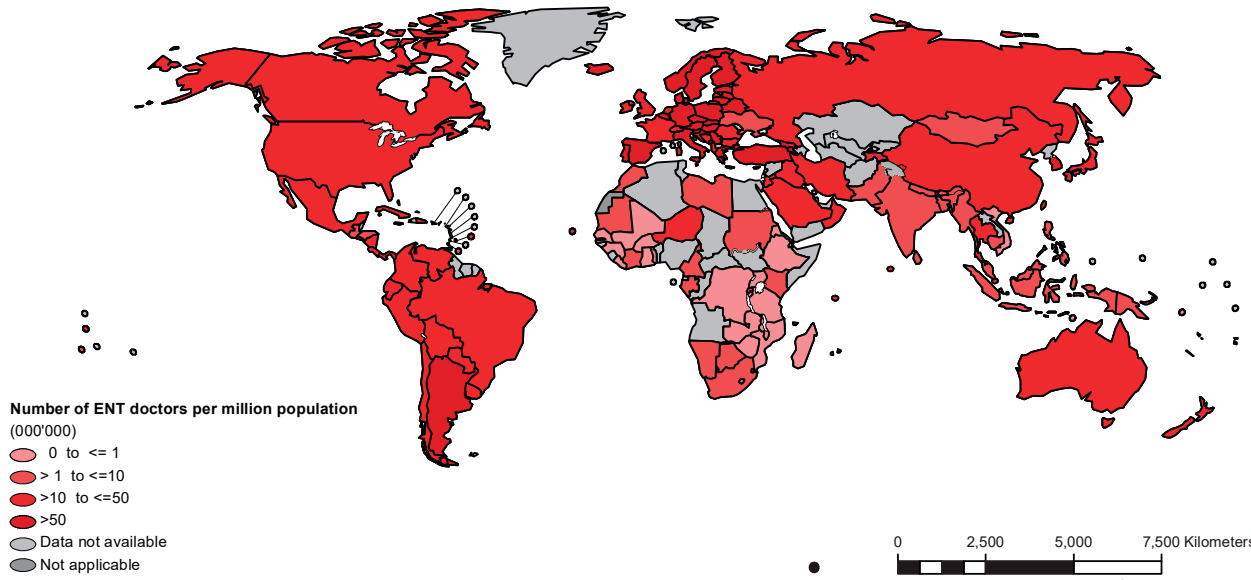


Figure 3.5c Availability of ear, nose and throat (ENT) specialists in 138 countries for which data were available



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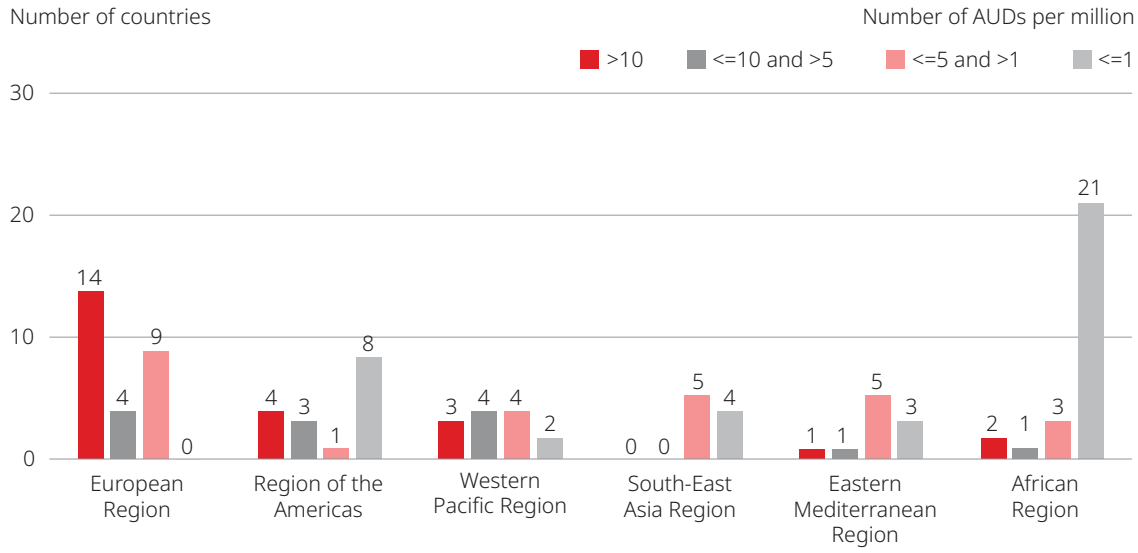
Data Source: WHO Ear and Hearing Care Workforce Poject
January 2020 update
Map Production: WHO BDD unit
World Health Organization

World Health Organization

AUDIOLOGISTS[21]

Audiologists provide specialist care in diagnosing and addressing hearing loss through hearing technology. The availability of audiologists is lowest in the WHO African Region where 78% of countries have fewer than 1 audiologist per 1 million population. The highest availability is seen in the European Region, where 52% of the countries have density of more than 10 audiologists per 1 million population (Figure 3.6a). In terms of income level, the difference between high- and low-income countries is substantial. As shown in Figure 3.6b, 65% of high-income countries have more than 10 audiologists per 1 million population, compared with 93% of low-income, and 76% of lower-middle-income countries which have fewer than 1 audiologist per 1 million. Figure 3.6c presents a map with the availability of audiologists in all 102 countries for which data were available.

Figure 3.6a Density of audiologists (AUDs) among WHO regions



[21] "Audiologist" refers to a person having undergone a recognized degree or diploma course in audiology.

Figure 3.6b Density of audiologists (AUDs) across World Bank income groups

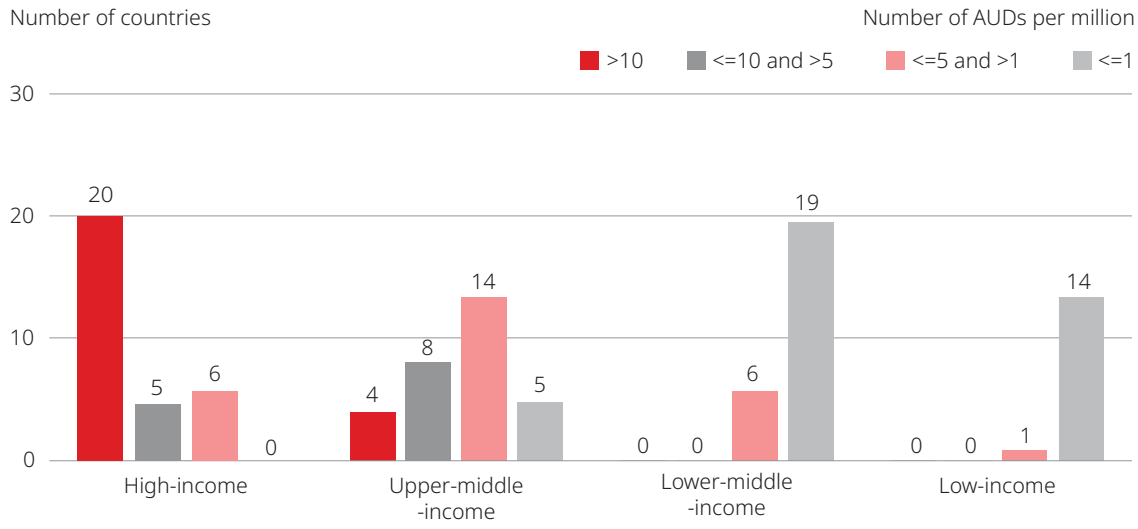
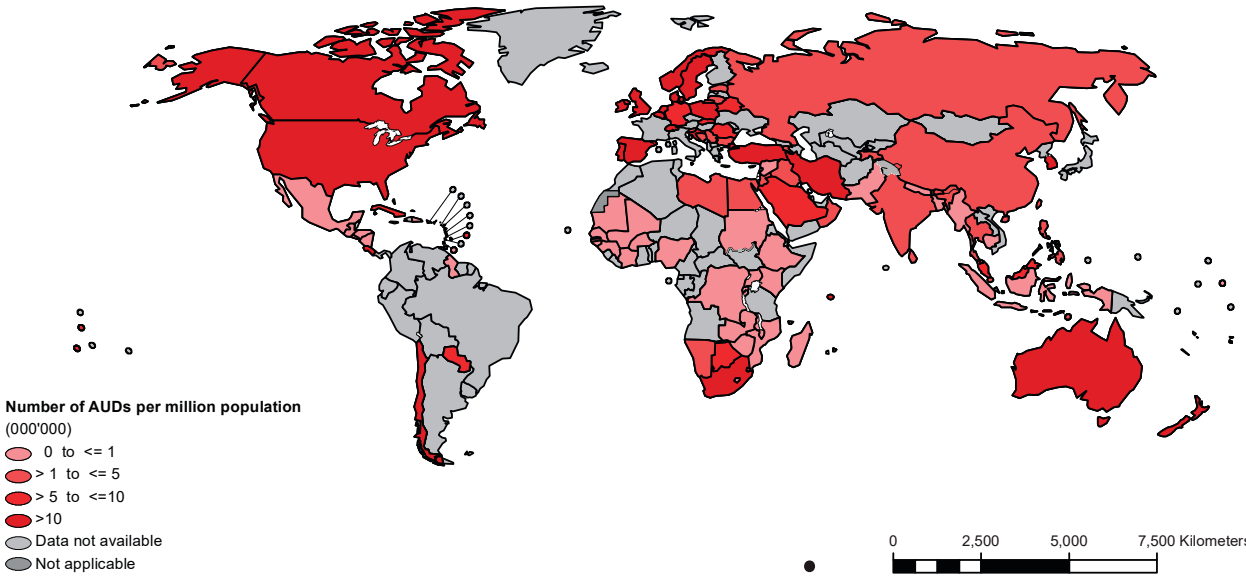


Figure 3.6c Availability of audiologists (AUDs) in 102 countries for which data were available



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Data Source: WHO Ear and Hearing Care Workforce Poject
January 2020 update
Map Production: WHO BDD unit
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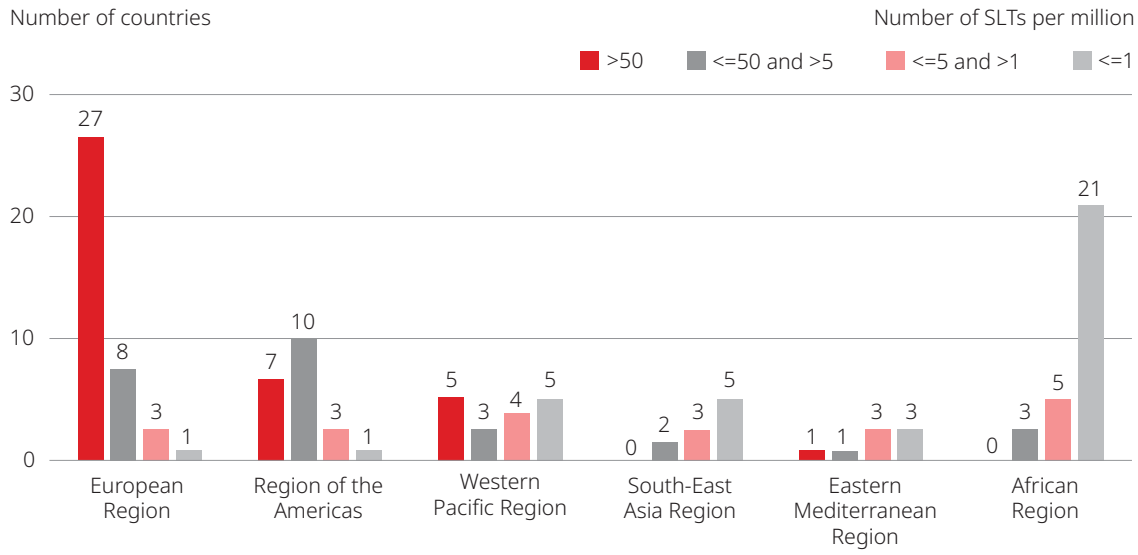
SPEECH THERAPISTS[22]

This specialist cadre is most commonly involved in the provision of rehabilitative therapy for people with hearing loss. Among WHO regions, the highest density of speech and language therapists is observed in the European Region, where 69% of countries have more than 50 speech and language therapists per 1 million population, followed by the Region of the Americas with 33%. The lowest density is observed in the African Region, where 72% of countries have fewer than 1 speech and language therapist per 1 million population (Figure 3.7a). In terms of income level, Figure 3.7b shows 79% of high-income countries having densities of 50 or more specialists per 1 million, whereas 87% of low-income countries and 66% of lower-middle-income countries have fewer than 1 speech and language therapist per 1 million. Figure 3.7c presents a map with the availability of speech and language therapists in all 124 countries for which data were available.

Figure 3.7a Density of speech and language therapists (SLTs) among WHO regions



[22] "Speech therapist" refers to a person having a recognized diploma or degree in speech therapy. (In some countries, speech therapy is a part of audiology training.)

Figure 3.7b Density of speech and language therapists (SLTs) across World Bank income groups

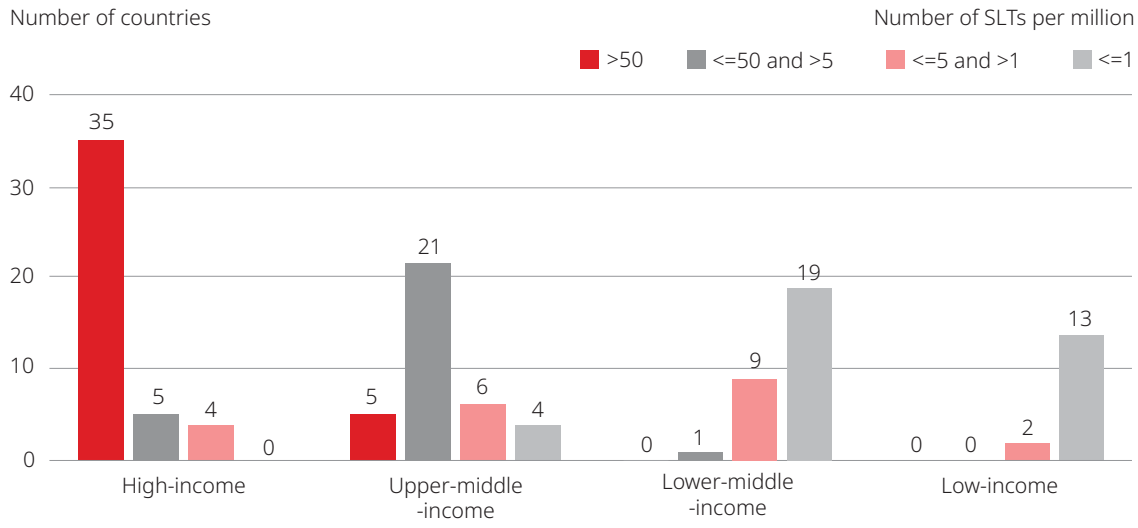
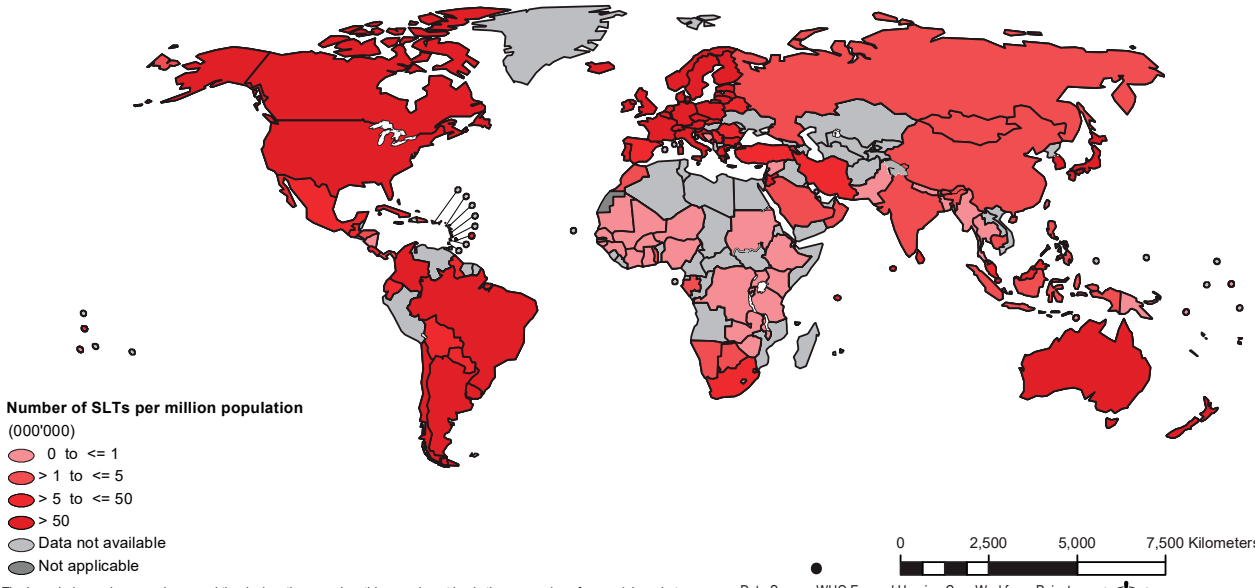


Figure 3.7c Availability of speech and language therapists (SLTs) in 124 countries for which data were available



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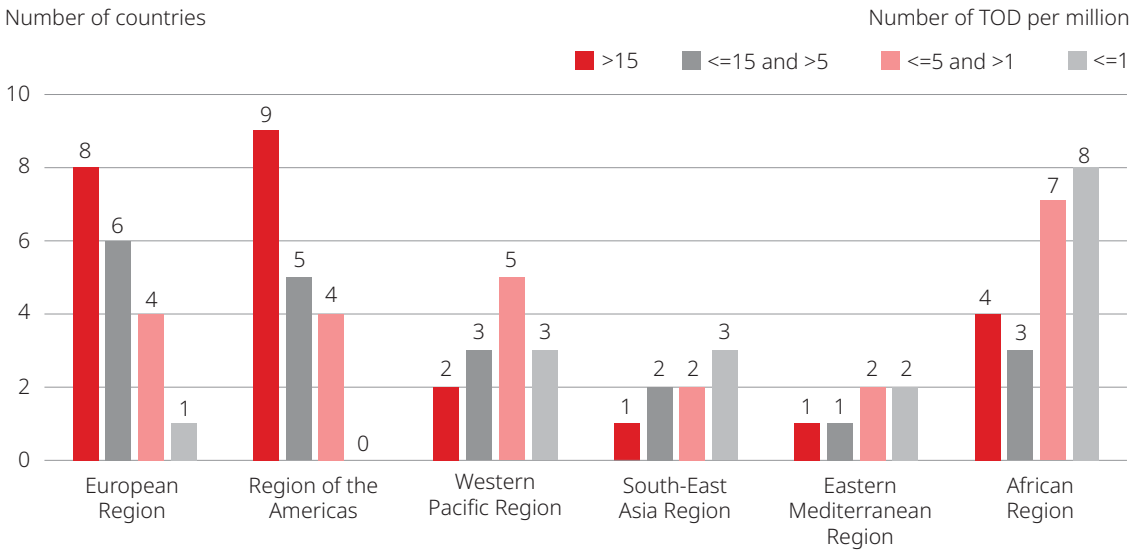
Data Source: WHO Ear and Hearing Care Workforce Poject
January 2020 update
Map Production: WHO BDD unit
World Health Organization

World Health Organization

TEACHERS OF THE DEAF[23]

Teachers of the deaf are specially trained to address the educational needs of students in schools who are deaf and hard of hearing. As shown in Figure 3.8a, the highest density of teachers of the deaf is observed in the Region of the Americas and the European Region with 50% and 42% of countries, respectively, having more than 15 teachers of the deaf per 1 million population. The lowest availability is observed in the African Region with 35% of countries having fewer than 1 specialist per 1 million population. Among high-income, and upper-middle-income countries, 38% in the Region of the Americas and 44% in the European Region have more than 15 specialists per 1 million population, compared with low-income countries, where 50% of countries have fewer than 1 teacher of the deaf per 1 million population (Figure 3.8b).

Figure 3.8a. Density of teachers of the deaf (TOD) among WHO regions



[23] A "teacher of the deaf" is a qualified teacher with the skills and knowledge required to provide quality teaching to mainstream learners and with the additional mandatory qualification and expertise in teaching deaf learners.

Figure 3.8b Density of teachers of the deaf (TOD) across World Bank income groups

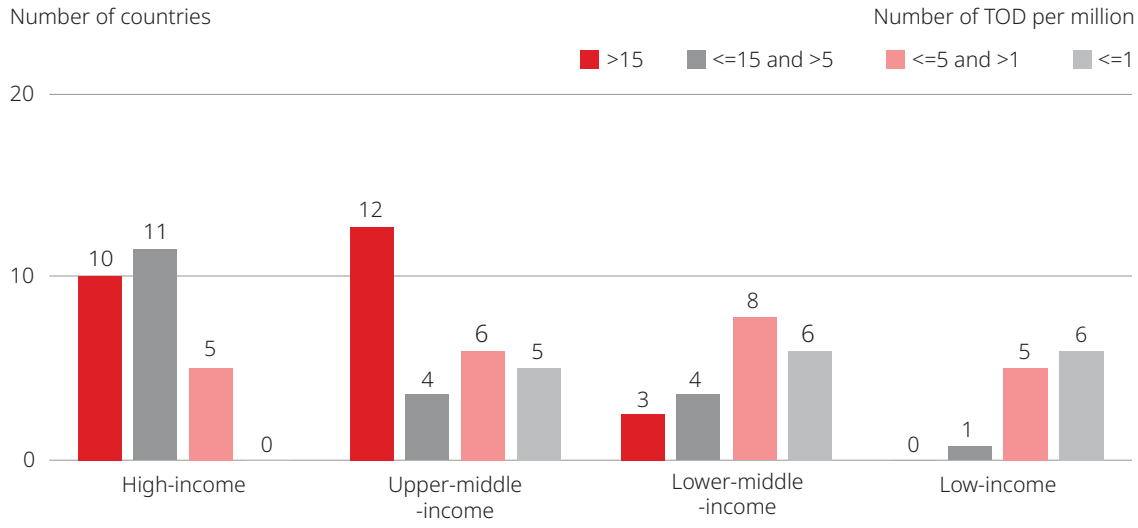
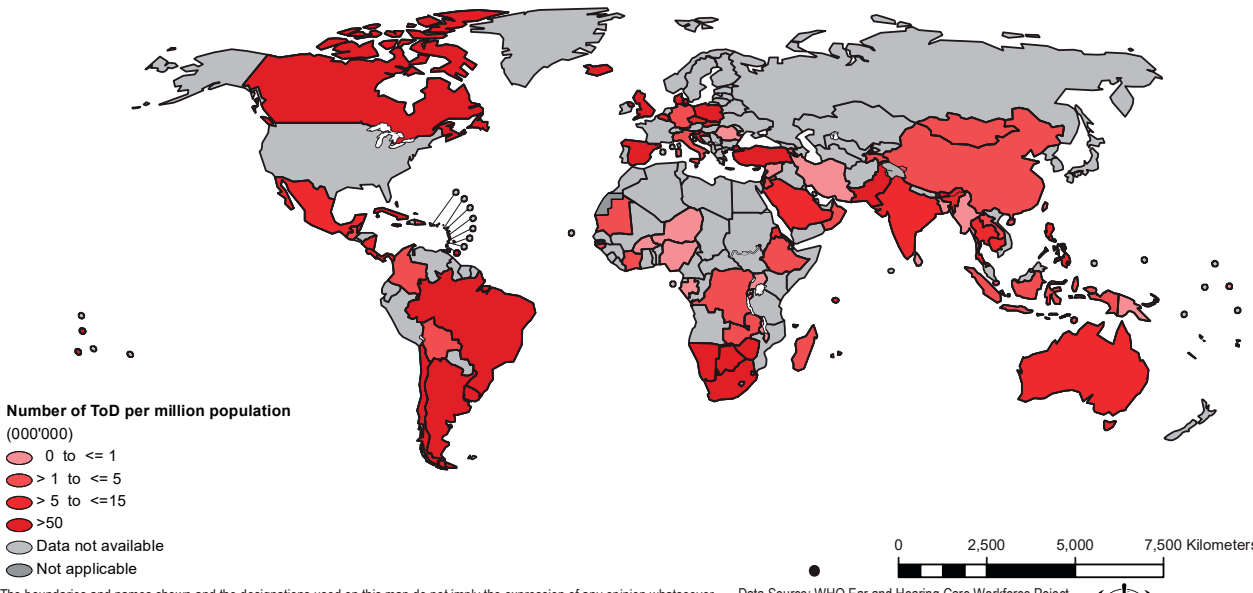


Figure 3.8c Availability of teachers of the deaf (TOD) in 86 countries for which data were available



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Data Source: WHO Ear and Hearing Care Workforce Poject
January 2020 update
Map Production: WHO BDD unit
World Health Organization

World Health Organization

Besides the cadres of service providers described above, many others play a significant role in the provision of hearing care; these include audiometrists, audiology technicians, hearing aid dispensers, rehabilitation specialists, and community health workers. Analyses of these service providers are not given in this report, primarily due to shortage of data and inconsistency in nomenclature. Nonetheless, study results clearly indicate large variations in EHC human resource availability, with significantly low ratios of population to service providers in many parts of the world.

CASE STUDY

Availability of EHC workforce in sub-Saharan Africa, Latin America and South-East Asia *(69, 102, 103)*

Several studies conducted in different regions of the world highlight the immense global shortage in the EHC workforce. A study based on data from 22 countries in sub-Saharan Africa showed that all countries except South Africa have fewer than 1 ENT specialist, audiologist or speech and language therapist per 100 000 population. Some countries, for example Burundi and Malawi, have no practicing speech therapists. Comparisons between 2009 and 2015 showed that although the total number of specialists has increased during this period, when taking into account population growth, the ratio of ENT specialists to the population has actually declined in some countries, and the severe shortage in professionals remains.

In Latin America, a study showed more than a 30-fold difference in the ratio of ENT specialists across countries – from 2.8 ENTs per million in Guatemala, to 61 in Argentina. In all countries studied, density of ENTs was concentrated primarily in capital areas and large cities, with rural areas disadvantaged. In Paraguay, for example, the density in the capital area was 148.8 ENT specialists per 1 million population, with only 4.1 per 1 million in the remainder of the country. In South-East Asia, a WHO report revealed that all countries except Thailand, with 2.68 ENT specialists per 100 000, had densities of fewer than 1 specialist per 100 000 population. The number of audiologists, audiometrists, speech and language therapists and sign language interpreters was even smaller, with all countries having 0.5 or fewer professionals in each category per 100 000 population. Across the region, the number of teachers of the deaf was higher than in other EHC cadres; Bhutan, for example, had a ratio of 2.73 teachers of the deaf per 100 000 population, and Thailand 1.49 per 100 000.

GAPS IN THE EAR AND HEARING CARE WORKFORCE: CONTRIBUTING FACTORS, IMPACT AND SOLUTIONS

To assess the true impact of the gaps and shortages in human resources within ear and hearing care and estimate the burden posed on existing professionals, WHO ran scenarios, taking examples from real-life situations. The scenarios were developed using the WHO Workforce Indicator for Staffing Needs (WISN) tool, and provided a very conservative indication of the gaps between human resources that are currently available and those that are required to undertake five common EHC interventions: ear examination and cerumen cleaning; hearing assessment; hearing aid fitting; post hearing aid fitting counselling; and diagnosing common ear conditions such as acute or chronic otitis media in children. Examples of gaps in these EHC interventions in selected countries are summarized in Box 3.2.

The principal factor contributing to these gaps may be the lack of adequate educational and training opportunities for the development of the relevant cadres of service providers. Substantial gaps in educational opportunities for hearing care professionals were reported by WHO as being most pronounced in low- and middle-income countries of the world *(100).* Even in countries where human resources for the provision of health-care services and hearing care are available in relatively large numbers, ensuring their equitable distribution is often a challenge. This is due mainly to:

- The concentration of EHC professionals and services in urban areas; urban-to-rural ratios are as high as 36:1 in some countries *(68, 69, 102)*.
- The predominantly clinical approach to ear and hearing care among professionals. Although a clinical approach for person-centred care is essential, it is insufficient for preventing and addressing the problem of hearing loss; the field requires professionals who can deliver high quality services at the individual level, while also addressing the subject at community and public policy levels *(74)*. This requires professionals in the field of ear and hearing problems to be oriented towards the public health aspects of these conditions.
- The lack of standardized terminology regarding the roles and competencies required for the different professional cadres which can create confusion among those working in the field of audiology and speech language pathology *(104)*.

The field of ear and hearing care requires professionals who can deliver high quality services at the individual level while also addressing the subject at interpersonal, organizational, community and public policy levels *(74).*

Box 3.2 Estimating the gaps in the EHC workforce*

1) Diagnosis and management of common ear conditions: Oman and India

WHO estimated, that in Oman, if all persons with wax impaction were to be treated by ENT specialists, at least 137 ENT doctors would be required to provide this service to the 181 000 persons in need of it – 40 more ENT specialists than those currently available. This gap in availability can be quantified as a ratio of 0.7, indicating that Oman has only about 70% of its workforce requirement to provide treatment for people with wax impaction. This is a large underestimation of the true gap, as this scenario assumed that ENT specialists were treating patients with ear conditions only, when in reality this cadre also provides care to persons with diseases of the nose, throat, head and neck. This option is therefore clearly unsustainable, given the current availability of ENT specialists in the country. Since many more GPs are available, the country has invested in training them to provide this service, especially in schools. It was estimated that if ENT specialists in Oman shared some of the activities involved in diagnosis and management of wax impaction with other cadres, up to 47% of their workload would be reduced.

A similar assessment of the city of Delhi, India, showed that 1075 ENT specialists would be needed to identify and diagnose all patients between 0–15 years of age with common ear diseases. Currently, there are fewer than 650 ENT specialists in the city, indicating a ratio of 0.6. The number of GPs available in the city is considerably higher. Hence it may be rational to share these tasks with GPs. Even primary level health workers could play a key role in improving identification of common ear diseases *(55, 102)*. Sharing tasks with other cadres could potentially reduce the workload of ENT specialists in Delhi by 50%.

2) Hearing assessment: Zambia

The role of assessing hearing is typically attributed to audiologists, whose availability is limited in many parts of the world, especially in low- and middle-income countries. In Zambia, it is estimated that, with a population of more than 17 million, over 600 audiologists would be required to undertake hearing assessment of all those who could potentially have hearing loss. Since there is only 1 qualified audiologist and 14 audiometrists serving the needs of the entire country, this poses a major challenge to EHC provision. The ratio between existing and required staff was 0.01, indicating that current availability meets only about 1% of their workforce requirement for assessing people with hearing loss. As part of its efforts to increase access to these services, nurses are trained to undertake hearing tests in addition to their other tasks *(105).* This will lead to the reduction of the workload of audiologists by approximately 48%.

3) Hearing aid fitting: Chile

The role of fitting hearing aids is traditionally attributed to audiologists, although other cadres can be developed or trained to undertake this task *(50, 55, 106)* where needed. WHO examined the availability of hearing aid fitting services in a hospital in Santiago, Chile. A tertiary level centre catering to the health needs of people, the hospital would need 78 professionals to fit hearing aids to all those who are potentially in need. The ratio of 0.01, similar to that observed in Zambia, indicates that currently the hospital meets about 1% of the workforce requirement to undertake this intervention. Since there is currently only one cadre in the hospital, medical technicians trained in hearing aid fitting undertake this role along with hearing testing.

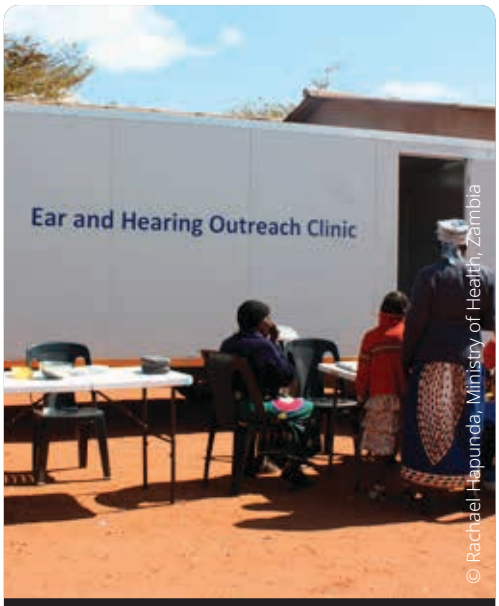
4) Counselling for the use of hearing aids and cochlear implants: Russian Federation

It is important that people fitted with hearing devices are properly instructed in their use and provided with regular counselling, as part of the aural rehabilitation process *(54)*. This role is commonly carried out by audiologists who fit the hearing aids. Although WHO estimated that 932 audiologists would be needed in the Russian Federation to provide this service, in 2018, there were only 389, indicating a gap between existing and required workforce of 0.42. Sharing this task with other cadres, such as speech therapists and audiometrists, could be useful not only in meeting the population's needs but also in reducing the current workload of audiologists by almost 54% *(101)*.

TASK-SHARING AS A MEANS TO ADDRESS GAPS IN THE EAR AND HEARING CARE WORKFORCE

Task-sharing involves the redistribution of clinical tasks, or their key components, among different cadres of health workforce teams. Unlike task-shifting, tasks are not taken from one cadre and given to another, rather additional cadres are given the capacity to take on specific tasks or actions. The appropriate reallocation of tasks, from highly qualified health workers to other health workers with shorter training and fewer qualifications, makes more efficient use of available human resources *(107)*. Tasks traditionally performed by specialists in the field of ear and hearing care can be undertaken by non-specialists, such as community health workers, health aides, nurses and technicians *(50, 55, 102, 106)*.

This approach has been adopted successfully in other areas of health with resource needs *(107–109)*; in the field of ear and hearing care it could improve access to such services as:



Trained nurses provide outreach services in the underserved parts of Zambia

- identification and care for common ear diseases at primary level (for example of ear conditions such as impacted wax; acute and chronic otitis media);
- hearing assessment and screening; and
- hearing aid fitting and post-fitting counselling.

The roles traditionally played by different cadres in ear and hearing care and the possibilities for task-sharing (where traditional cadres are insufficient to serve population needs) are depicted in Box 3.3 and based on currently available models and studies, along with expert input *(50, 55, 69, 106, 110)*.

Incorporating task-sharing must be part of an overall workforce strategy, and collaborative – i.e. driven by all stakeholders, including EHC professionals and other health workers, with the aim of improving access to high-quality services for those requiring them.

When developing a rational workforce strategy, important considerations are: *(50, 55, 106–108)*

- Task-sharing should be implemented alongside other efforts to increase the overall number of health-care providers including skilled workers.
- Task-sharing must be preceded by a situation analysis and assessment of currently available human resources for ear and hearing care.
- Training needs and procedures should be defined, along with quality assurance mechanisms.
- Tasks allocated to different cadres should comply with the health regulations of the country.
- Automated devices or telemedicine may be useful tools in improving the success of task-sharing.

When roles and responsibilities are shared from skilled to non-skilled cadres, supervision and support from ENT doctors or audiologists must be made available, as relevant.

Box 3.3 Task sharing possibilities among different cadres of EHC professionals

	Primary level health workers and nurses*	General practitioners	Audiologists	Ear nose and throat specialists	Speech therapists
Hearing screening	Community level screening and referral			Community level screening	Community level screening
Hearing loss assessment	Audiological diagnosis in adults with recognition of red flags that indicate need for specialized care				Audiological diagnosis in adults with recognition of red flags
Hearing aid fitting	In adults without any red flags			Mainly in adults without red flags	Mainly in adults without any red flags
Hearing rehabilitation	Auditory training and counselling for adults			Auditory training and counselling for adults	
Identification care for common ear diseases (wax, otitis media)	Identification and primary level care in the community, referral	Diagnosis and management of common uncomplicated conditions	Triaging, diagnosis and management of uncomplicated ear conditions		

Traditional roles Possible roles

*includes existing cadres of health workers and other cadres that could be developed to provide care at primary level *(111)*

CHALLENGES CAN BE OVERCOME

The lack of human resources needs to be tackled through innovative workforce strategies to facilitate access to ear and hearing care. Such strategies must focus on:

- Increasing the number of health workforce providing ear and hearing care through:
  - greater opportunities for education and training of relevant professional cadres including ENT specialists, audiologists, speech therapists, sign language teachers, hearing aid acousticians, audiometrists, as per the country's needs *(112)*. Besides establishing relevant educational programmes within the country, innovative solutions such as collaboration with experts outside the country or region is a potential option *(50)*.

  - task-sharing as a means of reducing the need for highly trained professionals and redistributing activities routinely performed by these specialists to different cadres of health workers available in the country *(50, 55, 69, 106)* that have lower training needs.

- Increasing the capacity of the available health workforce engaged in EHC provision:
  - For professionals in the field of ENT, audiology and speech therapy, this could involve including a module that focuses on the public health aspects of ear and hearing problems as part of professional education and training *(39, 44, 113)*.
  - For community and primary level health workers, nurses and others engaged in providing care and raising awareness among the population at large *(50, 106)*, this would require:
    - training for on-the-job learning, to update their knowledge and skills
    - supporting them in service provision through use of technology including m-health and telehealth services *(55, 114)*.

CASE STUDY I

Developing audiology education in China

In the 1990s, China acknowledged the need for specialists in the field of audiology and speech therapy. To address this human resource gap, the China Research and Rehabilitation Centre for Hearing and Speech Impairment established a multipronged approach that included:

1. *Specialized educational programmes*: In 1995, an educational programme to train hearing and speech rehabilitation professionals was started, in collaboration with leading universities in China. To date, over 1000 professionals have been trained, and provide care in national hearing and speech rehabilitation institutions across the country. In the coming years, the China Disabled Persons' Federation aims to found the China Rehabilitation University.
2. *Certification courses*: These were developed in:
   - Hearing aid fitting – those offering hearing aid services and selling devices are trained through a vocational training course to fit and maintain hearing aids. Over 1000 hearing-aid consultants have benefitted from this programme since 2008.
   - Paediatric audiology – this was established in 2009. Professionals employed in national rehabilitation institutions receive this advanced training. To date, over 500 paediatric audiologists have been trained.
3. *Programmes for continuing education*: These were initiated in 2012 to update the knowledge and skills of those already employed in national rehabilitation institutions.

These programmes are commonly undertaken in partnership with leading global universities, and nearly 200 professionals benefit from them each year.

These measures have greatly strengthened China's capacity to provide EHC services including implementation of a newborn screening and early intervention programme at the national level.

CASE STUDY II

Nurses provide ear care in South Tarawa in Kiribati*

A community based nurse-led ear health service for children has been operational on the island of South Tarawa in Kiribati since 2013. Based on "specialist ear nursing" that has been running successfully in New Zealand since the 1970s, this approach has brought EHC services to Kiribati, where a large number of children have discharging perforations accompanied by hearing loss. It is well known that such ear disease, while being easily preventable can, if left untreated, lead to serious medical complications, that cannot be easily managed.

To address this, nurses are trained in ear examination, the appropriate use of the otoscope, management of common ear conditions, hearing screening, and tympanometry. Initially the nurses worked in the three large primary schools of the island covering over 1500 students.

In 2018, the scope of their work was expanded to cover a specialist ear clinic opened at the Tungaru hospital. The clinic was established in response to data received from the emergency department which showed that nearly 25% of people presented with ear problems. Ear nurses are now available at this specialist clinic, providing EHC services three days a week. They are often supported through training and in providing specialized care by specialist teams visiting the island.

During the past six years, because of the regular care provided by ear nurses, the visiting team have seen a dramatic decrease in the chronic ear problems of the students under their care. It is now planned to expand this service to cover all primary schools on South Tarawa.

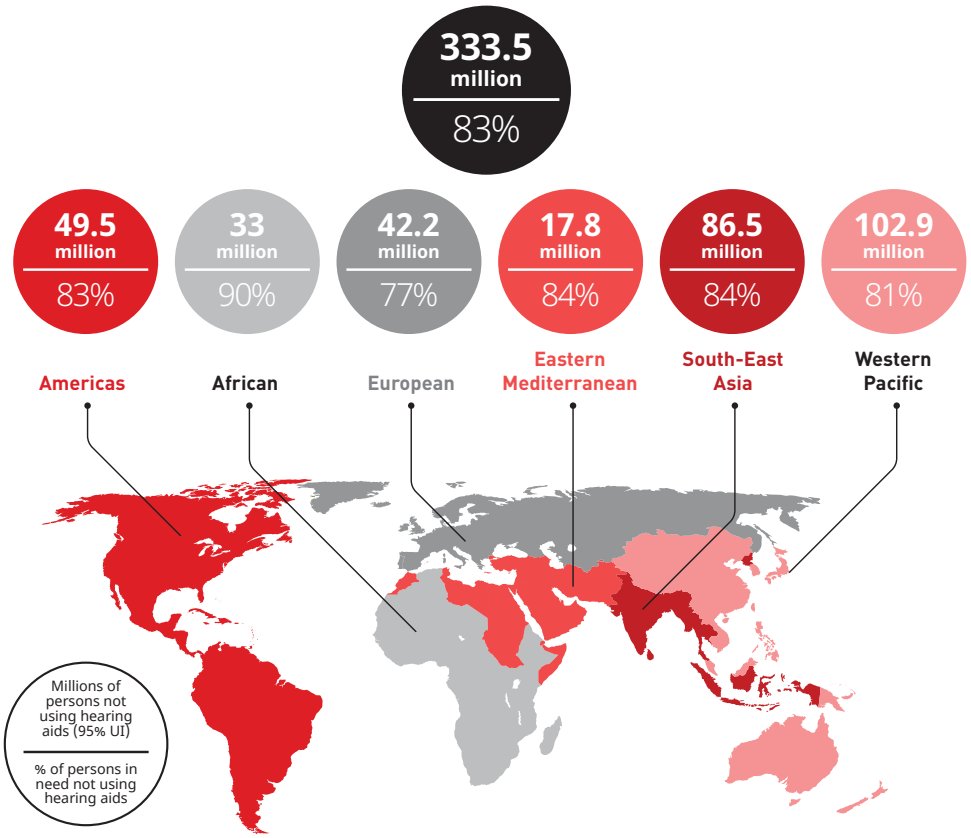
This experience from Kiribati exemplifies how a community-based EHC service delivered by trained ear nurses has the potential to provide low-cost, easily accessible hearing care.

*Source: *narrative contributed by Ms Kahn Bury, nurse trainer, New Zealand*

3.4.3 HEARING TECHNOLOGIES

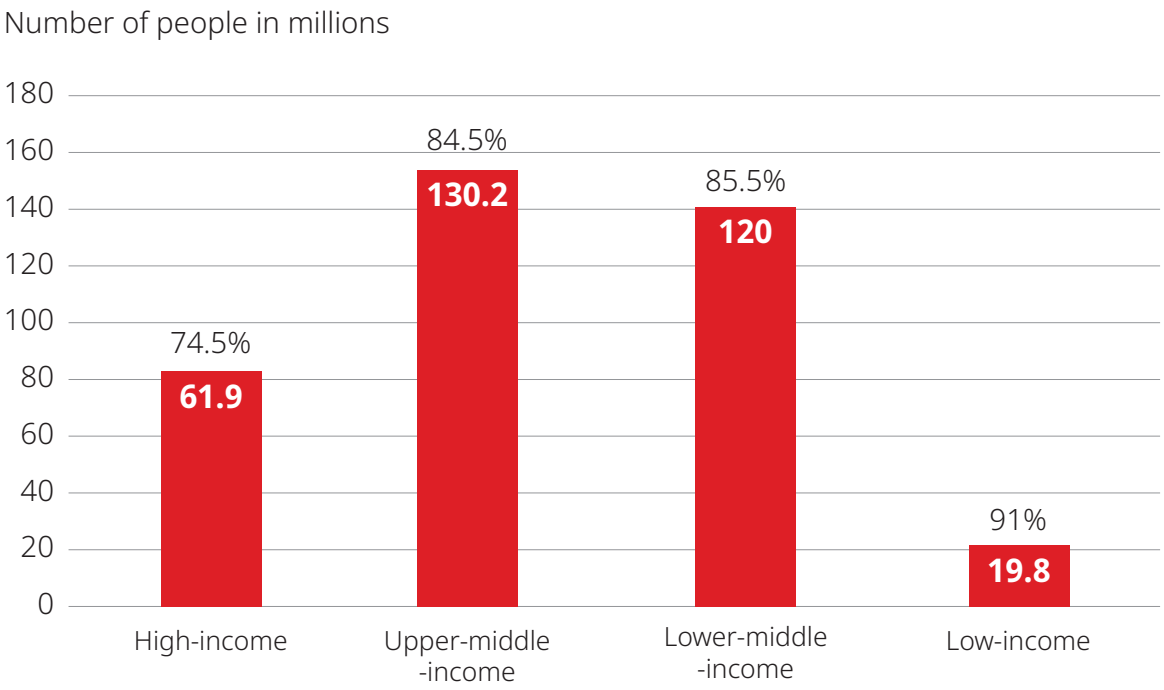
The term "hearing technologies" covers devices such as hearing aids and cochlear implants. WHO estimates that in low- and middle-income countries, less than 15% of those who need assistive devices have access to them *(115)*. The Global Burden of Disease study and WHO estimate that globally over 400 million people would benefit from use of hearing aids *(105)*; of these, fewer than 68 million actually use one, suggesting an existing coverage gap of 83% *(116)*. This gap is lowest in the WHO European Region (77%) and highest in the WHO African Region (90%) (Figure 3.9a). While low-income countries face the highest service gap (91%) with respect to hearing aids, even in high-income countries nearly three-quarters of the population in need of hearing aids do not use these devices (Figure 3.9b).

Figure 3.9a Numbers and percentages of people in need but not using hearing aids among WHO regions



Note: This illustration represents WHO regions, not country boundaries.

Fig 3.9b Numbers and percentages of people in need but not using hearing aids across World Bank income groups



This analysis, based on GBD data, further shows that the use of a hearing aid substantially reduces the disability associated with hearing loss (in terms of YLDs), especially in those with moderately severe, or severe hearing loss. In general, hearing loss accounted for 29 million YLDs, without adjusting for hearing aid use. Accounting for current hearing aid coverage (17%) brought this value to 25.3 million YLDs – i.e. a reduction of 12.6% (13.9–11.5%) in morbidity. It is estimated that if every person needing a hearing aid used one, the burden of disease in this population would be reduced from 25 million to 10.3 million YLDs – a possible reduction of 59% *(115)*.

The limited access to hearing aids is a reflection of the overall challenges which limit access to EHC services and have been outlined throughout this section. In the context of hearing aids, these challenges can be summarized as: (i) high cost of hearing aids; (ii) lack of human resources and services to deliver, fit, maintain and support use of the aids; and (iii) low awareness of and stigma associated with hearing loss.

If every single person in need of a hearing aid used one, the YLDs in this population would be reduced by 59%.

With cochlear implants, there is limited research and data on access and factors limiting their use *(41)*. However, as with hearing aids, issues such as high costs, and shortages of trained workforce and rehabilitation services, have resulted in their restricted accessibility to countries other than those in high-income groups – with considerable variation even within these *(117, 118)*.

CASE STUDY

"There is considerable variation in access to cochlear implantation among children. In a study of five countries, the Flanders area of Belgium estimated pediatric utilization rates at 93% of eligible children. The UK and some European countries are also reaching over 90%. In the United States, about 50% of the children who could benefit receive cochlear implants. This does not look at utilization by adults, which could be lower still." *(117)*

While the issues relating to human resources and services have already been addressed, their importance cannot be overstated. An appropriately trained health workforce is key to delivering hearing technology (See 4.2 of Section 4). However, low levels of awareness limit the uptake of services for assessment and rehabilitation, even in settings where these are available, as is evidenced from the consistently low global use (77–90%) of hearing aids. Even when services are sought, unrealistic expectations of these devices affect their continued use and benefit.

The issue of cost is critical to the use of hearing aids and cochlear implants. Costs vary hugely across the world and even within countries, depending on the device specifications and features. For example, in the United States alone, the price of hearing aids can range between US$ 500 and US$ 3000 *(119)*; the average cost of bilateral hearing aids is US$ 4700 *(71)*. At the same time, low cost devices are available in many places, such as India, where a digital device may sell for as little as US$ 50 *(120)*.

The use of devices often incurs out-of-pocket expenses, even in developed economies where they are easily available *(71)*. Moreover, the costs involve not only the device itself, but also earmolds and batteries, as well as fitting and maintenance services. A study conducted in Nigeria showed that annual costs for hearing aid batteries alone could exceed the total annual income of an average African farming family *(121)*. The cost barrier is aggravated by high import taxes and informal charges levied on medical appliances; and limited access to health insurance *(120)*.

The situation is further complicated by limited competition in this sector: a small number of manufacturers produce 98% of the devices sold globally *(122)* and typically concentrate on products most suitable for developed economies *(120)*.

Availability of affordable, high quality hearing technology is essential for hearing care provision. However, availability and affordability are not, by themselves, sufficient and need to be complemented with innovative approaches and effective service delivery models that can ensure equitable access to these devices and the relevant services that are crucial to their use.

CHALLENGES CAN BE OVERCOME

Addressing the gaps in hearing technology access and use requires a multipronged approach. Hearing aids and cochlear implants should be included as priority assistive products made available as part of government-led services, and their use promoted through:

- Policies that can ensure easy access to high-quality, affordable and safe technologies and services *(55, 123)*, in line with recommendations made in resolution WHA71.8 on improving access to assistive technology *(124)*. This resolution, along with the WHO's Priority Assistive Products List[24] provides concrete direction on inclusion of hearing technologies and related services within national health systems.
- Adopting affordable, high-quality products which comply with WHO recommendations, such as those set out in WHO's *Preferred profile for hearing-aid technology suitable for low- and middle-income countries (125)*.
- Considering newer, game-changing developments in hearing technology (as outlined in Section 2) when deciding on those hearing technologies most suited to a country's needs.
- Validating and implementing effective service delivery models that do not rely exclusively on highly-trained professionals; for example teleaudiology *(126, 127)*; use of self-fitting or trainable hearing aids *(106, 120)*; direct-to-customer services *(128)*; use of ehealth and mhealth platforms *(54, 129)*; and training of locally available manpower *(55)*. Such service delivery models should be adapted to the needs and health system of the country.
- Raising awareness on hearing loss and reducing associated stigma through:
  - communication campaigns that provide accurate and accessible information.
  - strengthening associations of people with hearing loss.
- Reducing costs by adopting measures such as waving import duties or taxes; pooled procurement; use of solar-powered batteries and locally-sourced materials *(120)*; and innovative reimbursement schemes *(55)*.
- Research and innovation in design and delivery of hearing aids and cochlear implants to suit the unique requirements of countries, as well as development of user-driven hearing technologies that reflect the diverse needs of individuals with hearing loss.
- Participation of hearing technology manufacturers in efforts to improve access by leveraging resources for training, and supporting larger numbers of practitioners. Manufacturers also have a role in ensuring their practices are aligned with maximizing access among all sections of society.

[24] https://www.who.int/phi/implementation/assistive_technology/global_survey-apl/en/

CASE STUDY I

Effective service delivery models and regulations can improve access to hearing aids

Active community-based screening and hearing aid fitting improves access and brings cost and health benefits *(130)*. A study conducted in India compared the efficacy of active screening for hearing loss followed by hearing aid fitting in the community, against passive screening and fitting at tertiary level. The study estimated the total costs and effects of these two approaches (i.e. community-based active screening approach versus fitting hearing aids to those who presented themselves for treatment at tertiary level facility). Health effects were estimated on the basis of compliance with the hearing aid, and associated changes in DALYs averted.

It was evident that while both models were cost–effective, active screening followed by hearing aid provision was the slightly more expensive option. However, this moderate difference was adequately offset by the advantages it provided in terms of higher coverage of hearing aid services and greater health benefits as determined by the significantly higher number of DALYs averted through the active screening approach.

CASE STUDY II

Over-the-counter hearing aid delivery can improve access and affordability *(128)*

In recent years, leading health agencies in the United States of America have prioritized provision of over-the-counter (OTC) hearing aids for improving access and affordability of these devices. A randomized control trial compared the "audiology best practice" (AB) model of service delivery with the OTC model and against a placebo. Both the models were efficacious in improving hearing and health outcomes in older adults. The OTC model had only marginally lower outcomes compared with the audiology best-practice model. This slight difference was offset by the potential of the OTC model in increasing accessibility and affordability of hearing aids, especially among older adults and was concluded to be an effective approach for future implementation.

CASE STUDY III

Government policies improve access to hearing technology: an example from the Russian Federation*

In 1991, the Government of the Russian Federation introduced a cochlear implant programme throughout the country, which complemented the existing hearing aid programme. As a result, infants born deaf are now fitted with hearing aids or cochlear implants as required and rehabilitation services are provided. Each year, up to 1100 infants across the country undergo cochlear implantation in six federal centres, financed by the Federal budget.

In addition, people of all ages can access hearing care, including hearing testing, hearing aid fitting and programming in regional audiological centres. Each year, 120 000 hearing aids are provided and paid for through the Federal Fund of Social Insurance. These measures have contributed greatly towards ensuring that people of all ages have access to the hearing care they need.

**Source:* information contributed by Dr George Tavartkiladze of the National Research Centre for Audiology and Rehabilitation, Moscow, Russian Federation; https://www.rosminzdrav.ru/ministry/61/22/stranitsa-979/statisticheskie-i-informatsionnye-materialy/statisticheskie-materialy; https://www.rosminzdrav.ru/open/kollegiya-ministerstva-zdravoohraneniya-rossiyskoy-federatsii/materialy-kollegii-ministerstvazdravoohraneniya-rossiyskoy-federatsii

CASE STUDY IV

Pooled procurement in the United Kingdom makes hearing aids accessible*

Recognizing the benefits of addressing hearing loss at all ages, the National Health Service (NHS) provide free at point of delivery hearing aids (and cochlear implants) to children and adults that require these devices. It is estimated that each year 750 000 hearing aids are fitted by the NHS. To be able to provide high quality devices in an affordable manner, the government has adopted systematic measures that ensure quality and reduce costs. These include:

- establishing the minimum technical specifications for hearing aids;
- testing of all hearing aids and hearing aid manufacturers prior to their acceptance by NHS;
- calling for tenders from manufacturers to achieve best possible technology and lowest possible pricing; and
- establishing a country wide supply chain.

- As a result of these policies, hearing aids are now available to the government at a highly competitive price. This approach has helped reduce the financial implications of hearing aid provision for the Government of the United Kingdom and benefitted people with hearing loss.

**Source:* information contributed by the NHS Audiology Supplies Group (ASG) working with the British Academy of Audiology (BAA).

3.4.4 HEALTH INFORMATION: DATA AND INDICATORS

Access to hearing care services is not only highly variable across countries, but is also poorly measured and documented at country level *(131)*. Indicators on hearing care are mostly not reflected within the health information systems of countries or well reported in literature. Survey data reported by WHO in 2014 *(100)* also shows a lack of epidemiological studies and information regarding prevalence and causes of hearing loss. Even when data are available, their usability can be limited due to differences in survey methods and definitions.

Since reliable information forms the basis for evidence-based policy-making and is a means for measuring progress, its lack poses a significant challenge. Absence of information on ear and hearing care in national health information systems can be considered as both a cause for, and an indication of, its low priority within health systems. The lack of epidemiological data makes it difficult for countries to understand the need for, and relevance of, hearing care, and therefore to include it in their national health plans. Without prioritization and due attention, indicators for hearing loss are not included in the surveillance protocols that feed into health information systems, thus perpetuating a cycle.

CHALLENGES CAN BE OVERCOME

- Reliable data on ear and hearing care can be collected through the use of standardized tools such as the WHO *Ear and hearing survey handbook (132),* and supported by research agencies. Initial valid data that are useful for advocacy, can be gathered relatively easily and at low cost by following approaches such as the rapid assessment of hearing loss (RAHL) survey protocol (see Box 3.4).
- To guide evidence-based decision-making, appropriate indicators for ear and hearing care should be included in the health information system of countries to provide a "synthesized" view of existing conditions and trends *(133)*.

Box 3.4 WHO efforts to standardize data collection

The following WHO tools can be used at health system level both for research, and to address the substantial gaps in data and information anticipated in the coming years:

Indicators for monitoring provision of EHC services (134): This set of 14 core and 21 supplementary indicators supports the collection of consistent health system level indicators and provides a standardized measure to gain an overview of progress being made by countries in the field of ear and hearing care.

Ear and hearing survey handbook (132): This WHO handbook provides guidance for undertaking a population-based prevalence study of hearing loss. The use of a standardized data collection methodology facilitates use of locally-gathered epidemiological data for regional and global estimates. The handbook includes an RAHL survey protocol which provides an easy and inexpensive method of assessing hearing loss prevalence.

3.4.5 GOVERNANCE AND FINANCING

It is important that governments take leadership in setting strategic direction and implementing policies that address hearing loss in an integrated manner through their health systems, as with any other health condition. Lack of governance and leadership in the field of ear and hearing care is evidenced by the absence of national strategies or national committees addressing this in countries across all regions *(100)*. This is despite the fact that a number of WHO Member States have initiated or accelerated action in this area of care, especially following the adoption in 2017 of the World Health Assembly resolution on prevention of deafness and hearing loss *(1)*.

The lack of leadership and governance is attributed to the lack of political attention, low perceived priority of hearing loss as a public health issue, and the lack of financial resources due to competing health priorities *(100)*. Despite the high impact of hearing loss, availability of cost–effective interventions, and WHO-led global action, the challenge of limited financial resources to address hearing loss persists at global and country level *(131)*.

CHALLENGES CAN BE OVERCOME

- Tailored communication and advocacy can be effective drivers for policy formulation *(43, 135*). Such advocacy has to be undertaken at global, regional and national levels and be based on facts and figures supported by evidence *(136)*.
- Overcoming the challenges of limited finances and political commitment requires a multipronged approach that focuses on: (i) defining a common global vision and marshalling international resources to support ear and hearing care *(131)*; (ii) integrating EHC services into health-care services across the life course *(55)*; and (iii) adopting innovative solutions and technology that can reduce costs *(55, 131)*.

Strategy development for ear and hearing care in Tunisia

CASE STUDY I

WHO accelerates global action for hearing care through advocacy

Since 2011, WHO has promoted World Hearing Day *(137)* as an annual advocacy event that highlights the importance of, and need for, ear and hearing care. Observed with a unique theme each year, World Hearing Day has been successful in engaging the efforts of different stakeholders across all WHO regions. Several events are organized in countries across the world in an effort to create awareness on ear and hearing care within the population at large and with policy-makers. It is also an opportunity to undertake screening and provide services to targeted sections in the community. In 2020, nearly 600 events from 107 countries were registered for World Hearing Day, marking the growing relevance of this public health field.

In 2018, in continuation of its advocacy efforts and to strengthen these through collaborative multistakeholder action, WHO launched the World Hearing Forum (WHF) *(138)* as a global advocacy alliance developed with partnership of all sectors engaged in ear and hearing care. WHF advocates for prioritization of hearing care and implementation of the World Health Assembly resolution WHA70.13 for prevention of deafness and hearing loss. The alliance defines the overall vision of global action for hearing loss. By gathering all stakeholders into one united front, the Forum hopes to have sustained and consistent advocacy that will result in greater prioritization of hearing care by public health agencies and governments.

CASE STUDY II

Pakistan prioritizes ear and hearing care in response to World Health Assembly resolution WHA70.13*

In 2017, the World Health Assembly resolution WHA70.13 on prevention of deafness and hearing loss, urged Member States to prepare national plans for the prevention and control of major causes of hearing loss, and for its early detection and management within the framework of health systems. Acting in response to this, the Government of Pakistan initiated actions and included provision of hearing aids free of cost to all its citizens, and a limited number of cochlear implants for deaf children. Steps are currently underway to launch the largest National Newborn Screening Programme, the implementation of which will ensure early identification of hearing loss, with the aim of ensuring prompt rehabilitation, so that every citizen of the country including those with hearing loss, have the opportunity to realize their highest potential.

**Source:* narrative contributed by Dr Maryam Mallick, Technical Advisor, WHO Pakistan

CASE STUDY III

Kenya responds to the call of the WHA resolutions for ear and hearing care

Responding to the call of the World Health Assembly resolutions on hearing loss adopted in 1995 and 2017, the Government of Kenya launched the national EHC strategy in 2016. The first step taken was to set up a national EHC technical working group and carry out a detailed situational analysis using the WHO EHC situation analysis tool. Based on this analysis, a comprehensive plan was outlined for a healthy and productive nation free from preventable hearing loss. Since the launch of the strategic plan, a number of concrete steps have been taken for its implementation across the different counties of Kenya:

- The national government has recognized the cadres of audiologists and speech therapists, providing a pathway for these cadres within the public service domain.
- Provision of hearing aids has now been included as a benefit under the national insurance fund.
- Concerted efforts are continually being made to improve the infrastructure and human resource availability for ear and hearing care in public and private sector facilities.

Besides these, the country also serves as a reference point for other countries in the East and Central African region, playing a pivotal role in training of the EHC workforce as well as development of national strategies in seven neighbouring WHO Member States.

CASE STUDY IV

Nongovernmental sector plays a role in improving access to ear and hearing care*

Nongovernmental organizations can play a significant role in supporting governments in the planning and provision of ear and hearing care. All Ears Cambodia (AEC) is an example of a local nongovernmental organization that has been working in partnership with the government for seventeen years to provide specialist ear and hearing care services to over 28 000 people in need of these.

Services focus on primary ear health care, treatment of ear infections in children, hearing testing and hearing aid fitting. Nine outreach clinics bring ear and hearing care services to remote and scattered villages in the country. The organization also supports the development of technical guidance and materials and conducts educational programmes in community and local schools to prevent hearing loss and change existing attitudes.

* *Source:* narrative provided by Glyn Vaughan of All Ears Cambodia

CASE STUDY V

Advocacy in the WHO African Region drives policy formulation in Madagascar*

In 2018, to promote action on ear and hearing care in response to resolution WHA70.13, 11 African countries came together with WHO and key non-state actors in the field to form the "Regional EHC forum for Central, East and Southern Africa". The Government of Madagascar was a part of the Forum and, based on the outcomes, established a national Ear and Hearing Care Committee in partnership with the international NGO, CBM.**

During 2019, under the leadership of the Ministry of Health (MoH) of Madagascar, a situation analysis was conducted, along with strategic planning, using WHO tools and guidance. The Government of Madagascar is now collaborating with multiple stakeholders to develop a national strategy for ear and hearing care, within the service of the Eye, Hearing and Oro-Dental Health. As a first step in this direction, the MoH led an awareness campaign for ear and hearing care on 3 March 2020 with nationwide activities to highlight hearing loss. The EHC national strategy, in its five-year phase, will ensure access to quality EHC services in 15 regions of Madagascar through health system strengthening, training and capacity-building at all levels of care.

**Source:* information contributed by Dr Diego Santana of CBM

**https://www.cbm.org

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Collaborative action can transform health systems*

*Contributed by Karen Mojica of Mayflower Medical Outreach, and Joaquin Escoto of the Ministry of Health, Nicaragua

At the time we started policy discussions on ear and hearing care in Nicaragua only two hospitals in the capital city provided any services for identification and management of ear and hearing problems. Surgeries for treating common ear diseases were infrequently done. People commonly had to travel far and wait long periods of time just to get a diagnosis of otitis media.

Having launched a national programme for people living with disabilities 'Todos con Voz', the Ministry of Health, along with WHO, international NGOs and local professional groups, in 2012 developed a comprehensive strategy to integrate ear and hearing care. Taking immediate steps, 59 doctors and nurses were trained in EHC, who further trained 1300 health workers, nurses and doctors to deliver services at the community level.

In parallel, infrastructure was developed at all levels of care provision. Over the years, basic ear and hearing care services have been established in 15 of the 19 SILAIS, with clinics run by ENT specialists and audiometric technicians. Surgical services were strengthened at the secondary and tertiary levels. Over the last six years, more than 18 000 audiological tests have been conducted and over 13 800 individuals have benefited from the programme. In 2017, the first national newborn screening programme was launched. Nearly a thousand babies are already receiving rehabilitation though this programme.

We have come a long way, but still have much more to do. We believe that it is the united efforts of all stakeholders that has made it possible for us to provide the ear and hearing care services the country so badly needed.

Joaquin Escoto, programme manager,
Todos con Voz, Ministry of Health, Nicaragua

SECTION 4

DESIGNING THE WAY FORWARD: A PUBLIC HEALTH FRAMEWORK FOR EAR AND HEARING CARE

WHO's mission in the field of ear and hearing care: "Make ear and hearing care accessible for all".

4.1 OVERVIEW

- Universal health coverage (UHC) is the key to achieving Goal 3 of the Sustainable Development Goals (SDG3) by 2030. SDG3 requires that all people, including those with hearing loss and ear diseases access quality and affordable services without suffering financial hardship.
- Access to ear and hearing services is summarized in the term "Ear and hearing care", which refers to a broad range of services for health promotion, prevention, identification, management and rehabilitation, delivered through national health systems, and that address ear and hearing conditions at all stages throughout the life course.
- The scope of ear and hearing care extends beyond health systems, covering access to education and communication as well as other support required for persons with hearing loss and their families. This is achieved through multisectoral collaborative action, in line with the principles of integrated people-centred ear and hearing care (IPC-EHC).

- Key public health interventions for EHC provision across the life course are summarized in the acronym "H.E.A.R.I.N.G.": **H**earing screening and intervention; **E**ar disease prevention and management; **A**ccess to technologies; **R**ehabilitation services; **I**mproved communication; **N**oise reduction; and **G**reater community engagement.
- Implementing H.E.A.R.I.N.G. interventions can significantly benefit countries. Annually, US$ 1.33 per capita additional investment is required into the health system to scale up the identification, treatment, and rehabilitation of ear and hearing problems. Over a 10-year period, this promises a return (or gain) of nearly US$ 16 for every 1 dollar invested.
- Making this investment over a 10-year period has the potential to benefit nearly 1.5 billion people across the world, avert 130 million DALYs, and bring productivity benefits of over US$ 2.4 trillion.
- Each country must determine which H.E.A.R.I.N.G. interventions best suit its needs through an evidence-based consultative prioritization exercise. Implementation must occur through an IPC-EHC approach and ensure that people receive a continuum of EHC services across the life course, delivered through a strengthened health system.
- The vision of IPC-EHC encompasses services that empower individuals and communities; strengthen governance and accountability; reorient the model of care by prioritizing ear and hearing care at primary and community levels; are coordinated within and across sectors; and create an enabling environment.
- The provision of IPC-EHC services requires action at all levels of the health system through:
  - *Leadership and governance*, for ensuring equitable access to EHC services at all levels of health-care service provision through: policy guidance and planning; collaboration and coalition-building across sectors; regulations including their enforcement; and oversight.
  - *Sustainable financing and social protection*, so that people can access quality EHC services, and are protected from financial catastrophe or impoverishment associated with having to pay for them.
  - *A competent, motivated and empowered health workforce,* which is essential for the effective provision of quality EHC services. Given the current shortages in the EHC workforce, this requires comprehensive steps including: scaling up and financing education programmes for the EHC health workforce; task-sharing through the training of other (non-EHC) cadres of health workers; and organizing health workers to deliver services at all levels of care.

- *Robust health information systems* that support IPC-EHC, and help to determine population needs and priorities; identify gaps in health systems' capacity; and report progress. This requires the setting of realistic and time-bound targets, along with tracking progress towards these through suitable indicators and standardized monitoring tools.
- *Equitable access to essential medical products and technologies* of assured quality, safety, efficacy and cost–effectiveness through inclusion in government lists of EHC-related diagnostic equipment, medicines, surgical equipment (for ear surgeries), hearing technologies and relevant vaccines.

- Governments and partners should also focus on relevant and impact-oriented research that supports implementation of IPC-EHC across the life course. Identified areas for EHC research are listed later in Section 4.

- Section 4 further builds on the World Health Assembly resolution of 2017,[25] and sets a global target of 20% relative increase in coverage of EHC services, to be reached by the year 2030. Tracer indicators for monitoring progress towards the global target are outlined and a framework for monitoring proposed.

- Section 4 sets out recommendations to the ministries of health of WHO Member States, international organizations, and stakeholders in the field of ear and hearing care, outlining actions needed to include IPC-EHC in their national health-care systems as a step towards fulfilling the mandate of UHC.

Whereas Sections 1–3 reviewed the various factors which impact a person's hearing across the life course, the available solutions to prevent and address hearing loss, and the challenges to be faced when ensuring accessible ear and hearing care, Section 4 outlines the vision of ear and hearing care and its place in the context of UHC. It introduces a set of key interventions that are essential for ensuring that people have access to EHC services, in line with the principles of UHC. The delivery of these interventions can only be achieved through health systems following an integrated people-centred approach. Section 4 further outlines the key enablers within and in support of the health system and makes recommendations for future action.

[25] See: https://apps.who.int/gb/ebwha/pdf_files/WHA70/A70_R13-en.pdf

> Universal health coverage: an ethical issue and a political choice.
>
> Dr Tedros Adhanom Ghebreyesus, Director-General, WHO, 2017

4.2 H.E.A.R.I.N.G. INTERVENTIONS AS PART OF UNIVERSAL HEALTH COVERAGE

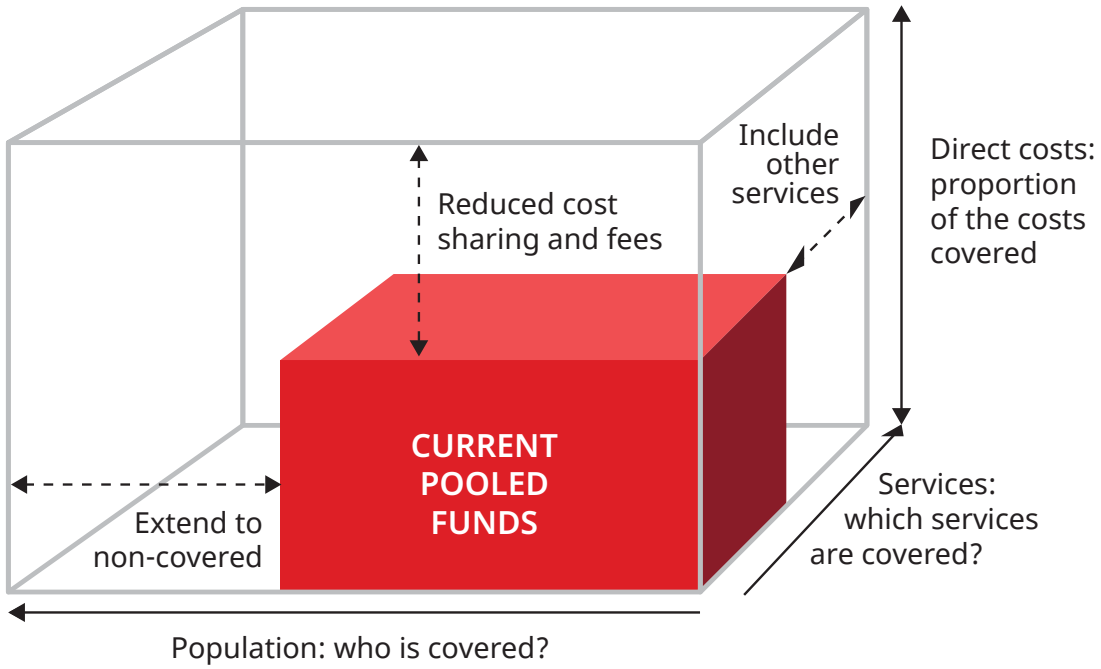
Sustainable Development Goal 3 (SDG3), to be achieved by 2030 *(2)*, aims to ensure healthy lives and promote well-being for all at all ages. WHO estimates that, at present, half of the world's population has no access to the health care they need, and has aligned its work to meet the challenge posed by SDG3. The principal element of this is summarized in target 3.8 which focuses on achieving UHC to facilitate access to quality, affordable, essential health-care services *(1, 2)*. Universal health coverage emphasizes the importance of access both to quality health services and to health information as a basic human right; furthermore, it is crucial for enabling the achievement of all other SDG3 targets. Given the substantial need for services to address ear disease and hearing loss, the mandate of this target cannot be fulfilled without the inclusion of these services within its purview.

Universal health coverage means that all people receive the health services they need without suffering financial hardship ... It includes the full spectrum of essential, quality health services, from health promotion to prevention, treatment, rehabilitation, and palliative care *(1)*.

The three main dimensions of universal health coverage, as illustrated in Figure 4.1, are: *(3)*

1. expanding priority services to include other services which were not available to the population earlier;
2. expanding coverage of services to include more people, especially low-income groups, disadvantaged groups, and rural populations; and
3. reducing out-of-pocket payments as a means of improving access to services and financial risk protection.

Figure 4.1 The three dimensions of universal health coverage



As countries advance in achieving these three dimensions, it is important that the quality and safety of services are always considered and maintained. To support countries in their efforts, WHO is currently developing an online compendium of priority interventions, along with the OneHealth Tool *(4)*, a specialized software that can facilitate decision-making according to country needs and priorities (Box 4.1). To promote equitable access to EHC services across the life course, WHO proposes a set of key interventions that must be delivered through the health systems in an integrated manner.

Older adults are screened for hearing loss in the community clinic in Indonesia

Box 4.1 UHC list of priority interventions and the OneHealth Tool *(4)*

Each country must follow their own path to achieve the goal of UHC and decide what services to cover and actions to prioritize, based on people's needs and available resources. To facilitate the choices that have to be made by countries in achieving UHC, WHO has developed a special software – the OneHealth Tool – and is currently putting together an online compendium of priority interventions. This will include a wide range of WHO-recommended interventions and will also outline their resource implications.

The compendium will help to guide country discussions for identification and prioritization of services to be included within health benefit packages. It will also include recommended evidence-based interventions to address the needs of those at risk of or living with ear and hearing problems in an equitable manner and without undue financial hardships.

The WHO OneHealth Tool can be used by countries to inform national strategic health planning and costing in low- and middle-income countries by helping planners to answer the following questions:

- What health system resources are needed to implement the strategic health plan?
- How much would the strategic plan cost, by year, and by input?
- What is the estimated health impact?
- How do costs compare with estimated available financing?

4.2.1 EAR AND HEARING CARE THROUGH IMPLEMENTING THE H.E.A.R.I.N.G. PACKAGE

Ear and hearing care refers to a broad range of services addressing ear and hearing problems at all stages through the life course, delivered through national health systems, and that include health promotion, prevention, identification, management and rehabilitation. The scope of ear and hearing care extends beyond health systems to cover the provision of accessible education and communication (e.g. through sign language learning or access to captioning etc.); as well as other support (e.g. social support) required for persons with hearing loss and their families, delivered through multisectoral collaborative action, in line with the principles of integrated people-centred ear and hearing care outlined later in Section 4.

The proposed package of EHC interventions which correspond to the acronym "H.E.A.R.I.N.G." includes actions that are required for holistic EHC provision through an integrated life-course approach. These must be considered by a country or a public

health programme when developing its health service policies for working towards universal health coverage. As reflected within the definition of ear and hearing care, the package is not limited to the health system, but also includes interventions that require a collaborative effort outside the formal health service delivery system.

It is also important to note that the H.E.A.R.I.N.G. set of interventions does not reflect some of those mentioned in Section 2, and which are relevant for prevention and management. Examples of actions not mentioned here, but would be relevant to countries based on their needs, include immunization against rubella and meningitis; maternal care; nutrition; and the prevention and monitoring of chemical exposure in the workplace. The set of H.E.A.R.I.N.G. interventions is not intended to be exhaustive, but rather to summarize the public health interventions most likely to be effective for integrated EHC provision across the life course. The aim of these public health interventions is to direct countries towards prevention efforts and enhance provision of clinical services at individual and societal levels.

This package is the result of an evidence-based process, undertaken in discussion with the WHO review group, external stakeholder and expert groups. The process followed is summarized in Figure 4.2; the main focus and objectives of the interventions are set out in Table 4.1.

Figure 4.2 Process followed for identification of the H.E.A.R.I.N.G. set of interventions

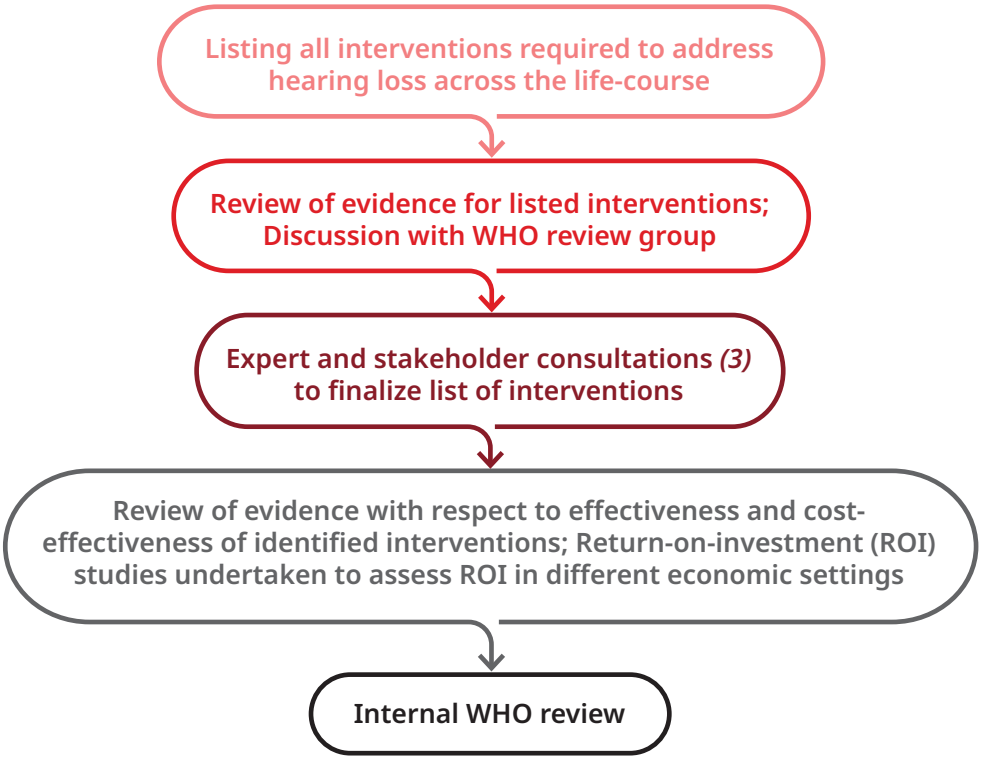


Table 4.1 H.E.A.R.I.N.G. package of ear and hearing care interventions

H	HEARING SCREENING AND INTERVENTION
E	EAR DISEASE PREVENTION AND MANAGEMENT
A	ACCESS TO TECHNOLOGIES
R	REHABILITATION SERVICES
I	IMPROVED COMMUNICATION
N	NOISE REDUCTION
G	GREATER COMMUNITY ENGAGEMENT

HEARING SCREENING AND INTERVENTION

Objective: To ensure the timely detection of, and interventions for, hearing loss, in those most at risk.

Life course: The fixed points across the life course are: newborns and infants; pre-school and school-age children; adults at higher risk of hearing loss (e.g. from exposure to noise or ototoxic chemicals at the workplace or those being administered ototoxic medicines for other illnesses); and older adults.

What is included: Hearing screening and early intervention programmes targeting:

- newborns and infants;
- pre-school and school-age children;
- all those at higher risk of hearing loss, for example, due to exposure to noise or ototoxic chemicals at the workplace, and those being administered ototoxic medicines for other illnesses; and
- older adults.

EAR DISEASE PREVENTION AND MANAGEMENT

Objective: To prevent and treat ear diseases at the earliest possible stage to avoid associated hearing loss and other complications.

Life course: Children are most at risk of diseases such as chronic otitis media, although these can also occur in adolescents and adults.

What is included:

Addressing common ear diseases through:

- prevention (e.g. good EHC practices or immunization);
- early identification at community and primary levels through trained workforce; and
- medical and surgical management at primary, secondary and tertiary levels (as required for acute and chronic otitis media).

ACCESS TO TECHNOLOGIES

Objective: To improve access to hearing aids, cochlear implants or hearing assistive technologies and related services to all those in need.

Life course: across all ages.

What is included:

- access to affordable, high-quality hearing aids and cochlear implants, along with batteries and services for maintenance; and
- availability of hearing assistive technologies (e.g. loop systems in public venues and schools).

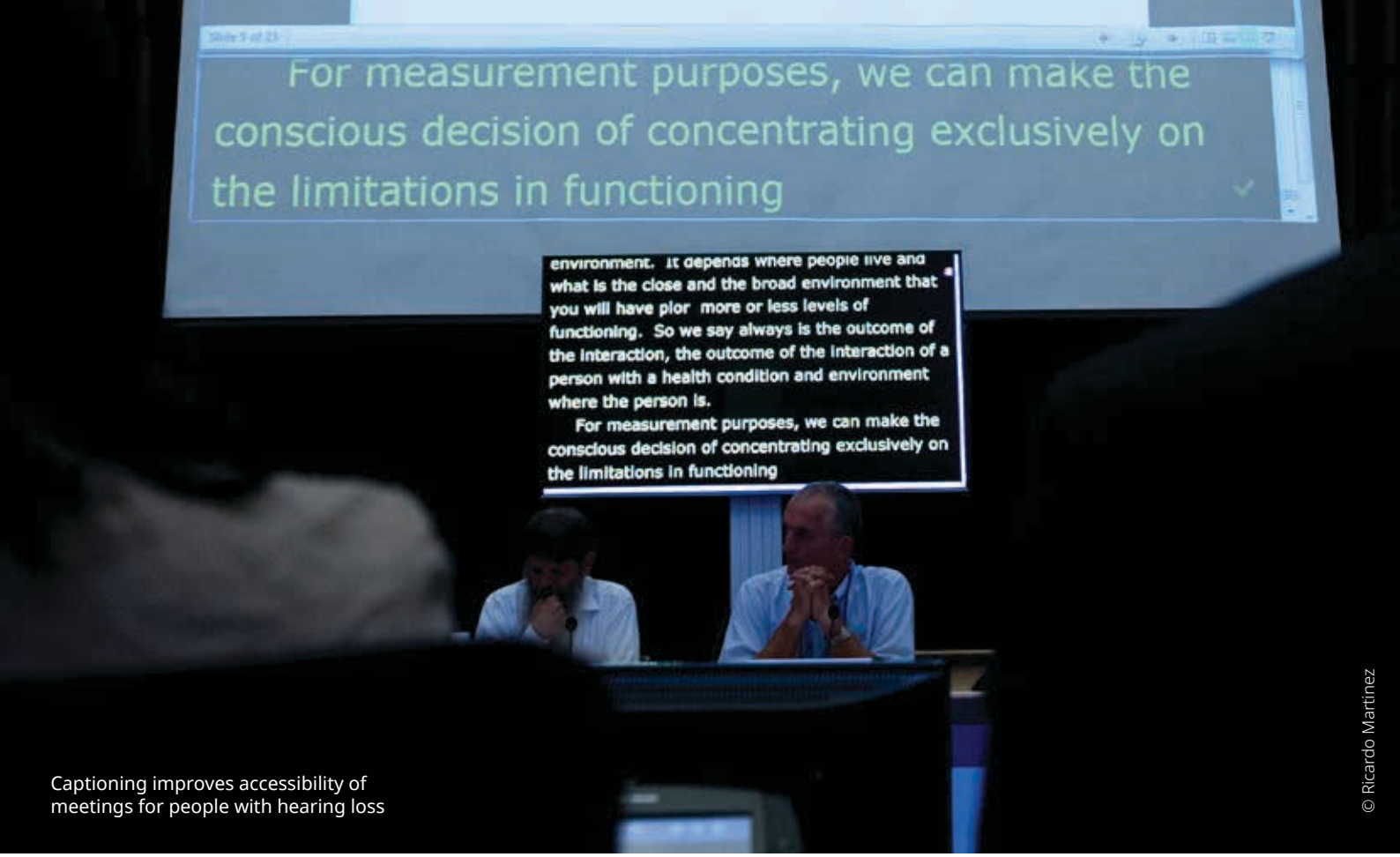
REHABILITATION SERVICES

Objective: To optimize functioning in people with hearing loss through auditory and speech rehabilitation services.

Life course: mainly required in children aged 0–15 years and adults aged above 60 years.

What is included:

- multidisciplinary, family-centred hearing and speech rehabilitation services for children with hearing loss; and
- counselling and auditory rehabilitation for adults with hearing loss, especially older adults.



Captioning improves accessibility of meetings for people with hearing loss

IMPROVED COMMUNICATION

Objective: To facilitate participation in all activities relevant to people with hearing loss

Life course: across all ages.

What is included:

- sign language learning and interpretation services, especially in educational and health-care settings; and
- captioning services in professional and recreational settings as a means of improving access to audio content for those with hearing loss.

NOISE REDUCTION

Objective: To ensure that no individual faces the risk of hearing loss due to loud sounds.

Life course: adolescents, and adults of working age.

What is included:

- occupational hearing conservation programmes for the reduction of hearing loss in the workplace.
- adoption of the global standard for safe listening devices (ITU-T H.870[26]) as a national standard;
- regulations for safe listening venues; and
- targeted programmes to change listening behaviours among pre-adolescents and adolescents.

GREATER COMMUNITY ENGAGEMENT

Objective: To change behaviours and attitudes towards hearing loss and its causes.

Life course: across all ages.

What is included:

- a multipronged communication strategy that generates greater community awareness and engagement for promoting:
  - healthy EHC practices, and safe listening
  - early identification of, and interventions for, hearing loss
- strengthening or establishing organization and associations that represent people who are hard of hearing or deaf, and empowering these groups to become active and articulated stakeholders; and
- collaborating with all stakeholders, including those who are deaf and hard of hearing, to identify and address the causes of stigma associated with hearing loss and ear problems.

Noise is now being acknowledged as an important public health issue and a top environmental risk faced by the world today. Given its far-reaching effects on hearing, as well as on other aspects of human health, strong, coordinated and urgent action is needed with the participation of governments, industry, civil society and the public at large.

[26] See: https://www.itu.int/rec/T-REC-H.870-201808-I

> Investments made in the timely and effective provision of H.E.A.R. interventions will result in health benefits, productivity gains and economic gains for society.

4.3 INVESTING IN EAR AND HEARING CARE: THE BUSINESS CASE

As countries move towards the goal of universal health coverage and identify benefit packages most suitable for their needs, it is essential that the budgetary impact of adopting different interventions and the benefits of making such an investment are fully understood. WHO estimates that achieving the SDG target of UHC would pose an additional annual cost of US$ 371 billion in low- and middle-income countries,[27] equivalent to US$ 58 per person per year, which would save 97 million lives and significantly increase life expectancy *(5)*.

For this report, and to assist countries in understanding the affordability and effectiveness of EHC provision, WHO estimated the additional financial resources required for delivering EHC interventions through health systems, and the return such investments would bring over time.

Analysis focused on the additional cost of scaling up integrated delivery of the four H.E.A.R.I.N.G. interventions that are directly delivered through the health systems: (i) **H**earing screening at different stages in the life course; (ii) **E**ar disease prevention and management; (iii) **A**ccess to hearing technologies across the life course; and (iv) **R**ehabilitation services across the life course. The return for every dollar invested was assessed, including the health impact and productivity gains resulting from improved employment opportunities *(6)*.

The time-frame for the analysis was set for 2020–2030. Two scenarios were considered: a "progress" scenario where scale-up reaches 50% of the population by 2030 (or remains at baseline coverage if already above 50%); and an "ambitious" scenario where scale-up addresses 90% of the population needs by 2030. The key outcomes of the analysis are summarized in Figure 4.3 and detailed information provided in the text following.

[27] Country income levels used in the *World report on hearing* are determined by the World Bank.

Figure 4.3 Investing in ear and hearing care: global requirements and benefits

SCALING UP EHC COVERAGE (%) BY 2030 REQUIRES:	PROGRESSIVE (50%)	AMBITIOUS (90%)
An additional annual per capita investment of (US$)	0.84	1.33
A total additional investment of (US$)	75 billion	120 billion

THIS LEVEL OF INVESTMENT COULD:	PROGRESSIVE (50%)	AMBITIOUS (90%)
Avert	>110 million DALYs	>130 million DALYs
Benefit	1.25 billion people	1.46 billion people
Result in health gains equivalent in value to (US$)	1.2 trillion	1.3 trillion
Result in productivity gains equivalent in value to (US$)	2.1 trillion	2.4 trillion
Bring a return for every 1 dollar invested of (US$)	15.8	16.1

4.3.1 TOTAL INVESTMENT

WHO estimated that ensuring EHC services at the current level of coverage would incur a cost of US$ 120 billion from 2020 to 2030. Compared with "business as usual", scaling up coverage of the four EHC interventions (H.E.A.R.) to 90% by 2030 would require an additional global investment of nearly US$ 120 billion; scaling up to 50%, an additional US$ 75 billion. The investment required varies considerably across country income groups (Figure 4.4) and WHO regions (Figure 4.5).

Figure 4.4 Costs for scale-up scenarios, 2020–2030, by country income group

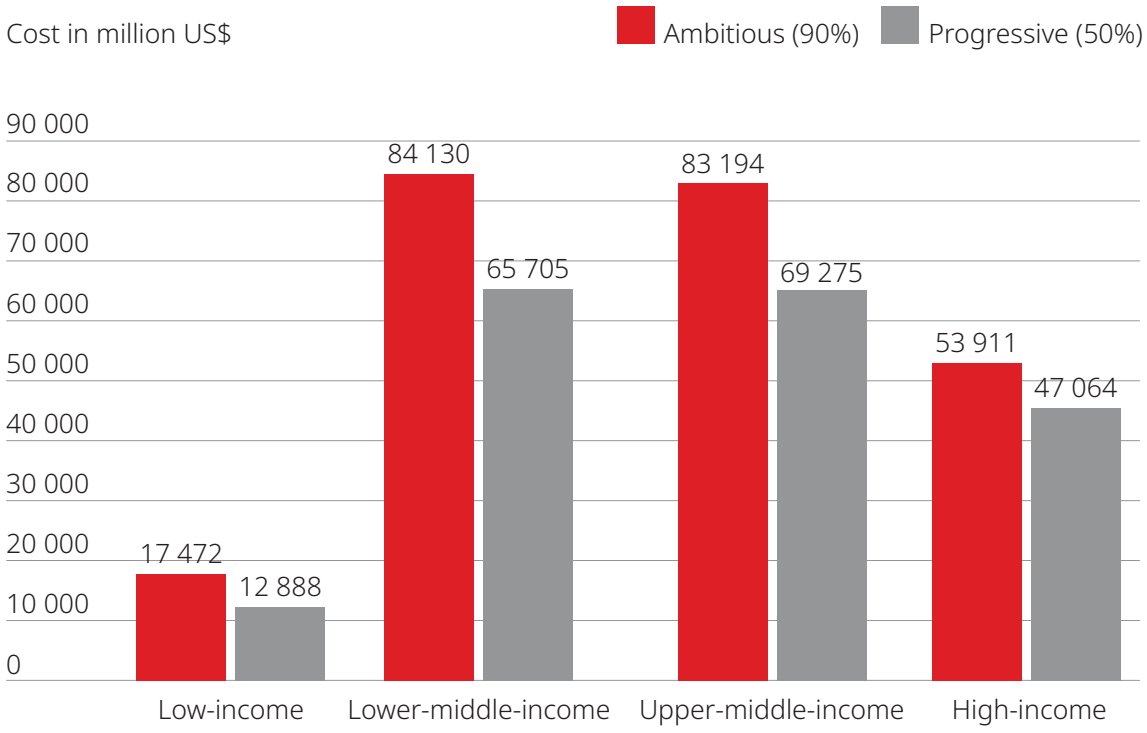
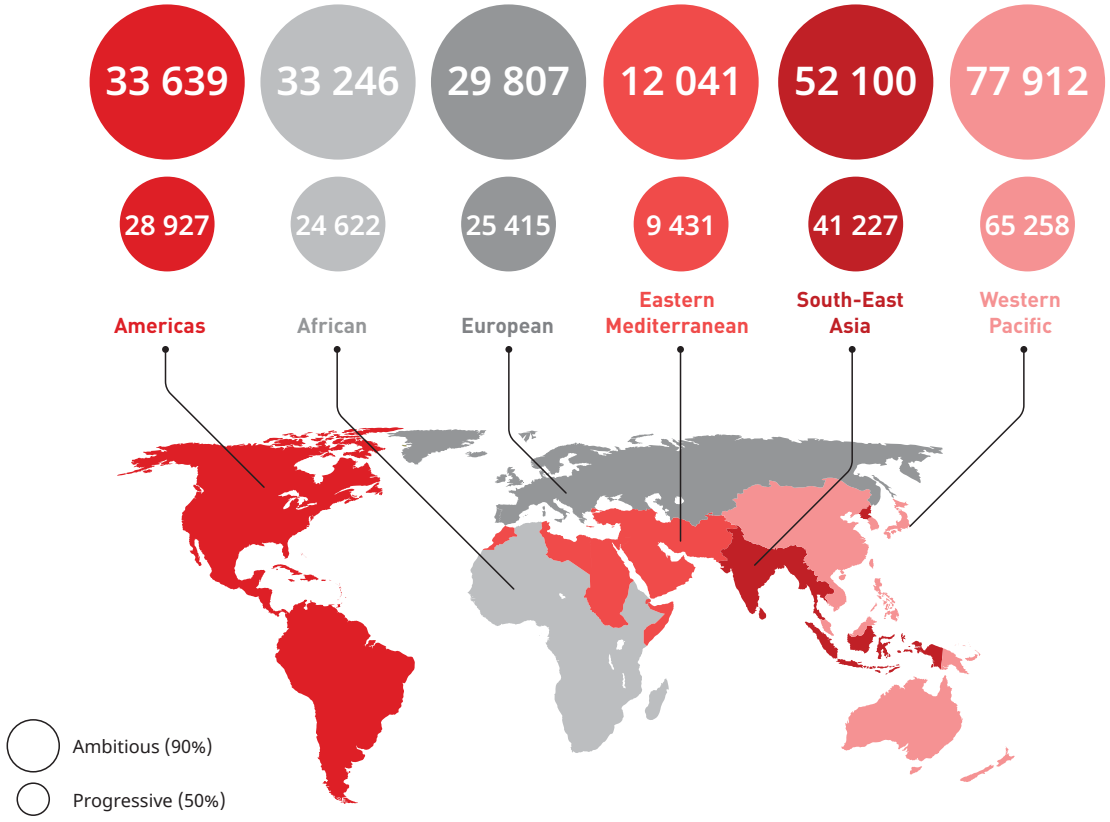


Figure 4.5 Costs for scale-up scenarios, 2020–2030, by WHO region

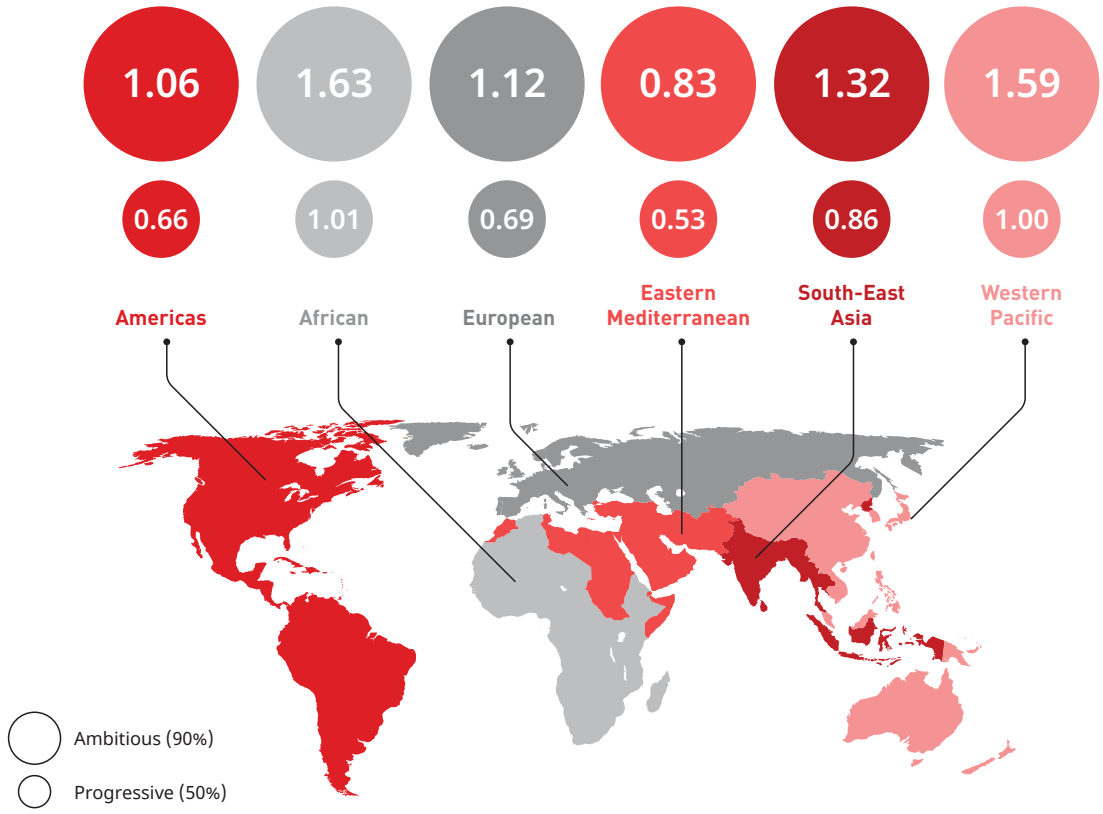


Note: This illustration represents WHO regions, not country boundaries.

Annually, US$ 1.33 per capita additional investment (over and above the current levels of expenditure) is needed to ensure that 90% of populations have access to services, while US$ 0.84 per capita could achieve 50% coverage. The investment required ranges from US$ 0.53 to more than US$ 1.63 per-capita in different regions of the world, with most per capita investment needed in the African, Western Pacific and South-East Asia regions (Figure 4.6). In the initial years, investment need increases, before levelling off and then decreasing as growing numbers of people have access to EHC services (Figure 4.7).

Annually, US$ 1.33 per capita additional investment is required to scale up ear and hearing care globally to 90% by 2030.

Figure 4.6 Per capita annual investment for scale-up scenarios, 2020–2030, by WHO region



Note: This illustration represents WHO regions, not country boundaries.

4.3.2 HEALTH IMPACT

With more than 130 million DALYs averted during 10 years, the health gains of EHC investment translates into a monetary value of over US$ 1.3 trillion for the same time period. As anticipated, higher population coverage will avert a greater number of DALYs across all income groups (Figure 4.8) and WHO regions (Figure 4.9).

Figure 4.7 Annual global costs for scale-up scenarios, 2020–2030

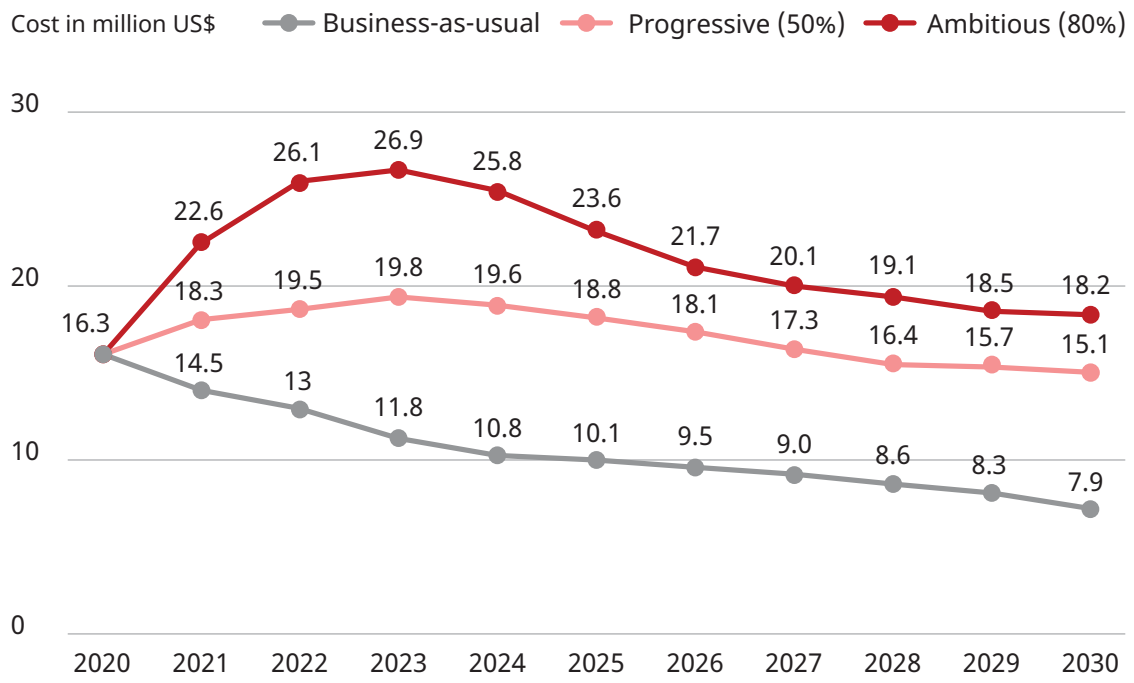


Figure 4.8 Number of DALYs averted for scale-up scenarios, 2020–2030, by country income group

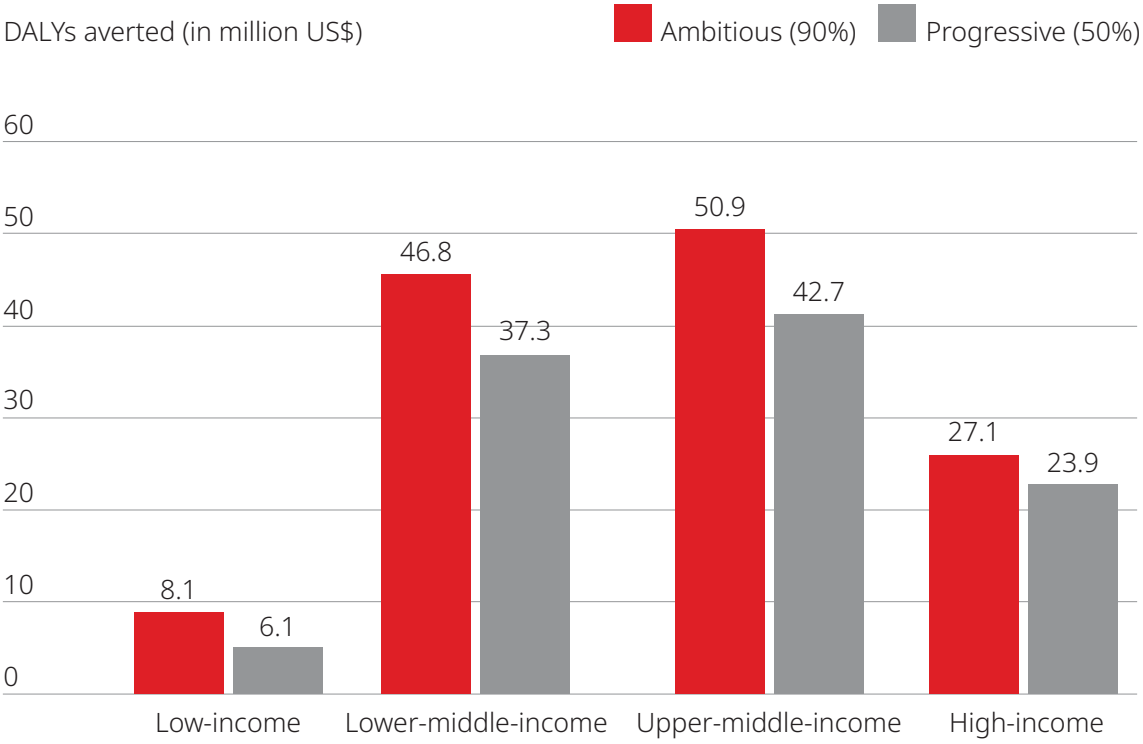
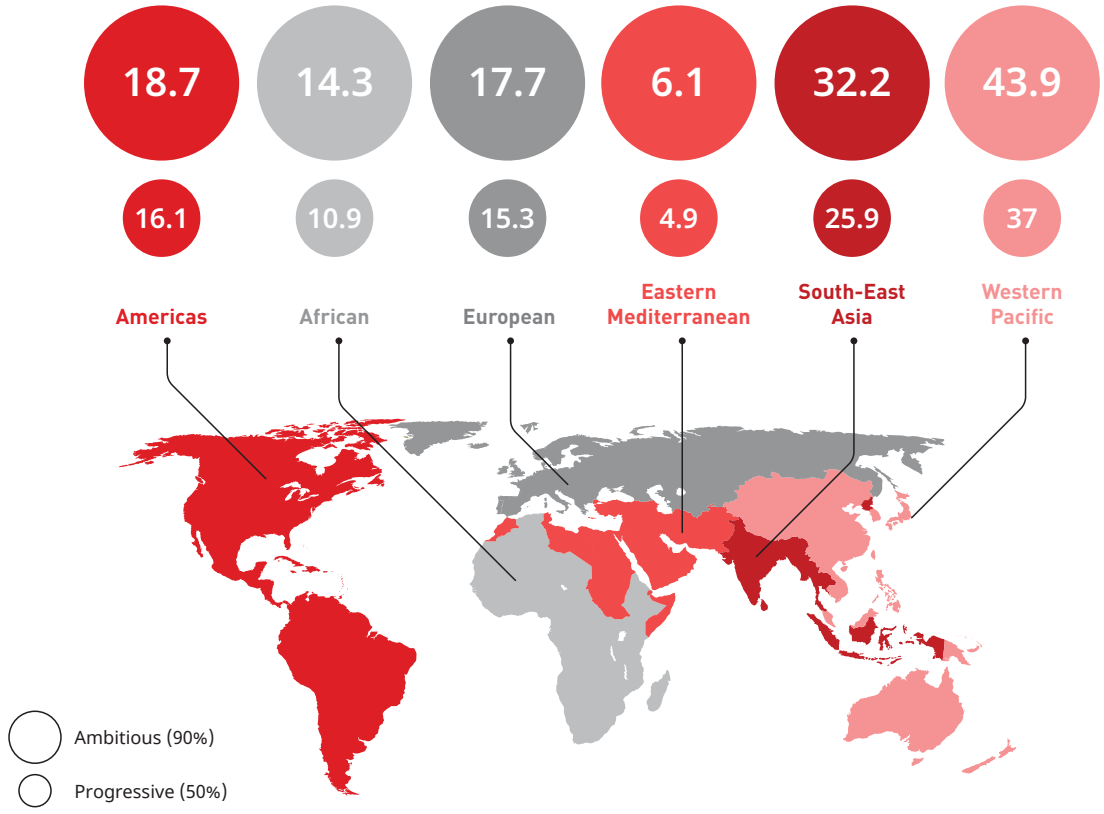


Figure 4.9 Number of DALYs averted for scale-up scenarios, 2020–2030, by WHO region (in million US$)



Note: This illustration represents WHO regions, not country boundaries.

When translated into monetary values, the health gains over 10 years would thus equal US$ 1.2 trillion when the scale-up targets 50% coverage; and US$ 1.3 trillion dollars when 90% coverage is attained. The breakdowns for country income groups are depicted in Figure 4.10 and for WHO regions in Figure 4.11. The monetary benefits are seen to be highest in high-income countries primarily due to the higher per capita GDP (gross domestic product) in these countries.

Figure 4.10 Monetized DALY benefits for scale-up scenarios, 2020–2030, by country income group

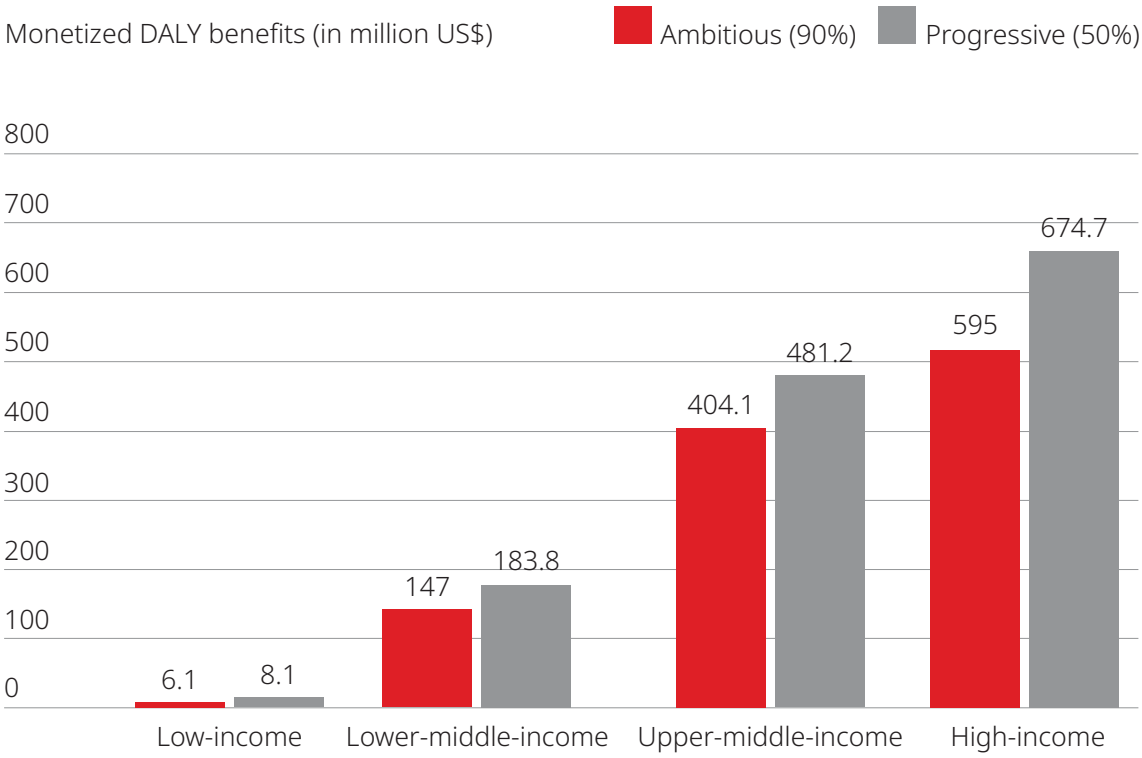
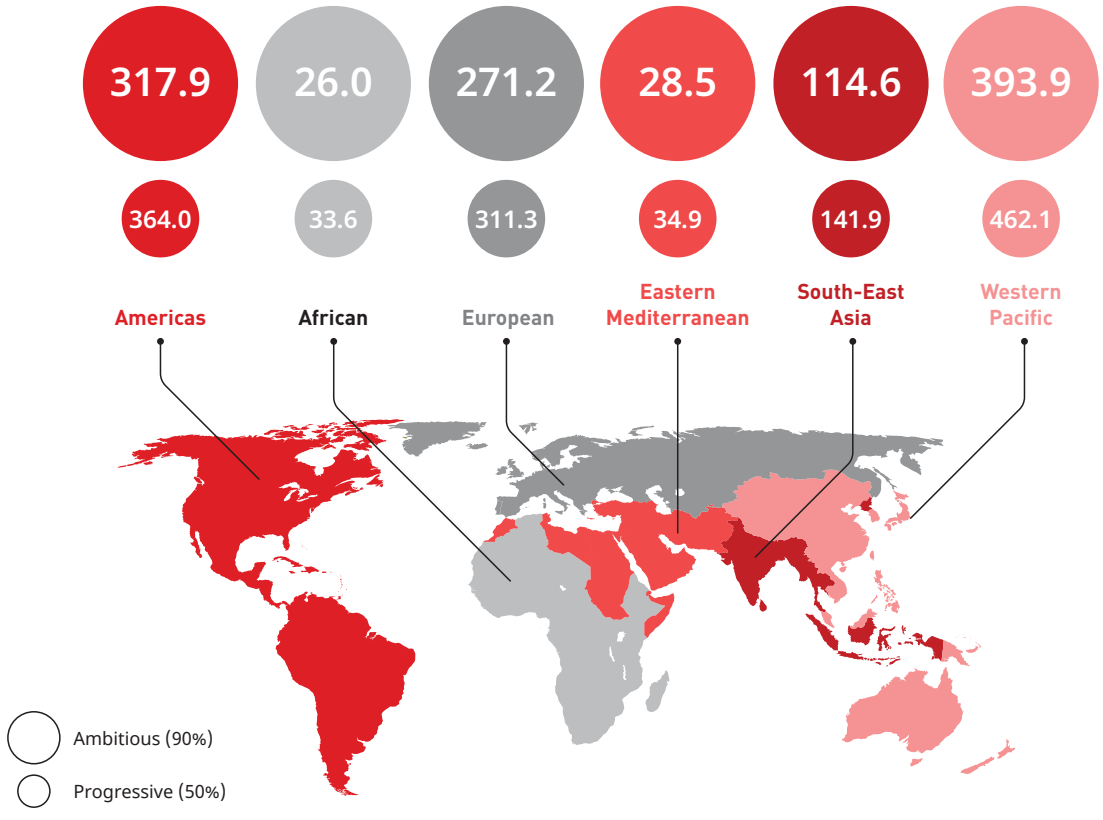


Figure 4.11 Monetized DALY benefits for scale-up scenarios, 2020–2030, by WHO region (in million US$)

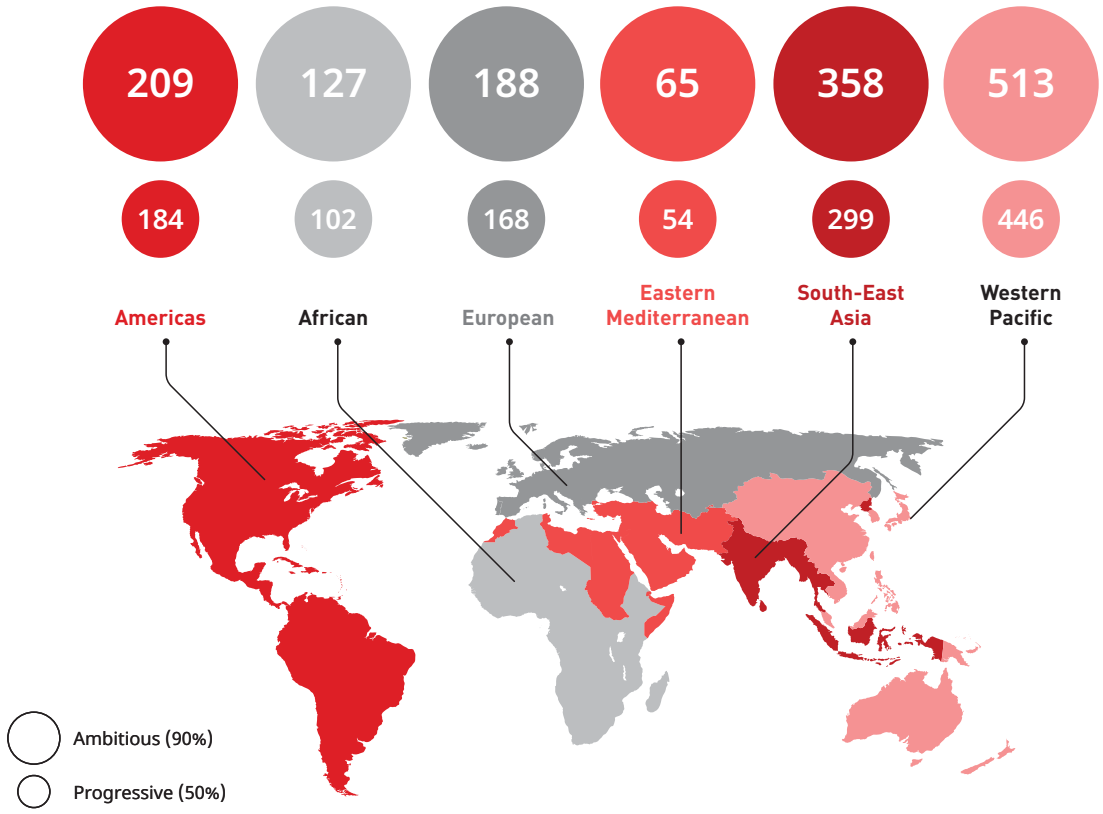


Note: This illustration represents WHO regions, not country boundaries.

4.3.3 NUMBER OF PEOPLE TO BENEFIT

Scaling up ear and hearing care has the potential to benefit nearly 1.5 billion people over 10 years, through having their ear and hearing problems addressed. The numbers are distributed proportionately in all regions, according to their total need (Figure 4.12).

Figure 4.12 Number of people to benefit through scale-up scenarios, 2020–2030, by WHO region, in millions



Note: This illustration represents WHO regions, not country boundaries.

4.3.4 PRODUCTIVITY GAINS

Investing in ear and hearing care would improve employment opportunities, and thus enhance productivity significantly within countries to the value of over US$ 2 trillion within a 10-year period. While the estimation of productivity gains considers a number of parameters including employment rates *(6)*, the overall gains are in line with the gross domestic product of the different regions. Hence, a higher economic value of productivity benefits is estimated in high-income parts of the world and are proportionate to the level of scale-up (Figure 4.13 and Figure 4.14).

Over 10 years, nearly 1.5 billion people can be benefitted through scaling up ear and hearing care.

Figure 4.13 Productivity gains for scale-up scenarios, by country income group

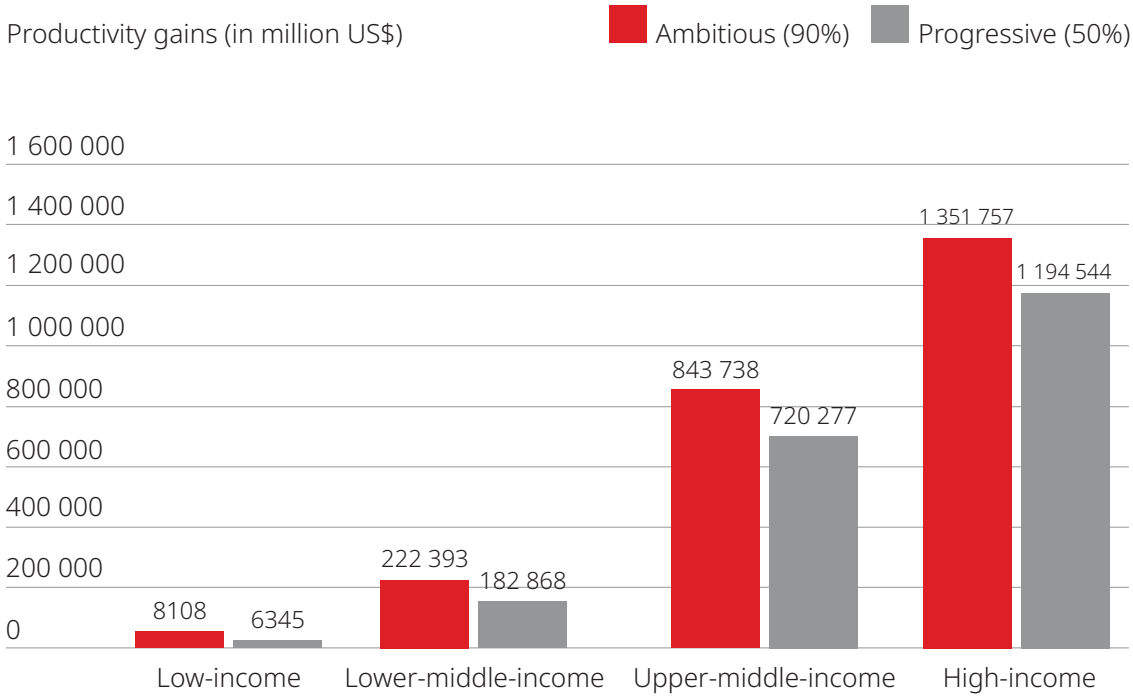
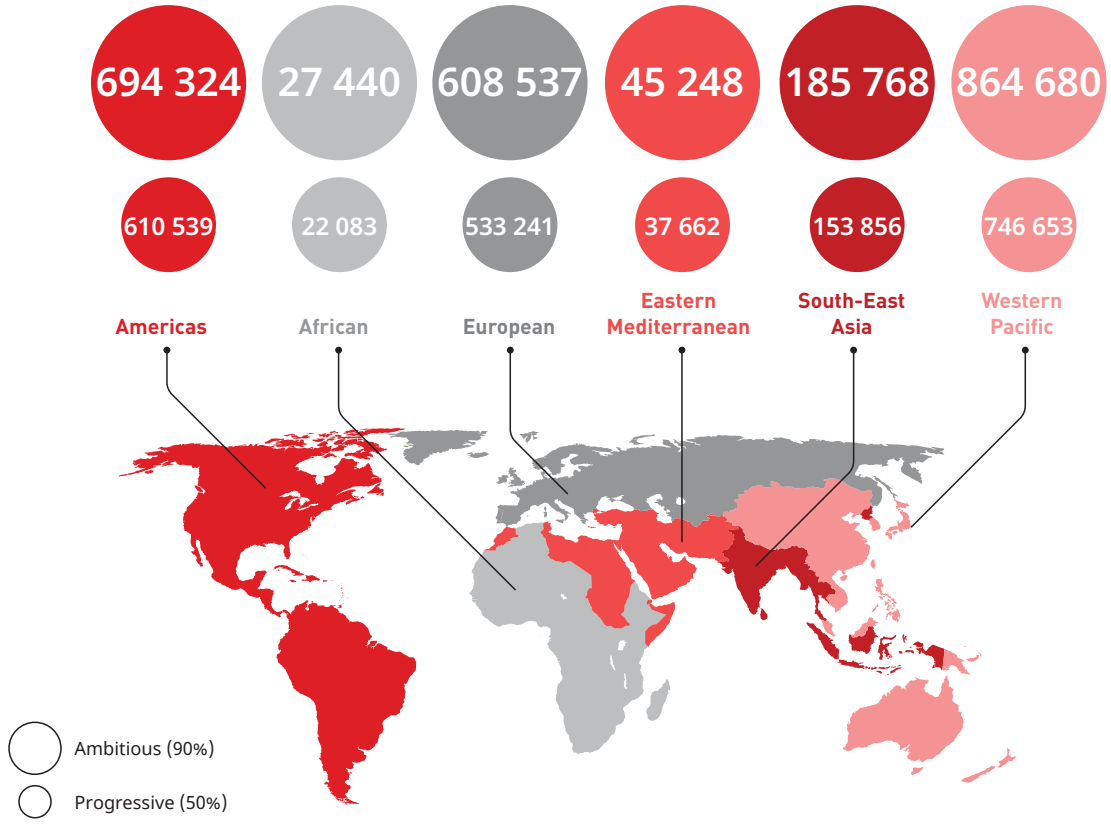


Figure 4.14 Productivity gains for scale-up scenarios, 2020–2030, by WHO region (in million US$)



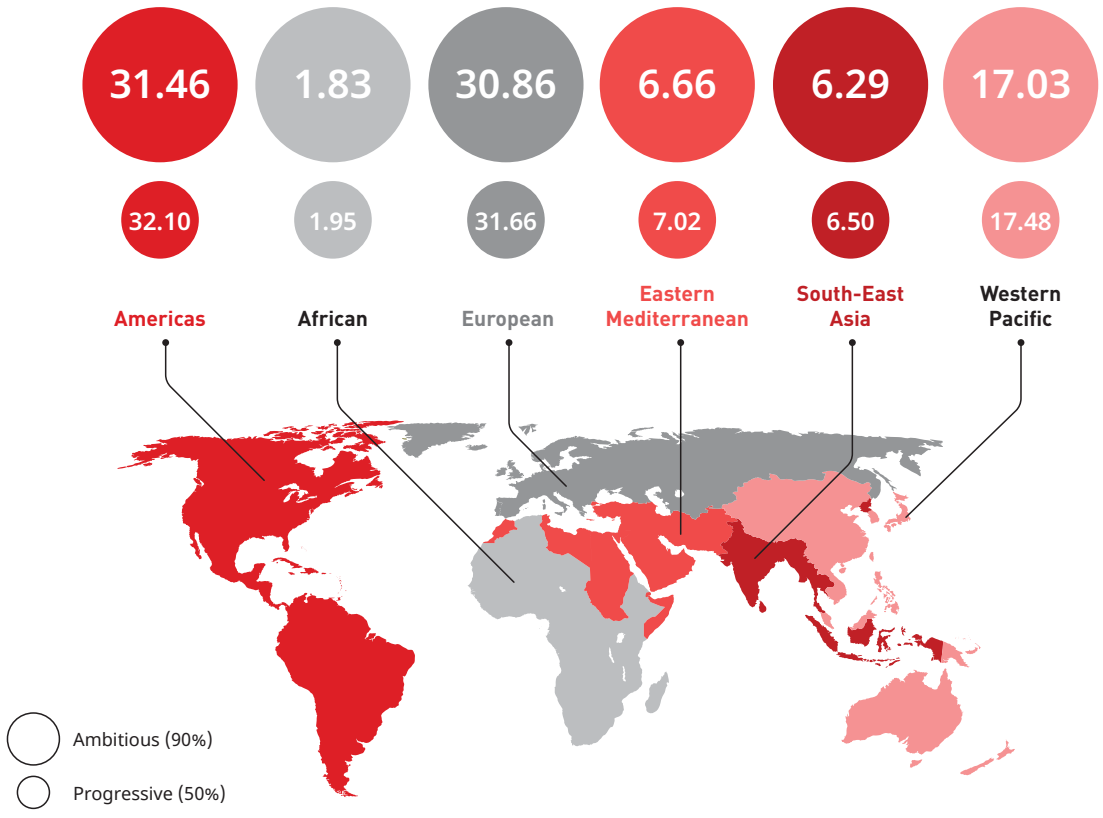
Note: This illustration represents WHO regions, not country boundaries.

4.3.5 RETURN ON INVESTMENT

Scaling up ear and hearing care will improve productivity, with gains of more than 2 trillion US dollars over 10 years.

As a result of the significant benefits and productivity gains that can be expected from effective scaling up of EHC services globally, the resources invested into this area of health undoubtedly would be a sound investment. Overall, it is estimated that the timely identification and management of ear and hearing problems through integration of H.E.A.R. interventions into health systems will, during the next 10 years, result in a return of around US$ 16 for every dollar invested, which compares closely with the two scale-up scenarios proposed (i.e. 50% or 90%) (Figure 4.15). Even though the analysis shows an excellent return for investment into ear and hearing care, it is likely that this is an underestimation since not all benefits can be quantified or monetized.

Figure 4.15 The net dollar return for every dollar invested for scale-up scenarios, by WHO region (in US$)



Note: This illustration represents WHO regions, not country boundaries.

4.3.6 MAKING INVESTMENTS

All countries must engage in an evidence-based policy dialogue to establish policies and finalize investments for integrating ear and hearing care into national health systems. This should be achieved through a systematic approach for prioritization based on the specific health needs of the country's population and should consider cost–effectiveness, equity, and financial risk protection. WHO tools for situation analysis *(7)*, and planning for EHC services *(8)*, provide useful guidance on developing a strategic policy. Use of the WHO OneHealth costing tool *(4)* can provide effective support and guidance to the country planning process.

Strategies identified through the prioritization and planning exercise must be integrated into a country's health system following a people-centred approach, as part of UHC implementation. In parallel, health system capacity must be strengthened, so that countries can deliver on their national aspirations for ear and hearing care and benefit from their investments in this field.

While the long-term aim is for all countries to achieve the ambitious scenario of 90% or higher coverage, a 50% overall coverage may be more realistic for some. Based on these outcomes as well other relevant considerations, countries must determine their national scale-up targets, and aim to align them with the global targets, as outlined below.

> Target: a 20% relative increase in effective coverage of H.E.A.R. interventions by 2030.

4.4 SCALING UP EAR AND HEARING CARE: GLOBAL TARGETS AND TRACER INDICATORS

Given the importance and benefits of investing in a systematic scale-up of EHC services, this report outlines the global target that countries must aim to achieve. Building on what has been learnt through data and information provided in this report, countries must strive to achieve a minimum of a 20% relative increase[28] in the effective coverage of EHC services from 2021 to 2030.

To monitor their progress towards this target, countries have to integrate and systematically assess a comprehensive set of indicators[29] within their national health systems (as detailed in section 4.6). This is fundamental to the effective provision of EHC services, and for tracking the performance of health systems over time. At the global level, however, three tracer indicators were identified that can serve as a reasonable proxy for measuring the growth of EHC services during the next 10 years. Identification was based on considerations that the three indicators should:

- cover different sections of the population across the life course;
- be based on effective interventions;
- focus on impact or health outcomes in the population groups assessed;
- have clearly outlined steps for improving their coverage; and
- be suitable for measurement at a five-year gap.

4.4.1 TRACER INDICATORS FOR MONITORING PROGRESS IN EAR AND HEARING CARE

The three EHC indicators for global surveillance are:

1. **Effective coverage[30] of newborn hearing screening services within the population**: defined as the proportion of infants with hearing loss in a defined population who have received suitable interventions within the first six months of life to address their hearing loss.

[28] Relative increase in coverage refers to the upscaling of services in proportion to the currently existing baseline service coverage.

[29] WHO EHC: indicators for monitoring provision of services https://apps.who.int/iris/handle/10665/324936?show=full

[30] Effectiveness is a measure of the degree to which evidence-based health services achieve desirable outcomes. It implies that people who need health services obtain them in a timely manner and at a level of quality necessary to obtain the desired effect and potential health gains. See: https://apps.who.int/iris/bitstream/handle/10665/174536/9789241564977_eng.pdf?sequence=1.

2. **Prevalence of chronic ear disease and unaddressed hearing loss in schoolchildren**: defined as the percentage of children of primary school age who have chronic otitis media or hearing loss for which they are not receiving rehabilitation.
3. **Effective coverage of hearing technology (e.g. hearing aids and implants) use among adults with hearing loss**: defined as the number of adults in a defined population having a perceived benefit through the use of hearing technology as a proportion of those with hearing loss (moderate or higher grade).

Details of the proposed indicators and data points needed in their estimation are summarized in WEB ANNEX B.

4.4.2 GLOBAL AND NATIONAL TARGETS

In consideration of the tracer indicators defined above, the targets for expanding coverage of EHC services are:

1. **A 20% relative increase in the effective coverage of newborn hearing screening services, by 2030.**
   - Countries with effective coverage rates below 50% should strive for a minimum of 50% effective coverage.
   - Countries with effective coverage rates of 50–80%, should strive for a 20% relative increase in effective coverage.
   - Countries with effective coverage rates currently above 80% should strive for universal coverage.
   - Countries with population groups covered by newborn hearing screening services should ensure a coverage of 95% or above.
2. **A 20% relative reduction in the prevalence of chronic ear diseases and unaddressed hearing loss in school-age children, aged 5–9 years.**
3. **A 20% relative increase in the effective coverage of adults with hearing loss that use hearing technology (i.e. hearing aids and implants), by 2030.**
   - Countries with effective coverage rates below 50% should strive for a minimum of 50% effective coverage.
   - Countries with effective coverage rates of 50–80% should strive for a 20% relative increase in effective coverage.
   - Countries with effective coverage rates currently above 80% should strive for universal coverage.

WHO proposes monitoring and reporting on these indicators once every five years, as a means of assessing progress towards the goal of making ear and hearing care accessible for all people. Countries should gather and report on data relevant to the indicators, which would greatly facilitate the study of global trends in ear and

hearing care during the coming years. While the consistent assessment of, and reporting on, these tracer indicators is key to global monitoring, the importance of measuring, as part of a comprehensive set of EHC indicators integrated within national health information systems, cannot be overstated.

School screening in India helps ensure that children with ear diseases or hearing loss can be identified early

The power of existing interventions must be matched by the power of health systems to deliver them to those in greatest need, in a comprehensive way, and on an adequate scale. *(9)*

4.5 PEOPLE-CENTRED EAR AND HEARING CARE DELIVERED THROUGH A STRENGTHENED HEALTH SYSTEM

The path to universal health coverage is through a strong and resilient people-centred health system with primary care as its foundation. This approach requires a shift in thinking, from health systems designed around health conditions or clinical services, towards integrated people-centred health services. Integrated health services provide people with a continuum of services covering health promotion, disease prevention, diagnosis, treatment, disease management, rehabilitation and palliative care. Services are coordinated across different levels and sites of care within and beyond the health sector, and according to their needs at all stages of life. The vision for IPC-EHC services is outlined below in Box 4.2; hypothetical examples of how such services could benefit individuals with hearing loss are provided in Box 4.3.

Being "people-centred" means that people in communities are viewed as partners in shaping both health policy and the services to be delivered through health systems. People-centred care means services are organized around the comprehensive needs of individuals, families and communities, rather than individual diseases. It also means that people have the required awareness, education and support to make decisions. Such an approach can ensure that health providers have greater satisfaction within a supportive work environment.

Additionally, it involves health systems being responsive to people's needs, including those for ear and hearing care across the life course; and that the required H.E.A.R.I.N.G. interventions are delivered in an integrated manner and without causing financial hardships to those needing care. This integrated, life-course approach is at the core of EHC provision recommended by this report.

Box 4.2 The WHO vision of IPC-EHC services

All people to have equal access to quality EHC services (as part of health services) that meet their needs across their life course; respect social preferences; are coordinated across the continuum of care; are comprehensive, safe, effective, timely, efficient and acceptable; and that all carers are motivated, skilled, and operate in a supportive environment.

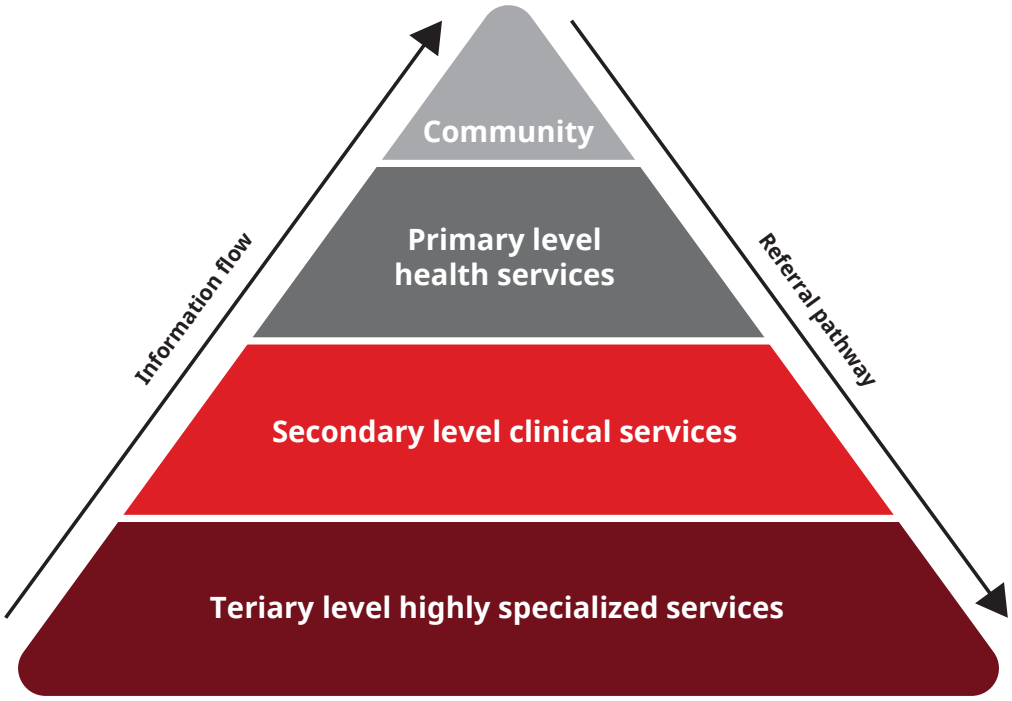
The key implementation principles of an integrated people-centred approach are that it should be:

- country-led
- equity-focused
- participatory
- evidence-based
- results-oriented
- ethics-based
- sustainable
- systems-strengthening.

Based on the integrated health services framework, IPC-EHC involves:

- **Empowering individuals and communities** through knowledge and accessible information so that they are aware of their ear and hearing care needs. This ensures that the critical barrier of knowledge in addressing hearing loss is overcome to ensure greater acceptance and use of the services which are offered.
- **Strengthening governance and accountability** through a participatory approach so that a shared vision can be achieved by all stakeholders. This means that EHC needs can be identified by policy-makers and community stakeholders in partnership, so that the most pressing needs are prioritized.
- **Reorienting the model of care** so that primary care and community-based quality EHC services can be prioritized so that people have access to relevant EHC interventions close to their homes. At the same time, they can access high quality clinical services at secondary and tertiary level facilities, coordinated through efficient referral pathways (Figure 4.16).

Figure 4.16 Reorienting the model of care



- **Coordinating services within and across sectors** by building linkages across various services and programmes within the health sector, so that individuals and families can have continuity of ear and hearing care across their life course. Coordination is also required across other (non-health) sectors including, among others, social services, finance, education, labour, housing, the private sector and law enforcement.

A child receives ear care at the community level

- **Creating an enabling environment** so that all blocks of the health systems work in such a manner that the delivery of services, as conceptualized, is possible. This has relevance to all parts of the health system including leadership; health information systems; access to high-quality, and safe, clinical services; workforce reorientation; regulatory frameworks; and finance reforms. These factors are discussed below (in section 4.3.2), as part of the health system enablers for the provision of ear and hearing care.

Box 4.3 The vision of IPC-EHC

WHAT WOULD IPC-EHC MEAN FOR LELA?*

(*a hypothetical example)

Lela is a bright young girl living in a rural district in a tropical middle-income country who has developed pain and discharge in her right ear and is unable to hear well from that side. She requires medical attention to cure her ear problem. What would IPC-EHC mean for her?

Empowered individuals and communities: Many children in the village suffer with discharging ear and associated hearing loss. So common is the condition, that the villagers used to consider this "normal" and did not pay much attention to it, thinking that the child would outgrow it with time. But now things have changed. People have clear and useful information about common health problems faced in their area. They understand that many children have hearing loss due to discharging ear and that the condition further affects a child's education and school performance. They also realize that some children have had serious problems as a result of ear infections, which could have been avoided. Engaging with their local governments, ear infections are now acknowledged as an important health issue in this community. So, Lela's parents understand that her ear discharge indicates a disease that requires attention and that they can receive advice and help from local health workers.

Strong governance: Due to the high prevalence and impact of ear diseases, the government, following dialogue with people of the community, adopted a policy for the provision of integrated ear and hearing care services. Implementation focused on raising awareness on ear and hearing problems, and the provision of EHC services across all levels of care. This makes it possible for Lela to receive the services she requires and for her parents to afford these.

Reoriented model of care: As a result of government policy, health-care providers, at community and primary health care (PHC) levels, have been trained to identify and address common ear problems. Now, when Lela develops pain and discharge, the community health worker detects the problem during a regular family visit. She advises Lela's parents on how to clean the ear and keep it dry, stressing the importance of doing so. She also directs them to the (PHC) centre where a doctor examines Lela's ear and gives her medicines to treat the infection. Since the PHC is close to their village, the parents are able to regularly take Lela back for follow up. When the infection recurs after a few months, the doctor refers Lela to the secondary level district hospital where specialized ENT services are available. With a referral slip and guidance received at the PHC, Lela's parents are able to make the overnight trip to see an ENT specialist. Lela is asked to come back after a few weeks and surgery is performed on her ear. This information is communicated back to the doctor at the PHC and the community health worker

Services coordinated across sectors: At the request of the doctor, the community health worker informs Lela's school of her ear condition, ensuring that her teachers make the required adjustments in the classroom so that she can hear them well.

An enabled environment: Lela's parents are able to afford the cost of the treatments and travel to the city due to the government's policies which ensure financial protection for EHC services, through the national health insurance scheme. Moreover, there is clarity across all levels of care regarding what needs to be done. Health workers are available and well trained in recognizing and addressing common ear and hearing problems.

Due to the government's well-implemented IPC-EHC approach, Lela can access the ear and hearing care she needs. Her ear is now healing well and she continues to go to the PHC for follow up. The community health worker also guides Lela'a parents on good ear and hearing care practices to make sure that Lela's sister and brother do not develop ear problems and that all family members learn to value and protect their hearing.

WHAT WOULD IPC-EHC MEAN FOR ARI AND MIA?*

(*a hypothetical example)

Ari lives with his family in a town that houses a major steel manufacturing plant. Like most people of the town, Ari works in this factory, as does his daughter Mia. The environment they work in is very noisy. During the past few years Ari has been experiencing a persistent ringing in his ears and has noticed that he often doesn't hear what his family are saying. He needs care for his ear and hearing problem. What does IPC-EHC mean for Ari?

Empowered individuals and communities: Many of the people in the town, especially those employed in the manufacturing of steel, are exposed regularly to loud levels of noise as well as ototoxic chemicals. Although the factory provides hearing protection to its employees, most of them used to avoid using this as they found it uncomfortable. As a result many have developed hearing loss. In the earlier days, most people just blamed it on "growing old" and made no connection between their hearing loss and their work-environment. When policy-makers and community stakeholders from the township held joint discussions to frame public health services here, the outcome was an understanding within the community members of the risk of noise exposure to their health and hearing. The policy-makers also understood that this was one of the important health challenges needing to be addressed within this community.

Strong governance: Following this, a comprehensive occupational hearing conservation programme was developed in consultation with experts and with the participation of the private sector company that runs the steel plant. Its implementation is closely monitored by the government to make sure that workers are aware of the need and means for hearing protection against noise and the ototoxic chemicals they are using; have access to high-quality, comfortable and effective hearing protectors; routinely have training and information sessions that reaffirm the need for hearing protection and the correct ways of using protective gear; are rotated regularly to non-noisy areas to reduce the risk of hearing loss; have access to noise-free rest areas; have regular, well-documented hearing examinations; and are referred for expert opinion when needed.

Reoriented model of care: Upon routine hearing examination at the plant, the nurse realizes that Ari has severe hearing loss in both ears. She immediately guides him to the medical centre in the town where specialized ear and hearing care services are available. He is advised to use a hearing aid and is able to be fitted with a suitable, high-quality hearing aid at the same centre. He has to return from time to time for the hearing aid to be checked and to learn how to use it well.

Services coordinated across sectors: The government is working with the steel company to make sure that a comprehensive hearing conservation programme is implemented at the factory and that those who develop hearing loss are able to get high-quality hearing aids and associated services in the health-care facilities close by.

An enabled environment: Clear, culturally-appropriate information in the local language is being provided to families living in the township, so that they can be more informed and aware of why hearing loss develops; the early signs; and how the use of hearing devices can help those with hearing loss. Due to the government-mandated regular hearing screening, hearing loss is identified early in , and they can get the services they need without undue out-of-pocket expenses.

As a result of these actions for IPC-EHC, Ari is able to participate in family conversations again. He encourages his daughter Mia to use hearing protection regularly and is very hopeful that she will not face the tinnitus and hearing problems that he has had. More than anything, the stigma associated with hearing loss is dissipating in the town, and people are starting to accept both the importance of protecting their hearing, and the need for addressing any hearing loss at the earliest stage.

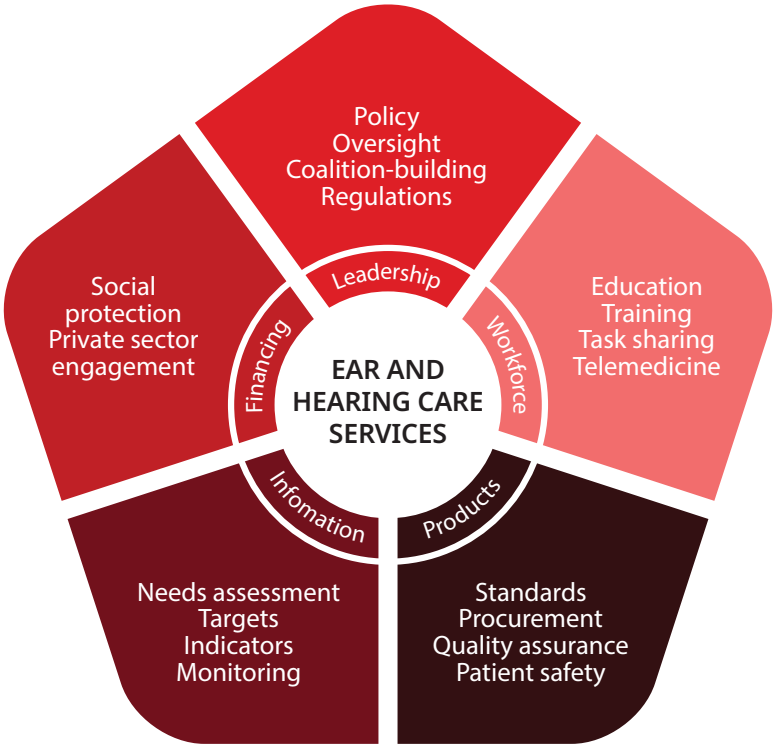
> Integrated people-centred ear and hearing care implemented through a strengthened health system can overcome the challenges faced.

4.6 HEALTH SYSTEMS ENABLERS FOR INTEGRATED PEOPLE-CENTRED EAR AND HEARING CARE

To integrate H.E.A.R.I.N.G. interventions into health systems, countries must assess and strengthen the capacity of their health systems to deliver these in an equitable manner across the life course. To achieve this, WHO envisages health systems comprising six building blocks: leadership and governance; health services; health workforce; medical products and technologies; health information; and financing. The six blocks of this system are shown in Figure 4.17 and described below in further detail. The "health services" block is central as it represents clinical and other services that are to be delivered at all levels of ear and hearing care across a person's life course. The key interventions relating to this are reflected in the H.E.A.R.I.N.G. package.

Equipping the system with the optimal resources, including human resources, information and communication technologies, medicines and medical devices, is central to facilitating the provision of services. This section provides information on those health system enablers that must be considered and developed during the planning phase for EHC service provision.

Figure 4.17 Strategies to strengthen health system for IPC-EHC



4.6.1 THE HEALTH SYSTEM BUILDING BLOCKS

LEADERSHIP AND GOVERNANCE

Leadership and governance is, perhaps, the most critical building block of any health system. It reflects the role of government in health and its relationship to other stakeholders or actors whose activities impact people's health. Furthermore, leadership and governance involves ensuring that a strategic policy framework exists and is combined with effective oversight, coalition-building, regulations, attention to health system-design, and accountability *(9, 10)*.

The main focus of governance for EHC provision is on guiding the health system in order to promote access to IPC-EHC services, and safeguard the interest of the population at large. Such leadership and policy-planning are key to ensure:

- Integration of the H.E.A.R.I.N.G. package of EHC services into the national health plans as part of the health system response to ear and hearing care needs. This requires coordination across various governmental sectors, and with nongovernmental partners, to ensure that all components of the package are carefully considered and systematically addressed as well as other needs identified, if relevant.

Policy development and planning can ensure that EHC services are integrated across all service delivery platforms across the life-course.

- Availability of EHC services at all levels of health-care service provision (community, primary, secondary and tertiary) across the life course. For example, EHC services must be part of child development plans, adolescent health, school health, healthy ageing, occupational health services etc. In addition, to make sure that these services are accessible, they must be integrated into services provided at the primary level.
- Alleviation of financial hardships posed by ear and hearing problems and social protection (as outlined in section 3.4.5).
- The backing of proposed EHC interventions with appropriate evidence-based policies and regulations.

The key functions of the health system for such integration include: *(9, 10)*

- Policy guidance and planning: in order to ensure equitable access to EHC services, formulating suitable strategies and technical policies is essential. Such policies must also identify the roles of public, private and voluntary sectors and the role of civil society.
- Intelligence and oversight: generation, analysis and use of intelligence on trends in prevalence of hearing loss and ear diseases; improvements in EHC workforce availability, effective coverage of services and health outcomes.
- Collaboration and coalition-building across different government sectors (see Box 4.4), and with actors outside government, including civil society and private sector for improving access to EHC services in all sections of the population.
- Regulations, e.g. for reduction of noise; expanding scope of practice of health workforce; enhancing accessibility of hearing technologies; including their implementation and enforcement.

Box 4.4 Government sectors engaged in ear and hearing care

- Ministry of Health (lead agency)
- Ministry of Social Welfare or Justice and Empowerment
- Ministry of Education
- Ministry of Labour
- Ministry of Environment
- Ministry of Finance or Planning
- Ministry of Works
- Provincial or state health regulators (if the system is decentralized)

The process of planning and monitoring EHC services at the country level can be supported by the use of available WHO tools. Application of the WHO EHC situation analysis tool *(7)* at the start of the planning process is a way of gaining a holistic view, not only of the problems and needs, but also of the health system and human resource capacity. Situation analysis and the planning process must be led by governments through a collaborative and transparent approach.

Policies developed must be in line with identified priorities and ensure the provision of quality ear and hearing care through the health system. These must address key challenges and be developed collaboratively with the relevant ministries and government agencies. Policies should foster an active collaboration with nonstate actors for effective implementation and monitoring. Available WHO tools to support the process of policy development are summarized in Box 4.5.

Box 4.5 WHO tools for the planning of EHC services

As part of implementing resolution WHA70.13, WHO launched a set of tools to support planning for the provision of integrated, quality EHC services. These tools include:

1. **EHC situation analysis tool** which provides a framework for collecting information on a country's EHC needs; a country's health system capacity for the provision of services required; and a profile of stakeholders that can contribute to the planning process.

2. **Manual for the planning and monitoring of national strategies for EHC** which provides detailed guidance on the process of policy development from the pre-planning phase through priority-setting, determining activities and resource requirements, to implementation, monitoring and evaluation. It also outlines the responsibilities of different entities engaged in the process.

3. **Indicators for the monitoring provision of EHC services** which lists a set of six core and supplementary indicators, each tailored to one of WHO's six health system blocks to enable their integration within the country's health system framework.

SUSTAINABLE FINANCING AND SOCIAL PROTECTION

A good health financing system harnesses adequate funds for people to use the required services – including EHC services – and be protected from financial catastrophe or impoverishment due to having to pay for them.

A robust health financing system must be founded on three key pillars: (i) the collection of revenues from households, companies or external agencies; (ii) the pooling of prepaid revenues in ways that allow risks to be shared; and (iii) the purchasing of equipment, medicines, services etc, or the process by which interventions are selected and services are financed and providers paid (Figure 4.18).

Figure 4.18 Pillars of a robust financing system

A ROBUST HEALTH FINANCING SYSTEM MUST BE FOUNDED ON THREE KEY PILLARS

1. **The collection of revenues from households, companies or external agencies**
2. **The pooling of prepaid revenues in ways that allow risks to be shared**
3. **The purchasing of equipment, medicines, services etc, or the process by which interventions are selected and services are financed and providers paid**

As with other health services, there is no single template for successful financing of EHC services across the life course; nonetheless principles and approaches that have proved effective for strategic purchasing *(11)* include: *(9, 12)*

- Minimizing out-of-pocket payments through a prepayment system involving pooling of financial risks across population groups. Taxation and health insurance are forms of prepayment.
- Ensuring social protection, especially for those of poor financial means and the vulnerable.
- Strengthening financial and other relationships with the private sector.

HEALTH WORKFORCE

Health systems can only function with the availability and equitable distribution of a health workforce that is competent, motivated and empowered to deliver quality care, and appropriate to the sociocultural context of the population served. As with any other public health domain, to ensure the effective provision of quality services for ear and hearing care, it is essential to: optimize performance, quality and impact of the health workforce through evidence-informed policies; align investment in human resources for health with the current and future needs of the population and of health systems; build institutional capacity for workforce development; and strengthen data on health workforce for monitoring and ensuring accountability *(13)*.

Countries at all levels of socioeconomic development face, to varying degrees, challenges in the education, deployment, retention, and performance of their health

workforce. Without addressing these challenges systematically, health priorities and targets will remain as aspirational goals only. This is no different for ear and hearing care than for other health conditions and initiatives.

The variable distribution of professionals, such as ENT specialists, audiologists, speech therapists and teachers of the deaf has been described in Section 3. Addressing the gaps in these cadres requires careful and evidence-based workforce planning so that IPC-EHC can be delivered across the life course. Several factors need to be considered to ensure opportunities for education and training, increased retention of the health workforce, and the improved distribution and performance of existing health workers. These include: *(9)*

As with other health services, a "well-performing" health workforce that is available, competent, responsive and productive, is at the centre of integrated person-centred ear and hearing care. This includes all those engaged in actions to protect and improve health, including health service providers, health management and support workers in private and public sectors *(9)*.

- increasing the numbers and skills of the EHC health workforce through scaling up and financing education programmes in a sustainable manner;
- designing training programmes for other (non-EHC) cadres of health workers that facilitate integration of ear and hearing care across services and at different stages of the life course through task-sharing;
- using telemedicine to improve access, especially in remote and underserved areas; and
- organizing health workers to deliver EHC services at different levels of care.

This requires accompanying policies that support such educational programmes and the promotion of task-sharing through an expanded scope of practice of (non-EHC) health workforce and accompanying reimbursement.

As outlined in Section 3, task-sharing, when implemented as part of a broader workforce strategy, can improve access to EHC services, reduce health-care disparities, increase efficiency, and improve access to, and quality of, care across the life course *(14–17)*. Such workforce-related solutions are facilitated by innovative technology and telemedicine services to promote access to quality services.

HEALTH INFORMATION

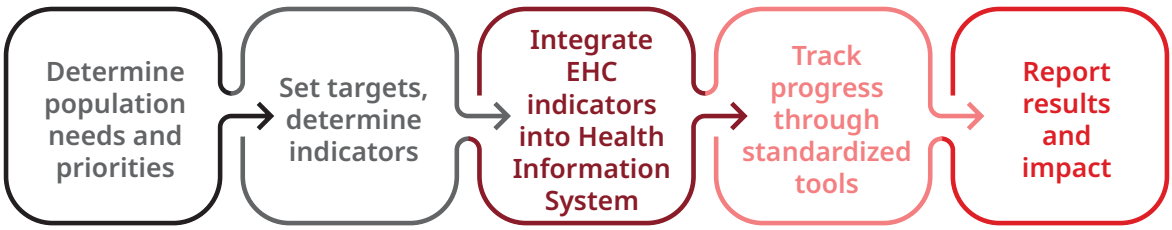
Sound and reliable information gained through a robust health information system is the foundation of decision-making across all health system building blocks. A health information system provides information on several factors:

- key health determinants (socioeconomic, environmental, behavioural, and genetic factors);
- the contextual environments within which the health system operates;
- inputs into the health system and related processes including policies, health infrastructure and equipment, costs, and human and financial resources;
- performance or outputs of the health system such as availability, accessibility, quality and use of health services and financial risk protection;
- health outcomes (mortality, morbidity, disease outbreaks, health status, disability, well-being); and
- health inequities.

Data and information relating to these factors are commonly gathered at the individual, health facility, and population levels *(18)*, and are necessary for both the planning and monitoring of IPC-EHC services provided across the life course. Planning and monitoring must aim to: *(19)*

- Determine population needs and priorities at different stages of the life course by estimating prevalence and causes of hearing loss in all ages, and studying its trends over time. The WHO *Ear and hearing: survey handbook* provides a standardized tool for this purpose *(20)*.
- Assess the health systems' capacity for provision of required clinical services; identify gaps and monitor its performance. The WHO *Ear and hearing care: situation analysis tool* is useful in this respect *(7)*.
- Set realistic, relevant, and time-bound targets; and identify relevant indicators to assess the effective coverage of services. WHO-set global targets are provided in section 4.4.2 and should be included in national targets, if relevant. National targets need to be determined according to identified country priorities for ear and hearing care, and actions planned to address these. The different stages of the approach to setting targets and indicators as described above are shown in Figure 4.19.
- Integrate indicators within the national health information systems and track progress through the use of standardized monitoring tools.
- Report progress towards the targets and demonstrate impact of the strategy; identify gaps in strategy implementation so that these can be bridged and course-correction undertaken.

Figure 4.19 Process for setting targets and indicators on ear and hearing care



The success of such an approach depends on: *(9)* a well-functioning health information system that ensures the production, analysis, dissemination and use of reliable and timely health information, including EHC indicators at different levels of the health system; an efficient surveillance system with a consistent application of the developed tools and instruments; and a compilation of the data related to indicators by the office responsible for ear and hearing care in the Ministry of Health and its regular reporting to the National Committee and publication in health reports *(19)*.

MEDICAL PRODUCTS, VACCINES AND TECHNOLOGIES

A well-functioning health system must ensure equitable access to essential medical products of assured quality, safety, efficacy and cost–effectiveness. These include: *(9)*

- vaccines;
- diagnostic equipment for ear examination and hearing assessment;
- medicines, e.g. antibiotics and eardrops;
- surgical equipment for microscopic and other ear surgeries; and
- hearing technologies, e.g. hearing aids, middle ear and cochlear implants.

In order to ensure their equitable access and rational use, EHC-related products should be included in government lists of essential medicines, medical devices and assistive technologies, aligned with available WHO lists *(21)*. Technical specifications should be developed, in line with international standards (e.g. the WHO "Preferred profile for hearing aids suitable in low- and middle-income countries") *(22)*. Materials should be procured reliably to avoid counterfeit and substandard products. Procurement and use of the included products should be monitored to ascertain their quality, effectiveness and safety. Health system requirements for ensuring equitable access to assistive devices and products are summarized in Figure 4.20.

Figure 4.20 Health systems requirements for equitable access to devices and products

National policies, standards, guidelines and regulations

Information on prices, trade agreements along with the capacity to negotiate prices

Reliable manufacturing practices and quality assessment

Efficient systems for procurement, supply, storage and distribution

Guidelines that maximize patient safety through the rational use of required medicines, technologies and equipment

Wherever possible, governments should encourage innovations and local adaptations of successful interventions, such as hearing technologies and diagnostic or surgical equipment. However, such innovations and adaptations must undergo rigorous testing to ensure compliance with the required internationally accepted quality and safety standards.

4.6.2 RESEARCH FOR EVIDENCE-BASED INTEGRATED PEOPLE-CENTRED EAR AND HEARING CARE

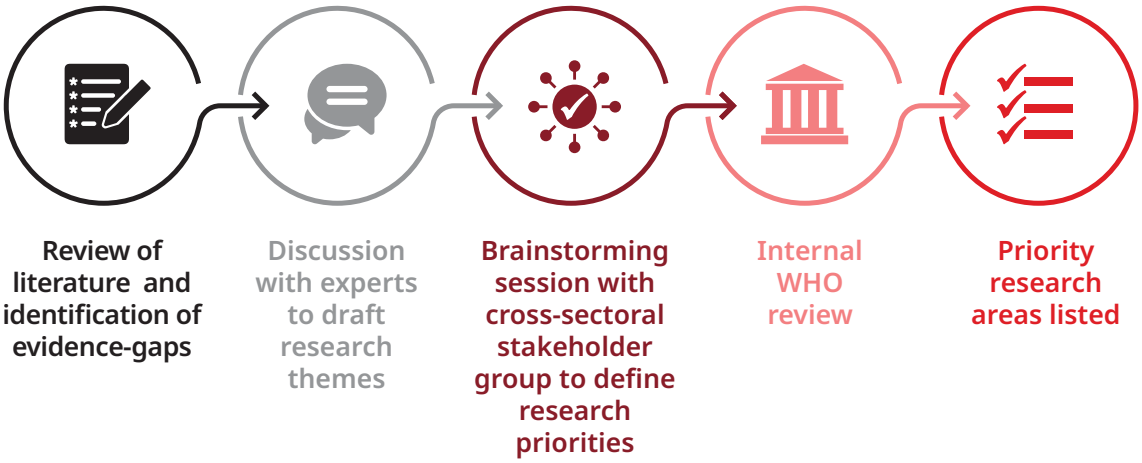
In addition to the points mentioned above, it is important to focus attention on relevant, impact-orientated research. Sound health policies and policy implementation *(23)* are founded on research, evidence and information. For this report, gaps in research and evidence were identified, along with priority areas to be targeted. The process for identifying priority areas for EHC research is summarized in Figure 4.21.

In the context of promoting IPC-EHC across the life course, research should be targeted towards: *(23, 24)*

- prioritization of EHC needs, particularly in low- and middle-income countries;
- building health systems' capacity for service impact;
- norms and standards that support the creation of an enabling environment;
- creating knowledge and products that can be adapted to different cultural and socioeconomic settings;
- translating quality evidence into affordable health technologies and evidence-informed policies; and
- impacting society.

Research, evidence and information are the foundation for comprehensive health policies and their implementation.

Figure 4.21 Process followed for identification of priority areas for research in ear and hearing care



IDENTIFIED PRIORITY AREAS FOR RESEARCH IN EAR AND HEARING CARE

Based on the gaps in evidence identified during the development of this report, along with inputs from experts and stakeholders actively engaged in service provision or advocacy within countries, the following areas were identified as a priority in the development and implementation of IPC-EHC:

1. Prevalence and causes of hearing loss assessed through population-based studies following a consistent methodology.
2. Study of barriers to accessing ear and hearing care services in different economic and cultural settings, along with strategies to overcome these barriers.
3. Ear and hearing care needs, barriers and approaches for improving access in vulnerable populations, including indigenous populations.
4. Hidden hearing loss and other effects of sound on human ears.
5. Approaches and tools for changing listening behaviours in those most at risk of hearing loss due to unsafe listening practices.
6. Innovative approaches for early identification of hearing loss across the life course, including their effectiveness and cost–effectiveness. Special focus should be on older adults and school-age children.
7. Service-delivery approaches that improve access to hearing rehabilitation including hearing technologies, especially in low- and middle-income countries.
8. Models of task shifting and task-sharing across cadres, including their effectiveness in improving access and cost–effectiveness of EHC services.
9. Training modalities for health workers and paraprofessionals on primary ear and hearing care.
10. Telehealth, m-health and e-health models for EHC service provision in underserved populations.

11. High-quality, cost–effective, hearing technologies that match country needs and can be manufactured locally, especially self-fitting and other similar technologies.
12. High-quality, cost–effective innovative diagnostic tools, hearing aids and implants.
13. Health financing models for improving access to hearing technologies and services.
14. Impact of policies and regulations in: improving access to technologies and services; increasing safe listening practices; preventing hearing loss through noise control, and ototoxic medicine/chemical regulation.
15. Effectiveness and cost–effectiveness of public health strategies such as:
    - standards and norms for safe listening devices and safe listening venues;
    - awareness campaigns for prevention of ear diseases and hearing loss;
    - noise reduction in occupational, recreational or environmental settings; and
    - immunization against vaccine-preventable causes of hearing loss.
16. New vaccines (e.g. CMV) and therapeutics for the prevention and management of hearing loss and models for their public health application.
17. Approaches for, and impact of, increased availability of sign language translation, captioning services and assistive technologies (e.g. loop systems).

The above list of priority areas for EHC research is not exhaustive: it focuses mainly on the public health aspects of ear and hearing care which relate to the H.E.A.R.I.N.G. interventions and health system enablers, and does not detail clinical and therapeutic areas of research. Research on novel therapeutics and clinical aspects is acknowledged as essential to ensure the availability of effective preventative, medical, surgical and rehabilitative solutions for ear diseases and hearing loss. However, research into cost–effectiveness and relevant service delivery models is equally important so that their intended benefits on public health can be realized.

CASE STUDY

Japan prioritizes research for hearing care

Japan has long prioritized care of older adults as an essential public health strategy; the country has the highest proportion of older adults in the world and has often been termed a "super-ageing" society *(25)*. The high incidence of hearing loss and its relationship with cognitive decline has prompted Japan to research this association scientifically and to share their knowledge with the rest of the world. At the same time, recognizing that noise exposure and unsafe listening is a cause for hearing loss, Japan has focused on the issue of safe listening through the engagement of its scientists in the development of the evidence-based WHO-ITU global standard for safe listening. Moreover, the Japanese Telecommunication Technology Commission (TTC, a Standardization body for information and communication technology in Japan) has adopted the WHO-ITU global standard as a national standard.

> Integrated people-centred ear and hearing care must be available and accessible to all, where and when needed, without causing financial hardships.

4.7 CONCLUSION AND RECOMMENDATIONS: MAKING EAR AND HEARING CARE ACCESSIBLE FOR ALL

Worldwide, over 400 million people experience limitations in their day-to-day lives due to unaddressed hearing loss, while over 1 billion are at risk of this growing threat. Despite its high prevalence and impact, the *World report on hearing* demonstrates that hearing loss can be prevented and its impact mitigated through timely and effective measures.

During the past few decades, the field of ear and hearing care has advanced substantially, with the development of both high-end technology, and innovative service delivery approaches. Despite these developments, the vast majority of those who need EHC services cannot access them. Even where services are available, people often fail to seek them out due to their low levels of knowledge regarding hearing loss, and the stigma associated with hearing loss. Hence, a public health approach is essential to ensuring that technology and innovation can reach and benefit all those in need.

The many challenges confronting the field of ear and hearing care – as analysed in this report, along with solutions presented – can be summarized to highlight the lack of public health attention given to ear and hearing care and the need for a public health approach.

Summarizing the rising risk, numbers, and impact of hearing loss that contribute a significant share of the Global Burden of Diseases, and are responsible for over 35 million DALYs annually,[31] must serve as a wake-up call for health policy-makers across the world. To ensure that all world citizens can enjoy a state of optimum health and well-being, EHC services must be accessible to all. Adopting a people-centred approach that integrates ear and hearing care into national health care systems as part of universal health coverage is the only way to confront this growing challenge.

The *World report on hearing* proposes the H.E.A.R.I.N.G. package as a comprehensive list of interventions to address all aspects of ear and hearing problems throughout

[31] See: http://www.healthdata.org/research-article/global-burden-369-diseases-and-injuries-1990%E2%80%932019-systematic-analysis-global-burden.

the life course. Along with showing the costs for investing in ear and hearing care, including the benefits and economic gains of doing so, the report further sets a global scale-up target for 2030 and outlines tracer indicators that can monitor global progress towards the target.

Countries must act to assess their own requirements, prioritize the interventions most relevant to serving their population needs, and integrate them systematically into their national health care plans using available resources. Key recommended actions for doing this are set out below.

4.7.1 RECOMMENDATIONS FOR MINISTRIES OF HEALTH

RECOMMENDATION 1:
INCLUDE IPC-EHC IN UNIVERSAL HEALTH COVERAGE

Actions:

- Determine population needs and priorities for ear and hearing care in each individual country and integrate the H.E.A.R.I.N.G. package into universal health care, based on identified priorities.
- Ensure equitable access to EHC services for all, including those living in remote areas or belonging to vulnerable groups.
- Provide financial risk protection and reduce out-of-pocket expenses for ear and hearing care.
- Involve other government sectors and civil society, including organizations for people who are deaf and hard of hearing in the planning and implementation process, to foster a holistic, collaborative approach.

RECOMMENDATION 2:
STRENGTHEN HEALTH SYSTEMS TO DELIVER IPC-EHC AT ALL LEVELS OF CARE

Actions:

- Consider IPC-EHC as part of national health plans for care provision at all levels of service delivery (community, primary, secondary and tertiary levels) in an integrated way, addressing needs of all sections of the population including vulnerable groups.
- Ensure the integration of ear and hearing care into health services provided across the life course, including, among others, child health programmes, healthy ageing, occupational health services, environmental health, and health promotion activities.

- Establish, or augment, educational programmes for the development of professional cadres for ear and hearing care.
- Strengthen the training of other (non-EHC) health-care providers and others (e.g. teachers, social workers, etc.) on hearing loss, its impact, and their roles in supporting access to effective communication.
- Improve access to high-quality, affordable hearing technologies (hearing aids, cochlear implants and other assistive devices) and services required for their effective use.

RECOMMENDATION 3:
UNDERTAKE AWARENESS CAMPAIGNS THAT ADDRESS ATTITUDES TOWARDS, AND STIGMA RELATED TO, EAR DISEASES AND HEARING LOSS

Actions:

- Inform the public on the avoidable causes of ear diseases and hearing loss, their impact, and the effectiveness of interventions across the life course.
- Develop an effective communication strategy to change listening behaviours among those at risk of hearing loss due to unsafe listening practices.
- Use the advocacy opportunity provided each year by the World Hearing Day, as a means to inform and educate the public on ear and hearing care.
- Include modules on IPC-EHC in professional training courses, such as for ENT, audiology and speech therapy, in order to foster a public health approach among EHC professionals.
- Advocate with relevant government sectors for communication and education through the provision of sign language services and other means, such as captioning.

RECOMMENDATION 4:
DETERMINE TARGETS, MONITOR NATIONAL TRENDS, AND EVALUATE PROGRESS

Actions:

- Assess progress towards EHC targets using the identified tracer indicators.
- Identify and include comprehensive EHC indicators in national health information systems and ensure their regular monitoring.
- Publish indicators and assess progress towards achieving the targets, as part of the national health reports.

- Assess hearing loss as part of population-based health surveys and report this in a standardized manner (i.e. in accordance with WHO grades of hearing loss[32]).
- Share data, knowledge and resources with other countries and across regions through strong partnerships and collaborative networks.

RECOMMENDATION 5:
PROMOTE HIGH-QUALITY PUBLIC HEALTH RESEARCH ON EAR AND HEARING CARE

Actions:

- Develop a national research agenda in line with global and national priorities.
- Promote and support research and studies that focus on the relevance, implications and application of research findings on public health.
- Strengthen links between ministries of health, research organizations and institutions for a collaborative approach to ensure that research is aligned with national EHC priorities.
- Establish a mechanism to encourage funding of public health research that focuses on ear and hearing care.

4.7.2 RECOMMENDATIONS FOR INTERNATIONAL ORGANIZATIONS

RECOMMENDATION 1:
ALIGN WITH WHO'S GLOBAL TARGETS FOR EAR AND HEARING CARE, AND SUPPORT THEIR MONITORING

Actions:

- Advocate for access to H.E.A.R.I.N.G. interventions as part of ongoing efforts to achieve SDG 3.8.
- Support low- and middle-income countries in the development, implementation and monitoring of IPC-EHC services.
- Support the creation of a WHO-led global monitoring system for assessing tracer indicators that monitor the effective coverage of H.E.A.R.I.N.G. interventions.

[32] See: https://www.who.int/pbd/deafness/hearing_impairment_grades/en/

RECOMMENDATION 2:
TAKE STEPS TO IMPROVE KNOWLEDGE, ATTITUDES AND PRACTICES WITH RESPECT TO EAR AND HEARING CARE

Actions:

- Engage with thought leaders and influencers at global and regional levels to raise awareness on, and outline, means for mitigating stigma related to hearing loss.
- Use the opportunity provided each year by the World Hearing Day to raise awareness on hearing loss.
- Promote the WHO Make Listening Safe[33] initiative and adopt practices that are aligned to its recommendations.

RECOMMENDATION 3:
STIMULATE GENERATION AND DISSEMINATION OF KNOWLEDGE ON EAR AND HEARING CARE

Actions:

- Encourage and support research related to ear and hearing care, in line with WHO-identified research priorities.
- Build international research collaborations that generate evidence relevant to country context and facilitate exchange of knowledge.
- Collaborate through data generation and sharing, using consistent methodology and platforms.

RECOMMENDATION 4:
PARTICIPATE ACTIVELY IN GLOBAL ACTION FOR EAR AND HEARING CARE

Actions:

- Join, support and contribute to the WHO-led World Hearing Forum[34] and its global action for ear and hearing care.
- Promote global collaboration for improving access to high-quality, affordable hearing technologies and related services.
- Ensure that ear and hearing care is integrated into global and regional initiatives targeting, in particular, the health of children, adolescents and older adults.

[33] See: https://www.who.int/activities/making-listening-safe
[34] See: https://www.who.int/activities/promoting-world-hearing-forum

4.7.3 RECOMMENDATIONS FOR STAKEHOLDERS, INCLUDING PROFESSIONAL GROUPS, CIVIL SOCIETY, AND PRIVATE SECTOR ENTITIES

RECOMMENDATION 1:
SUPPORT NATIONAL GOVERNMENTS AND WHO IN THE PROVISION AND MONITORING OF EAR AND HEARING CARE

Actions:

- Advocate with, and support governments in, the provision of IPC-EHC through integration of H.E.A.R.I.N.G. interventions into national health plans.
- Support WHO in monitoring identified tracer indicators, as a means for assessing the growth in the provision of EHC services globally over time.

RECOMMENDATION 2:
CONTRIBUTE TO THE GENERATION OF KNOWLEDGE REGARDING PUBLIC HEALTH ASPECTS OF EAR DISEASES AND HEARING LOSS

Actions:

- Undertake research in line with WHO identified research priorities; publish and share results.
- Improve EHC literacy among ear and hearing professionals by including a public health module in relevant professional courses.

RECOMMENDATION 3:
COLLABORATE TO ENSURE THAT ALL STAKEHOLDERS CAN CONTRIBUTE TO, AND SHARE A COMMON VISION OF, EAR AND HEARING CARE

Actions:

- Establish and support regional and subregional multistakeholder groups to identify region-specific needs, resources and opportunities, in collaboration with WHO.
- Join and support the World Hearing Forum for promoting coordinated and collaborative global action on hearing loss.

RECOMMENDATION 4:
HIGHLIGHT THE IMPORTANCE, NEED, AND MEANS FOR EAR AND HEARING CARE, AND ADVOCATE FOR ITS PRIORITIZATION IN GOVERNMENT HEALTH AGENDAS

Actions:

- Join the World Hearing Day advocacy event each year as a means for raising the profile of ear and hearing care within communities and decision-makers at all levels.
- Organize national and subregional launch events and policy dialogues to disseminate and advocate for the adoption of recommendations made in the *World report on hearing*.

The first meeting of the World Hearing Forum in December 2019 at the WHO headquarters in Geneva, Switzerland

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For more details refer to:
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