

Service delivery approaches for hearing aids in resource-limited settings

A World Health Organization background study



**World Health
Organization**

This report is a compilation of available evidence related to service delivery approaches for hearing aids in resource-limited settings, based on a systematic scoping literature review and stakeholder interviews. This review has been undertaken by the World Health Organization (WHO) in consultation with a technical working group. Financial support was provided by the ATscale Global Partnership for Assistive Technology.

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Acronyms

WHO: World Health Organization

WHA: World Health Assembly

ENT: Ear, nose, and throat

NGO: Non-governmental organization

Executive Summary

Globally, it is estimated that over 400 million people could benefit from the use of hearing aids, although only 17% of those who could benefit from using these devices use them. The issue of unaddressed hearing loss is highlighted in the World Health Assembly (WHA) resolution 70.13 on prevention of deafness and hearing loss (2017), and the WHA resolution 71.8 on improving access to assistive technology [1,2]. The World Health Organization (WHO) has been collaborating with ATscale to develop a market shaping strategy, which focuses on the challenges related to hearing aids, particularly in resource-limited settings. In March 2020, ATscale released a 'Hearing aids product narrative' which identified five key strategic objectives for improving access to hearing aids and related services. The first strategic objective is to “strengthen global policy guidance around service delivery standards, product selection, and product quality.” To this end, one suggested intervention is to develop and disseminate a preferred service delivery profile for provision of non-complex hearing aid services. This service delivery profile should be evidence-based, simplified, and based on the principles of task sharing. In collaboration with ATscale, WHO has undertaken this background study to inform the development of possible service delivery approaches suitable for resource-limited settings. This background study consists of two parts:

1. A systematic review of the literature

A systematic scoping review was conducted to synthesize evidence on service delivery approaches for hearing aid provision in resource-limited settings. A total of 15 peer-reviewed studies, conducted across 9 countries and in resource-limited settings, were included. These studies provided details on hearing aid service delivery approaches in hospitals, through large-scale donation programmes, in community-based settings, and by using telehealth strategies.

The review concluded that hearing aid services were provided by qualified hearing care providers as well as trained non-specialists. This supported the feasibility and effectiveness of task sharing strategies to provide services across the continuum of audiology care related to hearing aid service delivery. Furthermore, studies showed the feasibility, efficacy, and effectiveness of providing hearing aid services by utilizing low-cost and high-quality hearing aid technologies in rural and remote areas. The review supported provision of hearing aid services in community-based settings including through utilizing telehealth approaches.

2. Stakeholder interviews

Semi-structured stakeholder interviews were conducted to understand current practices and challenges related to hearing aid provision in resource-limited settings. Thirteen experts, who were involved in hearing aid service delivery in resource-limited settings across 11 countries, participated in the online interviews.

Current hearing aid service delivery programmes exist in several forms, such as in hospitals, specialized clinics, and in the community. Most programmes provided comprehensive hearing aid services and employed task sharing strategies among qualified hearing care providers and trained non-specialists to provide hearing aid services. Key strengths of programmes identified by participants included effective use of task sharing strategies, use of high quality, low-cost hearing aids, and high levels of stakeholder engagement. Opportunities identified by participants to improve hearing aid service delivery included: streamlining hearing aid service delivery processes, including the use of pre-programmed hearing aids, expanding the reach of the programme to serve more remote communities, and improving awareness among the public about benefits of hearing aids and the offering of hearing aid services.

The key conclusions from this report are as follows:

- Task sharing is a promising strategy to address the critical lack of health care workers to provide ear and hearing care services, specifically related to assistive technologies such as hearing aids, in resource-limited settings. Task sharing can create a more rational distribution of tasks and responsibilities among cadres of health workers, thus improving access to and cost-effectiveness of services while ear and hearing care services continue to be developed in resource-limited settings.
- Use of low-cost and high-quality hearing technology, such as pre-programmable hearing aids, alongside education and counseling can support provision of hearing related services that are supported by task sharing.

Introduction

Background

Hearing is critical for achieving a high quality of life. Hearing influences how individuals integrate into and relate to society and can impact educational and employment opportunities throughout the lifespan. Importantly, hearing is fundamental for the development of speech and language in childhood [3]. Furthermore, throughout the lifespan, hearing loss can have negative impacts on education attainment, employment prospects, mental health and psychosocial well-being, and has been associated with several health conditions, including cognitive decline and dementia [4-8].

The World Health Organization (WHO) estimates that over 430 million people currently live with disabling hearing loss, and that this number will substantially grow in the coming years [9]. In addition to the important impacts of hearing loss on individuals, hearing loss also has wide-ranging societal impacts. For example, unaddressed hearing loss poses an annual global cost of 980 billion international dollars per year and is one of the leading causes of morbidity globally [9,10].

While it is estimated that over 400 million people could benefit from assistive technology for hearing such as hearing aids, only 17% of those use these devices, which poses a tremendous global challenge [11]. Most individuals with disabling hearing loss reside in low- and middle-income countries, and the majority of these individuals could benefit from timely and effective interventions to manage their hearing loss, such as the use of hearing aids alongside rehabilitation services [9]. To address this large unmet need, improving access and affordability of assistive technology, including hearing aids, and related services, must be a priority.

Two barriers that limit access to hearing aids in resource-limited settings are i) the lack of a workforce trained in ear and hearing care, and ii) the high costs of traditional hearing aids and related equipment. First, there are sizeable gaps in the availability of hearing health care professionals, including ear, nose, and throat (ENT) specialists and audiologists, worldwide. This is demonstrated by the fact that 95% and 65% of high-income countries have *more than 10* ENT specialists or audiologists, respectively, per 1 million population, whereas 78% and 93% of low-income countries have *less than 1* ENT specialist or audiologist, respectively, per 1 million population [12]. Second, the cost of hearing aids, which varies globally, is often a barrier to their access. In the United States, the price of a single hearing aid can range from 500 to 3000 US dollars [13]. Although lower-cost options may be available in some areas of the world, the cost of

hearing aids, as well as the costs associated with their sustained use, such as batteries and repairs, remains unaffordable for many [14,15].

Optimizing service delivery approaches related to hearing aids is a key component of improving access and affordability of hearing aids in resource-limited settings. Hearing aid service delivery should be part of a continuum of hearing care provision including a focus on prevention, early identification, diagnosis, rehabilitation, support, and education. Specifically related to hearing aid provision, there are three primary steps of service delivery: 1) case identification and hearing assessment, 2) hearing aid fitting, and 3) hearing aid follow up and counseling (Figure 1). First, case identification refers to the way in which cases of hearing loss are identified. This may include case identification via hearing screenings or self-referral. Hearing loss should be diagnosed through hearing assessment. Second, hearing aid fitting refers to the processes included in prescribing and fitting hearing aids for a given individual, including hearing aid verification. Third, hearing aid follow up and counseling refers to any post-fitting hearing aid adjustments and rehabilitation services, including education counseling related to hearing aids.

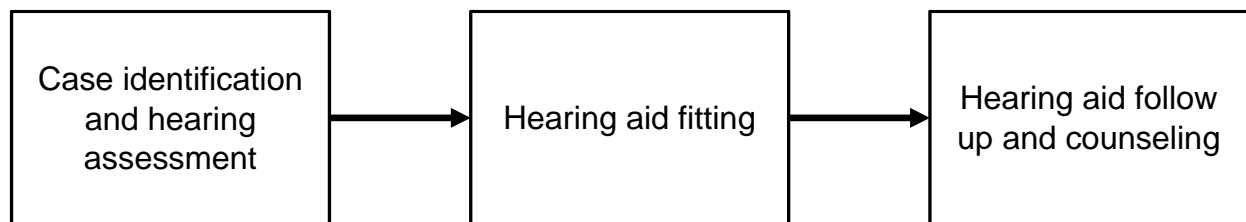


Figure 1: Main steps of hearing aid service delivery process.

Human resources and task sharing

Cadres of professionals who may be involved in providing ear and hearing care, including hearing aid services, include *qualified hearing care providers*, such as audiologists, ENT specialists, and speech therapists, as well as *trained non-specialist providers*, such as primary level health workers, including community health workers, nurses, and general practitioners. Task sharing is a strategy that reduces the need for highly trained professionals, such as qualified hearing care providers, and redistributes activities that are routinely provided by highly trained professionals to different cadres of health workers with lower training needs, such as trained non-specialist providers [9]. Task sharing must be preceded by a situational analysis of currently available human resources for ear and hearing care, and the tasks allocated to different cadres should comply with the regulations and laws of the given location [9].

In terms of hearing aid provision, trained non-specialist providers could be involved in all processes of hearing aid service delivery, including case identification and hearing assessment, hearing aid fitting and hearing aid follow up and counseling (Figure 1). Trained non-specialist providers should be supervised by a qualified hearing care provider.

Service delivery approaches

Next, a brief overview of four service delivery approaches is presented. These include central, community, satellite, and mixed approaches [16]. See Figure 2 for a depiction of these approaches.

Central models refer to a single hearing care center, such as a hospital or clinic, to which persons travel. In central models, care is often provided by qualified hearing care providers although task sharing with trained non-specialist providers is possible. In *community* models, care is delivered in the community, often by trained non-specialist providers who task share with qualified hearing care providers. *Satellite* models use a ‘hub and spoke’ approach, where the hub is a center of expertise (e.g., hospital or clinic) and the spoke is another location where services are provided (e.g., community, regional clinics). In satellite models, care is often provided by a remote qualified hearing care provider working with a trained non-specialist facilitator who is located with the recipient. Finally, *mixed* models combine two or more of the approaches described above, and thus often employ both qualified hearing care providers and trained non-specialist providers (Figure 2).

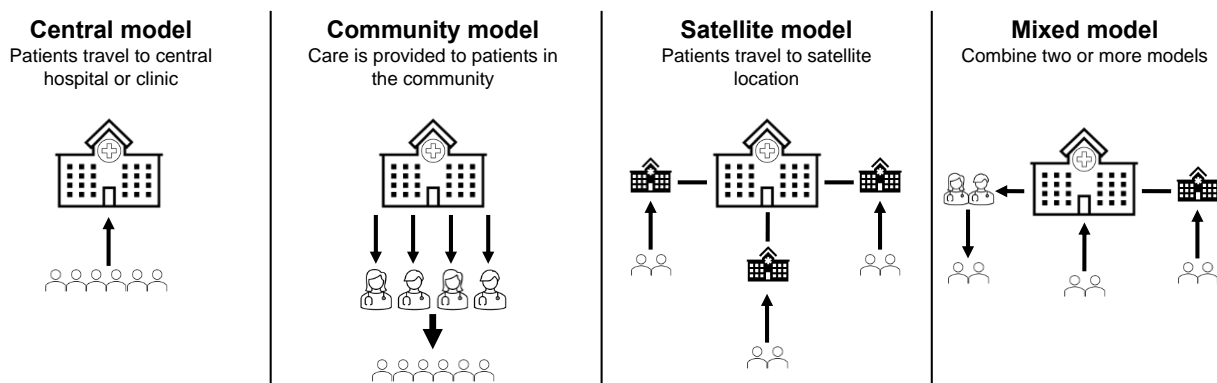


Figure 2: Depiction of central, community, satellite, and mixed models of care.

Purpose and scope of background paper

Understanding current practices in hearing aid service delivery can inform guidance and decision-making related to service delivery standards for hearing aid provision in resource-limited settings. This background paper aims to review the current practices and opportunities for hearing aid service delivery in resource-limited settings, to inform recommendations for a preferred profile.

This background paper includes insights from relevant scientific data, and stakeholder input to document current practices in hearing aid service delivery and future opportunities within this field. This background paper consists of two components, the key findings for which are described below.

1. A systematic scoping literature review
2. Semi-structured stakeholder interviews

Component 1: Systematic scoping literature review

Purpose

The purpose of this systematic scoping literature review was to synthesize evidence on service delivery approaches for hearing aid provision in low- and middle-income countries and resource-limited settings. This review has been published [17].

Method

This review followed PRISMA-ScR guidelines [18] and searched multiple databases and grey literature sources using specified search terms to identify relevant studies published in English, Spanish, and French between years 2000 - 2022. Titles and abstracts of peer-reviewed manuscripts were screened by a single reviewer and full texts were screened by two reviewers. Given the nature of this review, no critical appraisal of individual sources of evidence was conducted.

Results

A total of 331 non-duplicate citations were identified from the review. After the final review, 15 peer-reviewed studies published in English were included. Studies were from 9 countries, corresponding to representation from the African (n = 4 studies), American (n = 6 studies), South-East Asian (n = 3 studies) and Western Pacific (n = 2 studies) regions. One study was conducted in a low-income country, 4 in lower-middle income countries, 5 in upper-middle income countries, and 5 in resource-limited settings of high-income countries. The studies are categorized by the following approaches of service delivery, 1) hospital-based (central) service delivery and large-scale donation programmes, 2) community-based service delivery, and 3) telehealth (satellite).

Hospital-based (central) service delivery and large-scale donation programmes

Two studies described development and sustainability of audiology departments embedded into tertiary or secondary hospitals in the Dominican Republic and Malawi [19,20]. One study, conducted in a public hospital in South Africa, described hearing aid outcomes and barriers to hearing health care [21]. Another study described outcomes of two large-scale hearing

aid donation programmes in the Philippines [22]. Across these four studies, hearing aids were provided to both adults and children.

Service providers and programme development

In hospital settings, services were provided by qualified hearing care providers and trained non-specialists, who often worked together [19-21]. Similarly, in the study focusing on donation programmes, hearing aids were fitted by qualified hearing care providers who were volunteers of an international philanthropic organization [22].

Two studies described how audiology departments were embedded into existing hospitals, and methods for training qualified hearing care providers in new audiology programmes [19,20]. The development of an audiology clinic in the Dominican Republic was facilitated by a short-term qualified hearing care provider volunteer, who aided with startup and training [19]. The development of an audiology department in Malawi was led by a qualified hearing care provider and was later supported by task sharing among the ENT physician and trained non-specialists [20].

Hearing aid details, fitting, and counseling

Three studies included information on hearing aids and earmolds [19,20,22]. One study utilized both donated and reconditioned behind-the-ear hearing aids [19], and two utilized donated hearing aids only [20, 22]. In two studies, earmolds were made on site, either by following WHO guidance [19, 23], or by using locally available, low-cost materials to overcome resource limitations [20].

Two studies provided details on hearing aid fitting [19, 22]. In a hospital-based setting, hearing aids were fitted under standard procedures, including hearing aid verification and validation [19]. In large-scale hearing aid donation programmes, persons were fitted with the lowest power hearing aid available, the volume was increased until the person reported that the volume was comfortable. If the person did not report a comfortable volume with that device, the next most powerful device was fitted, and the process repeated [22].

Only one study described standard-of-care hearing aid follow-up processes, in which persons attended two follow-up appointments focused on hearing aid adjustments and counseling. Qualified hearing care providers were trained to repair hearing aids, and low-cost batteries were available [19].

Outcomes

Two studies evaluated outcomes related to hearing aids. In a study conducted in a South African public hospital, authors described that generally, hearing aids were poorly maintained and needed repair or replacement, and that a low proportion of persons used hearing aids daily. Barriers to hearing aid use and maintenance included access (e.g., transportation), language barriers, financial constraints (e.g., costs related to batteries, repairs, and travel to hospital), and cosmetic concerns [21]. In the study focused on large-scale donation programmes, researchers reported that a large proportion of individuals had difficulties managing their hearing aids and obtaining batteries. Few persons were appropriately fitted to prescribed target thresholds, and many experienced physical hearing aid discomfort [22].

Community-based service delivery

Seven studies focused on community-based hearing aid delivery. Five were randomized trials [24-28], and two were feasibility studies [29,30]. Four studies were conducted in low- and middle-income countries [24,25,29,30], and three were conducted in the United States in resource-limited settings [26-28]. Five studies evaluated samples of adults [26-30] and two evaluated samples of children [24,25].

Service providers and programme development

In all studies, care was provided by trained non-specialists [24-26, 28-30], or under a protocol developed for a trained non-specialist [27]. Three studies specified that trained non-specialists were supervised by qualified hearing care providers [26,28,30].

In two studies, trained non-specialists had experience or training in disability or rehabilitation, and additional training was based on the WHO Primary Ear and Hearing Care Training Package [24,25, 30-33]. Study-specific training protocols were also deployed. For example, non-specialists with relevant background (e.g., science, hearing health) participated in trainings that focused on study protocols, pure-tone audiometry, hearing aid fitting, earmolds, minor hearing aid repairs and maintenance, and counseling [26, 28-30].

Hearing aid details, fitting, and counseling

Varying levels of hearing technology were used. Two studies used pocket model analog hearing aids coupled to domes or custom earmolds [24,25], three used digital or semi-digital behind-the-ear hearing aids [26,29,30], and two used low-cost, over-the-counter hearing devices [27,28].

Five studies provided details on hearing aid fitting processes. Two studies specified hearing aids were fitted to standard prescription targets [29,30]. In one study, hearing aids were fitted via telehealth, in which tasks were performed by both trained non-specialist facilitators and qualified hearing care providers [26]. In two studies (pilot and follow-up randomized trial), participants underwent an intervention during which they were fitted with and oriented to an over-the-counter hearing device and received education on age-related hearing loss and rehabilitation (e.g., communication strategies, expectation management) [27,28].

Four studies provided details on follow-up and counseling related to hearing aid service delivery [26,27,29,30]. Three studies provided telephone follow-up [27,29,30], and in one study, participants additionally received text messages with information related to their new hearing aids [30]. In-person follow up, to make minor adjustments or provide counseling, also occurred in three studies [26,29,30].

Outcomes

Service delivery approaches were evaluated with researcher-developed questions, in terms of cost-effectiveness and health effects (measured by Disability-Adjusted Life Years averted) [25], and using standardized hearing aid outcome questionnaires [24,26-28,30,34-37]. Four studies reported participants used hearing aids regularly, defined as >1 hour/day (59% and 75% of participants) [27,28], >4 hours/day (80% of participants) [29], or daily use (88%) [30].

Two studies reported similar hearing aid outcomes and Disability-Adjusted Life Years averted for both community- and center-based service delivery approaches [24,25]. Furthermore, the community-based approach had less than half the costs of the center-based approach [24,25]. Other studies reported that study participants reported favorable hearing aid outcomes on measurement standardized tools, reduced hearing handicap and improved communication and communication self-efficacy [26-30].

Telehealth

Two case studies described hearing aid provision through telehealth [38,39]. One pilot study described the development of a hybrid (combination of telehealth and in-person services) audiology clinic in South Africa [40], and a case-control study compared outcomes for persons who received hearing-related treatment in the clinic or via telehealth [41]. Two studies were conducted in low- and middle-income countries [38,40] whereas 2 were conducted in high-income countries in resource-limited settings [39,41]. Three studies were conducted in adults [38,40,41], and one study did not specify participants' ages [39].

The number of studies that provided telehealth services for each step of hearing aid service delivery is as follows: hearing evaluation, 2 [39,41]; hearing aid fitting, 3 [38,39,41]; and hearing aid follow-up and counseling, 2 [39,40].

Service providers and programme development

In one study, qualified hearing care providers provided services directly to the person [40], and in three studies, in-person services were provided by a facilitator under the support of a remotely located qualified hearing care provider. Facilitators were trained non-specialists [39,41], or qualified hearing care providers [38].

Two studies described programme development and/or training of providers related to telehealth [38,40]. More specifically, one study outlined the processes of establishing a hybrid audiology clinic that included telehealth and in-person services [40]. Another study detailed that a telehealth facilitator was trained online by a remotely located audiologist, and that the training focused on hearing aid features and fitting processes [38].

Hearing aid details, fitting, and counseling

Two studies specified that participants used their own hearing aids [38,39]. Three studies described successful hearing aid fittings via telehealth, which were conducted by qualified hearing care providers and supported by on-site trained non-specialist facilitators [38,39,41]. One study, which also utilized a qualified hearing care provider and on-site trained non-specialist facilitator described how hearing aid adjustments could be successfully conducted via telehealth [41]. Finally, two studies described hearing aid follow up and/or counseling in the context of telehealth [39,40]. In one study, authors noted the availability of telehealth services reduced the wait time for a user by two months [39].

Outcomes

Three case or pilot studies indicated it was feasible to conduct virtual trainings for facilitators [38], provide hearing aid services to persons located in remote regions [39], and to use a mixed model of hearing aid service delivery that incorporated in-person and telehealth services [40]. Another study showed there were not substantial differences in hearing aid satisfaction for persons fitted with hearing aids in person or via telehealth, thus supporting the feasibility of telehealth services [41].

Conclusions

Results from this systematic scoping review support the feasibility, efficacy, and effectiveness of hearing aid service delivery approaches that can improve access to hearing aids in resource-limited settings. More specifically, studies supported the feasibility, efficacy, and effectiveness of community-based care, telehealth, and task sharing with trained non-specialist providers to overcome limited human resources trained in ear and hearing care. These approaches, which should be supported by low-cost and high-quality innovative technologies and by the training of new providers, can help to improve access to ear and hearing care.

Component 2: Semi-structured stakeholder interviews

Purpose

The purpose of these semi-structured stakeholder interviews was to understand current practices and challenges related to hearing aid provision in resource-limited settings.

Method

Thirteen experts who worked in resource-limited settings participated in the interviews. The goal of these interviews was to gain insight on current practices and opportunities in hearing aid service delivery in resource-limited settings.

Recruitment and participants

WHO experts identified potential participants with experience in service delivery approaches for hearing aids in resource-limited settings. Stakeholders were invited to participate in an interview. They were provided with background information, the main research topics and purpose of the interview, and any other requested information. All participants were involved in hearing aid service delivery in resource-limited settings.

Interview process

All participants provided informed consent and declared any relevant conflicts of interests. All interviews were led by a WHO staff member, lasted approximately 60 minutes, and were conducted online using Zoom or a similar platform if preferred by the participant. With the consent of participants, the interviews were recorded.

Semi-structured interviews included questions focused on the i) structure of the programmes, ii) work force, iii) entry point, iv) hearing aids, v) counseling, rehabilitation, and follow up, vi) reach and impact of the programmes, and vii) opinions on strengths, weaknesses, and opportunities. The topics covered under each of these categories are presented in Figure 3.

Figure 3: Topics covered during stakeholder interviews.

Structure of programme

- Overview of programme
- Stakeholder involvement and leadership
- Financing
- Population served

Work force

- Training
- Number of employees and amount of time dedicated to programme

Entry point

- Entry point to programme
- Requirements for programmes
- Costs

Hearing aid details

- Procurement
- Number and type of devices provided
- Who chooses and fits hearing aids
- Verification
- Supplies
- Technical support and repairs

Counseling, rehabilitation, and follow-up

- Who provides services
- How are services provided
- When are services provided

Reach and impact of programme

- Population served by programme
- Retention of patients in programme
- Cost effectiveness or efficiency

Strengths, weaknesses, and opportunities

- Strengths and weaknesses
- Opportunities for improvement

Data analysis

This study used thematic analysis. Consistent themes and unique, but relevant, responses are presented below.

Results

The 13 participants were from the following 11 countries: Cambodia, Guatemala, India, Kiribati, Nepal, Peru, Philippines, Samoa, United States, Vietnam, and Zambia, indicating representation from the African, American, South-East Asian, and Western Pacific regions. The 13 participants provided information related to 15 different programmes of hearing aid service delivery. Three of these programmes served adults, six served children, and six served both adults and children.

Structure of the programme

Hearing aid delivery programmes are run in hospitals, specialized clinics, and also in the community. Some programmes are integrated into primary health systems, whereas other programmes exist independently and are not affiliated with primary health systems or the government. While most programmes are located in a single large city, some additionally offer community-based services or have several sites, and some are located exclusively in community settings. Most programmes offer services free of cost to persons, although some require that they pay some fees for the services received.

In terms of programme development, most programmes partnered with non-governmental organizations (NGOs), or the local or national government to initiate the programmes. In a few other cases, local or international qualified hearing care providers such as ENT physicians, audiologists, and/or teachers of the deaf worked with the government, namely the ministry of health, to advocate for hearing health care in a given country. Initial funding for the programmes was often provided through these NGO or government partners, and additional funding sources included foundations or charities.

For the vast majority of programmes, ongoing funding is provided by more than one source, such as NGOs, the government, and donations or private sources. Programmes are often led by NGO or government leaders, or in some cases, by qualified hearing care providers, including ENT physicians or audiologists, or other professionals. Most programmes are supported by a technical group, who offer oversight of the hearing aid programmes.

All but one programme described below is currently active. Most programmes began in the last 20 years, although two have been running for over 30 years.

Work force

Few programmes relied solely on qualified hearing care professionals with specialized training, including ENTs specialists, audiologists, speech-language pathologists, and/or teachers for the deaf. Rather, most programmes included a combination of qualified hearing care providers, who took a supervisory role, and trained non-specialists, such as interns, health/medical officers or technicians, or community health workers. A few programmes employed only trained non-specialists. The number of workers employed and the number of hours per week worked varied by given the needs of the programme. Several programmes had full-time employees, whereas others employed part-time workers or relied on volunteers.

In terms of work force training, multiple types of training (e.g., university-level, diplomas, and certificates) were offered. In some cases, qualified hearing care providers within the programme provide specialized training for the non-specialist employees. Other programmes noted they rely on international volunteers to provide in-person or virtual training. For several programmes, non-specialist workers completed degree courses in audiology or ENT at nearby universities. Several programmes noted that they use WHO resources, such as Primary ear and hearing care: training manual, to provide training [31-33].

Entry point

The common entry points to the programmes were through screening, referrals from a health care provider, or self-referral, and most programmes accepted persons from any entry point. Screenings occurred in schools (for children only), primary health care clinics or hospitals, or in community-based settings. For persons who were referred, the referrals were most often from primary care providers. Persons could also self-refer, and generally heard about the hearing aid programmes through word of mouth or online.

Nearly all participants indicated that hearing assessment is conducted in the programme. Some persons enter the programme with results from screening audiometry, though a more comprehensive hearing assessment is completed upon entry to the programme. In most cases, participants indicated that the programme pays for the costs of the hearing assessment, the costs for which are covered by the programme itself, or by donors or other charity funds.

Hearing aids

Two-thirds of programmes relied on donated hearing aids, most of which used 'new' or unused hearing aids, whereas others provided refurbished hearing aids. The remaining one-third of programmes purchased new hearing aids. Hearing aids are procured by programme leaders, including qualified hearing care providers, or those working at partnering NGOs, hospitals, or governments. The main reasons that programmes decide to obtain or purchase a certain type of hearing aid include quality, ease of repair (including warranty), price, availability of technical support, and import regulations. Most programmes provide bilateral hearing aids (for both ears; when needed), although others provide a unilateral hearing aid (for a single ear). Programmes that focus on children are more likely to provide bilateral hearing aids whereas those that focus on adults are more likely to provide a unilateral hearing aid.

The types and models of hearing aids vary across programmes. Most programmes provide digital behind-the-ear hearing aids, though some programmes also offer in-the-ear or completely-in-the-canal hearing aids. When a given programme offers several types of hearing aids, the hearing care provider decides which hearing aids will be most appropriate for the persons and also fits them with hearing aids. Most programmes provide non-custom earmolds or domes only, although a few programmes offer custom earmolds. Most programmes offer battery-operated hearing aids while fewer offer rechargeable devices.

In terms of hearing aid fitting processes, all except two programmes had access to hearing aid function verification systems, namely free field audiometry and/or real ear measures. Others verified hearing aids using live voice testing and/or insertion gain.

Most programmes supply batteries upon hearing aid fitting, and most continue to provide batteries free of cost, either as needed, or at pre-specified time intervals (e.g., every 3 to 6 months). Some programmes provide additional accessories for hearing aid maintenance, including hearing aid dehumidifiers. The vast majority of programmes also provide ongoing technical support for hearing aid users, which is available either from the hearing aid manufacturers, or the hearing care providers in the programme.

Counseling, rehabilitation and follow up

All programmes except one provide counseling, which is provided by workers of the programme. However, few programmes provide comprehensive rehabilitation services; when offered, these services are provided by qualified hearing care providers.

In most cases, persons receive follow-up care as needed. However, a few participants reported their programmes had standardized timelines for follow-up appointments, which ranged from every 3 months to a year. Most programmes offer replacement hearing aids, either as needed (e.g., if the hearing aid is broken or if a more powerful hearing aid is needed) or within a certain time frame, ranging from 3 to 5 years.

In terms of follow-up hearing assessments, most programmes recommend persons have their hearing evaluated once per year. In fewer cases, hearing assessments are recommended as needed.

Reach and impact of the programme

In most cases, participants approximated details on the reach and impact of the programme. There was a wide range of reported number of people covered, ranging from 50 to over 300,000 individuals who received any hearing-related services. Most participants did not have cost-effectiveness or efficiency data readily available for their programmes.

Similarly, most participants did not have an estimate for the proportion of people who stop using their hearing aids. Among the participants who did have an estimate, the number ranged from 10 to 30%. Hypothesized reasons for hearing aid non-use included stigma, perceived lack of benefit or expectations not being met. Other reasons included that the hearing aids may be stolen or lost, that batteries can be difficult to obtain, and that follow-up care is difficult to obtain given barriers, such as long distance and high costs, to travel to the clinic.

Most participants could not estimate how many persons leave the programme, but some participants estimated those numbers to range from 5 to 25%. While many participants said they did not know the exact reason why participants left the programme, they hypothesized that reasons include: transportation or travel barriers, cost barriers, lack of time, illness, lack of perceived benefit or loss of hearing aids, or simply forgetting to attend the follow-up.

Opinions on strengths, weaknesses, and opportunities

Next, common themes related to participants' perceptions of strengths and weaknesses of programmes, and future opportunities are presented. Key strengths that were identified by participants included: i) hearing aids are high quality and low cost, ii) hearing aid service delivery approaches involve several engaged stakeholders, and iii) trainings related to hearing aids are available, which can promote the use of task sharing. On the other hand, weaknesses identified

by participants included: i) lack of funds, ii) human resource limitations, iii) limited trainings available for non-specialists, iv) difficulties in the availability or procurement of hearing aids, v) difficulties in extending hearing aid services beyond a large city and the need for community-based services, vi) limited awareness of the target population on the availability of services, vii) retention of persons in the programme, and viii) challenges in securing ongoing funding.

Participants also provided valuable perspectives on opportunities to improve hearing aid service delivery programmes. Common themes included, i) utilizing processes to streamline the hearing aid service delivery process, such as optimizing procurement so there are fewer challenges in importing audiological equipment and assistive devices, and use of pre-programmed hearing aids and digital and mHealth technologies, ii) implementing tools to measure the reach and benefit of the programme, iii) expanding the reach of the programme to serve more remote communities, iv) offering or improving training opportunities for non-specialists, for example, online training courses, and focus on skills-based and culturally sensitive trainings, and v) improving awareness among the general public about benefits of hearing aids and the offering of hearing aid services.

Conclusions

Expert participants shared details about service delivery programmes, which are described above. Key findings include: i) in current hearing aid service delivery programmes, the territorial coverage of many programmes is limited and centralized and with this, the coverage of the population is limited, which demonstrates a need for expanding community-based hearing aid services, ii) current limitations to programmes, which can be addressed, include programme inefficiencies and including lack of follow-up services, iii) there are examples of and opportunities for task sharing with trained non-specialist providers for successful provision of hearing aid services and accompanying support, and iv) a successful hearing aid programme requires involvement of multiple relevant stakeholders.

Discussion and conclusions

This background paper, which compiled evidence obtained via a systematic scoping literature review and stakeholder interviews, documents current practices in hearing aid service delivery in resource-limited settings, and highlights opportunities for improvement. The key findings are discussed below.

Key finding 1: Task sharing is a promising strategy to address the critical lack of health care workers to provide ear and hearing health services, specifically related to assistive technologies such as hearing aids, in resource-limited settings.

Both the systematic scoping literature review and the semi-structured stakeholder interviews identified several successful examples of task sharing. The systematic scoping review showed that task sharing was used in hospital and community-based settings, and when services were delivered via telehealth. More specifically, the review showed successful examples of the development and implementation of different levels of specialist and non-specialist training programmes, which resulted in an expanded workforce trained in ear and hearing care [19,20]. Furthermore, this review showed that in community-based settings, it was feasible for trained non-specialists to provide services across the continuum of audiological care, including hearing assessment, earmold impressions, hearing aid fitting and adjustment, counseling and follow up, and hearing aid maintenance and minor repairs [24,25,27-30]. Community-based services, which often relied on trained non-specialist providers, yielded similar outcomes compared to those provided in clinical settings, when services were provided by qualified hearing care professionals [24,26], and were shown to be cost-effective [25]. Results from the stakeholder interviews also showed successful examples of task sharing among long-standing and successful programmes for hearing aid provision in resource-limited settings. Most programmes employed both qualified hearing care providers and trained non-specialist providers, where trained non-specialist providers were supervised by qualified hearing care providers.

In studies included in the systematic review and in stakeholder interviews, several approaches to training non-specialist providers were employed. For example, one hospital-based study, a 3-month, in-house audiometry training was developed and implemented [19]. In community-based studies, trainings ranged from 4 days to 8 weeks, and trained non-specialist providers often had some background in hearing or a related field [28-30]. In some cases, trainings were specific to the study protocol, and in others, they additionally focused on pure-tone

audiometry, hearing aid fitting, earmolds, minor hearing aid repairs and maintenance, and counseling [29,30]. Other materials that were commonly used for training, both in studies included in the systematic review and in programmes described during the stakeholder interviews, included the WHO Primary Ear and Hearing Care Training Package [24,25,31-33]. Other examples of training for non-specialists included diplomas or certificates related to ear and hearing care, which could be provided at local universities, by workers of a given programme, and/or by international volunteers who provide in-person or virtual trainings.

Key finding 2: Use of low-cost and high-quality hearing technology, such as pre-programmable hearing aids, can support provision of hearing-aid related services supported by task sharing.

The vast majority of studies included in the systematic literature review and programmes described in stakeholder interviews provided low-cost hearing aid technologies, given that these studies or programmes are in resource-limited settings. These hearing aids were either donated (either new or used and refurbished) or purchased new, often at a low cost. Often, hearing aids were behind-the-ear hearing aids coupled to foam tips or domes, rather than to custom earmolds. This choice is likely because such hearing aids can be fit to users with varying audiological profiles, and reduces the need to manufacture earmolds, which could not always be done on site. However, there were successful examples of manufacturing custom earmolds on site using WHO guidance [19-20] or other low-cost materials.

In addition to those described in the review and interviews, there are several types of low-cost hearing aids that can optimize hearing aid fitting processes. For example, pre-programmed hearing aids contain pre-set amplification protocols developed based on common configurations of hearing loss while still allowing for volume adjustment [42]. A recent report, which was conducted in 23 sites across 16 low- and middle-income countries, found that pre-programmed hearing aids have the potential to yield positive outcomes in those settings. Furthermore, that report suggested that incorporating pre-programmed hearing aids into service delivery approaches was feasible [43]. Importantly, the use of such technologies can allow for trained non-specialist providers to effectively provide quality services, as the fitting process with pre-programmed hearing aids or similar devices is simplified as compared to traditional hearing aids [44]. High quality and low-cost technologies are necessary to maximize the cost-effectiveness of hearing aid provision.

Conclusions

As described above, the results from the systematic literature review and stakeholder interviews support the key findings that i) task sharing is a strategy that could address the critical lack of health care workers to provide ear and hearing health services, thereby improving access to hearing aids, and ii) low-cost and high-quality hearing aid technology can support provision of hearing-aid related services that are supported by task sharing. It is recognized that optimizing service delivery approaches related to hearing aid provision can improve access to and affordability of hearing aids. One example of this is provided in the United States, which recently passed legislation to allow consumers to directly purchase over-the-counter hearing aids [45]. Optimizing service delivery approaches to connect individuals with low-cost hearing technology and supporting innovations is particularly important in resource-limited settings, where access to hearing health care, including to hearing aids, is especially poor [9]. Along these lines, this background paper identified the need to expand provision of quality hearing aid services into community-based settings, and also demonstrated that it is feasible to do so.

Importantly, provision of hearing aids is a cost-effective approach that can mitigate the burden of hearing loss on individuals and society [46-48]. Task sharing is a crucial strategy to overcome the global dearth of qualified hearing care providers [9,49-51]. It is important to note that hearing aid provision is only one part of a comprehensive ear and hearing care programme. Therefore, service delivery approaches related to hearing aids must include the components of testing, follow up and related services; be harmonized with ear and hearing care programmes; and be optimized to reach the desired target population in a given setting.

Limitations

Limitations of the systematic scoping literature review are as follows. Given the nature of this review, authors did not assess risk of bias for the included studies. This review was conducted in English, French, and Spanish, but there may be other relevant articles published in other languages that were not identified through our search. Importantly, this review reflects the strengths and limitations of the studies included. In terms of the stakeholder interviews, while there was relatively diverse representation of hearing aid service delivery programmes, responses are unique only to the 15 programmes described. Therefore, there are likely other practices in hearing aid service delivery that were not captured in these stakeholder interviews.

Additional resources

This background work is one component of a larger piece of work that aims to inform the development of service delivery approaches suitable for resource-limited settings. All documentation was informed by discussion with and input from a group of stakeholders, and furthermore, a technical working group was involved in the development and revision of these documents. Pilot testing for hearing aid service delivery models is underway. Additional key components of this work that are currently available are described in the following documents.

1. Hearing aid service delivery approaches for resource-limited settings [52].
2. Review of market shaping project reports and outcomes related to hearing aids [53].

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