Community-based assessment and rehabilitation of hearing loss: A scoping review

Abstract

Although the World Health Organization (WHO) recommends the use of a Community-Based Rehabilitation (CBR) model, little is known about how CBR has been applied in the hearing healthcare setting. The purpose of this scoping review was to identify and describe studies on Community-Based Hearing Rehabilitation (CBHR) programs within the applied context. The review was conducted in September 2020 with updated searches in November 2021 according to the Joanna Briggs Institute (JBI) methodology and reported using the guidelines and checklist for Preferred Reporting Items for Systematic Reviews and Meta Analyses-Extension for Scoping Reviews (PRISMA-ScR). Fifty-nine peer-reviewed research articles were included in the review. A narrative synthesis was conducted to map out the types of CBHR programs. Studies were classified into audiological themes: awareness, screening and assessment of hearing in newborn/infants, children, and adults, training of community health workers, rehabilitation, cost-effectiveness, and describing the service delivery models. Further categorization was made based on CBR aspect matrices for each study. Most of the studies come from high-income countries in North America and Europe. CBHR studies predominantly focused on creating awareness, training, and hearing screening and/or assessments in communities and evaluating effectiveness in providing knowledge and access to hearing health services in rural or underserved communities. Further work is needed to examine the outcomes and effectiveness of CBHR using controlled studies. Moreover, more work is needed in low- and middle-income countries where the application of CBHR is critical for increased access and affordability.

Key Words

Community-based rehabilitation, Community-based hearing rehabilitation, Hearing loss, Healthcare model, Community healthcare worker

What is known about the topic

- The WHO provides a guideline for community-based rehabilitation.
- Community health workers (CHWs) play an important role in CBHR.
- Rural areas and/or low-income countries have limited access to hearing healthcare care due to traveling, financial burden of services, or lack of professionals in the area or country.

What this paper adds

- Provides the various contexts of community-based hearing healthcare including creating awareness, screening and/or assessment of hearing in infants, children and adults, training of (CHWs) as well as in providing rehabilitation services.
- Highlights that CBHR literature focuses on the screening of hearing with limited hearing rehabilitation services.

- Provides the aspects of CBR that are utilized and aspects that need more attention in CBHR literature.

Introduction

Healthcare models have changed as knowledge of disabilities and treatment approaches have increased. The medical model, relating disabilities to biological factors and health conditions was developed in the 19th and 20th centuries. During the 1960's and 1970's the social approach of disabilities was used to shift the perspective of the isolated medical model to social effects and discrimination of those with disabilities (Khasnabis et al., 2010). This model led to the initiation of Community-Based Rehabilitation (CBR) in 1978. The key focus of CBR is to improve the quality of life for individuals with disabilities and their families by meeting their basic needs and ensuring their inclusion and participation in society. The World Health Organization & International Disability and Development Consortium (2015) defines CBR as a "multisectoral approach working to equalize opportunities and social inclusion of people with disability while combating the perpetual cycle of poverty and disability". This action may include but is not limited to equal access to health care, education, skills training, employment, family life, social mobility and political empowerment. In other words, CBR is a multidimensional approach that aims to promote inclusion and participation of people with disabilities (Chung, 2019).

It is estimated that 450 million individuals in the world's population have disabling hearing loss requiring rehabilitation (World Health Organization, 2020). The WHO estimates suggest that in 2050, 2.5 billion people will be living with hearing loss with 700 million in need of rehabilitation (World Health Organization, 2021). The global increase in hearing loss and the existing inaccessibility and cost barriers to hearing healthcare underlie the global call to action by the WHO (World Health Organization, 2021). According to the World Report on Hearing, nearly 1 trillion international dollars is lost yearly from unaddressed hearing loss (World Health Organization, 2021). The need for more routes of access to hearing services are even more pressing now in the presence of the COVID-19 pandemic. The World Report on Hearing recommends universal services in the provision of ear and hearing care according to the acronym, H.E.A.R.I.N.G. This stands for Hearing screening & intervention, Ear disease prevention & management, Access to technologies, Rehabilitation services, Improved communication, Noise reduction, and Greater community engagement (WHO, 2021). These services should be available in community-based programs to overcome financial burdens of patients and decrease the negative social and financial effects of unaddressed hearing loss. Community-Based Hearing Rehabilitation (CBHR) provides support to persons with hearing disabilities in rural, remote, or suburban areas, while also making the interventions more affordable (Thammaiah et al., 2017). Many living in rural areas and/or low-income countries postpone seeking intervention due to traveling, financial burden of services, or lack of professionals in the area or country. CBR for hearing loss could not only benefit economic burden, but also improve social-emotional factors, education, and quality of life.

There are a few frameworks that provide detailed descriptions of components involved within CBR. For example, based on Mitchell's (1999) findings Finkenflügel et al. (2005) suggested that the key aspects of CBR includes screening, knowledge, local resources, participant, implementation, stakeholders, and evaluation as illustrated in Table 1. In addition, the World

Health Organization (2010) provides a CBR matrix that provides the basic framework of CBR programs as shown in Figure 1. The matrix illustrates five key aspects of an individual's (a) health, (b) education, (c) livelihood, (d) social, and (e) empowerment. It also provides subcategories of activities within these main aspects. Applying these frameworks to examine the CBHR studies can support better understanding of the scope and extent of literature in this area whilst highlighting gaps in current scientific evidence.

[Insert Table 1 here]
[Insert Figure 1 here]

Despite the longstanding WHO advocacy for using CBR to alleviate accessibility and affordability challenges in hearing healthcare (World Health Organization, 2012), there is limited understanding of how CBR has been applied in this field. In a recent review conducted by O'Donovan et al. (2019) the focus was on community health workers (CHWs) and their role, training, and cost-effectiveness in addressing the ear disease and hearing loss. However, there is lack of understanding of CBHR in the broader context in line with its definition. The aim of this scoping review was to identify and describe studies on CBHR programs in relation to hearing rehabilitation and to examine the context and services applied. This included addressing the available community-based hearing rehabilitation literature and how it relates to audiological themes and key aspects and basic framework of CBR. Which specifically lead to the following questions:

1. What community-based rehabilitation programs are available for prevention/awareness of hearing loss?
2. What community-based hearing rehabilitation programs are available for screening and assessment of hearing loss?
3. What is the cost-effectiveness of community-based rehabilitation programs?
4. How are volunteers or CHWs trained for community-based hearing rehabilitation?
5. What models of CBHR are explained in-depth and may have the potential to be implemented elsewhere?
6. What rehabilitative hearing services are offered through community-based hearing programs?

Materials & Methods

Protocol and Registration

The scoping review was performed in accordance with the Joanna Briggs Institute (JBI) methodology (Peters et al., 2019) and reported using the guidelines and checklist for Preferred Reporting Items for Systematic Reviews and Meta Analyses-Extension for Scoping Reviews (PRISMA-ScR; Tricco et al., 2018; see Supplementary Table 1). As this was a scoping review, registering the protocol was not possible.

Eligibility Criteria

Participants, Concept, and Context (PCC) design (Joanna Briggs Institute, 2020) were referenced to when creating the inclusion criteria to address the research questions as illustrated in Table 2. Peer-reviewed, English-language publications and with no date restrictions were included in the criteria.
[Insert Table 2 here]

Types of Evidence Sources
Only peer-reviewed publications in the English language at any date in time were included. Pre-prints and review studies were excluded. Both quantitative and qualitative studies were included. In addition, manuscripts describing the CBHR service delivery models as well as its implementation were included.

Information Sources
To identify potentially relevant documents, PubMed, CINAHL Complete, and ComDisdome bibliographic databases were searched in September 2020. Databases were chosen as a research team and with the input of our institution librarian that has indicated these databases as useful resources for hearing sciences. In addition, an updated search was also performed during November 2021. Manual searches consisted of searching references from included articles and reviews.

Search
A comprehensive search strategy was created using medical subject headings (MeSH) with the help from an university librarian to cover four key domains: community-based, rehabilitation, hearing loss, and effectiveness. The full electronic search strategy consisted of ("community-based" OR "community-delivered" OR "community participation" OR "community engagement" OR "community program" OR "community" OR "community role" OR "community-based participatory research" OR "community integration" OR "therapeutic community") AND ("rehabilitation" OR "assessment" OR "service" OR "provision" OR "screening" OR "neonatal screening" OR "mass screening" OR "hearing conservation" OR "early intervention" OR "education" OR "hearing test" OR "hearing aids" OR "hearing device" OR "tele-assisted" OR "tele-health" OR "telerehabilitation" OR "internet-based intervention") AND ("hearing loss" OR "hearing disabilit*" OR "hearing impair*" OR "person with hearing impairment" OR "person with hearing loss" OR "hearing disorders" OR "hard of hearing" OR "deaf" OR "deafness") AND ("effectiveness" OR "functional" OR "feasib*" OR "evaluat*" OR "cost-effectiveness" OR "outcome" OR "efficacy" OR "evaluation studies as topic" OR "treatment outcome" OR "comparative effectiveness research" OR "cost-benefit analysis"). Search terms and Boolean combinations were inserted into electronic databases and adapted to each database search format (i.e., separating the string of phrases into different search boxes separated by "AND").

Selection of Sources of Evidence
Two reviewers () independently screened all the articles using the Rayyan software (Ouzzani et al., 2016) to identify articles that met the inclusion criteria by reviewing the title and abstracts. Subsequently, full-text articles were analyzed to finalize study eligibility. Disparities and ambiguities were discussed and resolved with a third reviewer ().

Data Charting
The search and data extraction were undertaken between September and November 2020 and follow-up searches in June 2021 and September 2021. Two authors () independently extracted and organized data from studies using an extraction sheet based on the JBI scoping review template including, the country the CBHR took place, who applied the CBHR, the target

population, and the study design. Additionally, the studies were classified according to the key aspects of CBR mapping the studies to two different frameworks (Table 1 & Figure 1). Furthermore, the studies were categorized into eight different audiological themes based on the data extraction. The themes were named based on discussion within the research group. These included: (a) awareness/prevention, (b) children screening/assessment, (c) infant screening/assessment, (d) adult screening, (e) cost-effectiveness, (f) training of CHWs, (g) model types, and (h) rehabilitation. The authors collected data regarding the distribution of studies across the countries and the income level of these countries with studies in this review. A sample of the data (20%) extraction was cross-checked by __ for accuracy.

Data Items

A list of variables was listed and defined before extracting the data from included studies. Important information to extract were discussed as a research team. This information included the location, study design, population, who was applying the CBHR, outcome measures, recruitment of participants, outcomes, sample characteristics (number, age, gender), and equipment being used. These variables were extracted to provide a brief overview each CBHR study.

Synthesis of Results

The results are described below with a narrative summary of relevant data from the included studies summarized in Table 3.

Results

Selection of Sources of Evidence

The flow diagram represents the number of articles screened and assessed for eligibility (see Figure 2).

[Insert Figure 2 here]

Characteristics of Sources of Evidence

The scoping review identified 59 CBHR articles published from 1982 to 2021 (see Table 3) representing studies from 16 out of 195 countries (see Figure 3). The CBHR studies were conducted the most in United States (16); followed by India (7), and United Kingdom (7) (see Supplementary Figure 1). Figure 4 illustrates the income levels of the countries in which the CBHR studies were conducted (World Bank Group, 2021). The majority (59.3%) of the studies used a cross-sectional design. Only four studies (6.8%) were randomized controlled trials (RCTs) and three (5%) were qualitative studies with two of these being mixed methods. Target populations ranged from newborns to the elderly across different cultures with 33.9% of the studies targeting adults, 50.8% targeting children (2-17years), and 15.3% studies targeting both populations. CBHR was facilitated by a range of people including the CHWs, audiologists, audiometrists (health-care technician who works under an audiologist), nurses, graduate students, and midwives. There were many different terms describing CHWs including village health workers, health visitors, community health aides, etc. Studies included in this review were categorized based off the main CBR aspects as described in two frameworks provided by the Finkenflügel et al. (2005) and the World Health Organization (2010). According to the CBR framework 1 (Finkenflügel et al., 2005), the studies' main objectives fell under screening (31;

52.5%), stakeholders (10; 16.9%), knowledge (7; 11.9%), evaluation (4; 6.8%), local resources (4; 6.8%), and implementation (3; 5.1%).When classifying the studies according to the CBR framework 2 (World Health Organization, 2010), only three studies were classified under empowerment and all the remaining studies were classified under health. Detailed descriptions of study characteristics are provided in Table 3. Classification of studies based on audiological themes are presented in Table 4.

[Insert Table 3 here]
[Insert Figure 3 here]
[Insert Figure 4 here]
[Insert Table 4 here]

Awareness and Prevention of Hearing Loss

Seven studies were identified for CBR programs based on awareness (Choi et al., 2019; Dodds and Harford, 1982; Griest et al., 2007; Lukes and Johnson, 1999; Martin et al., 2017; McCullagh, Yang, et al. 2020; and Smith et al. 2018). Implementation of hearing loss awareness which was facilitated by graduate students, community volunteers, nurses and moderators at various locations was explained in the studies (see Supplementary Table 2).

Providing community-based hearing intervention to Korean Americans was evaluated by Choi et al. (2019) using pre- and post-intervention focus groups and measured self-reported hearing disability following aural rehabilitation consisting of communication strategies, counseling, and orientation of listening devices. The goal of this study was to provide an affordable culturally adapted community-based hearing rehabilitation by using less expensive listening devices and the Hearing Equality through Accessible Research and Solutions (HEARS) program. The study also took into consideration on how much the participants and communication partners would be willing to pay for the intervention which ranged from $0 to $500. Educational seminars in retirement homes, hotels, senior activity centers, and health fairs were also evaluated (Dodds and Harford (1982). Griest et al. (2017) assessed the Dangerous Decibels hearing loss prevention program's effectiveness on knowledge, attitude, and behavior pertaining to hearing and hearing loss prevention in 4th and 7th-grade students. In a similarly motivated study by Martin et al. (2017), American Indian communities adapted the Dangerous Decibels program. In Lukes and Johnson (1999) study, 7th and 8th graders enrolled in an industrial technology class listened to the audio and watched a demonstration on hearing protection. The effectiveness of a hearing conservation intervention was explored for individuals exposed to farm operations using community-based interactive youth educational program while comparing it to the same program with an additional Internet-based booster and a control group (McCullagh, Yang et al., 2020). Improving awareness of sensory impairment, Smith et al. (2018) assessed whether educational intervention for community nurses leads to positive feedback. Overall, these community awareness programs were successful in engaging and increasing knowledge and awareness of hearing loss and prevention.

Hearing Screening and Assessment

Newborn and Infants

Community-based newborn or infant hearing screening increases avenues for early identification and intervention of hearing loss. Sixteen studies were focused on newborn and/or infant hearing

screening (see Supplementary Table 3). Studies by Akilan et al. (2014), McPherson et al. (1998), Ramkumar, John et al. (2018), and Ramkumar, Vanaja et al. (2018) included children and infant populations, therefore, were included in both *Newborn and Infants* and *Children* sections.

Context. The settings for infant hearing screening varied from rural villages to health facilities. In rural villages CHWs went door to door in the village screening infants and had mobile tele-vans for tele-ABRs (auditory brainstem response) if further evaluation was needed (Akilan et al., 2014; Ramkumar, John et al., 2018; Ramkumar, Vanaja, et al., 2018). Ramkumar et al. (2013) assessed the tele-ABR in comparison to face-to-face ABRs with the tele-van stationed at a convenient location approximately 1 kilometer (km) from the hospital. One study had the option of screening in the child's home, well baby clinic, or in the hospital if the infant was hospitalized. Health clinics where children received their immunizations was a popular time to conduct the hearing screenings (McPherson et al., 1998; Olusanya et al., 2008; Olusanya & Akinyemi, 2009; Olusanya, Ebuehi et al., 2009). Midwife obstetric units (MOU) were utilized for screening during postnatal follow-ups (de Kock et al., 2016; Khoza-Shangase & Harbinson, 2015). Infants also had their hearing screened during their initial inpatient screening in the birth hospital then referred out to an audiologist's private practice for rescreening and diagnostics (Danhauer et al., 2008). Other health care facilities included primary care setting, special care nurseries, and the combination of a medical center, a local hospital, and a private obstetric clinic (Basu et al., 2008; Johnson & Ashurst, 1990; Lin et al., 2004; Owen et al., 2001).

Facilitators. In some studies, village health workers facilitated the hearing screening of infants (Akilan et al., 2014; Ramkumar et al. 2013; Ramkumar, John et al., 2018; Ramkumar, Vanaja, et al., 2018). The village health workers also assisted in the electrode montage set up for the tele-ABRs with a tele-technician to assist with the equipment allowing the audiologist to remotely complete the electrophysiological assessment. Nurses, community health nurses, CHWs, health visitors, and "trained screeners" facilitated hearing screening in the hospital settings, health clinics, and special care nurseries (Danhauer et al., 2008; Johnson & Ashurst, 1990; McPherson et al., 1998; Lin et al., 2004; Olusanya et al., 2008; Olusanya & Akinyemi, 2009; Olusanya, Ebuehi et al., 2009; Owen et al., 2001). One MOU had two trained non-professional screeners with no former healthcare training and a third screener who was resident health promotor acting as a substitute if the screener was absent (de Kock et al., 2016). Two studies had the audiologist performing the screening (McPherson et al., 1998; Khoza-Shangase & Harbinson, 2015); however, other studies listed the audiologist's primary role of training or supervision of screeners (Akilan et al., 2014; de Kock et al., 2016; Lin et al., 2004; Owen et al., 2001; van der Ploeg et al., 2012).

Method. Screening methods implemented by CHWs were mostly Transient Evoked Otoacoustic Emissions (TEOAEs), Distortion Product Otoacoustic Emissions (DPOAEs), and Automated Auditory Brainstem responses (AABR) (Akilan et al., 2014; Basu et al., 2008; Danhauer et al., 2008; de Kock et al., 2016; Khoza-Shangase & Harbinson, 2015; Lin et al., 2004; McPherson et al., 1998; Olusanya et al., 2008; Olusanya & Akinyemi, 2009; Olusanya, Ebuehi et al., 2009; Owen et al., 2001; Ramkumar, John et al., 2018; Ramkumar, Vanaja, et al., 2018; van der Ploeg et al., 2012). Studies also implemented remote follow-up ABR assessments (Akilan et al., 2014; Ramkumar, John et al., 2018). Ramkumar et al. (2013) compared tele-ABRs to face-to-face

ABRs in a mobile van. In Johnson & Ashurst (1990) study, distraction testing conducted by health visitors was used to screen infants at risk for sensorineural hearing loss (SNHL).

Feasibility. A theme of parental compliance and perception regarding community-based infant screening programs became apparent throughout the following studies (Akilan et al., 2014; Danhauer et al., 2008; Lin et al., 2004; Olusanya & Akinyemi, 2009; Owen et al., 2001; Ramkumar, John et al., 2018). The second section in Supplementary Table 3 provides the studies that take parental compliance and perception of the community-based screening into consideration. These studies demonstrated that implementation of community-based screening programs for infants in rural villages and healthcare settings are generally accepted and have parent's compliance. CHWs were an asset to screening a larger number of newborn and infants. Community-based hearing screening programs a feasible way of screening newborns and infants for hearing impairment.

Children

Nineteen studies were focused on community-based children hearing screening (see Supplementary Table 4).

Context. Children hearing screening primarily (10 studies) took place in educational settings such as preschool centers, local community primary schools, day care centers, and Early Childhood Development (ECD) centers (Eksteen et al., 2019; Elliot et al., 2010; Dawood et al., 2021; Gomes & Lichtig, 2005; Holtby et al., 1997; Jayawardena et al., 2018; Jayawardena et al., 2020; Smith et al., 2012, Smith et al, 2015; Yousuf Hussein et al., 2018). Six studies included home visits in underserved communities for children hearing screening (Akilan et al., 2014; Dawood et al., 2021; O'Donovan et al., 2021; Ramkumar, John et al., 2018; Ramkumar, Vanaja et al., 2018; Yousuf Hussein et al., 2016). Health clinics or a walk-in clinic at hospital were settings used for children screening with one providing the screening during the child's 3-year-old checkup (Dawood et al., 2021; Harries & Williamson, 2000; Jayawardena et al., 2018). Dawood et al. (2021) also included health campaigns as one of their locations for screenings. Another study had preschool students screened at the Office of Childhood Hearing in the San Francisco Department of Public Health (Cedars et al., 2018). Berg et al. (2006) did not explicitly state where the hearing screening took place.

Facilitators. Personnel that performed the screenings in these community-based programs consisted of CHWs, nurses, audiometrists, and audiologists. Individual titles given to these community-based hearing screeners are located in Table 3. Indigenous health workers, aboriginal health workers, village health care workers, health visitors, and CHWs were all facilitators of hearing screening with no prior training experience. These personnel screened children's hearing in the child's homes, preschool centers, primary schools, daycare centers, ECD's, health clinics, and health campaigns. Clinics and schools utilized working nurses to facilitate the hearing screening. The audiometrist performed the screening in the San Francisco Department of Public Health. Jayawardena et al. (2018) also had nongovernmental organization volunteers trained to complete screenings. It was stated in three studies that an audiologist facilitated the training of CHWs (Berg et al., 2006; Eksteen et al., 2019; Dawood et al., 2021). Otolaryngologists oversaw the training of screeners in three other studies (O'Donovan et al., 2021; Jayawardena et al., 2018; Jayawardena et al., 2020).

Method. Several of the studies utilized mHealth or telehealth hearing screening methods (Eksteen et al., 2019; Elliot et al., 2010; Dawood et al., 2021; Jayawardena et al., 2018; Jayawardena et al., 2020; Ramkumar, John et al., 2018; Ramkumar, Vanaja et al., 2018. Smith et al., 2012; Smith et al, 2015; Yousuf Hussein et al., 2016; Yousuf Hussein et al., 2018). This included mobile hearing screening apps, tele-ABR, and telemedicine database service which allowed otolaryngologists to review screening information. Telemedicine (shared database upload) and follow-up assessments allowed ear health specialists such as audiologists and ENT specialists to monitor, review, and conduct follow-up assessments based on the screening results the CHWs obtained. However, O'Donovan et al. (2021) used whispered voice testing for the hearing screening and ENTraview (i.e., telemedicine enabled otoscope) for the screening of ear disease. Five of the studies conducted the screening or follow-up assessments in a tele-van with wireless broadband internet connection or satellite connectivity (Akilan et al., 2014; Elliot et al., 2010; Ramkumar, John et al., 2018; Ramkumar, Vanaja et al., 2018; Smith, 2012; Smith et al., 2015).The utilization of mHealth or tele-health hearing screening methods allowed better access for children hearing screening and allowed for professional collaboration with the CHWs.

Studies that did not use mobile or telehealth methods applied Conditioned Play Audiometry (CPA), DPOAEs, TEOAEs, tympanometry, impedance screening, McCormick Toy Test (MCTT), and a questionnaire. (Berg et al., 2006; Cedars et al., 2018; Gomes & Lichtig, 2005; Harries & Williamson, 2000; Holtby et al., 1997; McPherson et al., 1998). However, Gomes & Lichtig (2005) was the only study to ask parents to fill out a questionnaire (Portuguese adapted Dube, 1995) to assess if the parent's report differentiated between the children who failed the hearing screening versus children who passed. Based on these studies, interprofessional collaboration of CHWs, audiologists, and ENT specialists provide the most accessible and reliable screening for children in the community.

Adults

Six studies evaluated adult hearing screening in the community-based settings (see Supplementary Table 5.

Context. In Dodds & Harford (1982), Northwestern University Hearing Clinic implemented a hearing loss awareness program within retirement homes/hotels, senior activity centers, and health fairs. The study also evaluated the feasibility of hearing screening in less-than-ideal conditions by comparing the thresholds obtained at the community-based setting to the clinical results from those participants that followed up in the clinic. An ear care program, Shruti, has a goal to deliver awareness, screening, diagnosis, and treatment for underserved communities. A partnership with Shruti and the Delhi government under the National Program for Prevention and Control of Deafness (NPPCD) led to outreach and screening of hearing at three sites in Delhi City: a community assembly of a village and two construction sites (Gupta et al., 2020). The health and quality of life benefits of hearing screenings for adults in homes or community health centers were highlighted in a study consisting of adults at the age of 76 in Tórshavn, Faroe Islands (Haanes et al., 2021). Jayawardena et al. (2018) also evaluated the feasibility to screen adults in their community in Kenya at a walk-in clinic in Tawfiq Muslim Hospital and three local schools where audiologists and otolaryngologists are sparse. As mentioned earlier, two studies also screened adults during home-based visits in rural areas, one associated with a community-based primary care (Yousuf Hussein et al., 2016 & O'Donovan et al., 2021).

Facilitators. Graduate students and nurses facilitated screenings in homes or senior activity/community-based centers (Dodds & Harford, 1982 & Haanes et al., 2021). The other four studies recruited CHWs to facilitate the screenings (Gupta et al., 2020; Jayawardena et al., 2018; Yousuf Hussein et al., 2016; O'Donovan et al., 2021).

Method. The technology used to screen adult's hearing consisted of portable audiometers (Haanes et al., 2021;), Shoebox Professional Audiometer on an iPad Mini 2 (Jayawardena et al., 2018), ENTraview device for air conduction threshold screening (Gupta et al., 2020), the hearScreen application (Yousuf Hussein et al., 2016), and as mentioned earlier, O'Donovan et al. (2021) used whisper testing to screen hearing. Overall, community-based adult hearing screening in less-than-ideal settings can assist in overcoming the barrier of lack of services.

Rehabilitation

Seven studies fell within the rehabilitation theme and addressed hearing aids and aural rehabilitation (see Supplementary Table 6). Three studies were focused on hearing aids (Borg et al., 2018; Emerson et al., 2013; Gupta et al., 2020), and the remaining four studies were focused on aural rehabilitation programs (Choi et al., 2019; Coco et al., 2019; Marrone et al., 2017; Nieman et al., 2017).

Hearing Aid Provision Programs

Borg et al. (2018) evaluated center-based compared to community-based provision of hearing aids in low-resourced locations and the respective impact on rehabilitation. Center-based services included initial ear and hearing screening/assessment, hearing aid fitting at the hearing center, and custom-made earplugs. The community-based model consisted of an ear and hearing screening and assessment, delivery and fitting of aids and earplugs in the participant's home. In another study trained CWHs provided hearing aids to 111 individuals and measured outcomes using the Abbreviated Profile of Hearing Aid Benefit (APHAB) (Emerson et al. 2013). A study by Gupta et al. (2020) included the provision of hearing aids by CHWs if there was no need for an earmold impression or fine tuning; however, if there was a need, the patient was referred to a partner hospital. The study used the International Outcome Inventory for Hearing Aids (IOI-HA) to assess the benefits of a community-based hearing aid provision. All three community-based hearing aid provision programs were successful and provided an effective option in low or lower-middle income countries.

Aural Rehabilitation Programs

Hearing Equality through Accessible Research and Solutions (HEARS), a non-governmental organization founded in 2014, provides aural rehabilitation consisting of hearing loss education, communication strategies, and counseling for low-income communities. Choi et al. (2019) evaluated the effects of HEARS on Korean Americans and their communication partners (CPs) in a Korean church by pre-intervention and post-intervention focus groups and several self-reported questionnaires assessing hearing abilities, social and emotional functioning, health, and quality of life facilitated by bilingual moderators. In a similar study, Nieman et al. (2017) evaluated the implementation of the HEARs program by trained interventionists who recruited older adults living in low- and middle-income areas for HEARS sessions which took place in the participant's building that are provided by a nonprofit for low- and middle-income older adults.

This included hearing screening, listening device provision and orientation, communication education, and counseling. The intervention was well accepted, beneficial, and 67% of the participants were interested in serving as future program trainers. Coco et al. (2019) assessed the Oyendo Bein ("Hearing Well") study administered by CHWs which consisted of counseling-based group aural rehabilitation at a community gathering center. The study allowed individuals to discuss the negative impacts of hearing loss and learn ways to decrease negativity for themselves and their families. Another study used the Oyendo Bien program facilitated by CHWs and assessed and provided interactive group sessions on hearing health education, communication strategies, and interactive peer support groups. This program took place in the federally qualified health center (Marrone et al., 2017). Overall, these studies demonstrated CBHR increasing hearing benefit and improving the negative social and emotional effects of hearing loss for individuals with hearing loss and their communication partners.

Cost-effectiveness

Four studies examined the cost-effectiveness of CBHR programs (see Supplementary Table 7). Grill et al. (2006) compared a hospital and community-based screening program which demonstrated health effects to be equal between the two programs. Monte Carlo simulations revealed that costs in the hospital setting would be lower in 48% of the trials. However, any statistically significant difference between the hospital and community settings in prevalence, test specificity and sensitivity, and costs would alter the cost effectiveness between the two settings. Nguyen et al. (2015) compared the cost-effectiveness of the community-based Mobile Telemedicine-Enabled Screening and Surveillance service (MTESS) to the existing community-based Deadly Ears Program. This program consists of an Indigenous health worker (IHW) who provides screening and referrals to the surgical outreach clinic. At the clinic a referral is made to the general practitioner or booked for surgery at the appropriate location. The study concluded that MTESS was cost effective compared to the Deadly Ears Program. A telehealth diagnostic study reported that despite its cost, satellite connectivity could be viable to reach underserved communities with auditory brainstem response testing (Ramkumar et al. 2018). Rob et al. (2009) compared the screening and provision of hearing aids at secondary and tertiary care levels. Active screening and provision of aids at the secondary care level was more expensive than the passive screening and provision of hearing aids at the tertiary level, but secondary care had a higher coverage of hearing aid services. Overall, more research is necessary to establish if CBHR is cost effective; however, these programs are feasible options for reaching underserved or rural communities.

Hearing Health Programs for CHWs

Twelve studies assessed training individuals about hearing loss, infant hearing health, prevention and rehabilitation of a hearing loss, and ear and hearing care (Alvarenga et al. 2008; Araújo et al. 2013; Araújo et al. 2015; Coco et al., 2021; Gomes & Lichtig 2005; McCullagh, Cohen, et al. 2020; Melo et al. 2010; Mulwafu et al. 2017; O'Donovan et al., 2021; Owen et al. 2001; Sánchez et al. 2017; Smith et al. 2018). These studies described the results of infant and adolescent based training and hearing health training for CHWs (i.e., community health agents, health visitors, and community nurses, and volunteers) (see Supplementary Table 8).

Infant and Adolescent Based Programs

Araújo et al. (2013) evaluated the effects of "Infant Hearing Health" interactive tele-education training for CHWs with a post-training questionnaire administered 6 months after the training. In a similar subsequent study (Araújo et al. 2015), there was a decrease of knowledge across a 15-month period following the "Infant Hearing Health" training. Melo et al. (2010) assessed how effective an 8-hour conference-based training for community health agents with no prior hearing health experience by pre and post training questionnaires based on the World Health Organization. O'Donovan et al. (2020) evaluated the effectiveness of a two-day workshop and an ongoing discussion forum on WhatsApp by Observed Structured Clinical Examinations and engagement on the forum for CHWs performing screening hearing and ear disorders. Owen et al. (2001) evaluated health visitors performing OAE testing who attended a community-based universal neonatal hearing screening training. McCullagh, Cohen, et al. (2020) evaluated using community-based training to provide hearing conservation education to farm and rural youth. Lastly, Gomes & Lichtig (2005) evaluated the use of non-specialists trained by a professional to administer the questionnaire to detect hearing loss in children. The described studies were effective in increasing CHW's knowledge in child hearing health and screening and providing CHWs the ability to screen hearing and implement awareness of hearing loss for children.

Non-Specific Population Programs

Alvarenga et al. (2008) evaluated a Family Health Program which involved training community health agents on the primary ear and hearing care. Group A took part in an 8-hour intervention consisting of audio-visual material and a manuscript. Group B took part in two 4-hour meetings without a manuscript. A recent study took teleaudiology into consideration. CHWs were trained in hearing and intervention basics, teleaudiology, patient confidentiality, and assisting remote audiologists with hearing aid fittings. These trainings had an introductory level, intermediate level, and a hands-on facilitator level. It was assessed by surveys and knowledge-based and performance-based assessments (Coco et al., 2021). Mulwafu et al. (2017) assessed the effectiveness of training based on the Basic and Intermediate Manual of World Health Organization's Primary Ear and Hearing Care Training Resources (World Health Organization, 2006a; 2006b). This was evaluated by a 60 multiple choice question test, the number identified with ear or hearing disorders through the screening and at the health centers, and focus group discussions. The Freire Empowerment Educational Model was the foundation for training CHWs in Sánchez et al. (2017). It consisted of a focus group, 3-hour workshop, 24-hour multisession, and interactive training for more than 6 weeks. Smith et al. (2018) evaluated 3 to 4-hour educational interventions based on sensory impairments. These studies found effective ways to train CHWs to obtain enhanced knowledge to identify individuals with hearing or ear disorders, assist remote audiologists, educate and support individuals with hearing loss and their families, and gain knowledge, empathy, and compassion for individuals suffering with hearing loss. One study led to community nurses being more likely to refer patients to a hearing or ear specialist (Smith et al., 2018).

Community-Based Service Delivery Models

Five studies were focused on describing the community-based approaches and/or service delivery models including ways to teach, inform, learn, and train individuals within the hearing health community (see Supplementary Table 9).

An outreach program based on the primary ear and hearing care for a rural community was assessed (Billard, 2014). This community-based model was facilitated by "siutilirijiit", the supportive personnel for the audiologist and "aaniasiurtiapik", who acts the local resource contact for the audiology program. The model reviewed the steps taken and the roles of each person, as well as the challenges the community-based program faced. Behl et al. (2012) evaluated the value of tele-practice for infants and toddlers within a learning community. Self-sustaining programs, using the Dangerous Decibels program and promoting hearing health across tribal communities were assessed (Martin et al. 2017). Community involvement was encouraged from 15 Alaskan communities in the development of a model for hearing and ear disease screening with a telemedicine referral pathway (Robler et al., 2020). As mentioned earlier in rehabilitation, Borg et al. (2018) provided a community-based model, which involved and audiometric technician performing ear and hearing screening and trained CHWs facilitating ear and hearing assessments and the delivery and fitting of aids and earplugs in the participant's home. Overall, these community-based service delivery models were successful in the provision of hearing aids, received positive feedback and participation regrading tele-medicine for hearing and ear disease screening, and were effective in promoting hearing health through the participation of the community. These studies can serve as a resource for those interested in implementing community-based hearing rehabilitation programs in other locations or settings based on examples outlining the structure of models and roles of personnel involved.

Discussion

This review has investigated the different applications and contexts of CBHR programs. CBHR program studies cover a range of aspects including who facilitates the CBHR, contexts, target populations, and CBHR frameworks. A wide variety of community members facilitated CBHR in the included studies, such as CHWs (i.e., village health workers, health visitors, aboriginal health workers, etc.) audiometrists, nurses, midwives, and allowed audiologists and otolaryngologists to review and participate through telemedicine platforms. CBHR took place in participants homes, community centers, churches, schools, early child development locations, health campaigns, health clinics, retirement homes, MOUs, well baby clinics, special nurseries, and hospitals, therefore, these programs targeted a diverse population in age. These populations included newborns, infants, children, adults, mothers of children or infants, and CHWs.

In this review, we classified the CBHR studies according to two different CBR frameworks. Although each article presented multiple aspects of the CBR matrices, studies were categorized by their main focus. In the included studies, the most common CBHR framework 1 (see Table 1) focus was screening with 31 studies. This was followed by stakeholder (10) and knowledge (7). Therefore, the most common aspects of CBHR applied are screening or assessment of hearing loss, community involvement or training to implement CBHR, and providing knowledge and awareness to populations regarding hearing loss. The hearing screening and assessment articles were most appropriately categorized under health-medical care for CBR provided by the World Health Organization (2010). According to CBR Guidelines provided by Khasnabis et al. (2010), the goal of medical care is to provide access to those with disabilities. The combination of training and collaboration of CHWs and hearing health specialists, such as audiologists and

otolaryngologists, provide the desired outcome of the ability for CHWs to identify and recognize the need for a referral whether specialized or general. This interprofessional collaboration not only provides more quality medical care, but also offers more accessible hearing screening/assessment services to those in rural or underserved communities.

Articles with "education" as their main objective were not identified. Meaning there was no articles containing community-based hearing training programs for those in the school education system. Although, community-based training programs for teachers or those involved in the educational setting could be helpful for those with hearing impairments. Training of educational employees on troubleshooting devices, communication strategies, or classroom acoustics would benefit children and even those at higher levels of education to receive optimal learning environments. No articles were found for the livelihood category. Research on community-based vocational training for those with hearing loss should be considered. Even though there were no articles with the main CBR aspect as the social component, rehabilitation articles included aspects of relationships, marriage, and family and culture arts. For example, Coco et al. (2019), Marrone et al. (2017), and Choi et al. (2019) had the CBHR programs culturally adapted to the population they were serving. Focus groups were found to be helpful in achieving feedback on improvements in cultural adaptations to the programs. Cultural adaptations are essential when providing any kind of services to populations. Listening to participants and implementing feedback will increase the chances of well-received services. Audiologists and other professionals should take this into consideration to create culturally competent CBHR programs.

CBR is a valuable strategy to improve accessibility of healthcare services to underserved communities and populations. This is particularly a relevant topic within hearing healthcare with limited audiologists available especially in low- and middle-income countries where the prevalence of hearing loss is highest (World Health Organization, 2021). Even in high-income countries such as the United States, audiologists are centered around urban areas while rural areas lack professional services (Planey, 2019). However, in this review over half (31; 52.5%) of the studies were conducted in high-income countries. Upper-middle income countries had 12 CBHR studies (20.3%), and lower-middle income countries had 14 studies (23.7%). Unfortunately, there were only 2 studies (3.4%) found for low-income countries. This emphasizes the need for more research pertaining to the feasibility and effectiveness of CBHR in the low- and low-to-middle-income countries for whom CBHR services are particularly relevant.

The most common audiological theme that was studied extensively in the studies was screening/assessment of hearing (41; see Table 4). This was followed by the training of CHWs to carry out CBHR (12). Hearing screening is a relatively easy task to teach and train non-professional individuals to perform. It is also a simple task and not time consuming for CHWs with the correct training. This could be why there is a significant number of studies pertaining to hearing screening. This also allows hearing professionals to focus on patients that need these services and provide aural rehabilitation. Whereas, hearing loss awareness and aural rehabilitation services take more time and resources to train CHWs to perform these tasks. These two audiological services also would rely more on professional services. Aural rehabilitation might require more extensive software, equipment, and training of CHWs thereby relating to the

lack of these CBHR programs. However, Coco et al. (2021) trained CHWs to assist remote audiologists in hearing aid fittings. This could be a valuable tool for not only rural areas, but also in the face of the COVID-19 pandemic, therefore more research should be conducted in this area. Also, awareness of hearing loss in the field of audiology is not as common as providing the diagnostic and rehabilitation services. Therefore, it would be helpful to have CHWs conduct awareness programs to help prevent hearing loss, explain the negative effects untreated hearing loss, and direct individuals where to obtain services. The least amount of studies were found under service delivery model and cost effectiveness. This may be due to the extensive nature and complexity involved in evaluating the broken-down costs of every part of the CBHR program and analyze and compare the effectiveness of service delivery models.

This extensive search for CBHR studies revealed the lack of strong levels of evidence, indicating the need for more controlled trials in evaluating the CBHR outcomes. Another limitation of study designs in this area was the lack of qualitative data. Future research should try to implement these study designs to create stronger evidence for CBHR programs. This scoping review shows how valuable CHWs are for the implementation and maintenance of CBHR programs. Therefore, it is also important to invest in adequate training and support to these workers. A study interviewed CHWs about their experiences as paraprofessionals (Laurenzi et al., 2021). It revealed the need to provide CHWs with self-care and boundary setting skills, opportunities of routine debriefing, more supportive supervision, and avenues for professional and career development. This should be taken into consideration when implementing CBHR programs.

Limitations

Articles fell into many categories of the CBR matrices, thus, the main aspects of the CBHR program may be contested. The generalization of these findings may be difficult through different contexts, therefore, more CBHR models and studies should be produced in different locations to provide more evidence for CBHR.

Conclusions

The current review highlighted that CBR has been applied across various elements of hearing healthcare including creating awareness, screening and/or assessment of hearing in infants, children and adults, training of CHWs as well as in providing rehabilitation services. However, it appears that much of the literature focuses on hearing screening and assessment and limited emphasis on offering rehabilitation services. According to the CBR framework 1, the studies' main objectives fell under screening, stakeholders, evaluation, implementation, knowledge, and local resources. According to the CBR framework 2, only three studies were classified under empowerment and all the remaining studies were classified under health, although no studies were focused on livelihood, social and empowerment. Moreover, most of the studies on CBHR were conducted in high-income countries such as the United States and the United Kingdom. Overall, the studies show positive outcomes of CBHR in all settings, although much work is needed to examine the outcomes of rehabilitation services offered via CBR as well as to examine applications of CBHR in low- and middle-income countries where implementation of CBHR is more critical.

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The authors declare no conflict of interest

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Tables

Table 1: Key aspects of community-based rehabilitation (Finkenglűgel et al., 2005)

Heading	**Subjects included**
Screening	Disability surveys, prevalence studies, screening instruments, assessments, etc.
Knowledge	Knowledge, awareness, attitudes, behavior, traditional beliefs, traditional healers
Local resources	Use of local resources (funding, technology), cost effectiveness
Participation	Integration, inclusion, participation, mainstreaming, accessibility
Implementation	Development of services, implementation of projects, working with other organizations, ownership, disability rights
Stake holders	Stakeholders, community involvement, manpower planning, training, curriculum development
Evaluation	Follow-up studies, project evaluation, comparing different types of rehabilitation

Table 2: Participants, Concept, and Context (PCC; Joanna Briggs Institute, 2020)

Population	Individuals receiving or providing community-based hearing rehabilitation.
Concept	Community-based hearing assessment and/or rehabilitation.
	Training of community health workers in hearing assessment and/or rehabilitation.
	Community-based programs providing awareness/prevention of hearing loss.
	Cost effectiveness of community-based hearing assessment and/or rehabilitation.
	Describing models of community-based hearing assessment and/or rehabilitation.
Context	Any country
	Peer-reviewed articles
	No date restrictions
	English language

Table 3: Overall Characteristics

Study	Country	Study Design	Target Population	CBHR applied by	CBHR Framework 1 (Finkenglűgel et al., 2005)	CBR Framework 2 (World Health Organization, 2010)
Akilan et al. (2014)	India	Cross-sectional	Mothers of children under the age of two who had undergone the community-based hearing screening, mothers with older children also showed interest and were included	Village health workers/Audiologist	Screening	Health-Medical care
Alvarenga et al. (2008)	Brazil	Cross-sectional	Community health agents	No hearing rehabilitation was implemented due to the training design	Stakeholders	Health-Medical care
Araujo et al. (2013)	Brazil	Cross-sectional	Community health workers	No hearing rehabilitation was implemented due to the training design	Stakeholders	Health-Medical care
Araujo et al. (2015)	Brazil	Longitudinal study	Community health workers	No hearing rehabilitation was implemented due to the training design	Stakeholders	Health-Medical care
Basu et al. (2008)	UK	Retrospective Case Note Review	Infants	Health visitors	Screening	Health-Medical care
Behl et al. (2012)	USA	Cross-sectional	Administers/service providers from 6 intervention programs	Community members	Evaluation	Health-Promotion
Berg et al. (2006)	Bangladesh	Cross-sectional	Children 2-9 years	Community health workers	Screening	Health-Medical care

Billard (2014)	Canada	Prospective cluster-randomized controlled trial	Inuit of Nunavik	Interpreters/health workers, Audiologists, Hearing instrument Specialist	Implementation	Health-Assistive devices
Borg et al. (2018)	Bangladesh	Cluster-randomized trial	Adolescents 12 to 18 years	Community workers	Evaluation	Health-Assistive devices
Cedars et al. (2018)	USA	Cohort study	Children attending preschool programs	Audiometrist	Screening	Health-Medical care
Choi et al. (2019)	USA	Feasibility pilot study	Korean American (KA) >/= 55 years and their CPs	Bilingual moderators	Implementation	Health-Rehabilitation
Coco et al. (2019)	USA	Qualitative phenomenology approach	Adults (Hispanic/Latinos)	Community health workers	Knowledge	Empowerment-Advocacy and Communication
Coco et al. (2021)	USA	Non-randomized feasibility study	Volunteer CHWs	No hearing rehabilitation was implemented due to the training design	Stakeholders	Health-Medical care
Danhauer et al. (2008)	USA	Cross-sectional	Babies/Parents	Nurses/Audiologist	Screening	Health-Medical care
Dawood et al. (2021)	South Africa	Two group comparative	Children 3-10 years	Community health workers/ school health nurses	Screening	Health- Medical care
de Kock et al. (2016)	South Africa	Two group comparative	Infants	Trained non-professional screeners	Screening	Health-Medical care
Dodds & Harford (1982)	USA	Cross-sectional	Senior citizens over 65 years	Graduate students	Knowledge	Health- Promotion
Eksteen et al. (2019)	South Africa	Cross-sectional	Children 4-7 years	Community health workers	Screening	Health-Medical care
Elliott et. al (2010)	Australia	Cross-sectional	Children 0-16 years. For hearing screening 5-16 years.	Aboriginal health worker	Screening	Health-Medical care
Emerson et al. (2013)	India	Pilot study	Individuals with hearing loss 14-70 years	Community healthcare workers	Evaluation	Health-Assistive devices

Gomes & Lichtig (2005)	Brazil	Cross-sectional	Preschool children 3-6 years	Volunteers that were local nursery school employees	Screening	Health-Medical care
Griest et al. (2007)	USA	Cross-sectional	4th-grade and 7th-grade students	Dangerous Decibel Program	Knowledge	Health-Prevention
Grill et al. (2006)	UK	Retrospective Cross-sectional	Hospital and community-based newborn hearing screening systems in England	Screeners	Local resources	Health-Medical care
Gupta et al. (2020)	India	Retrospective Cross-sectional	Underserved community of rural and urban slums	Community health workers	Screening	Health-Medical care
Haanes et al. (2021)	Denmark	Cross-sectional	76-year-olds living in the municipality of Tórshavn	Nurses	Screening	Health-Medical care
Harries & Williamson (2000)	UK	Cross-sectional	Children 3 years	Health visitors	Screening	Health-Medical care
Holtby et al. (1997)	UK	Cross-sectional	English children 5-6 years	School nurses	Screening	Health-Medical care
Jayawardena et al. (2018)	Kenya	Cross-sectional	All community members	Community health workers and nursing staff	Screening	Health-Medical care
Jayawardena et al. (2020)	Haiti	Cross-sectional	Children in school between the ages 5-18 years	Community health workers	Screening	Health-Medical care
Johnson et al. (1990)	UK	Cross-sectional	Infants considered to be at risk of sensorineural deafness.	Health visitors	Screening	Health-Medical care
Khoza-Shangase & Harbinson (2015)	South Africa	Quantitative research longitudinal design	Low-risk neonatal	Audiologist	Screening	Health-Medical care
Lin et al. (2004)	Taiwan	Cross-sectional	Healthy newborns	Hearing screener	Screening	Health-Medical care
Lukes & Johnson (1999)	USA	Pilot project	7th and 8th graders	Occupational nurses/school nurses	Knowledge	Health-Prevention

Marrone et al. (2017)	USA	Pilot study	Mexican American Adults	Community health workers	Knowledge	Empowerment-Advocacy and Communication
Martin et al. (2017)	USA	Cross-sectional	American Indian Communities	Community volunteers	Implementation	Empowerment-Community Mobilization
McCullagh, Cohen, et al. (2020)	USA	Descriptive design	Community volunteers	Community volunteers	Stakeholders	Health-Promotion
McCullagh, Yang, et al. (2020)	USA	Cluster randomized controlled trial	Rural farm 4 graders attending Safety Day event	Community volunteers	Knowledge	Health-Prevention
McPherson et al. (1998)	Australia	Cross-sectional	Infants attending for their initial immunizations children who were suspected of having hearing problems.	Clinic nurses or audiologist	Screening	Health-Medical care
Melo et al. (2010)	Brazil	Cross-sectional	Community health agents	No hearing rehabilitation was implemented due to the training design.	Stakeholders	Health-Medical care
Mulwafu et al. (2017)	Malawi	Cluster randomized controlled trial	Community health workers	Community healthcare workers	Evaluation	Health-Medical care
Nguyen et al. (2016)	Australia	Cohort study	Indigenous Australian	Deadly ears program: Senior Indigenous health worker; Mobile Telemedicine-Enabled Screening and Surveillance: Indigenous health workers with advanced hearing health training	Local resources	Health-Medical care

Nieman et al. (2016)	USA	Prospective pilot randomized control trial	Old adults	Trained interventionist	Knowledge	Health-Rehabilitation
O'Donovan et al. (2021)	Uganda	Cross-sectional	Community health workers	Community health workers	Stakeholders	Health-Medical care
Olusanya et al. (2008)	Nigeria	Cross-sectional	Infants 3 months or younger	Community health care workers	Screening	Health-Medical care
Olusanya & Akinyemi (2009)	Nigeria	Cross-sectional	Mothers of infants (who failed screening test and were schedule for additional testing)	Community nurses	Screening	Health-Medical care
Olusanya, Ebuehi, et al. (2009)	Nigeria	Retrospective Cross-sectional	Infants 3 months or younger	Not stated	Screening	Health-Medical care
Owen et al. (2001)	UK	Prospective Cohort Study	Newborn babies and health visitors	Health visitors	Screening	Health-Medical care
Ramkumar et al. (2013)	India	Cross-sectional	Newborns	Technician, Village health workers, and audiologists	Screening	Health-Medical Care
Ramkumar, John et al. (2018)	India	Cross-sectional	Children under 5 years	Village health workers/Audiologists	Local resources	Health-Medical care
Ramkumar, Vanaja, et al. (2018)	India	Cross-sectional	Children under 5 years	Village health workers/Audiologists	Screening	Health-Medical care
Rob et al. (2009)	India	Observational study design	Adults with hearing loss	Community hearing workers/audiologists	Local resources	Health-Medical care
Robler et al. (2020)	USA	Mixed methods randomized trial	School aged children	Not stated	Stakeholders	Health-Medical care
Sánchez et al. (2017)	USA	Cross-sectional	Community members with hearing loss	Community healthcare workers	Stakeholders	Health-Rehabilitation
Smith et al. (2012)	Australia	Retrospective cross-sectional	Children 18 years and under	Indigenous health workers	Screening	Health-Medical care
Smith et al. (2015)	Australia	Retrospective Cross-sectional	Patients under 18 years	Indigenous health workers	Screening	Health-Medical care

Smith et al. (2018)	UK	Mix methods-longitudinal design	Community nurses	No hearing rehabilitation was implemented due to the training design.	Stakeholders	Health-Medical care
van der Ploeg et al. (2012)	Netherlands	Cohort study	Healthy newborns	Nurses	Screening	Health-Medical care
Yousuf Hussein et al (2016)	South Africa	Cross-sectional	All community members, including children four years and older, and adults that were seen by CHWs during home-based visits	Community health workers	Screening	Health-Medical care
Yousuf Hussein et al. (2018)	South Africa	Cross-sectional	Children in Early Child Development centers age ranging 3-6 years	Community healthcare workers	Screening	Health-Medical care

Table 4: Audiological themes

Audiological Themes	Quantity
Awareness	7
Cost-effectiveness	4
Rehabilitation	7
Screening	41
Hearing Health Programs for CHW	12
Service delivery model	5

Figures

Figure 1: CBR Framework 2 (WHO; 2010, page 25)

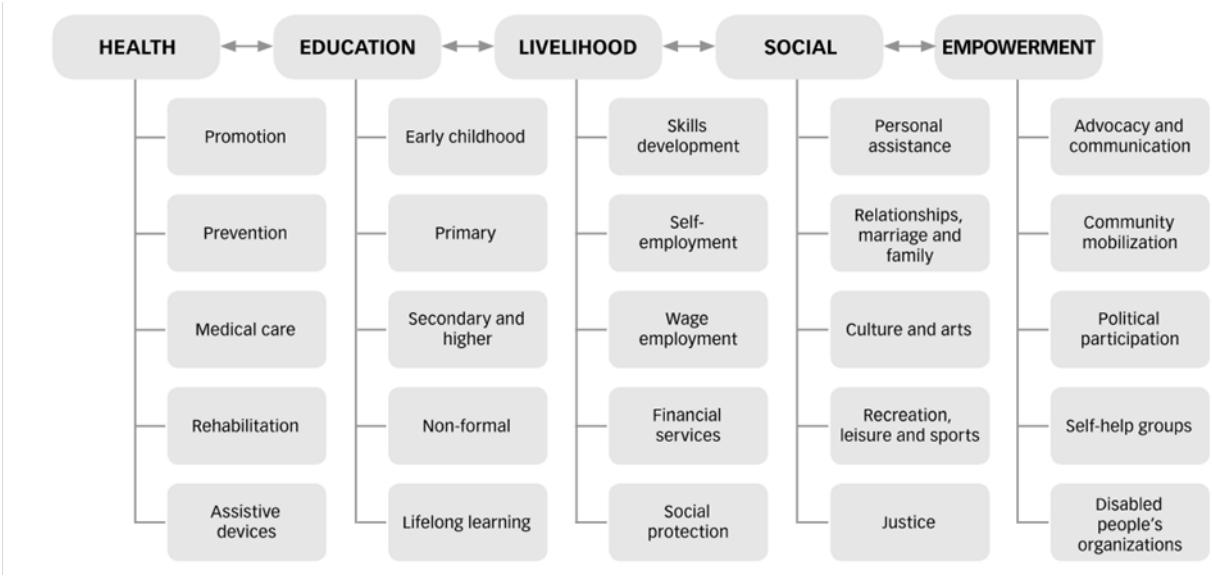


Figure 2: PRISMA flow diagram (Moher et al., 2009)

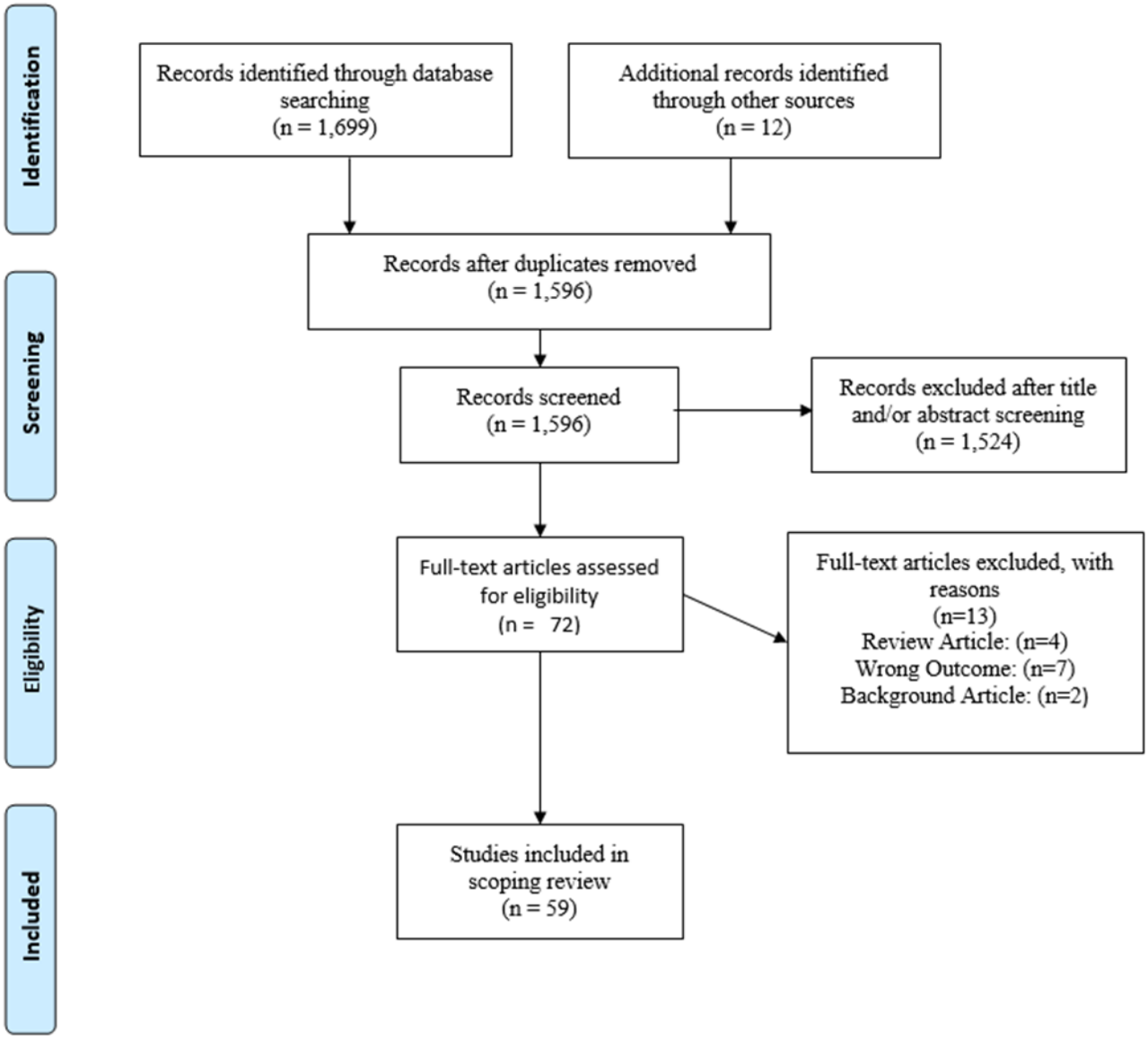


Figure 3: Distribution of CBHR studies across the globe

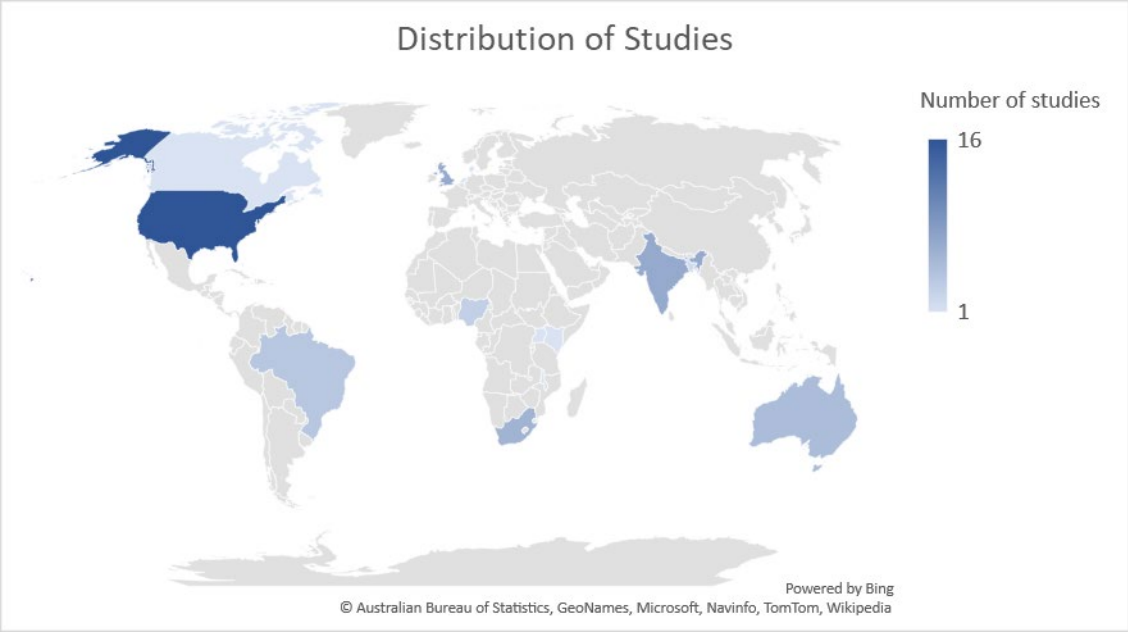
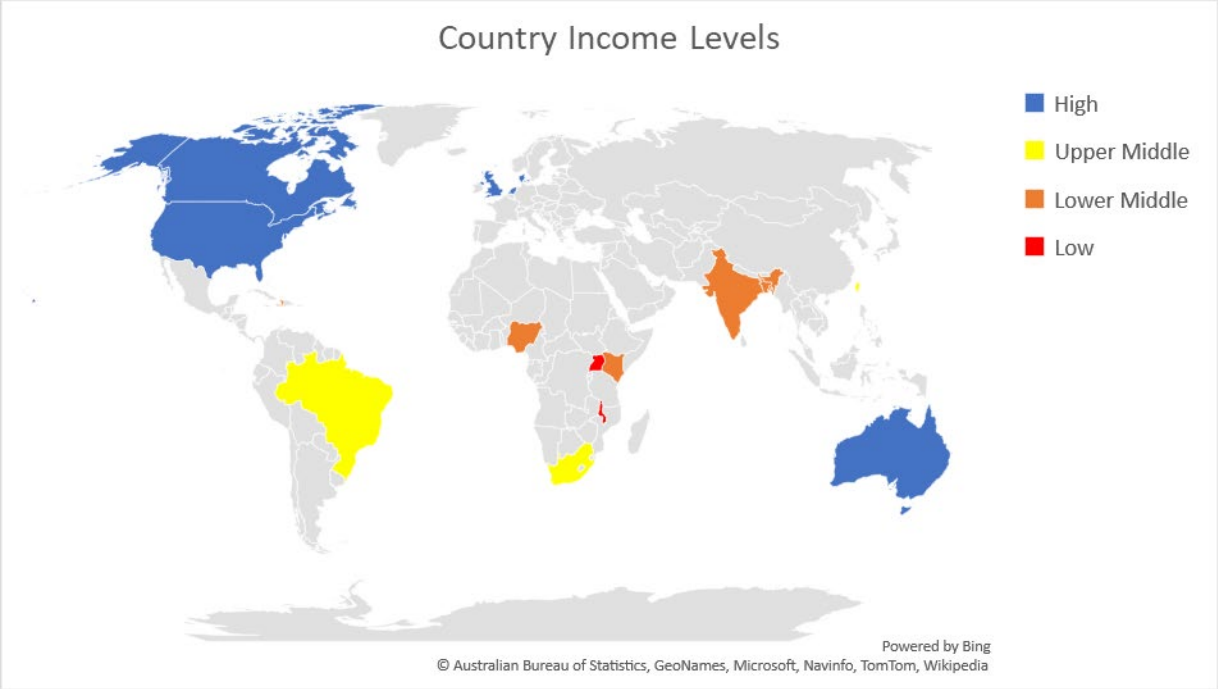


Figure 4: Classification of countries where CBHR studies were conducted based on income levels



Supplementary Tables

Supplementary Table 1: Preferred Reporting Items for Systematic reviews Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist (Tricco et al., 2018)

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist			
Section	**Item**	**PRISMA-ScR Checklist Item**	**Reported on Page #**
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	1-2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	2-3
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	3
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	4
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	4
Information sources	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	4

Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	4
Selection of sources of evidence	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	5
Data charting process	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	5
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	5
Critical appraisal of individual sources of evidence	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	NA
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	5
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	5
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	5-6
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	NA
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	6-13
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	6-13
DISCUSSION			

Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	13-15
Limitations	20	Discuss the limitations of the scoping review process.	15
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	15
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	15

Supplementary Table 2: Summary of CBR studies focusing on awareness

Awareness					
Authors	**Recruitment**	**Awareness implemented how?**	**Sample Characteristics (N, M/F, Mean Age)**	**Outcome measured by**	**Study Outcome**
Choi et al. (2019)	Where: Suburban Korean Church in Maryland. How: Church announcements and church newsletter 2-3 weeks prior of the screening session at the church.	Culturally adapted K-HEARS (Hearing Equality through Accessible Research and Solutions)	n=15, M-67%, 67.9 (8.1) **CP**s- n= 15, M-13%, 62.9 (11.6)	Focus groups	Six weeks post-intervention, participants' mean hearing handicap score reduced from 15.7 to 6.4. Communication partners demonstrated improved social-emotional function. Post-intervention focus group revealed increased hearing benefit, confidence in hearing health navigation, and awareness in hearing health among study participants.
Dodds & Harford (1982)	Where: 2 Retirement Homes, 1 Retirement Hotel, 8 Senior Activity Centers, 2 Health Fairs. How: Bulletin Boards, Mail, Monthly Activity Bulletins, Local Newspaper.	Educational Seminars	Specific sample characteristics were not provided.	Questionnaire (not specified)	Positive feedback from those who completed the questionnaire, suggesting many senior citizens are interested in learning more about hearing loss, hearing aids, and aural rehabilitation.
Griest et al. (2007)	Sampling specifics were not provided.	Dangerous Decibels	**Total**; n=1,028 **4th-graders:** n=478 **4th-grader study group**: n=223, M-54% **4th-grader comparison group**: n=255, M-56% **7th-graders**: n=550 **7th-grader study group:** n=284,	Questionnaires (Ability to retain knowledge and attitudes)	The Dangerous Decibels hearing loss prevention program was effective at producing long-term improvements in the knowledge base of 4th- and 7th-grade students. Future studies should include components on peer pressure and should incorporate repeated, multimodality interventions to increase the likelihood of long-term improvement in adolescents.

			M-52% **7th-grader comparison group:** n=266, M-50%		
Lukes & Johnson (1999)	Where: Mesa, Arizona (Two Junior High Schools) How: Occupational nurses contacted schools in the area. Two junior high schools were chosen for the pilot program.	"Hearsafe" video, "Say What? An Introduction to Hearing Loss" audio, and demonstration of hearing protection	Sample characteristics were not provided.	Pretest and posttest.	The success of this pilot study supports the expansion of a partnership between industry and schools with the goal of hearing conservation.
Martin et al. (2017)	Representatives to the Northwest Portland Area Indian Health Board invited the Oregon Health and Science University Prevention Research Center (PRC) to partner in promoting hearing health among youth in their communities.	Adapted Dangerous Decibels Program.	Specific sample characteristics were not provided.	Survey and continuation of the programs	The intervention was effective at changing knowledge, attitudes, beliefs, and behaviors in the target population
McCullagh, Yang, et al. (2020)	Pre-existing Safety Days protocols for recruitment and consenting participants	**Group A:** 20-min face-to-face interactive lesson **Group B:** 20 min face to face interactive lesson + 3 month follow-up Internet based booster **Group C:** no intervention	**Total:** n=1,979, M-46% **Group A:** n=662, M-47%, 9.77 (1.73) years **Group B:** n=680, M-45%, 9.62 (1.65) years **Group C:** n=637, M-46%, 9.57 (2.38) years	Martin et al. questionnaires 3 month and 12 month follow ups	This study represents one of very few clinical trials testing the effectiveness of hearing conservation interventions for farm operators or farm youth. Combined face-to-face and Internet interventions were more effective in increasing knowledge and improving attitudes toward use of hearing conservation strategies than comparison groups not receiving the dual interventions.
Smith et al. (2018)	Where: Community setting in the Western Isles of Scotland	3-4 hour educational intervention	n=41, Specific sample	Pre and post-workshop	Overall participants knowledge and awareness of sensory impairments

	How: Nurses were invited via invitations distributed to each five locality teams across the four islands.	Sensory training workshops	characteristics were not provided.	questionnaires 3 month post-workshop postal questionnaire 6 month post-workshop focus group	increased, empathy and compassion for patients with sensory impairments increased, and participants were more likely to refer patients with sensory impairments to specialists.

Supplementary Table 3: Summary of CBR studies focusing on newborn and infant hearing screening and assessment

Newborn and Infants					
Study	**Recruitment**	**Sample Characteristics (N, M,F, Mean Age)**	**Screening Method Used**	**Who Performed Screening**	**Study Outcome**
Basu et al. (2008)	Data recorded for 10,074 well babies between March 2004 and December 2005 from The Newborn Hearing Screening Program (NHSP) England. Screening is done through a hospital or community-based.	n=10,074 Gender specifics were not provided. 10 days	OAE and AABR	Health visitors	This study demonstrates that community-based NHSP under-taken by health visitors is an effective method of screening and it has the capacity to meet all the standards set by the national program. This study has demonstrated that it is possible to rehabilitate babies with permanent hearing loss identified by the screen within the timescales set by the program. Specific guidelines are required for the management of children with unilateral hearing loss.
de Kock et al. (2016)	All infants attending the postnatal follow-up visits were offered routine screening as part of the universal screening program.	**Total**: n=7,452 M-51.7% **First stage**: 6.1 (8.1) days **DPOAE:** n=3,573, **AABR:** n=3,879	DPOAE or AABR	Trained non-professional screeners	Postnatal visits at community-based MOUs create a useful platform for hearing screening and follow-up. AABR technology with negligible disposable costs provides opportunity for AABR screening to be utilized in community-based programs. AABR screening offers lower initial referral

					rates and a higher true positive rate compared to DPOAE.
Johnson et al. (1990)	Infants were identified by telephoning all 10 special care nurseries in the region once a week or identified from birth registration data.	n=4,116 Gender specifics were not provided, 7-8 months	Distraction testing	Health visitors	The distraction test as routinely applied by health visitors can be a sensitive if somewhat non-specific screening test. The effectiveness of as screening program using the test is severely limited however, by failure to test all the infant population.
Khoza-Shangase & Harbinson (2015)	The study was conducted at a Community Health Centre's MOU department in Gauteng, South Africa. All neonates during a one-month period were potentially included in the study (from 30 August to 30 September 2009).	n=272 M=54.8% **Session 1:** 4.2 **Session 2:** 3.9	DPOAEs	Audiologist	Current findings highlight the importance of studying methodologies to ensure effective reach for hearing screening within the South African context. These findings argue for UNHS initiatives to include the MOU three-day assessment to ensure that a higher number of neonates are reached and confounding variables such as vernix have been eliminated.
McPherson et al. (1998)	Eight community health clinics in the northern Brisbane region.	n=2,305 **Target Infants**=1,305 Gender specifics were not provided. 22.21 months	TEOAEs	Clinic nurses or audiologist	The results suggest that TEOAE screening has potential as a technique in the community health setting but improvements in instrumentation are required to reduce `could not test' cases and to separate probable

					conductive hearing loss from cases likely to have other disorders.
Olusanya et al. (2008)	Infants who were attending one of the four Bacille Calmette-Guérin (BCG) clinics between July 2005 and April 2006 were enrolled in the study.	n=2,003, M- 51.1%, 17.7 (19.1) days	TEOAE & AABR	Community health care workers	Routine hearing screening of infants attending BCG immunization clinics by community health workers was feasible and effective for the early detection of permanent congenital and early-onset hearing loss in Lagos, Nigeria.
Olusanya, Ebuehi, et al. (2009)	All mothers attending four of the seven primary health care centers which administered routine Bacille Calmette-Guérin (BCG) immunization from July 2005 to April 2008 were enlisted.	n=7,175, M-52.3%, 16.35 (17.30) days	1st Stage: OAE 2nd Stage: AABR	Community health workers	Community-based UNHS facilitates early detection of infants at risk of sensorineural hearing loss born outside hospitals and the overall performance is comparable to conventional hospital-based UNHS. Maternal education at antenatal clinics may be valuable in addressing the associated risk factors.
Ramkumar et al. (2013)	Mothers at the post-natal ward were informed about the purpose of study and provided with information by the neonatologist and ward nurses.	n=30, M=54.2%, Mean age was not provided. 8-30 days	Tele-ABR and Face-to-Face ABR	Technician, Village health workers, and audiologists	The results suggest that conducting tele-ABR in a mobile van is feasible and produces similar recordings to those obtained in face-to-face mode.

Ramkumar, Vanaja, et al. (2018)	119 children were selected using random sampling from 2880 infants and young children under the age of 5 years who had received DPOAE screening by village health workers.	**Total:** 2088 **Sample:** n=119, **Infants:** n=76, Gender and mean age specifics were not provided.	DPOAE	Village health worker	The validity of DPOAE screening conducted by trained village health workers was acceptable. This study supports the engagement of grass-root workers in community-based hearing health care provision.
van der Ploeg et al. (2012)	All Dutch newborns are offered NHS which is part of the Youth Healthcare Program (YHP)	n=552,820, Gender specifics and total mean age information were not provided.	TEOAE screening in the first two sessions and AABR in the third session.	Nurses	The study shows that the Dutch community-based newborn hearing screening in the youth health care is of high quality. However, both participation in diagnostic testing after a positive screen result and the timing of the diagnostic testing can still be improved.
Parental Perception & Compliance					
Akilan et al. (2014)	A sampling frame of mothers of infants and children under 2 years of age who received hearing screening in all the villages was obtained. Random sampling was conducted to select participants from two villages serviced by each village health worker.	**Mothers:** n=83, M-0% **Children**: n=83 **Age of mothers:** 18–30 years 71 31–40 years 12 **Age of children:** <2 years 70 >2 years 13	OAEs & Remote ABR	Village health workers-OAEs/Remote audiologist for ABR	Mothers in the community accepted hearing screening services delivered by health workers. The health workers were effective in delivering the services. Pre-school teachers seemed to have played a pivotal role in communicating about the hearing screening program to the mothers. Ultimately, collaborating with local NGO facilitated acceptance and

					compliance due to the NGOs strong presence in the community.
Danhauer et al. (2008)	Three researchers made initial telephone calls to the babies' parents prior to mailing the questionnaires.	n=150 **Babies analyzed:** n=34, M-64.7% **Responses:** n=7 M-85.7% No specific mean ages were provided.	AABR/Probe of Parents' Perceptions	Level one-Nurses Level 2-Audiologists	This maturing EHDIP generally met national benchmarks and continued to serve the infants and families well. However, parents' compliance with physician visits and audiologic follow-up for habilitation including hearing aids in a timely manner could still be improved.
Lin et al. (2004)	From March 2000 to December 2002, two hospitals and four obstetric clinics in Tainan city participated in this study. The subjects were healthy newborns whose parents agreed to pay for otoacoustic emissions (OAE) hearing screening. They were tested in the newborn nursery before discharge.	n=5938, M-51.5%, Mean age was not provided.	The protocol used an initial TEOAE screening followed by a diagnostic ABR	Hearing screener	This study was a cooperative effort between hospitals and clinics and was performed in a pay-for-screening model. The program was feasible and well regarded by parents in Tainan city. The screening rate is acceptable. The referral rate is similar to other studies.
Olusanya, Akinyemi, et al. (2009)	Participants were drawn from a population of mothers previously described in a study who were enrolled for a three-stage infant hearing screening program at the time of attending four	n= 2,003, M- 50.2%, 17.1 (19.1) days	TOAE & Automated ABR	Community health care workers	Place of delivery was the only factor that correlated albeit marginally with infant hearing screening compliance in this population. The likely influence of issues such as the number of return

	community health centers to obtain Bacille De Calmette-Guérin (BCG) vaccinations for their babies.				visits for follow-up services, ineffective tracking system and the prevailing unfavorable cultural perception towards childhood deafness on non-compliance independently or through these factors warrant further investigation.
Owen et al. (2001)	All newborn babies registered with participating health centers were offered neonatal hearing screening by health visitors using OAE during the trial period, January–December 1999.	n=683, Gender specifics were not provided, 18 days	OAEs	Health visitors	HVs are able to perform OAE testing in the neonatal period at home and in local health center clinics. They achieve high population coverage rates and low false positive rates. Universal neonatal hearing screening by HVs using OAE testing is feasible, well received, and could be less demanding of HV time than the current distraction testing. This model of universal neonatal hearing screening should be considered by the National Screening Committee.
Ramkumar, John et al. (2018)	VHWs went door-to-door in 51 villages.	**Total**: n=1,335 **Infants**: n=687, Gender specifics were not provided, 1.5	DPOAEs & Remote ABR	Village health workers/Remote audiologist for follow-up ABR	This community-based hearing screening program, tele-audiological diagnostic testing resulted in 86% follow-up compliance, a rate exceeding the Joint Committee on Infant Hearing (JCIH2007) benchmark of 75% compliance for hospital-based pro-grammes. Settings with constrained resources can benefit from a community-based program integrated with tele-diagnostics

Abbv: AABR-Automatic auditory brainstem response, ABR-auditory brainstem response, BCG-Bacille Calmette-Guérin, DPOAE-Distortion product otoacoustic emissions, EHDIP-Early Hearing Detection and Intervention Program, HV-health visitor, MOUs- Midwife obstetric units, NGO-non-governmental organization, NHSP-Newborn Hearing Screening Program, OAE-otoacoustic emissions, TEOAE-transient evoked otoacoustic emissions, UNHS- Universal Newborn Hearing Screening

Supplementary Table 4: Summary of CBR studies focusing on children hearing screening and assessment

Children Screening/Assessment					
Study	**Recruitment**	**Sample Characteristics (N, Male %, Mean Age)**	**Screening Method Used**	**Who Performed Screening**	**Study Outcome**
Akilan et al. (2014)	A sampling frame of mothers of infants and children under 2 years of age who received hearing screening in all the villages was obtained. Random sampling was conducted to select participants from two villages serviced by each village health workers.	n=83 mothers, M-0% n=83 children, **Age of mothers** 18-30 years 71 31-30 years 12 **Age of Children** <2years 70 >2years 13	OAEs & Remote ABR	Village health workers-OAEs/Remote audiologist for ABR	Mothers in the community accepted hearing screening services delivered by health workers. The health workers were effective in delivering the services. Pre-school teachers seemed to have played a pivotal role in communicating about the hearing screening program to the mothers. Ultimately, collaborating with local NGO facilitated acceptance and compliance due to the NGOs strong presence in the community.
Berg et al. (2006)	In Kishoreganj, Bangladesh. Sampling specifics were not provided.	n=4,003, M-51.3%, Mean age for the total population was not provided. (2-5 years) 52.5% (6-9 years) 47.5% **Subgroup**- n=569, M-53.6%,	(2-9y) CPA, (2-5y) OAEs and tympanometry	Community health workers	These results suggest that hearing screening using CPA for older (6—9 years) and OAE/tympanometry for younger (2—5 years) children is feasible.

		Mean age for the total population was not provided. (2-5 years) 100%			
Cedars et al. (2018)	Preschool programs. Sampling specifics were not provided.	**Year 1** n=1,436 M-50.8%, 2.1–3.0 =63(4.4) 3.1–4.0 =464 (32.3) 4.1–5.0 =661(46) 5.1–6.0 =248(17.3) **Year 2** n=1,821, M- 51.4%, 2.1–3.0 = 108(5.9) 3.1–4.0 = 592(32.5) 4.1–5.0 = 816(44.8) 5.1–6.0 = 305(16.7)	CPA and DPOAEs	Audiometrist	The addition of an immediate second-line OAE screen to pure tone screening for preschool children improved both the effectiveness and efficiency of our community-based hearing screening program, and eliminated disparities inability to test associated with age, language, and communication delay. The reduction in referral volume also corresponded to an improvement in follow-up rates, possibly by improving resource allocation.
Dawood et al. (2021)	SHN: schools. CHWs: Early Childhood Development centers, clinics, home visits and health campaigns. Convenience sampling.	n= 6,805 M- 49.6% 7.62 years	hearX Group a hearScreen app	School health nurses/Community health workers	No significant difference between SHNs and CHWs using m-health technology in screening outcomes when controlling for age, headphone type, noise levels, and age.

Eksteen et al. (2019)	Partnerships with local non-profit organizations supporting the preschool centers in the community and introduced the screening program to preschool center principals. Mapped all preschool centers via mobile platform and invited principals to sign a participation agreement. CHWs distributed posters, leaflets, and awareness within the preschool centers	n=8,023 M-49.5%, 1066 children 4 years old 3671 children 5 years old 3286 children 6–7 years old	hearX Group a hearScreen app	Community health workers	mHealth-supported CHW-delivered hearing screening in preschool centers provided a low-cost, acceptable and accessible service, contributing to lower referral numbers to resource-constrained public health institution
Elliott et al. (2010)	Selected local community primary schools and daycare centers. Specific sampling information was not provided.	**Total** n=743 **Hearing Screened** n=359, Gender specifics were not provided, 0–4 48, 5–9 412, 10+ 286	Van with wireless broadband Internet connection Audiometric hearing screening	Aboriginal health worker	It is feasible to integrate a mobile telehealth screening service with existing community-based services to provide specialist review and treatment planning at a distance. Community consultation, engagement, and collaboration in all areas of the project have been important.
Gomes & Lichtig (2005)	Where: In the community How: Asked to answer the questionnaire and allow their children to undergo the hearing screening procedures	n=133 M-49.6% 4.23 years	Portuguese adapted Dube (1995) parent-report questionnaire	Volunteers that were local nursery school employees	The results showed that the volunteers reproduced the evaluation of the professional regarding the use of the questionnaire. The questionnaire did not differentiate between the children who failed in the audiological screening from those

					who did not, suggesting further refinements are necessary.
Holtby et al. (1997)	The 19 primary schools screening for hearing loss was already scheduled to take place in the study period.	n=610 Gender specifics and the mean age were not provided.	Pure tone audiometry screen and impedance screen	School nurses	In choosing the method to be used, it must be borne in mind that the impedance method is technically more efficient but takes longer than pure tone audiometry screening. However, the latter method allows opportunity for other health inquiries in these children.
Harries & Williamson (2000)	Children at their 3-year health check.	n=65 M-51% 3 years	McCormick Toy Test (MCTT)	Health visitors	The results from this small-scale validation study suggest that the MCTT is a useful tool use in the community setting.
Jayawardena et al. (2018)	Advertised with flyers in the community as well as by word of mouth. Local schools were contacted in advance to identify student who would benefit from audiometric evaluation.	n=87 Gender specifics and mean age information were not provided.	Showbox Professional Audiometer on an iPad Mini 2 tablet for play audiometry and otoscopic endoscopy	Community health workers, nursing staff and NGO volunteers	This study demonstrates the feasibility of a non–otolaryngology-based hearing screening program. This may become an important tool in reducing the impact of hearing loss and urologic pathology in areas bereft of otolaryngologists and audiologists by allowing CHWs to

					gather important patient data prior to otolaryngologic evaluation.
Jayawardena et al. (2020)	In schools by schoolteachers and directors.	n=127 M-39.4% 11.4 years	hearX- hearScreen and HearTest applications and HearScope endoscopic camera for otoscopy	Community health workers/nursing staff	This study demonstrates the utility of an efficient, unified platform for performing pediatric hearing screening in a LMIC. By using a multi-tiered hearing screening paradigm coupled with a mobile otologic endoscope, CHWs can efficiently screen children for hearing loss and associated pathology.
McPherson et al. (1998)	Eight community health clinics in the northern Brisbane region. Sampling specifics were not provided.	n=2,305 Gender specifics were not provided. 22.21 months	TEOAEs	Clinic nurses or audiologist	The results suggest that TEOAE screening has potential as a technique in the community health setting but improvements in instrumentation are required to reduce `could not test' cases and to separate probable conductive hearing loss from cases likely to have other disorders

O'Donovan et al. (2021)	Recruiting specifics were not stated.	n= 312 Gender specifics were not provided. 24 years	Otoscopy/whispered voice test of hearing	Community health workers	Training of CHWs is feasible and effective in screening for hearing and ear disorders in the community.
Ramkumar, John et al. (2018)	Village health workers went door-to-door in 51 villages.	**Total:** n=1,335 **Children**: n=648 Gender specifics were not provided. 1.5 years	DPOAEs and remote tele- ABR assessment	Village health workers/Remote audiologist for follow-up ABR	This community-based hearing screening program, tele-audiological diagnostic testing resulted in 86% follow-up compliance, a rate exceeding the Joint Committee on Infant Hearing (JCIH2007) benchmark of 75% compliance for hospital-based programs. Settings with constrained resources can benefit from a community-based program integrated with tele-diagnostics
Ramkumar, Vanaja, et al. (2018)	119 children were selected using random sampling from 2880 infants and young children under the age of 5 years who had received DPOAE screening by village health workers.	**Total:** 2208 **Sample:** n=119, **Children:** n=43 Gender and mean age specifics were not provided.	DPOAE and Remote tele-ABR assessment	Village health worker Remote audiologist for follow-up ABR	The validity of DPOAE screening conducted by trained village health workers was acceptable. This study supports the engagement of grass-root workers in community-based hearing health care provision.

Smith et al. (2012)	Where: Schools in Cherbourg and the surrounding communities. Sampling specifics were not provided.	n=1,685 M-51% 7 years	Video-otoscopy, tympanometry, pure tone audiometry	Indigenous health workers	The community-based screening service led by local Indigenous health workers and supported by a telehealth link to a tertiary children's hospital has proved to be a feasible method for routine screening of children at risk of hearing impairment
Smith et al. (2015)	Retrospective review of service activity over a six-year period, from Jan 2009–Dec 2014.	n=4,291 Gender specifics and the mean age were not provided.	Video-otoscopy, tympanometry, pure tone audiometry	Indigenous health workers	Results suggest that community-based screening, integrated with specialist ENT services may improve ear and hearing health.
Yousuf Hussein et al (2016)	Participants were selected from the community. Convenience sampling was used to invite all community members.	Total 820 Children n=108 Gender specifics and the mean age were not provided.	hearScreen application	Community health workers	Smartphone-based hearing screening allows CHWs to bring hearing health care to underserved communities at a primary care level. Active noise monitoring and data management features allow for quality control and remote monitoring for surveillance and follow-up.
Yousuf Hussein et al. (2018)	CHWs mapped 250 ECD centers	n=6,424 M-46% 4.94 years	hearScreen application	Community healthcare workers	Early Childhood Development hearing screening programs using an mHealth point-of-care diagnostics and cloud-based data management and referral systems can be successfully implemented by CHWs within LMICs to

					identify children prior to school entry.

Abbv: ABR-auditory brainstem response, CPA-conditioned play audiometry, DPOAE-Distortion product otoacoustic emissions, ENT- Ear, Nose, Throat doctor, LMIC-low middle income countries, MCTT- McCormick Toy Test, NGO-non-governmental organization, OAE-otoacoustic emissions, SHN-school health nurse, TEOAE-transient evoked otoacoustic emissions

Supplementary Table 5: Summary of CBR studies focusing on adult hearing screening and assessment

Adult Screening/Assessment					
Study	**Recruitment**	**Sample Characteristics (N, M,F, Mean Age)**	**Screening/Assessment Method Used**	**Who Performed Screening/Assessment**	**Study Outcome for Assessment/Screening**
Dodds & Harford (1982)	Retirement homes, retirement hotel, senior activity centers, and health fairs. For the homes and hotels through bulletin boards, mailboxes, monthly activity bulletins and local newspaper.	Specific sample characteristics were not provided.	Portable audiometers-air conduction	Graduate students	Suggests that it is feasible to test this population under less-than-ideal conditions if reasonable precaution is used to maintain a quiet room.
Gupta et al. (2020)	Retrospective review of the data contained from the Shruti screening program.	Overall sample characteristics were not provided. **HA population**: n=120 M-59.1%	ENTraview-Telehealth device	Community health workers	Shruti screening program and referral process has been successful in reaching the rural population in India through telehealth and community involvement.
Haanes et al. (2021)	The Preventive home visits-team contacted every person born in 1941 (76 years old) by phone living in Tórshavn	n= 74, M-37.8%, 76 years	KAS screen (Kartlegging av Alvorlig Kombinerte sansetap blandt eldre) [Screening of serious,	Nurses	The study found that 77% had some degree of hearing loss indicating that it would be beneficial for mandatory hearing screenings taking place in homes

	and invited them to participate in the study.		combined sensory loss among older people] Screening Audiometer, AS608 Interacoustics – air conduction		or community health houses conducted by nurses.
O'Donovan et al. (2021)	Recruiting specifics were not stated.	n= 312 Gender specifics were not provided. 24 years	Otoscopy/whispered voice test of hearing	Community health workers	Training of CHWs is feasible and effective in screening for hearing and ear disorders in the community.
Jayawardena et al. (2018)	The walk-in clinic at Tawfiq Muslim Hospital in Malindi was advertised with flyers in the community as well as by word of mouth. Local school were contacted in advance to identify student who would benefit from audiometric evaluation.	n=87, Gender specifics and mean age information were not provided.	Showbox Professional Audiometer on an iPad Mini 2 tablet for play audiometry and otoscopic endoscopy	Community health workers, nursing staff and NGO volunteers	This study demonstrates the feasibility of a non–otolaryngology-based hearing screening program. This may become an important tool in reducing the impact of hearing loss and urologic pathology in areas bereft of otolaryngologists and audiologists by allowing CHWs to gather important patient data prior to otolaryngologic evaluation.
Yousuf Hussein et al. (2016)	Participants were selected from the community. Convenience sampling was used to invite all community members.	Total n=820, Adults n=598, Adults M-29.4%, mean age was not provided.	hearScreen application	Community health workers	Smartphone-based hearing screening allows CHWs to bring hearing health care to underserved communities at a primary care level. Active noise monitoring and data management features allow for quality control and remote

					monitoring for surveillance and follow-up.

Abbv: ENT-ear, nose, throat, HA-hearing aid, NGO-non-governmental organization

Supplementary Table 6: Summary of CBR studies focusing on rehabilitation

Rehabilitation							
Study	**Recruitment**	**Sample Characteristics (N, M,F, Mean Age)**	**Rehabilitation**	**Who offered Rehab**	**Setting**	**Outcome Measured by**	**Study Outcome**
Borg et al. (2018)	Community workers of local NGOs in 13 sub-districts of Bangladesh selected individuals who could be potential participants.	**Total:** n=140, M-44%, 15 years **Community based**: n=77, M-38.7%, 14.8 (2.1) years **Centre-based:** n=65, M-50.8%, 15.3 (1.9) years	Provision of hearing aids	**Community-based group**: Community worker **Centre-based group:** Audiometric technician	**Community-based group:** In adolescent's homes Centre-**based group:** Hearing center	(IOI-HA) included in the follow-up questionnaire.	The community-based approach is a viable and effective option for hearing aid delivery in low-resourced settings. The approach needs to be adapted to particular contexts, and possible downsides may need to be counteracted by special interventions.
Choi et al. (2019)	Suburban Korean Church in Maryland. Announcements were made by the church pastor and in the church newsletter 2-3 weeks prior of the screening session at the church.	**KAs:** n=15, M-67%, 67.9 (8.1) years **CPs**: n=15, M-13%, 62.9 (11.6) years	Culturally adapted K-HEARS (Hearing Equality through Accessible Research and Solutions with pre-intervention and post intervention focus groups.	Bilingual moderators	Korean church	KAs-Korean versions of HHIE-S, UCLA Loneliness Scale, PHQ-9, SF-12, ALHQ CPs- SOS-HEAR KA CPs- IOI-AI & self-report willing to pay	Six weeks post-intervention, participants' mean hearing handicap score reduced from 15.7 to 6.4. Communication partners demonstrated improved social-emotional function. Post-intervention focus group revealed increased hearing benefit, confidence in hearing health navigation, and awareness in hearing health among study participants
Coco et al. (2019)	Individuals were recruited for participation in the Oyendo Bien study by local Community	n=10, Gender specifics were not provided, 73 years	Oyendo Bien (Mexican American cultural adaptation of living WELL with Hearing Loss)	Community health workers	Community Gathering Center	Observation notes were constructed using a sensitizing	The current study demonstrates a phenomenological approach to explore the lived experiences of individuals with hearing loss within a group AR setting. The

	Health Workers via word-of-mouth, radio advertisements, flyers, a press release to the local newspaper, and community hearing screenings conducted by audiologists.					framework that focused on interactions, reactions to educational information, and how dyads described their communication over the course of the five sessions and the HHIE-S Spanish version.	data in the observations revealed variations in the subjective experience of communication with hearing loss within an AR intervention, highlighting the importance of qualitative study.
Emerson et al. (2013)	Camps were conducted with the help of the local government organization and nongovernmental agencies (NGOs), using local propaganda machine which included television broadcasting and advertising in the regional language papers.	n=111, M-57% Total mean age specifics were not provided.	Provision of hearing aids	Community health workers	Camps	APHAB	Results show that trained CHWs are effective in detecting disabling hearing loss and in providing HAs. APHAB can identify and pick up significant improvements in communication in daily activities and provides a realistic expectation of the benefits of a hearing aid. The model of using trained CHWs to provide rehabilitative services in audiology along with self-report outcome measures can be replicated in other developing countries.
Gupta et al. (2020)	Retrospective of the data contained from the	**HA population:** n=120	Provision of hearing aids.	Not stated.	Hospital Hearing Aid	International Outcome	Shruti screening program and referral process has been

	Shruti screening program.	M-59.1% Mean age was not provided.		Possibly community health workers in the field and an audiologist at the hospital.	fitment and earmold facility (if earmold or fine tuning was required) In the field (if not)	Inventory for Hearing Aids	successful in reaching the rural population in India through telehealth and community involvement.
Marrone et al. (2017)	CHWs contacted participants through other health promotion programs offered by FQHC.	**Total**: n=21 **Participants**: n=10 **CPs**: n=11 Gender specifics and mean age information were not provided.	O'Yendo Bien Programs (Mexican American cultural adaptation of living WELL with Hearing Loss).	Community health workers	Federally Qualified Health Center (FQHC)	2 week post-intervention focus groups and 1 year follow up interviews	Post program focus groups revealed increased self-efficacy and decreases stigma. After 1 year, 7 of 9 participants with hearing loss contacted for follow-up had sought some form of hearing-related healthcare.
Nieman et al. (2017)	Community-dwelling individuals were recruited in partnership with a nonprofit that provides subsidized, independent housing to low- and middle-income older adults. Participants were recruited from three buildings that house predominantly low-income and minority, primarily African American, older adults.	n=15, M-46.7%, 70.1 (68.6–76.4) years	HEARS (Hearing Equality through Accessible Research & Solutions) With pre-intervention and post intervention focus groups.	Trained interventionist	Conducted in the participant's buildings.	HHIE-S (Hearing Handicap Inventory for the Elderly-Screening), revised QDS (Quantified Denver Scale of Communication Function), revised UCLA Loneliness Scale, PHQ-9 (Patient Health Questionnaire),	The HEARS (Hearing Equality through Accessible Research & Solutions) intervention is feasible, acceptable, low risk, and demonstrates preliminary efficacy. HEARS offers a novel, low-cost, and readily scalable solution to reduce hearing care disparities and highlights how a community-engaged approach to intervention development can address disparities.

						SF-36 (Short-Form General Health Survey), IO-AI (International Outcome Inventory-Alternative Interventions) and self-reported willingness to pay.	

Abbv: APHAB-Abbreviated Profile of Hearing Aid Benefit, ALHQ-Attitudes towards Loss of Hearing Questionnaire, AR- aural rehabilitation, CP-communication partner, FQHC-Federally Qualified Health Center, HEARS-Hearing Equality through Accessible Research and Solutions, HHIE-S-Hearing Handicap Inventory for the Elderly-Screening, IO-AI-International Outcome Inventory-Alternative Interventions, IOI-HA-International Outcome Inventory for Hearing Aids, NGO- non-governmental organization, PHQ-9-Patient Health Questionnaire, QDS-Quantified Denver Scale of Communication Function, SF-Short-Form General Health Survey, SOS-HEAR- Significant Other Scale for Hearing Disability, UCLA-University of California, Los Angeles

Supplementary Table 7: Summary of CBR studies focusing on cost effectiveness

Cost Effectiveness			
Study	**Cost-effectiveness method**	**Cost information**	**Study outcome**
Grill et al. (2006)	Clinical effectiveness analysis using a Markov Model and a one-way, multiple sensitivity analyses were performed on all relevant parameters, and multivariate simulations were used for probabilistic modelling (Monte Carlo).	Both hospital and community programs yielded 794 QCM at the age of 6 months with total costs of £3,690,000 per 100,000 screened children in hospital and £3,340,000 in community. Simulated costs would be lower in hospital in 48% of the trials. Any statistically significant difference between hospital and community in prevalence, test sensitivity, test specificity and costs would result in significant differences in cost-effectiveness between hospital and community.	The evaluation of the Newborn Hearing Screening Programme will serve as a valuable tool and example to justify and improve large scale screening programs.
Nguyen et al. (2015)	Deterministic and probability sensitivity analyses.	Annual equivalent cost for the total cost of the Deadly Ears Program is 78,243. Annual equivalent cost for the total cost of the MTESS Service is 236,200. The model showed that compared with the Deadly Ears Program, the probability of an acceptable cost-utility ratio at a willingness-to-pay threshold of $50,000/QALY was 98% for the MTESS service.	The findings of this analysis indicate that, from a health service perspective, the supplemental mobile telemedicine-enabled screening and surveillance (MTESS) service is cost effective compared to the Deadly Ears Program alternative alone.
Ramkumar, John, et al. (2018)	Economic analysis was carried out to estimate cost incurred and outcome achieved for hearing screening, follow-up diagnostic assessment and identification of hearing loss. Two-way sensitivity	Total cost for CBHSP broadband internet for tele-diagnostics: 3,038,671 (Indian Rupees). Total cost for CBHSP with satellite connectivity in mobile tele-van for tele-diagnostics= 3,140,026 (Indian Rupees). Cost difference: $1.14 per child screened, $80 per child followed-up, and $304 per child	Settings with constrained resources can benefit from a community-based program integrated with tele-diagnostics

	analysis determined the most beneficial cost-outcome.	identified. Patient perspective: Average wage loss and travel cost $3.	
Rob et al. (2009)	Sensitivity analysis was applied to test the robustness of results towards the use of alternative values on key parameters, including the proportion of patients wearing hearing aids, the lifetime of the hearing aids, the difference in health state valuation between treated and untreated deafness, and cost of hearing aids.	Active screening and provision of hearing aids at the secondary care level costs around Rs.7,000 (US$152) per patient, whereas provision of hearing aids at the tertiary care level costs Rs5,693 (US$122) per patient. The cost per DALY averted was around Rs. 42,200 (US$900) secondary care level and Rs. 33,900 (US$720) at tertiary care level. Costs of food and transport ranges between Rs. 2 (US$0,04) and Rs. 39 (US$0,83).	Active screening and provision of hearing aids at the secondary care level is slightly more costly than passive screening and fitting of hearing aids at the tertiary care level but seems also able to reach a higher coverage of hearing aids services. Although crude estimates indicate that both passive and active screening programs can be cautiously considered as cost-effective according to international thresholds, important questions remain regarding the implementation of the latter.

CBHSP-community-based hearing screening program, MTESS- mobile telemedicine-enabled screening and surveillance, QCM- quality weighted detected child months, Rs.- Indian rupee

Supplementary Table 8: Summary of CBR studies focusing on hearing health programs for community workers

Training					
Authors	**Type of Training**	**Sampling (where and how they were recruited)**	**Sample Characteristics**	**Outcome measured by**	**Study Outcome**
Alvarenga et al. (2008)	**Group A Bauru:** 8-hour intervention consisting of audio-visual material along with a manuscript based on the World Health Organization: Primary Ear and Hearing Care Training **Group B Sorocaba**: 2 meetings consisting of 4 hours with the same intervention, but without the manuscript to follow along. Training was conducted by audiologists.	Sampling specifics were not provided.	**Total:** n=106 **Group A:** n=31, 29 years **Group B:** n=75, 32.3 years Gender specifics were not provided.	Pre and post-training questionnaires on the WHO material	The results indicate the effectiveness of the training program for community health agents of a Family Health Program with the use of texts and with an interactive approach
Araujo et al. (2013)	CHWs received training in basic computing during a single, onsite, four-hour session. "Infant Hearing Health" CD-ROM interactive tele-education tool during two four-hour sessions.	Study was performed at the Dental Faculty of Bauru, University of São Paulo as a collaboration among the Telemedicine Program of the Faculty of Medicine, University of São Paulo and the University of the Vale do Itajaí, Brazil. Sampling specifics were not provided.	**Total** n=90 **Group I:** n=47 **Group II**: n=43 Gender and mean age specifics were not provided.	Pre- and post-training questionnaire and 6 months after the training program simulations interactive model through Cybertutor in a two-hour session led by a tutor.	The CHWs ’ training in infant hearing health using an interactive tele-educational tool was effective, as the CHW demonstrated significant short-term information retention and applied such data in hypothetical situations representative of their daily activities.

Araujo et al. (2015)	Training involved the prevention and rehabilitation of hearing impairment, organized into five modules.	Twenty-four CHWs with representativeness of different FHS teams in Bauru and who had participated in a training program in the area of infant hearing health, joined the study. Sampling specifics were not provided.	n=24, Gender and mean age specifics were not provided.	After a 15-month period the CHWs completed the same questionnaire that was completed immediately after training.	A significant decrease of the Community Health Workers knowledge on infant hearing health was observed, which demonstrates that the community health workers training should occur continuously.
Coco et al. (2021)	Introductory training sessions: 1 hour and were guided by instructional PowerPoint-delivered presentations and group discussion, facilitated by the trainer. Intermediate training session: 1.5 hours, by PowerPoint-delivered presentations and group discussion, facilitated by the trainer which added roles on teleaudiology team and patient safety and confidentiality. Facilitator training lasted a total of 12 hours over 2 consecutive days, a combination of instructional presentations and active learning components.	Recruitment of CHWs was done by flyer, e-mail, and word-of-mouth at partnering health center.	n=12, M-0%, 30–49 17% (2) 50–69 8% (5) 70–79 17% (2) Not reported 12% (3	Introductory survey, Intermediate knowledge-based assessment, Computer Proficiency Questionnaire, Facilitator performance-based assessment, asked to report their understanding of privacy and confidentiality in teleaudiology, and open-ended questions regarding the training and teleaudiology	Teleaudiology trainings for CHW's were found to be feasible. Due to the recent demand for teleaudiology in the COVID-19 pandemic more research is need in the efficacy, effectiveness, adoption, and implementation of teleaudiology.

Gomes & Lichtig (2005)	Two days of training: lectures, discussions, role play, and videos of the questionnaire being administered.	Volunteers from the local nursery school. Sampling specifics were not provided.	n=7, M-0%, Mean age was not provided.	The k-test was applied in a statistical analysis comparing the registers collected by the community volunteers and by the researcher through the parent report questionnaire.	The results showed that the volunteers reproduced the evaluation of the professional regarding the use of the questionnaire. The questionnaire did not differentiate between the children who failed in the audiological screening from those who did not, suggesting further refinements are necessary.
McCullagh, Cohen, et al. (2020)	Online or face to face training sessions consisting of identifying learning objectives, teaching/learning methods, time allowed, and teaching and learning materials to the coordinators conducted by study personnel.	Safety Day coordinators recruited local volunteers via personal contacts and networking.	n=22, M 21%, 43 years	10-item instrument used to measure the adherence of the lesson delivery to the curriculum. 5-item instrument used to measure the quality of teaching methods.	The study outcome supported the use of community volunteers to implement a tested curriculum for an effective method to provide hearing conservation education to farm and rural youth.
Melo et al. (2010)	8-hour video conference training using the courseware: World Health Organization (WHO) guide - Primary ear and hearing care training resource - basic, intermediate and advanced levels	All the community health agents of the city had no previous experience in hearing health and were invited to take part of the study.	**Total:** n=50, **Face-to-Face**: n=31, 30 (7) years **Video conference**: n=19, 31(8) years Gender specifics were not provided.	Pre and post-training questionnaires on the WHO material	The video conference was effective as a learning tool for the training of community health agents on child hearing health. However, this instrument should be used as a complementary material to the traditional form of training.

Mulwafu et al. (2017)	The training manual was based on both the Basic and Intermediate Manual of WHO Primary Ear and Hearing Care Training Resources.	Health workers were selected among Malawian Health Surveillance Assistants, which is the formal cadre of CHWs in Malawi.	**Total**: n=57 **Control arm**: n=28, M-59%, 37 years **Intervention arm:** n=29, M-54%, 38 years	60 multiple choice questions from the first six modules of the WHO Primary Ear and Hearing Care Trainer's Manual, number of patients with ear or hearing disorders identified by CHWs and number recorded at health centers and focus group discussions	Training was effective in improving the knowledge of CHW in ear and hearing care in Malawi and allowing them to identify patients with ear and hearing disorders. This intervention could be scaled up to other CHWs in low-income and middle-income countries.
O'Donovan et al. (2021).	Two-day workshop by two ENTs and two doctors. Training was based on the WHO Primary Ear Care Manual. Ongoing training took place through WhatsApp.	CHWs were selected and invited from four villages in Seeta Nazigo Parish.	n=13 M-38.5% 44.9 (9.1) years	Observed Structured Clinical Examinations and engagement on the WhatsApp forum.	Training of CHWs is feasible and effective in screening for hearing and ear disorders in the community.
Owen et al. (2001)	An introductory study day and practical training was given by a qualified audiologist. Final supervision and assessment of competence within the health Centre setting was undertaken by an experienced tester.	From four rural and four city health centers. Sampling specifics were not provided.	n=14, Specific sample characteristics were not provided.	Questionnaire (not specified)	Health visitors are able to perform OAE testing in the neonatal period at home and in local health center clinics. They achieve high population coverage rates and low false positive rates. Universal neonatal hearing screening by health visitors using OAE testing is feasible, well received, and could be less demanding of health victors

					time than the current distraction testing. This model of universal neonatal hearing screening should be considered by the National Screening Committee.
Sánchez et al. (2017)	The Freire Empowerment Education Model (Wallerstein and Bernstein, 1988) was the basis for training. Focus group, 3-hour workshop, and 24-hr multisession, interactive training >6 weeks	CHWs employed by the FQHC in the Platicamos Salud program, now Community Health Services with leadership skills. Sampling specifics were not provided.	n=12, M-0% , 58-73 years	Thematic analysis was completed for the focus group data. Pre- and post-training assessments and case study discussions	Initial results suggest it is feasible to train CHWs to engage community members regarding hearing loss and facilitate culturally relevant peer-health education and peer-support groups for individuals with hearing loss and their family members. In efforts to increase access to audiological services in rural or underserved communities, application of the CHW model with a partnership of audiologists deserves further consideration as a viable approach.
Smith et al. 2018	3-4 hour educational intervention- Sensory training workshops: simulation practice, information on assessment and referral pathway	All nurses in a community setting in the Western Isles of Scotland were invited via invitations distributed to each five locality teams across the four islands.	n=41, Specific sample characteristics were not provided.	Pre and post-workshop questionnaires, 3 month post-workshop postal questionnaire, 6 month post-workshop focus group	Participants had positive perceptions on the training. Overall participants knowledge and awareness of sensory impairments increased, empathy and compassion for patients with sensory impairments increased, and participants were more likely to

					refer patients with sensory impairments to specialists.

CD-ROM-compact disc read-only memory, COVID-19-Coronavirus infectious disease 2019, ENT-ear, nose, throat doctor, FHS-Family Health Strategy, FQHC-Federally Qualified Health Center, OAE-otoacoustic emissions, WHO-World Health Organization

Supplementary Table 9: Summary of CBR studies focusing on community-based service delivery models

Community-based service delivery model			
Study	**CBHR Outcome**	**Model Details**	**Study Outcome**
Behl et al. (2012)	Knowledge Expansion	The learning community was comprised of administrators and providers from six programs that were providing early intervention therapeutic services via telepractice. Members attended in-person meetings, web-based and phone meetings, and internet-based social media.	The outcomes of the learning community demonstrate that this approach has been a successful medium to foster new knowledge, research, and tools to support telepractice for early intervention services.
Billard (2014)	Primary Ear and Hearing Care for a rural community	"Siutilirijiit" community health workers/interpreters recognized as being part of the Hearing and Otitis Program (HOP) team and can assume their HOP duties (screening a school, assist at the time of audio visit, etc.) while being replaced in their position and "aaniasiurtiapiit" community health workers/interpreters that are occasionally travel to communities at time of audiologist's visit assume office services outside these periods. 6 part time audiologist employed by the Inuulitsivik Health Center. Each audiologist is assigned to one community with two visits a year, one or two weeks/visit depending on community size. Coordinator: An audiologist employed by Inuulitsivik Health Center 1 day/week. Occasionally visits Puvirnituq for training or other coordination tasks. Hearing instrument specialists visits all communities once or twice a year.	An overview of the outreach program Hearing and Otis Program and the challenges the community-based program face.
Borg et al. (2018)	Hearing aid delivery in low-resourced settings.	Community- based model: 1. Initial ear and hearing screen- Audiometric technician at local NGO 2. Ear and hearing assessment- Community worker at participant's home 3. Delivery and fitting of hearing aids- Community worker at participant's home. 4. Earplugs- Soft standard earplug Centre-based approach: 1. Initial ear and hearing	The community-based approach is a viable and effective option for hearing aid delivery in low-resourced settings. The approach needs to be adapted to particular contexts, and possible downsides may need to be counteracted by special interventions.

		screen- Audiometric technician at local NGO 2. Ear and hearing assessment-Audiometric technician at hearing center 3. Delivery and fitting of hearing aids-Audiometric technician at hearing center 4. Earplugs-Custom-made earmold	
Martin et al. (2017)	The intervention was effective at changing knowledge, attitudes, beliefs, and behaviors in the target population	1. Relationships were established with tribal communities. 2. Formal presentations were made to community leadership. 3. Community advisory teams were established. 4. All of the local media and communication networks were included 5. The evidence-based Dangerous Decibels program was presented 6. An evening community event was hosted by the Prevention Research Center. 7. Students participated in the Dangerous Decibels Virtual Exhibit 8. The program gradually become self-sustaining	Self-sustaining programs promoting hearing health in all communities were achieved through approval of community leaders and engagement of community members in the design, administration, and evaluation of the effort; use of a well-developed, evidence-based intervention; and high-level training of local participants who could confidently and effectively continue delivering the program following a gradual transition to independence.
Robler et al. (2020)	More research is needed to prove the effectiveness of the Hearing Norton Sound project.	15 communities were included in the program with stakeholders from healthcare and educational sectors. 11 focus groups pertaining to hearing loss and the proposed screening project. All children underwent the current school screening protocol, mHealth screening, and an audiometric evaluation. The 15 communities were randomized for the telemedicine referral pathway. The community health aides would set up at telehealth appointment with an audiologist for the child and then the audiologist would refer to another telehealth appointment with an otolaryngologist if needed. This was compared to the standard referral process.	Developing a community-involved mHealth screening and referral process.

HOP-Hearing and Otitis Program, NGO-non-governmental organization

Supplementary Figures

Supplementary Figure 1: Distribution of studies across countries