

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

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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

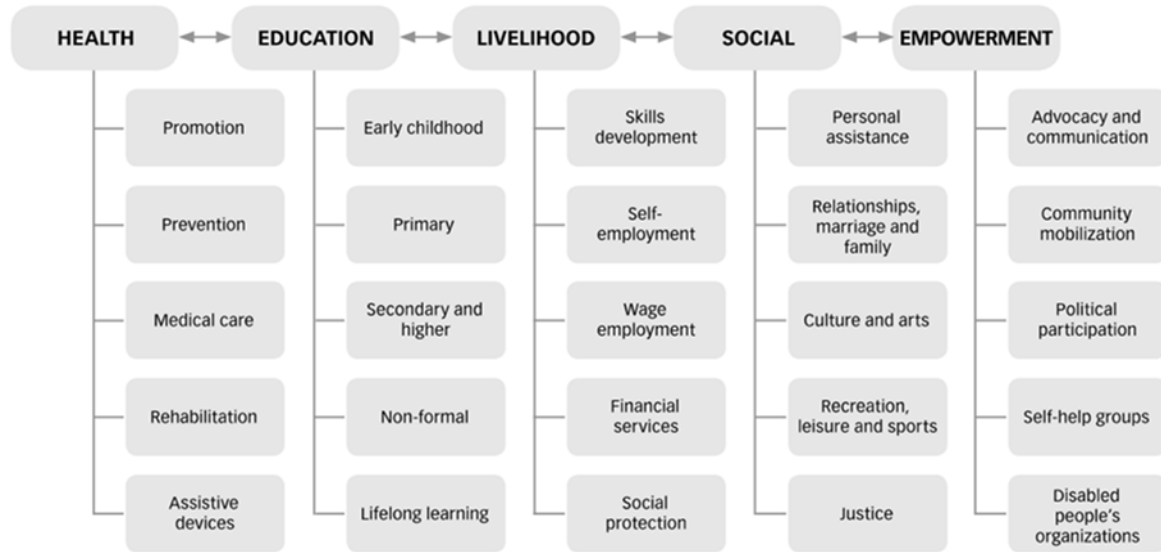
communication, Noise reduction, and Greater community engagement (WHO, 2021). These services should be available in community-based programs to overcome financial burdens of patients and decrease the negative social and financial effects of unaddressed hearing loss. Community-Based Hearing Rehabilitation (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.

Table 1: Key aspects of community-based rehabilitation (Finkenglügel 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

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



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.

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

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.

Table 3: Overall Characteristics

Study	Country	Study Design	Target Population	CBHR applied by	CBHR Framework 1 (Finkenglügel 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) \geq 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

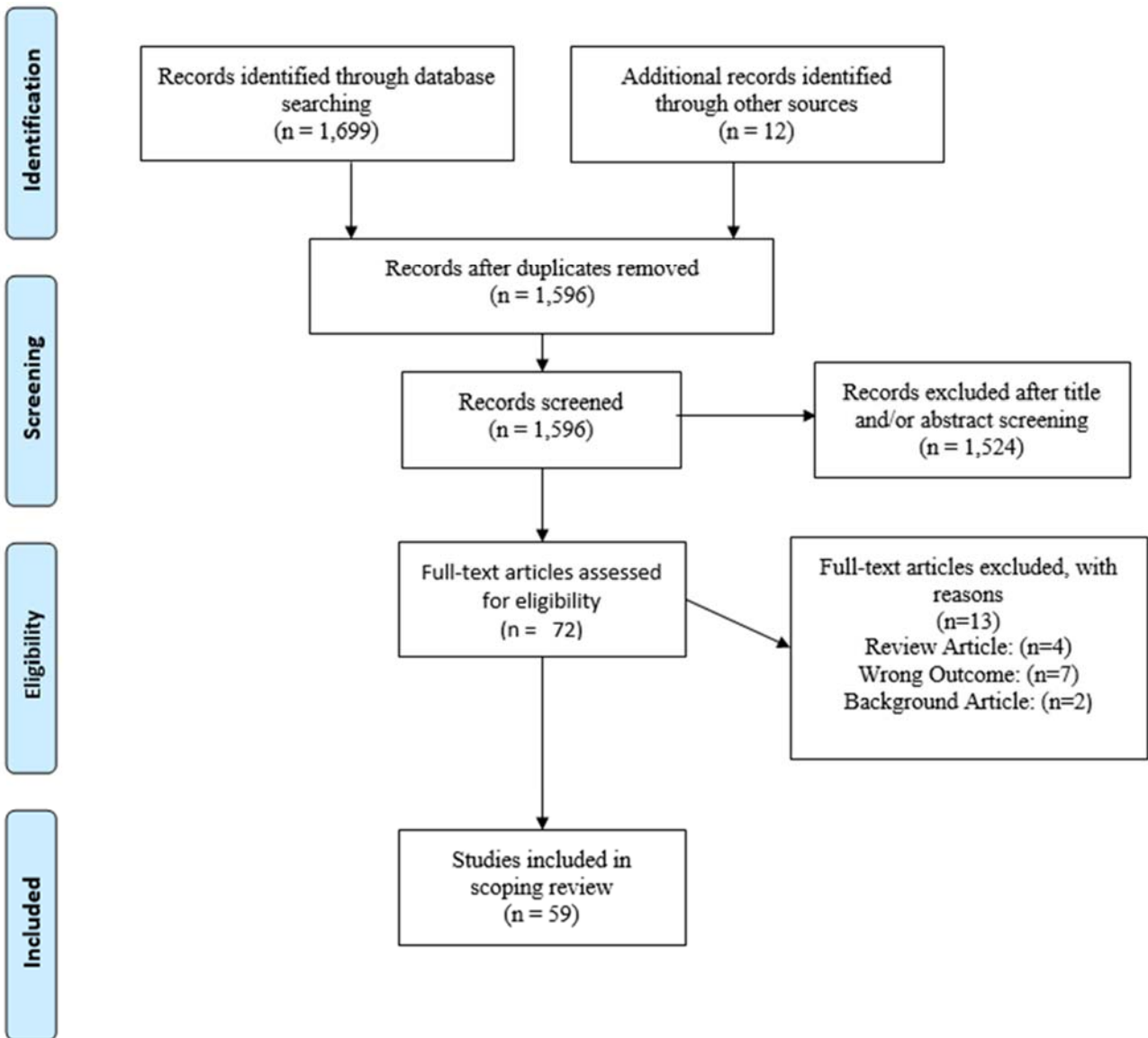
Olusanya & Akinyemi (2009)	Nigeria	Cross-sectional	Mothers of infants (who failed screening test and were schedule for additional testing)	Community nurses	Screening	Health-Medical care
Olusanya, Ebuehi, et al. (2009)	Nigeria	Retrospective Cross-sectional	Infants 3 months or younger	Not stated	Screening	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

Results

Selection of Sources of Evidence

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

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



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.

Figure 3: Distribution of CBHR studies across the globe

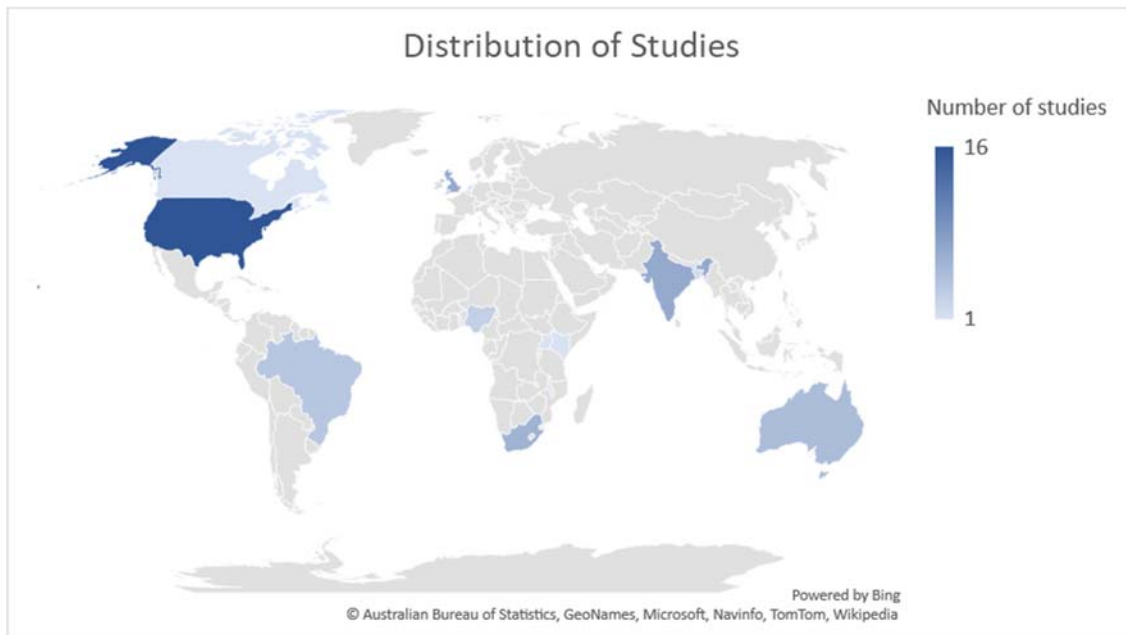


Figure 4: Classification of countries where CBHR studies were conducted based on income levels

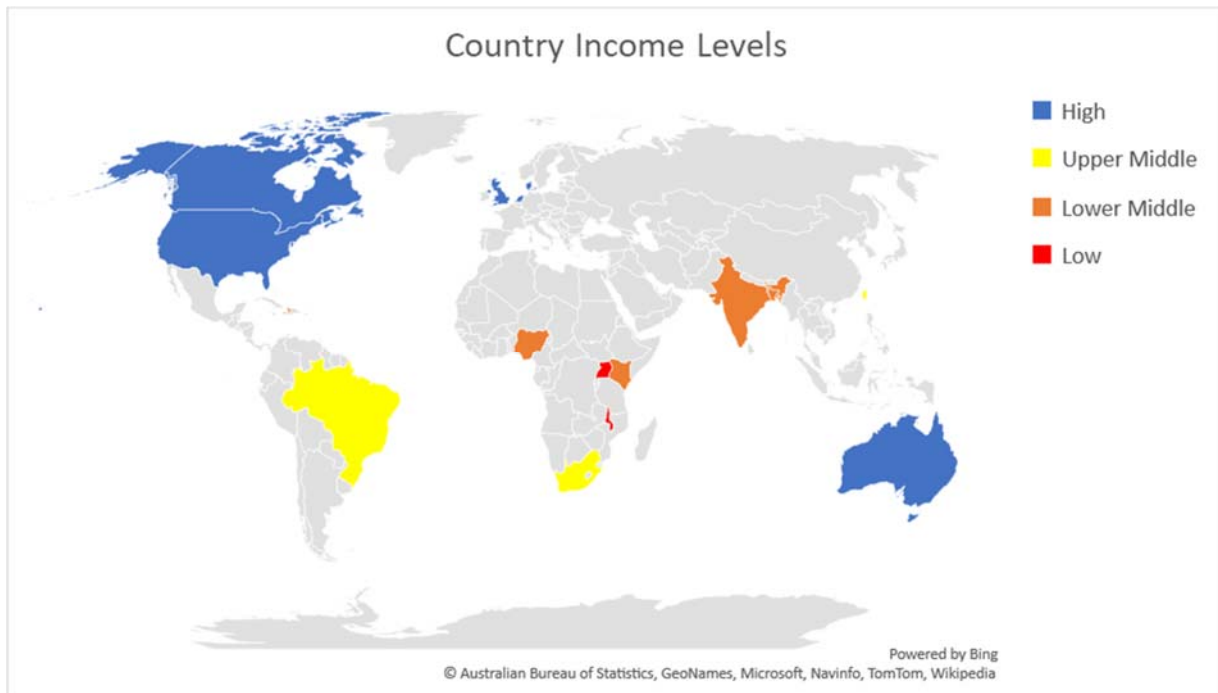


Table 4: Audiological themes

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

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 ENTview (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 “siutilirijit”, 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 regarding 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.

Funding

No funding was provided for this scoping review.

Conflicts of Interest

The authors declare no conflict of interest

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