Needs and readiness to use tele-practice for identification and rehabilitation of children with hearing and speech-language disorders: perceptions of public sector care providers in South India

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Abstract

The current study was a first step towards planning the implementation of tele-practice in a South Indian state's public-sector services for childhood hearing and speech, language disorders. The aim was to understand the perceptions of public-sector health care providers (HCPs) regarding their need and readiness to accept and implement tele-practice-based diagnostics and rehabilitation services. A cross-sectional study design was used, which included focus group discussions (FGDs), semi-structured interviews (SSIs) and geo-spatial analysis. Participants in the qualitative component included various cadres of health HCPs in public-sector services. Theoretical saturation and cross-case variance were used to assess the data's sufficiency. A hybrid deductive-inductive thematic analytical approach was used to analyse the data. Geo-tags and geo-locations of addresses of all children with disabilities and all the public-sector service providers were used to generate geospatial maps. The HCPs considered the currently available services for childhood hearing and speech-language disorders to be insufficient and reported shortage of professionals to meet current demands. There was inconsistent availability of suitable equipment and professionals in the existing district-level facilities. HCPs were comfortable using technology, and were willing to investigate tele-practice, but they required training in tele-practice [Q2].

Keywords

Barriers; needs; readiness; tele-practice; semi-structured interviews; focus group discussions; thematic analysis; geographic information systems

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Introduction[Q4]

As per the Census of India (2011), 2.21% of persons in the total population have disabilities. Among those with disabilities, 19% are reported to have hearing disabilities and 7% have speech difficulties. The Government of India has established national institutes under the Ministry of Social Justice and Empowerment to provide diagnostic and rehabilitation services for children with disabilities. The Rashtriya Bal SwasthyaKaryakram (RBSK) is one such scheme under this programme that seeks to enhance the early identification of childhood disabilities in rural areas. In addition, in the state of Tamil Nadu, several measures for early identification and intervention of childhood disabilities have been taken up through the establishment of the State Commission for Welfare of the Differently Abled (1992) [Q5]. Other programmes such as Sarva Siksha Abhiyan (SSA), or 'education for all,' and the Integrated Child Development Scheme (ICDS) (for the nutritional and health status of children and coordination of policy implementation to promote child development) are also involved in providing some services for children with disabilities (CwDs).

However, these programmes are faced with a shortage of professional staff capable of providing audiology and speech-language pathology services. In India, the estimated audiologist/SLP ratio is 4.41 per 100,000 population based on the annual report of the Rehabilitation Council of India (RCI, 2022). The lack of availability of professionals coupled with the long commute that many families face, particularly those living in rural/ remote areas, to access these facilities located in towns and cities, serves as a major deterrent to the uptake of services. Given this scenario, tele-practice is considered as an alternative to help overcome some of these challenges (Mohan, Anjum, & Rao, 2017).

While tele-practice has gained momentum as an evidence-based practice over the last two decades, its adoption into routine clinical usage can only be brought about through focused efforts (Bauer, Damschroder, Hagedorn, Smith, & Kilbourne, 2015; Kilbourne, Glasgow, & Chambers,2020) across various levels of the patient, provider, clinic, facility, organization, community, and policy environment. So far, in the Indian context, only survey-based studies have been conducted to explore provider's perspective on uptake and challenges in delivering tele-practice services for hearing and communication disorders (Aggarwal, Patel, & Ravi, 2021; Bajaj & Karuppali, 2022; Bhattarai, Sanghavi, & Abhishek,2022; Mohan, Anjum, & Rao, 2017; Nihara & Seethapathy, 2022; Rao & Yashaswini, 2018).

Therefore, as a first step in this direction, it is essential to conduct a systematic needs and planning assessment (Ekeland, Bowes, & Flottorp, 2010; Kidholm et al., 2012), with all key stakeholders (Peters, Bhuiya, & Ghaffar, 2017), which will facilitate reflective learning and a deeper understanding of the issues at hand. Subsequently, its translation from research to clinical usage can be achieved through the systematic application of implementation science (Kilbourne, Glasgow, & Chambers, 2020).

With this in mind, we carried out a qualitative study to understand the perceptions of health care providers working in the public sector in the state of Tamil Nadu (South India) regarding their need (demand) for diagnostic and rehabilitation services offered for children (less than 6 years) with specific emphasis on audiology and speech-language pathology

services in their facilities. We also explored their readiness (acceptability, integration, and practicality) to accept and adopt tele-practice based diagnostic and rehabilitation services as part of their care services. We believed that the use of qualitative methods such as SSIs and FGDs with its emic focus would enable an in-depth exploration of the phenomenon, thus, highlighting the perspectives of the stakeholders concerned and, in the process, enhancing the validity of our findings. The understanding so obtained would be the first step towards planning the implementation of tele-practice in the public-sector health services.

Theoretical framework

In conducting this study, we used the Bowen's feasibility framework (Bowen et al., 2009) that includes the constructs of acceptability, demand, implementation, practicality, adaptation, integration, expansion, and limited efficacy. As the scope of the present study was limited to understanding the 'needs and readiness' for tele-audiology services, we selected the constructs of demand to capture needs and the constructs of acceptability, integration, and practicality to capture readiness aspects.

Demand refers to the uptake of intervention/service in a defined population or setting. *Acceptability* relates to the manner in which different stakeholders react to or perceive the intervention while *Integration* looks at the level of system change needed to integrate a new programme or process into an existing infrastructure or programme. Finally, *Practicality* explores the extent to which a service/intervention can be delivered when resources, time, commitment, or some combinations thereof are constrained in some way.

In the selection of the framework to guide the study we exhaustively also reviewed several telemedicine frameworks (Addotey-Delove, Scott, & Mars, 2020; AlDossary, Martin-Khan, Bradford, Armfield, & Smith, 2017; Jennett, Jennett, Yeo, Pauls, & Graham, 2003; Kiberu, Scott, & Mars, 2019; Mauco, Scott, & Mars, 2018). Several attributes from these telemedicine frameworks that we believed were relevant to our study were incorporated into the Bowen's framework (Table 1).

Furthermore, to strengthen the assessment of demand/need, we included a geo-spatial analysis to augment the findings of the qualitative methods described above.

Materials and methods

This study was approved by the appropriate Institutional Ethics Committee (Reference number – IEC-NI/19NOV/71/90).

Selection of study site

From the 38 districts of the state of Tamil Nadu, 12 districts were initially shortlisted based on the following factors; proportion of children under 6 years of age; distance of the district from Chennai city and area in square metres. Following feedback and suggestions provided by the Office of the State Commissioner for Persons with Disabilities, Tamil Nadu, two rural districts, Ariyalur and Perambalur, with nearly equal populations, areas, and socio-economic conditions, were selected as the study sites.

Study design

Using a cross-sectional study design this qualitative study was carried out using FGDs and SSIs. Geo-spatial data was also collected using locations of health care providers and children with disabilities. The COREQ (COnsolidated Criteria for REporting Qualitative Research) Checklist (Tong, Sainsbury, & Craig, 2007) was used to analyse and report the qualitative data (supplemental file 1: COREQ checklist).

Selection and description of participants

a *Qualitative component*

Study participants—The study participants included different cadres of HCPs, namely, (i) the District Differently Abled Welfare (DDAW) officers (ii) audiologist and speech-language pathologists (ASLPs) working in public-sector services, (iii) special educators in early intervention centres (EICs) and SSA Special educators (iv) government pre-school teachers (*anganwadi workers*), and (v) nurses at primary health centres (PHCs). The details of HCPs available in each cadre and those included in the study with sampling methods are provided in Table 2.

The FGDs with the SSA special educators and anganwadi workers were conducted in the offices of the DDAW office in the respective districts of Ariyalur and Perambalur. The SSIs were conducted either through in-person sessions at the DDAW office or through video-conferencing on account of the COVID-19 pandemic. The SSIs and FGDs were carried out between February 2021 and October 2021.

Research team—The FGDs and SSIs were conducted by VR and NJ both of whom are trained in qualitative research methods. SK provided overall mentorship and guidance. There was no specific relationship established by the interviewers with the participants prior to the interview.

Study guides and data collection

The guides for the FGDs and SSIs were based on the theoretical framework and focused on; obtaining information on the current availability of services for diagnosis and rehabilitation of hearing and speech-language disorders; perceived need for and acceptability of tele-practice as an alternative; readiness of the HCPs to use technology (mobile phone/internet/ computers) and perceptions on potential barriers and challenges to implementing tele-practice in their community. The interview guides were further informed and expanded upon based on each interview, the guides were also customized as per the HCPs cadre (supplementary file no. 1, https://osf.io/w4ryd/files/osfstorage/64d5fdc19cbf03724a1e471d), thereby enabling deeper insights. Two experts with experience in qualitative research and tele-practice further reviewed the guides for content, wording, and relevancy to objectives.

Written informed consent was obtained from all participants prior to data collection. All the FGDs and SSIs were audio recorded, and field notes were also taken. The FGDs were completed in 45 minutes while the SSIs took approximately 30 minutes to complete.

Data analysis

The FGD and SS transcripts were imported into NVivo software version 12 for the purpose of analysis. We used a hybrid deductive-inductive analytical approach wherein we were initially guided by the Bowen's feasibility framework, which enabled us to develop a codebook. Subsequently, using the thematic analytical approach as described by Braun and Clark (Braun & Clarke, 2006; Clarke & Braun, 2013) data was familiarized through repeated readings of the transcripts and data was then coded using the code book developed earlier and inductively added new codes were based on new information gathered (supplementary file no. 2, https://osf.io/w4ryd/files/osfstorage/64d5fe439cbf03724b1e47d2). VR and NJ coded five transcripts independently and updated the existing codebook by adding codes generated inductively from the interviews. Any coding differences were discussed and resolved among the authors. The remaining transcripts were coded based on the updated codebook. We analysed the coding categories for important patterns in the data that were relevant to the study objectives and compiled them under themes. Following this exercise, 21 categories were identified. We carefully reviewed these categories as we moved closer to theme building to help determine how best they explained our data and addressed our research questions. This was an iterative process which involved re-visiting our transcripts and reviewing our codes and sub-categories. We finally identified three themes that we believed provided good insights into the needs and readiness of HCPs to adopt tele-practice based diagnostic and rehabilitation services as part of their care services. We defined and named each theme and supported them with suitable quotes extracted from the transcripts (supplementary file no. 3, https://osf.io/w4ryd/files/osfstorage/64d5fe43a2be6b71fe31485e).

a *Geo-spatial data*

The geo-spatial analysis of CwDs and HCPs was undertaken as part of the situational analysis to understand the availability of services in these two districts, to inform the demand and need for services.

Study sample

The addresses of CwDs below 6 years of age and HCPs (centre and staffing) across different departments including Welfare department (DDAW), Ministry of Social Justice, EICs, Ministry of Health Early Diagnostic Centres (EDCs), General Hospital (GHs), PHCs, and Ministry of Education (SS) were obtained with permission from the government database for the two districts.

Procedure

The data were recorded in excel sheets for the purpose of analysis. As a measure of authentication, the geo locations of all the HCPs and 60 randomly selected CwDs (30 in each district) were geo-tagged manually by two field workers employed for this purpose. Geo-locations for the remaining children's addresses were obtained using Google Map © Google Inc. (version 6.21) platform to capture the latitude and longitude information. Information on the availability of staff/professionals in each service centre was obtained by the field worker either through a door-to-door survey or through telephone verification.

Geo-spatial analysis

Data was imported into a web-based geographical information system (GIS) analysis software TNGis. Visual spread maps of CwDs, service centres, and staff/professional availability were obtained. The geolocation was integrated into the Google map software© Google Inc. (version 6.21) to obtain the minimum, maximum, and average distances travelled by CwDs by road to avail diagnostic and rehabilitation (therapy and education) services in the selected districts. Travel time was estimated from Google map software between 10 am and 12 noon as well as from 2 pm to 4 pm, considering the typical travel time to seek services. The information on the availability of specialists in each service centre and the number of CwDs in both districts were used to calculate the Person-to-Provider (ASLP, Occupational Therapist, Physiotherapist, Psychologist, Special Education) ratio.

Results

In all, 50 participants (12 SSIs and five FGDs with 38 participants) were carried out with HCPs, employed by the government or worked with the government in the 2 selected districts. All participants were between the ages of 25 and 55 years. The details regarding participants gender and years of work experience are provided in Table 2.

The DDAW officers had either a master's or a bachelor's degree in Psychology/Sociology. The EIC in-charge had a master's degree in social work. The ASLPs had either bachelor's or master's degrees in audiology and speech-language pathology. Two of them worked in the study districts, while the other two were recently transferred from these districts to other districts. These two ASLPs were also included as they were aware of the service delivery in the study districts.

There are a total of about 988 anganwadi workers, 52SSA special educators and 200 Village Health Nurses (VHNs) in the two districts wherein the government had given us permission to carry out data collection. We were, however, provided access to only two PHCs from where we were able to carry out focus group discussions with a limited number of persons from each of these cadres. The anganwadi workers who participated had completed 10th grade higher secondary school. The SSA special educators had completed Diploma or B.Ed in special education for hearing impairment. The Village health nurses had either completed the auxiliary Nurse Midwife course, or Multipurpose Health Workers course, or a general nursing diploma course. The multi-purpose rehabilitation therapist (MPRT) had completed Diploma in Physiotherapy.

Using opportunistic sampling, six VHNs working in the PHCs, and one MPRT assisting the DDAW officers in door-to-door provision of aids and appliances using the Mobile Therapy Unit (MTU), were later included.

The findings from our analysis are presented under three themes as per the constructs of the Bowen's framework that guided our study, namely, 1. Demand/ Need for tele-practice 2. Acceptability of tele-practice services and 3. Integration and practicality of tele-practice services. The constructs of Integration and practicality of services have been combined and are presented as one theme as there was considerable overlap between these constructs.

Demand/need for tele-practice

This theme has two sub-themes, the first is titled (a) *Demand/Need* for enhanced services-qualitative findings which present the findings from the qualitative interviews and FGDs. The second sub theme is titled (b) Demand/Need – Geo-spatial analysis findings which present the results of our geo-spatial analysis.

Demand/ need for enhanced services-qualitative findings—The demand/need for tele-practice was inferred from existing service gaps. This was probed by asking HCPs about available facilities to identify speech, language, and hearing problems and rehabilitation facilities for the same. The possible barriers to accessing services and suggestions, if any, to improve the services were also probed. The HCPs reported that services for screening and identification of hearing loss were available through EDCs and at the GH. However, the DDAW office was not always able to provide hearing testing and speech-language assessments due to lack of ASLPs in the facility. When professionals were available, they organized camps for the identification of disability (including hearing and speech-language disorders) and also provided guidance and support to parents of CwDs. Children suspected with hearing impairments were referred to the GH for hearing aid and cochlear implant-related assessments. An MTU was also used to conduct screening camps once a month and to provide Unique Disability ID (UDID) cards at the doorstep.

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'We are completely dependent on GH for an Audiologist. It is difficult for
the DAPs (Differently Abled Persons) to commute to GH. It would be better if
we have an Audiologist in the centre so that we can complete our work' (DDAW
OFFICER, SSI)
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'We are managing with the resources and manpower available here but the
equipment for testing is only availablein the GH' (DDAW OFFICER, SSI)
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'Testing was carried out in the DDRO (District Disabled
Rehabilitationoffice), when Audiologists were here. Otherwise, we will do it
in GH' (SSA, FGD)
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In terms of the personnel available to provide any type of services for childhood hearing loss and/or speech difficulties, VHNs, anganwadi workers, and SSA special educators described carrying out grass-root level informal hearing screening assessments. Speech-language therapy was often available only through the SSA special educators who counselled parents regarding speech stimulation, even though they did not have any formal training nor were they monitored by a speech-language therapist. None of the HCPs reported carrying out evaluation and rehabilitation of speech and language, articulation, and stuttering difficulties.

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'To identify problems in hearing and speech for young children less than 6
years, we (VHN) clap hands and check when they are born. There is something
called milestones on what age what should the baby do, and we use that also
to screen. We call the baby's name if they have named the baby and check
the name call also. Anganwadi teachers also check in their own community. We
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refer the children to the main PHC and they will refer to GH, we take the
patients there' (VHN, FGD)
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'We used to see the parents daily, the parent would report that the child
is not responding to the sound. So, we too will present the same sound and
check if the child is able to hear. If the child doesn't respond to the
sound, we will inform RBSK (Rashtriya Bal SwasthyaKaryakram) only then we
will refer them to go to GH' (anganwadi workers, FGD)
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'As the availability of audiologist or speech therapist is minimal. We
select the patients and give instructions to the SSA to follow up with the
patients' (ASLP, SSI)
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'We only provide therapy. There is no speech therapist in EIC or day care
centres. Speech therapists are available in GH and in DEIC (District Early
Intervention Center) (One person in the DDRO Office and another person in
GH)' (SSA, FGD)
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Unfilled vacancy positions of ASLPs in DDAW office and presence of less qualified substitutes were reported by SSA special educators and DDAW officers. They felt that both specialists (audiologist, speech therapist) and infrastructure for tests must be available at the block level for adequate service availability. In addition to lack of resources, VHNs, those in charge at the EIC, SSA special educators and anganwadi workers also reported challenges with respect to inadequate travel facilities for parents to avail services from GHs. Financial difficulties such as wage loss and travel costs were other difficulties that parents faced. They also believed that access to services could improve with focused training programmes for existing grass-roots level HCPs regarding appropriate methods of screening and speech therapy. Compensation for wage loss was another suggestion that was made to enhance adherence to follow-up for rehabilitation.

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'In this office there was an Audiologist who was working, who was
transferred to another district, so the Audiologist position is vacant here
for 1.5 years' (DDAW OFFICER, SSI)
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'Speech therapists and audiologists are not available in Ariyalur district.
In the ENT department, the facilities are available in Ariyalur GH and
audiometricians are available' (MPRT, SSI)
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'It would be better if we can establish more centres block wise and increase
the number of centers. It would be nice if we could have one center per
block' (MPRT, SSI)
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Demand/ need – geo-spatial analysis findings—The population of CwDs (0 to 6 years of age) at the time of this study was 260 in Ariyalur and 235 in Perambalur as per the most recent Government database. A visual spread map of the two districts with the geographic locations of CwDs across the districts are provided in Figure 1(a, b) and Figure

2(a, b). The maps suggest the widespread locations of CwDs over the 1940 square kms of Ariyalur and 1756 kms of Perambalur districts.

The geographic distribution of all public sector health and rehabilitation service centres in the two districts are presented in Figure 3(a, b). At the time of analysis, there were a total of 52 centres in Ariyalur and 48 centres in Perambalur. The details of the average distance travelled to avail services in each centre in these districts are provided in Table 3.

The availability of HCPs including various rehabilitation professionals, special educators and VHNs was determined by field workers who visited each of the centres (see Table 4). The demand versus capacity for rehabilitation professionals to cater to the needs of CwDs was high. At best, only one ASLP was available to provide audiology treatment and speech therapy services for over 200 children. While the status of special educators was slightly better.

Acceptability of tele practice service—With regard to their *comfort with technology*, the grass-root level HCPs reported using mobile phones routinely as a part of their day-to-day work and for reporting purposes. During the course of the COVID-19 pandemic, mobile phones were used for consultation by various cadres of HCPs, as the government had provided them with these devices. The HCPs also indicated their interest to use mobile phones to conduct screening for childhood hearing loss and speech language disorders as a solution for last mile services.

'During this covid time, mobile phones are used for consultation. We are providing therapy through the phone only. Government has given it to us' (SSA, FGD)

'This will actually work well because everybody has a phone. If they are getting trained in this process, the reach in the villages will be better. Everybody is aware of computers, internet, whatsApp video call etc' (DDAW OFFICER, SSI)

On the *perceived usefulness of tele-practice*, online testing was thought to be possible and useful, as it had the scope to provide access to specialist consultation over video-conferencing. The HCPs felt that parents would be interested in availing services at their doorstep or through video calls rather than travelling long distances for screening. Yet, they cautioned that the stigma associated with the identification of disability must be addressed for better uptake of services.

ASLPs contended that the SSA special educators and VHNs, who worked at the community level could be involved in facilitating tele-practice-based assessment and follow-up rehabilitation services. However, they believed that direct in-person visits were necessary for speech-language therapy and other such rehabilitation services as they would establish rapport and promote eye-contact, which are important pre-linguistic skills considered essential in speech and language therapy. They had apprehensions about home-based therapy

services as parents may not have the necessary technical skills. Tele-practice was therefore considered more suitable for screening and diagnosis.

'Tele-practice will definitely be effective. Through the internet and headphones, it is a good facility to be used. It is also good to operate this procedure through video conference. It can be hundred percent efficient. It will be very easy and beneficial for them. When this technology is applied, people will have trust in it. They will definitely come' (MPRT, SSI)

'Therapy can be provided through video call with the help of SSA workers who will be there with the child. This can be done because with the onset of corona everything has become online and online classes are going on for the children' (EIC NGO incharge, SSI)

'Tele practice for diagnosis will work out but for speech therapy will not work out as we have to sit with the patient and maintain eye contact and to bring concentration is very difficult'(ASLP, SSI)

'Parents will come. Once in 15 days follow up can be done' (anganwadi workers, FGD)

Integration and practicality of tele-practice—HCPs were asked about their opinion on suitable personnel to conduct screening and their readiness for tele-practice. Some HCPs reported that their knowledge of tele-practice was limited, and they therefore needed training. They also expressed their apprehension regarding the support of higher administrative officials towards tele-practice infrastructure and implementation. In particular, they were concerned about potential challenges they may face in maintaining a balance between their administrative work and their clinical work if they had to provide tele-practice services.

Regarding suitable personnel for grass root level mobile/tablet-based screening, the grass root level HCPs suggested that anganwadi workers may be the most suitable as they use mobile phones for reporting and are routinely involved with young children. The anganwadi workers, however, were concerned about their low wages and time management with the increased workload. The ASLPs believed that the SSA special educators would be the most suitable, as they have basic computer skills and could be more easily trained to provide screening services. According to them, SSA workers were already involved in disability-related welfare measures in the community. There was an overall preference for a hybrid approach where specialists (ASLPs) would provide in-person therapy while using tele-practice for follow-up services. The grass-root level HCPs, like the SSA special educators and anganwadi workers, could provide doorstep services. SSA workers at the grass-roots level could assist with consultations, and they could also conduct follow-up, monitoring, and post-specialist consultations utilizing tele-practice.

Generally, the HCPs suggested the use of MTU, Block Resource Centres (SSA centres), and PHCs/anganwadi centres as the points of care for enabling tele-practice. These suggestions were based on the availability of power supply, the internet, computers, and the need to strengthen last-mile services. They also believed that government schools were a possible point of care for rehabilitation services. Their suggestions were also indicative of a need for strengthening services at the community/village and block levels.

The HCPs reported internet facilities to be sparse in the communities and only available at the SSA block resource centres or upgraded primary health centres. They felt that the MTU had good infrastructure for tele-practice.

'First preference is anganwadis teachers. Because from there only, we receive information that the 0-6 months child is not speaking. In my point of view, we can provide the training to both of them'(EIC NGO incharge, SSI)

'Screening can be done by SSA workers. It can be definitely provided because it is they who reach out to the children more than anybody else … it would be better to provide training to do screening and identify more number of disabled children' (DDAW OFFICER, SSI)

'We can provide rehabilitation services and we use SSA teachers, parents and teachers or someone else. At first, we can provide therapy and SSA can follow up. We can provide therapy in any common place, and they will come' (ASLP, SSI)

'We have MTU in our office, it has all the infrastructure facilities, and we also have equipment so we can do the tele-practice block wise' (ASLP, SSI)

'The internet won't be there in many remote areas. Only block offices, internet facilities are available. Mobile clinics also can visit at block level' (VHN, FGD)

Discussion

This situational analysis provided key information regarding needs and readiness among public sector HCPs in the southern state of Tamil Nadu towards the implementation of a comprehensive model of tele-practice for speech language and hearing services for children. In general, both the grass root level and the professionally trained care providers expressed their willingness to use technology such as mobile phone-based screening and real-time remote tele-diagnostic assessment as a possible means of bridging service gaps. We discuss our findings under the heads of (1) need for services and (2) readiness for tele-practice.

1 Need for services

Overall, the HCPs believed that the currently available services for hearing and speech-language disorders were inadequate. It is well acknowledged that in India, rural areas receive fewer health care services due to a lack of personnel and proper infrastructure (Mathur,

Srivastava, Lalchandani, & Mehta, 2017). The situation in other low and middle-income countries such as Sub-Saharan Africa is very similar with poor audiology and speech therapy services (Fagan & Jacobs, 2009). Even when some services are available, accessing them has been a challenge due to limited public transportation, poor road connectivity, and long distances and travel times. These challenges are typical in rural settings and are a deterrent for availing routine therapy services (Dew et al., 2013).

GIS can provide insight into the gaps and needs to improve the availability of services (McLafferty, 2003) and have been used to maximize access to healthcare (Higgs, 2004). Therefore, it can serve as a useful planning tool to identify potential service locations.

The findings of the GIS analysis from our study revealed an inadequate distribution of disability services both with respect to facilities as well as health professionals. This data confirm the shortage evident from the RCI data (RCI, 2022). A similar scenario was evident in Bangladesh where the number of rehabilitation professionals for every one million population was extremely low at 9.4% physical therapists, 1.3% occupational therapists, 0.9% speech and language therapists and 0.7% audiometrists (Imam et al., 2022). In contrast, in developed countries like USA, the ratio is as high as 57.7 per 100,000 population (ASHA, 2022).

In addition to inadequate trained staff, families are also faced with health care accessibility issues. We noted in our study that most families had to travel an average of about 2 kms to access primary care clinics. The distance travelled to access diagnostic and rehabilitation services for childhood disabilities was considerably more at about 35–38 kms. Availability of trained ASLPs in both districts was also very poor on account of which special educators were providing services related to speech and language therapy and aural rehabilitation for children with disabilities in these communities. This raises major concerns about the quality of services provided, given the fact that these cadres of HCPs lacked training nor was there any monitoring of services rendered by them.

Studies from Bangladesh also identified service gaps and improvement opportunities (Imam et al., 2022; Uddin, Islam, Rathore, & O'Connell, 2019). Authors reported that only 1.2% of the 1102 rehabilitation units surveyed offered comprehensive multi-disciplinary services, including physiotherapy, occupational therapy and speech language therapy and only 6.2% of the rehabilitation services were located in rural areas. There were no qualified physiotherapists, occupational therapists and speech-language therapists in public hospitals in Bangladesh (Mamin, and Hayes, 2018[Q6]). Another study conducted in rural areas of New South Wales, Australia, recommended that community-based rehabilitation in rural and remote areas requires place-based and person-centred strategies; outreach programmes working with individuals and local communities; support for families' travel access to procure locally available services, and the implementation of technology to enhance service delivery (Dew et al., 2013). The HCPs in our study too spoke about the need for, improved diagnostic and rehabilitation services for CwDs and stressed that these must be made available at village/block levels, adequately staffed with qualified professionals.

1 2 Readiness for tele-practice

When professional resources are limited, innovative service delivery models, such as the use of tele-practice, have the potential to develop sustainable services in remote or low-resource areas (Swanepoel & Clark, 2019). Tele-practice has been used for screening, diagnosis and rehabilitation of hearing and speech, language disorders in various countries and have shown good outcomes.

Smartphone-based hearing screening for preschool children (Dillon, Mee, Moreno, & Seymour,2018; Hussein, Swanepoel, & Mahomed, 2018), middle ear screening using video-otoscopy (Mandavia, Lapa, Smith, & Bhutta, 2018; Ramkumar, 2017; Ramkumar et al., 2016; Ramkumar, Rajendran, Nagarajan, Balasubramaniyan, & Suresh, 2018b) have been explored. Communication disorders have been screened as a part of developmental screening using mHealth applications (Maleka & Fatoki, 2016). With respect to diagnostic assessments, tele-diagnostic confirmation of hearing loss among children in rural settings has been conducted (Campbell & Hyde, 2010; Dharmar et al., 2016; Govender & Mars, 2018; Hatton, Rowlandson, Beers, & Small, 2019; Ramkumar et al., 2018a; Ramkumar, Nagarajan, Shankarnarayan, Kumaravelu, & Hall, 2019; Stuart, 2016). Similarly, tele-speech language assessments have also been performed (Burns et al., 2019; Malandraki, McCullough, & Perlman, 2012; Malandraki, McCullough, He, McWeeny, & Perlman, 2011).

Towards rehabilitation services, tele-hearing aid and cochlear implant fitting and programming (Dennis, Gladden, & Noe, 2012; Gonzales, Zappler AuD, Coco AuD, & Julie, 2016; Luryi et al., 2020; Skar y ski, wierniak, Bruski, Ludwikowski, & Skar y ski, 2018, 2019) as well as tele-aural rehabilitation (Blaiser, Edwards, Behl, & Munoz, 2012; Broekelmann, 2012; Galvan, Case, & Todd Houston, 2014; Houston, 2011; Houston & Stredler-Brown, 2012) were explored. Tele speech and language therapy (Clark, Fischer, Lehman, & Bloomfield, 2019; Grogan-Johnson, 2012; Øra, Kirmess, Brady, Sørli, & Becker, 2020; Short, Rea, Houston, Scott, & Forducey, 2016) have also been conducted.

However, most of these studies are university-based exploratory research involving the private sector where the research populations were predominantly urban. The present study, however, involved public sector programmes that cater to larger populations that are predominantly rural. The HCPs in our study were knowledgeable about devices such as mobile phones and computers. Several grass-root level HCPs used mobile phones to report their activities and expressed their comfort using such devices for health care delivery. HCPs also expressed willingness to explore tele-diagnostic assessment and tele-rehabilitation. However, they believed that adequate training was essential prior to the use of mobile phones to screen for childhood hearing loss or speech and language disorders. Mhealth tools used for interventions by community health workers (CHWs) were found to be effective both in a global scoping review (Early, Gonzalez, Gordon-Dseagu, & Robles-Calderon, 2019) and a systematic review conducted among developing countries (Agarwal, Perry, Long, & Labrique, 2015). However, the need for effective training for CHWs to adopt mHealth tools, and enhanced communication within health care teams that employ CHWs for such screening was emphasized (Early, Gonzalez, Gordon-Dseagu, & Robles-Calderon, 2019). In India too, lack of adequate training as well as digital resource to deliver services

via tele-practice and thereby practical limitations in day-today use was reported by speech-language pathologists (Bhattarai, Sanghavi, & Abhishek, 2022) and audiologists (Nihara & Seethapathy, 2022).

The HCPs provided insights on the limitations in internet services in these rural communities; hence, tele-practice interventions should be designed for low bandwidths. The HCPs, including ASLPs, EIC – Non-Governmental Organizations (NGO) in-charge, EIC – special educators, anganwadi workers and SSA special educators and VHNs, believed that the anganwadi workers, VHNs and SSA special educators were the best-suited grass root level personnel for carrying out mobile phone-based screening for hearing and speech-language problems among young children. In addition, they suggested that greater community involvement should precede the implementation of such services. Studies that examined the workload of the anganwadi workers reported that these workers have often been commissioned for various child related health related screening and nutrition programmes. However, the record keeping that they had to undertake often took three times the recommended time, preventing them from completing their responsibilities related to preschool instruction and home visits. Poor honorarium, registration work, meetings outside of job hours were some of their key constraints (Kaur, Thakur, Singh, & Saini, 2016; Tripathy, Kamath, Baliga, & Jain, 2014). Anganwadi workers in the present study shared similar concerns and wanted additional remuneration and workload reassignment to perform m-health based screening for hearing and speech-language disorders. This suggests that either more anganwadi workers need to be employed or an alternate cadre of community workers need to be trained and made available for disability-related services at a ratio of 1:1000 (World Health Organization, 2012).

In many countries around the world, it is common for physicians to delegate primary care duties to nurses. In order to fill service gaps, this practise should also be widely adopted for the identification and rehabilitation of children with disabilities (Maier & Aiken, 2016). In order to increase the scalability of mental health care, task-shifting-based models were investigated in low-income nations (Hoeft, Fortney, Patel, & Unützer, 2018) indicating perhaps, that such strategies could also be applied for speech, language and audiology related services.

HCPs were willing to explore the use of tele-/remote-testing and videoconferencing for the diagnosis and rehabilitation of childhood hearing and speech, language disorders. However, there were some apprehensions about tele-rehabilitation. Concerns that telehealth services should not replace in-person care were also identified as a potential barrier in Australian tele-speech language therapy services (Dunkley, Pattie, Wilson, & McAllister, 2010).

Strengths and limitations

The use of qualitative methods and Bowen's framework are major strengths of this study. Our hybrid methodological approach involved a combination of deductive and inductive strategies which contributed to the rigour of the study. At the outset, the use of Bowen's framework provided both the rationale and structure for the study. Later, the use of a data driven inductive approach carried out during data collection and while coding data ensured that we were not limited by the framework. We do accept that the selection of study sites

was not entirely in our control and our sample size could have been higher. However, these are issues over which we did not have much control given that we were working with government facilities. We therefore took additional care to thoroughly explore all relevant issues with each respondent during the interviews and FGDs. At the stage of coding, we kept our minds open to the generation of new codes and categories beyond the ones developed a priori through the Bowen's framework thereby ensuring comprehensive exploration and saturation of themes. It is important to highlight here that our HCPs across different cadres and across the two districts in Tamil Nadu reported similar issues concerning the need for training, the lack of facilities and personnel and of the difficulties faced in reaching such services to rural and remote areas, attesting to the transferability of these findings to other parts of the state.

Conclusion

This study was conducted as part of a situational analysis towards planning the implementation of tele-practice in the public-sector to bridge service gaps for childhood hearing and speech, language disorders in rural areas. The various cadres of HCPs involved in providing early identification and rehabilitation services for CwDs, felt that the current services were insufficient. Due to a lack of availability of professionals, other non-specialists assisted in rehabilitation, however, this was done without task shifting-based training or supervision. There was also inconsistent availability of suitable equipment and professional shortages in the existing facilities.

HCPs were comfortable using technology, but they required training in tele-practice. Suitability of VHNs, government pre-school teachers as screening personnel, the suitability of mobile therapy van for tele-practice and need for block-level services were some key practicality and integration-related aspects identified from this study. These findings will now inform the proposed implementation plan for these rural districts.

Acknowledgements

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Note: Snapshot PDF is the proof copy of corrections marked in EditGenie, the layout would be different from typeset PDF and EditGenie editing view.

Author Queries & Comments:

Q1 : Please provide a short biography of the author(s).

Response: Vidya Ramkumar has spent the last decade working on developing service delivery models using e-and mhealth tools to bridge gaps in hearing health care services in the underserved regions. The SRESHT lab was set up by her in 2020 (Services To Reach Children With Speech & Hearing Disorders Using Telepractice see SRESHT Lab) to pursue implementation research in community-based interventions using tele-practice. She is involved in development of low-cost indigenous assistive and testing devices that can support early identification and rehabilitation of children with developmental and hearing disabilities. She is also a Fulbright-Nehru Doctoral Professional Research fellow (2014). Neethi Jesudass is pursuing her Ph.D. in the area of "Situational analysis and needs assessment (Tele-practice)". Her clinical and research interests include tele-practice, newborn hearing screening, and diagnostic audiology. She has over twelve years of experience. Shuba Kumar is a social scientist with extensive experience in qualitative research. She is involved in several collaborative projects across health care disciplines and also is a master trainer for qualitative research

Q2 : The abstract is currently too long. Please edit the abstract down to no more than 150 words.

Response: This study was an initial step toward planning tele-practice in a South Indian state's public-sector services for childhood hearing and speech-language problems. The aim was to understand the perceptions public-sector health care professionals (HCPs) regarding their willingness and need for tele-practice-based diagnostics and rehabilitation services. Focus group discussions (FGD), semi-structured interviews (SSI), and geo-spatial analysis were employed in a cross-sectional study. Different public-sector HCPs participated in the qualitative study. Data sufficiency was assessed using theoretical saturation and cross-case variance. Data was analyzed using hybrid deductive-inductive thematic analysis. Geo-tags and geo-locations of all children with disabilities and all the public-sector service providers were used to generate geospatial maps. HCPs felt that childhood hearing and speech-language disorder services were inadequate and lacked sufficient qualified professionals. There was inconsistent equipment and professional availability in district-level facilities. HCPs were comfortable using technology, and were willing to investigate tele-practice, but they required training in tele-practice.

Q3 : The funding information provided (DBT/Wellcome Trust India Alliance) has been checked against the Open Funder Registry and we found a partial match with "Wellcome Trust/DBT India Alliance". Please check and resupply the funding details.

Response: Wellcome Trust/DBT India Alliance IA/CPHI/19/1/504614

Q4 : Please check that the heading levels have been correctly formatted throughout.

Response: The heading levels are correctly formatted

Q5 : The year for "State Commission for Welfare of the Differently Abled (1992)" has been changed to "2021" to match the entry in the references list. Please provide revisions if this is incorrect.

Response: The year of establishment is 1992. The error in reference list is corrected

Q6 : The reference "Mamin, and Hayes 2018" is cited in the text but is not listed in the references list. Please either delete the in-text citation or provide full reference details following journal style.

Response: Mamin, F. A., & Hayes, R. (2018). Physiotherapy in Bangladesh: inequality begets inequality. Frontiers in Public Health, 6, 80.

Q7 : The disclosure statement has been inserted. Please correct if this is inaccurate.

Response: Yes this is correct

Q8 : The CrossRef database (www.crossref.org/) has been used to validate the references. Mismatches between the original manuscript and CrossRef are tracked in red font. Please provide a revision if the change is incorrect. Do not comment on correct changes

Response: No change

Q9 : Please provide missing page range for reference "Houston and Stredler-Brown, 2012" references list entry.

Response: Vol. 112 Issue 3, p283-296. 14p.

Q10 : The reference "Indian speech and hearing association, 2020" is listed in the references list but is not cited in the text. Please either cite the reference or remove it from the references list.

Response: This reference maybe removed from the list

Q11 : The images in figures 1 to 3 are pixelated. Please resupply the figures.

Response: Response file attached "Figure 1.docxFigures 3.docxFigures 2.docx".
Response: Response file attached "Figure 1.docxFigures 3.docxFigures 2.docx".

CM1 : Pls note the request for change in order of authors. Neethi Jesudass maybe designated as first author and Vidya Ramkumar as corresponding author. Neethi's name maybe written as Neethi Jesudass

a. Perambalur - CWD (all)
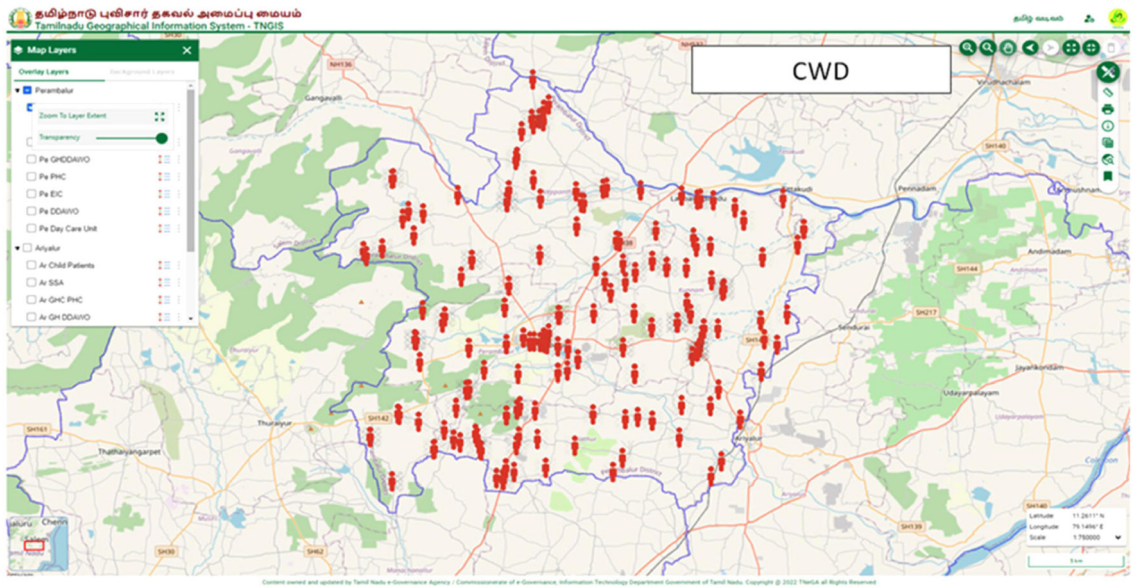
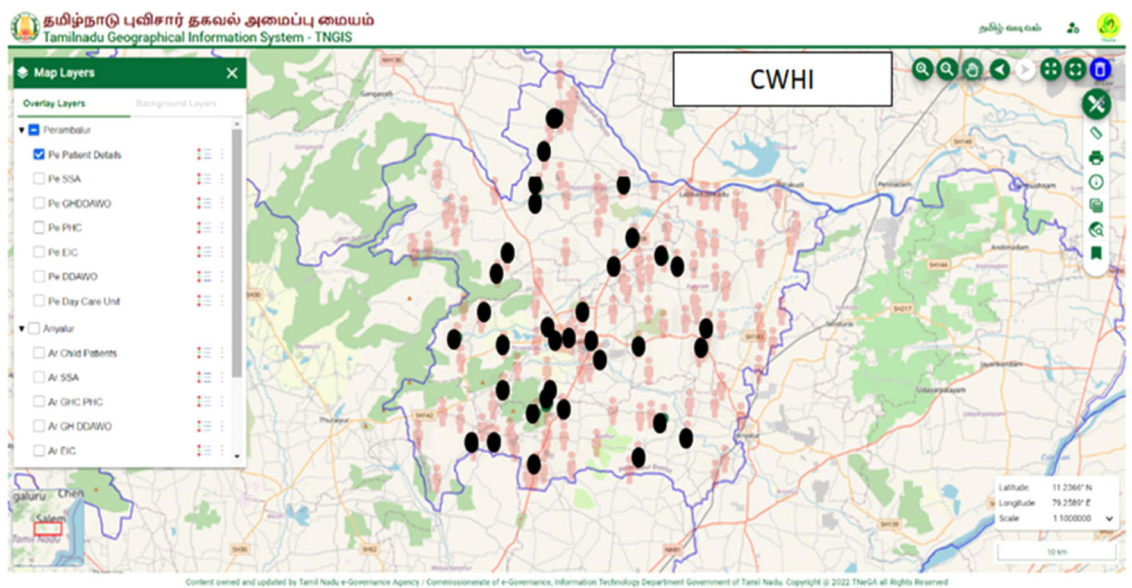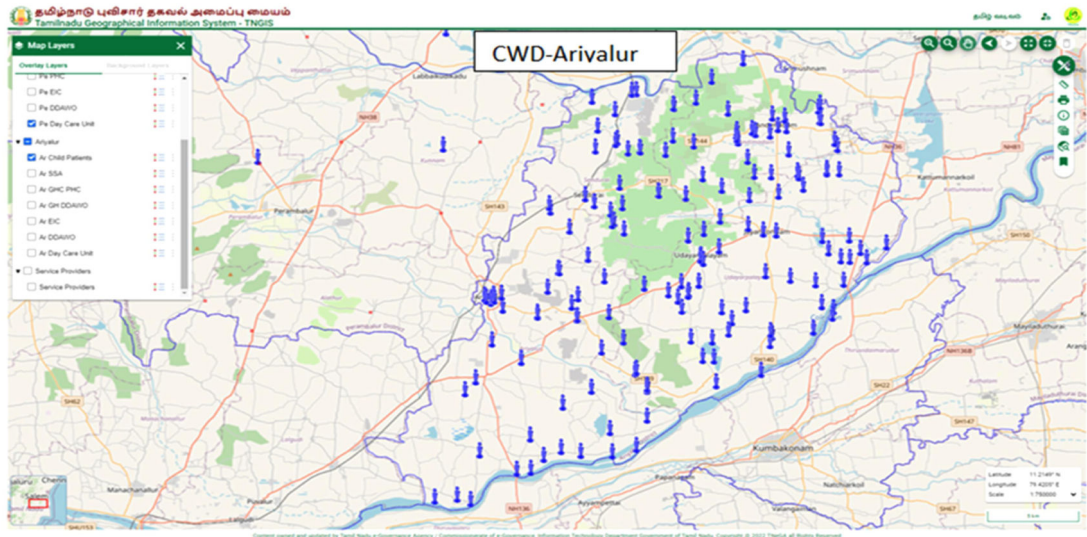## b. Perambalur - Children with Hearing Impairment (Black dots)

Figure 1.
[Q11]a. Perambalur – CWD (all). b. Perambalur – Children with Hearing Impairment (Black dots).

a. Ariyalur - CWD (all)

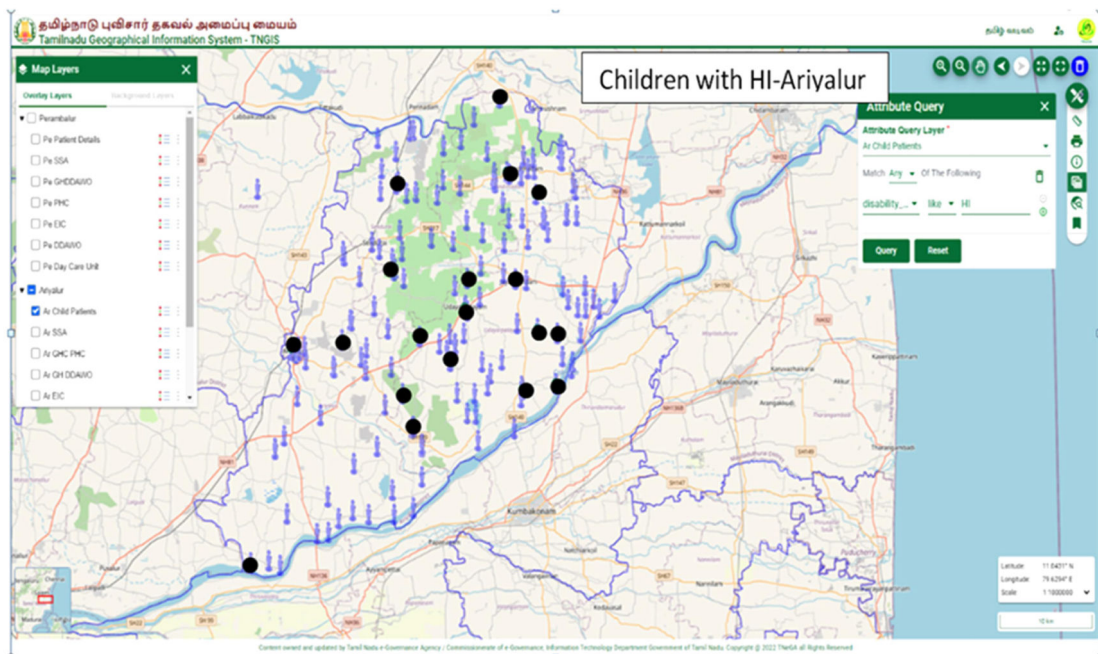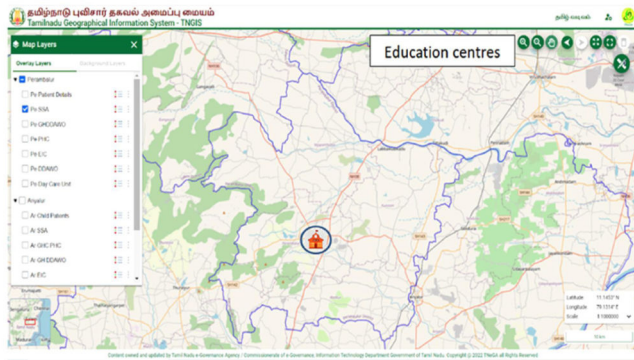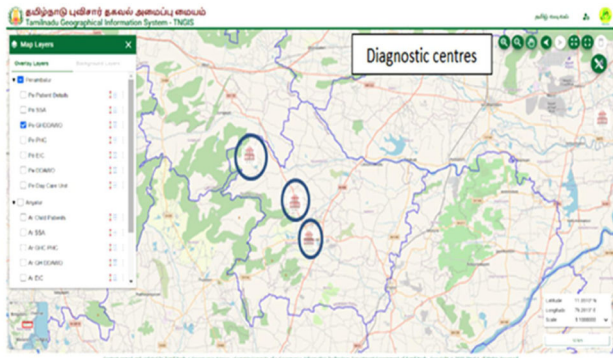### b. Ariyalur- Children with hearing impairment (black dots)

Figure 2.
a. Ariyalur – CWD (all). b. Ariyalur – Children with hearing impairment (black dots).
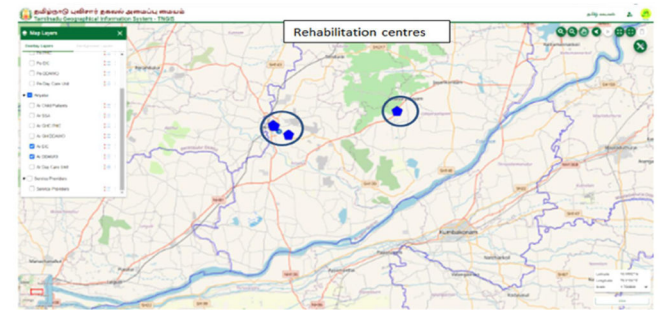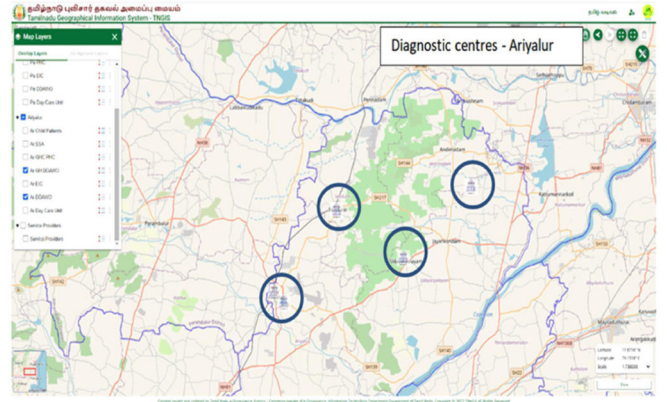
Figure 3.
a. Perambalur – Service Provider spread maps. b. Ariyalur – Service Provider spread maps.

Table 1

Theoretical framework.

S. No.	Bowen's feasibility framework	Telemedicine frameworks	Attributes included
1	Demand/Need		Barriers and challenges in seeking health care
			Availability of services
			Accessibility to services
			Satisfaction with the quality of health care
2	Acceptability	Agreeable for intervention	Use of communication links between stakeholders
			Participation
			Attitudes
			Customs & beliefs
		Comfort	Comfort with the use of mobile phone based screening
			Comfort with hearing and speech-language by GRW
3	Integration	Organizational readiness	Political will
			Policy – political will, willingness to adapt health systems
			Infrastructure availability/capacity
		Clinical skills	Training needs
			Learning readiness
		Time management of providers	
		Technical	
4	Practicality	Economic	Patient and provider perspective
		Affordability	Patient perspective
			Provider perspective
			Technical

Table 2

Details of SSIs and FGDs.

Stakeholder	No. of available HCPs	Sampling method	Participant details		
			SSI	FGD	Years of work experience
District Differently Abled Welfare Officer s	2	No sampling	2 (females)	–	25
Multi-purpose rehabilitation therapist	1	Opportunistic sampling	1 (male)	–	7
Early Intervention Center (EIC)– In-charge	3	No sampling	3 (2 females, 1 male)	–	25
Audiologist & Speech Language Pathologist s	2	No sampling	2 + 2[a] (2 females, 2 males)	–	5
EIC – Special Educators	2	No sampling	2 (females)	–	8
Anganwadi workers	988	Included based on permission	–	12 (11 females, 1male)	20–25
Sarva Shiksha Abhiyan special educators	52	Included based on permission	–	20 (16 females, 4 males)	20–25
Village Health Nurses	200	Included based on permission	–	6 (females)	5–8

[a]Two ASLPs who worked in these districts were also additionally included.

Table 3

Number of service centres in Ariyalur and Perambalur and the average distance travelled to avail services for CWD.

Type of service	Selected district	Centres offering service	Road travel distance in kms
Diagnostic services	Ariyalur	DDAWO-1 GH-4	38
	Perambalur	DDAWO-1 GH-3	37
Rehabilitation services	Ariyalur	DDAWO-1 Day care centres-5 SSA BRC-1	37
	Perambalur	DDAWO-1 Day care centres-10 SSA BRC-1	33
Special education (EIC-MR)	Ariyalur	2	32
	Perambalur	1	33
Special education (EIC-HI)	Ariyalur	1	37
	Perambalur	1	25
Primary health care	Ariyalur	38	6
	Perambalur	31	6

Table 4

Service provider to CWD ratio.

Provider	Ariyalur service provider to CWD ratio	Perambalur service provider to CWD ratio
Audiologist/Speech language Pathologist	1:260	1:235
Occupational Therapist	1:260	0:235
Physiotherapist	1:260	1:235
Psychologist	0:260	0:235
Special educator	5:260	3:235
Village Health Nurse	38:260	31:235