

MOBILE HEALTH (MHEALTH) TECHNOLOGY FOR NON-COMMUNICABLE DISEASE SERVICES: ENHANCING THE PERFORMANCE OF COMMUNITY HEALTH WORKERS

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DOI: [10.5281/zenodo.10279166](https://doi.org/10.5281/zenodo.10279166)

Abstract

Background: There are 1.2 billion mobile customers in India, and smartphone users in rural India were 67.6% in 2021. Mobile health (or mHealth) refers to delivering healthcare services and managing patient data using portable electronic devices and software applications. Non-communicable diseases (NCDs) account for 41 million annual deaths globally, and 85% of premature deaths occur between 30 and 69 years due to NCDs in Low- and Middle-Income Countries (LMICs). Community health workers (CHWs) serve as a bridge between the communities and the health centers. In India, 10.4lakh Accredited Social Health Activists (ASHAs) and 2lakh Auxiliary Nurse Midwives (ANMs) serve as CHWs. Their services have contributed to a decrease in maternal and infant morbidity and mortality rates as well as the burden of communicable diseases. To facilitate tasks and enhance outcomes, mobile technologies are developed, tested, and deployed by community health professionals. Our study aimed to examine and qualitatively determine the potential of mobile phone technology in improving CHWs' performance and effectiveness in the delivery of NCD services. **Methods:** A qualitative study with 65 in-depth interviews with ASHAs, ANMs, and supervisor were conducted from selected Primary Health Centres (PHCs) and Subcentres in the Suryapet district of Telangana in 2021. The CHWs were asked about their experience using mobile technology to deliver NCD health services. The in-depth interviews were audio recorded, transcribed verbatim, and coded using the software Atlas.ti. **Results:** Inductive thematic analysis was adopted to analyze the data. The themes identified were enlisted as beneficial: 1) Reduction in CHWs' workload, 2) Improvement in the data collection, 3) Increasing service access and quality, 4) Training and supervision of personnel management, 5) Reporting and monitoring, and 6) Better organization of CHWs tasks and improvement in community health outcomes. The CHWs reported a few challenges to using mobile phones, such as a lack of training on new mHealth solutions, weak technical support, and systemic challenges. **Conclusion:** mHealth interventions are essential to aid in CHWs' performance and can improve patient outcomes and reduce the burden of NCDs. The study found an increasing technical uptake, acceptance, and steady decline in costs provide scope to expand mHealth technology in LMICs in the future.

Keywords: NCD Screening, Mobile Phones, ANM, ASHA, Chronic Diseases.

INTRODUCTION

Non-Communicable Diseases (NCDs) are a global public health challenge, responsible for 41 million annual deaths worldwide, as reported by the World Health Organization (WHO) in 2022 (WHO, 2022). In India, NCDs contribute to approximately 5.87 million (60%) of all deaths. Cardiovascular diseases account for 42.7% of NCD deaths annually, followed by respiratory diseases (19.4%), cancers (15.5%), and diabetes and kidney diseases (8.2%) in India (World Health Organization, 2022). However, despite efforts to reduce their prevalence, mortality, and morbidity, NCDs are expected to continue as the leading cause of death and disability worldwide (Rasulova, Jalilova, & Mukhamedova, 2023). The burden of NCDs is disproportionately felt in low and middle-income countries (LMICs), with more than 85% of premature NCD-related deaths occurring in these regions (Melkamu & Jeanne,

2019). Factors such as urbanization, globalization, unhealthy lifestyles, obesity, aging populations, and reduced physical activity contribute to the alarming increase in chronic diseases (WHO, 2023). Developing countries' healthcare systems face challenges in meeting the rising demand for chronic disease care due to resource constraints (Gaudin & Yazbeck, 2021; Kurapati & Rakshase, 2022). However, mobile health technologies (mHealth) offer a promising solution to improve chronic disease services. By leveraging mHealth, there is potential to enhance early detection, patient monitoring, and overall NCD management, especially in LMICs, where prevention and management programs are inadequate (Fan & Zhao, 2022).

mHealth, the use of portable electronic devices and software applications for healthcare services, is more prevalent in high-income countries compared to low middle-income countries (Singh & Landman, 2017). In developing country settings, particularly rural areas, modern information and communication technologies (ICTs) can reduce geographical barriers, improve access to healthcare information, and overcome institutional obstacles for patients and healthcare workers. Mobile phones enable remote access to medical research and ongoing training for rural healthcare providers, helping to address the shortage of medical professionals (Kahn, Yang, & Kahn, 2010; Mechael, 2009). Policymakers are increasingly turning to affordable ICTs like mobile phones to bridge the lack of medical expertise in rural regions (Viljoen, Klinker, Wiesche, Uebernickel, & Krcmar, 2021). Recent reviews show that mobile phone technology has significantly improved rural maternal healthcare and essential services in developing countries (Bangal, Borawake, Gavhane, & Aher, 2017; Latif et al., 2017). The widespread availability of mobile phones has facilitated remote diagnosis and training for community health workers (CHWs) in areas with severe personnel and resource shortages (Braun, Catalani, Wimbush, & Israelski, 2013; Feroz, Jabeen, & Saleem, 2020). This has led to an increase in mHealth initiatives, especially in underdeveloped regions. This paper adopts an interpretivist approach to explore how mobile phones empower rural healthcare workers to deliver higher quality healthcare while also addressing obstacles that impede the success of mHealth projects.

Community health workers (CHWs) are essential to addressing people's health concerns because they provide essential primary care. CHWs serve as a bridge between the communities and the health centres. In India, 10.4 lakh Accredited Social Health Activists (ASHAs) and 2 lakh Auxiliary Nurse Midwives (ANMs) serve as CHWs (PIB, 2021). Their services have decreased maternal and infant morbidity and mortality rates as well as the burden of communicable diseases. mHealth is a promising solution to NCD service challenges with integration of CHWs (Feroz et al., 2020). To facilitate tasks and enhance outcomes, mobile technologies are developed, tested, and deployed. Our study aimed to examine and qualitatively determine the potential of mobile technology in improving CHWs' performance and effectiveness in the delivery of NCD services.

METHODOLOGY

This qualitative study aimed to explore the experiences of Accredited Social Health Activists (ASHAs) and Auxiliary Nurse Midwives (ANMs), along with their supervisors, in utilizing mobile technology to deliver Non-Communicable Disease (NCD) health services. The study was conducted in the Suryapet district of Telangana in 2021.

Participants: The study involved a total of 65 participants, including 30 ASHAs, 30 ANMs, and 5 supervisors, selected from various Primary Health Centres (PHCs) and Subcentres in the Suryapet district. These community health workers were chosen as they play a vital role in delivering primary healthcare services in rural areas.

Data Collection: In-depth interviews were employed as the primary data collection method. The researchers conducted face-to-face interviews with each participant to gain a comprehensive understanding of their experiences with mHealth technology. During the interviews, participants were encouraged to share their thoughts, challenges, and successes related to using mobile technology for delivering NCD health services.

Interview Procedure: The interviews were conducted in a semi-structured format, allowing participants the flexibility to share their unique perspectives while covering specific topics related to mHealth technology and NCD service delivery. Open-ended questions were used to stimulate rich and detailed responses from the participants. The researchers also employed probing techniques to delve deeper into certain areas of interest and ensure a comprehensive exploration of the topic.

Data Management: To ensure accuracy and consistency in data analysis, all in-depth interviews were audio recorded. After each interview, the recordings were transcribed verbatim to capture the participants' exact words and expressions. The transcriptions served as the primary data source for analysis.

Data Analysis: The researchers utilized qualitative data analysis software, specifically Atlas.ti, to manage and analyze the transcribed data. The software facilitated the coding process, enabling the identification of key themes, patterns, and insights from the participants' narratives. Thematic analysis was employed to categorize the data and identify recurring themes related to the use of mobile technology for NCD health services.

Ethical Considerations: Ethical approval was obtained from the university review board before commencing the study. Informed consent was obtained from all participants, ensuring their voluntary participation, confidentiality, and anonymity throughout the research process.

This qualitative study employed in-depth interviews with ASHAs, ANMs, and supervisors in the Suryapet district of Telangana to investigate their experiences in using mobile technology for delivering NCD health services. Through audio recording, verbatim transcription, and coding using Atlas.ti, the researchers gained valuable insights into the benefits, challenges, and overall impact of mHealth technology on the performance of community health workers in NCD service delivery. The findings from this study can offer valuable insights to policymakers, healthcare providers, and researchers in the ongoing efforts to enhance healthcare services in rural settings using mobile health technologies.

ICT for Healthcare Development Model

The ICT for Healthcare Development Model proposed in this paper aims to outline a systematic approach to leverage Information and Communication Technologies (ICTs) to enhance the performance of community health workers (CHWs) in Non-Communicable Disease (NCD) service delivery.

The model is designed to address the challenges faced by CHWs in underserved areas and promote the effective adoption and utilization of mobile technology for NCD healthcare services (Chib, 2010).

1. **Needs Assessment:** The first step of the model involves conducting a comprehensive needs assessment to identify the specific healthcare challenges faced by CHWs and the requirements for implementing mobile technology solutions. This assessment includes evaluating the existing healthcare infrastructure, technological capabilities, financial resources, and the technical skills of CHWs.
2. **Technology Selection:** Based on the needs assessment, the model involves selecting appropriate ICT tools and solutions that align with the requirements and capabilities of CHWs and the healthcare system. This may include mobile apps for data collection, digital platforms for training and supervision, and communication tools for improved collaboration.
3. **Training and Capacity Building:** To ensure effective adoption and utilization of ICTs, comprehensive training programs are designed and delivered to CHWs and relevant healthcare personnel. Training encompasses technical skills, data management, adherence to protocols, and the use of mobile apps for data reporting and patient care.
4. **Technical Support:** Continuous technical support is provided to CHWs to address any challenges or issues encountered during the use of mobile technology. A dedicated support team ensures that CHWs can navigate the apps smoothly and troubleshoot any technical problems.
5. **Infrastructure Improvement:** To overcome technology-related limitations, efforts are made to improve infrastructure in underserved areas. This includes enhancing network connectivity, ensuring access to electricity, and providing necessary resources for mobile technology usage.
6. **Cultural Sensitization:** To address cultural barriers, awareness-building initiatives are implemented to promote the acceptance and understanding of mobile technology among CHWs and the local community. Ensuring privacy and confidentiality of patient data is emphasized to build trust.
7. **Monitoring and Evaluation:** Regular monitoring and evaluation of the ICT for Healthcare Development Model are conducted to assess the impact of mobile technology on CHWs' performance, healthcare service delivery, and patient outcomes. Feedback from CHWs, supervisors, and patients is gathered to make necessary improvements.

Conceptual framework based on the model

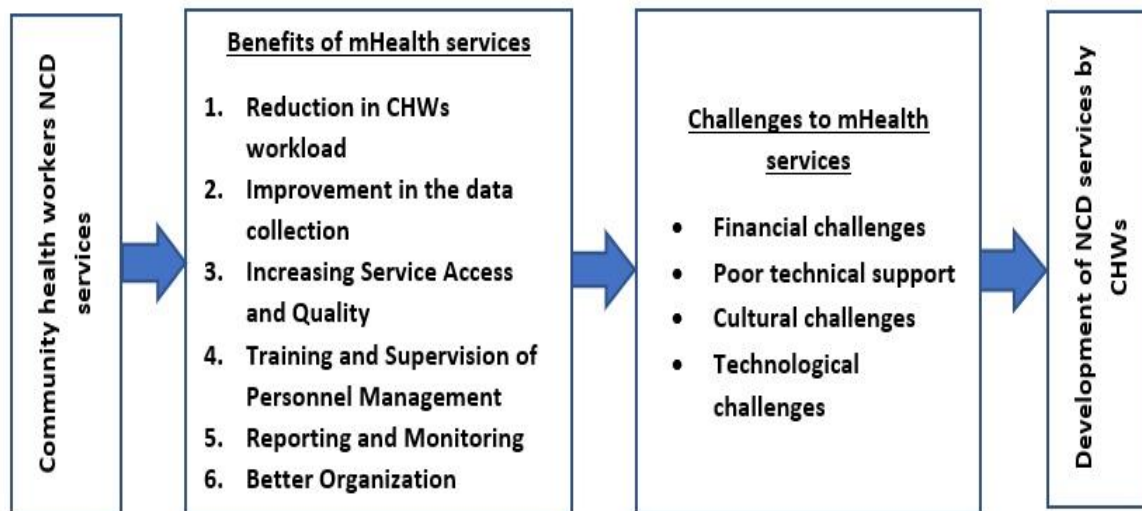


Figure 1: Community health workers NCD services benefits and challenges

RESULTS

Evidence was found that mobile phones were beneficial for, but we also found that their use was hindered by a number of obstacles.

1. Reduction in CHWs workload

The integration of mobile technology in NCD service delivery brought about a significant reduction in the workload of CHWs. Participants reported that mobile apps and digital platforms streamlined their daily tasks, enabling them to focus more on direct patient care and health promotion activities.

One of the key benefits of mobile technology was the automation of administrative tasks. CHWs no longer had to maintain multiple paper-based registers and forms, which were time-consuming and prone to errors. The mobile apps allowed CHWs to record patient data, treatment information, and health assessments directly into their devices. This reduced the need for manual paperwork.

"With the mobile app, I don't have to carry around heavy registers anymore. It's all on my phone, which makes my work much easier." (ASHA3)

Moreover, mobile technology facilitated efficient data management. CHWs could access patient records and treatment histories at their fingertips, eliminating the need to search through piles of paperwork. This not only saved time but also ensured that CHWs had all relevant information readily available during patient visits.

"The mobile app allows me to quickly check a patient's medical history and treatment plan. I can provide better care without having to dig through files."(ASHA7)

Mobile apps also enabled timely reminders and notifications for important healthcare tasks. CHWs received alerts for upcoming patient visits, vaccination schedules, and health awareness sessions. This proactive approach helped CHWs stay organized and prevented them from missing crucial healthcare activities.

"The app sends reminders for follow-ups and immunizations. It helps CHWs stay on track and ensures that patients receive timely care."(SP4)

Furthermore, mobile technology improved communication between CHWs and healthcare facilities. CHWs could quickly and easily communicate with doctors and specialists for expert advice and referrals. This streamlined process reduced the time spent on coordinating patient care and facilitated prompt decision-making.

"If I encounter a complex case, I can consult a doctor through the app. It saves time, and I can provide better care to my patients."(ANM8)

The reduction in CHWs' workload due to mobile technology allowed them to focus on patient-centered activities, resulting in improved healthcare service delivery. The automation of administrative tasks, efficient data management, timely reminders, and improved communication enhanced CHWs' efficiency and effectiveness in delivering NCD health services to their communities.

2. Improvement in the data collection

The use of mobile technology significantly improved data collection processes for community health workers (CHWs) delivering NCD health services. Participants reported that mobile phones enabled them to collect accurate and real-time patient information, leading to more efficient and reliable data management.

With mobile applications specifically designed for data collection, CHWs were able to record patient details, medical histories, and treatment progress directly into their devices. This eliminated the need for manual paper-based records, which were often prone to errors and delays in updating.

"Earlier, we had to carry heavy registers and write down everything. Now, with the mobile app, I can enter all the details on the spot, and it's saved securely."(ASHA11)

The mobile apps also had built-in data validation features, reducing the chances of missing or incomplete information. CHWs mentioned that the apps prompted them to provide all necessary data fields, ensuring comprehensive patient records.

"The mobile app doesn't let me proceed if I miss any information, which is helpful. It ensures that we have complete and accurate data."(ANM9)

Moreover, the real-time nature of data collection allowed for immediate updates and accessibility of patient records by authorized personnel. Supervisors and healthcare authorities could access the data remotely, enabling timely decision-making and monitoring of CHWs' activities.

"I can view all the data from my office. It helps me track the progress of each CHW and intervene if there are any concerns."(SP2)

Additionally, mobile technology enabled the integration of multimedia elements, such as photographs and videos, into the patient records. This enhanced the visual documentation of patient conditions and treatment outcomes, providing a more comprehensive view of the healthcare provided.

"We can capture images of wounds or medical procedures and attach them to the patient's record. It helps in understanding the case better."(ANM16)

Overall, the improvement in data collection through mobile technology not only enhanced the accuracy and timeliness of patient information but also facilitated evidence-based decision-making and better continuity of care. The seamless integration of data collection into the mobile apps streamlined CHWs' workflow, enabling them to focus more on patient care and health promotion activities.

3. Increasing Service Access and Quality

Mobile technology played a pivotal role in increasing service access and improving the quality of healthcare delivered by CHWs in the context of NCD services. Participants highlighted how mobile phones enabled better communication and collaboration between CHWs and healthcare facilities, leading to improved service delivery and patient outcomes.

By leveraging mobile apps, CHWs could quickly and easily connect with doctors at Primary Health Centres (PHCs) and higher-level healthcare facilities. This facilitated timely referrals and consultations for patients with complex health needs, even in remote rural areas.

"When we encounter challenging cases, we can reach out to the doctors at the PHC through the mobile app. They guide us in managing the patients, which is very beneficial."(ASHA19)

The real-time communication also allowed CHWs to seek expert advice promptly, leading to more accurate diagnoses and appropriate treatment plans. The availability of medical expertise through mobile technology bridged the gap between the communities and formal healthcare institutions, ensuring better access to specialized care for patients.

"Earlier, we had to wait for days to get a doctor's opinion. Now, it's just a phone call away, and we can provide better care to our patients."(ANM6)

Furthermore, mobile technology enhanced the quality of healthcare services delivered by CHWs by providing access to up-to-date medical research, treatment guidelines, and best practices. The mobile apps included resources and training modules that CHWs could access remotely, enabling continuous learning and skill development.

"The mobile app provides us with the latest information on NCD management and treatment options. It empowers us to offer evidence-based care to our patients."(SP1)

In addition to facilitating communication with healthcare professionals, mobile technology improved service access for patients as well. Patients could receive timely reminders for health check-ups, medication adherence, and health awareness sessions through SMS or app notifications. This proactive approach resulted in better engagement and follow-up with patients, ultimately leading to improved health outcomes.

"we send reminders for patient medications and health check-ups on their phone. It helps them stay on track with their treatment." (ASHA12)

The use of mobile technology in NCD service delivery by CHWs significantly improved service access and quality, ensuring that patients in remote and underserved areas had better access to specialized care and evidence-based healthcare. The seamless integration of mobile apps into CHWs' workflow enhanced communication,

collaboration, and training, ultimately leading to improved health outcomes for the communities they served.

4. Training and Supervision of Personnel Management

Mobile technology played a critical role in enhancing training and supervision of community health workers (CHWs) engaged in NCD service delivery. Participants highlighted how mobile apps and digital platforms provided them with continuous training, updates on medical guidelines, and remote supervision, thereby improving their skills and performance.

Through mobile applications, CHWs received regular and easily accessible training modules on NCD management, patient care, and health promotion. The training materials were tailored to the specific needs of CHWs, ensuring that they remained well-informed about the latest developments in healthcare.

"We receive training videos and interactive modules through the mobile app. It keeps us updated and helps us provide better care to our patients." (ASHA11)

Moreover, mobile technology facilitated remote supervision by higher-level healthcare authorities and supervisors. Supervisors could monitor CHWs' activities, review patient records, and provide feedback through the app. This remote supervision mechanism enabled prompt corrective actions and improved the quality of healthcare services provided by CHWs.

"I can check the work of CHWs from anywhere through the app. If there are any issues, I can guide them and ensure that they deliver quality care." (SP2)

Mobile apps also allowed for skill assessments and quizzes, helping supervisors evaluate CHWs' understanding of the training materials and identify areas for improvement. This data-driven approach to supervision and training enhanced the efficiency and effectiveness of personnel management in NCD service delivery.

"We have regular quizzes and assessments through the app. It keeps us motivated to learn and perform better." (ANM16)

Furthermore, mobile technology facilitated peer learning and knowledge exchange among CHWs. They could share their experiences, challenges, and best practices through the app's communication features, fostering a collaborative learning environment. This social support system contributed to the continuous improvement of CHWs' skills and the sharing of innovative approaches to NCD management.

"We have a group chat where we discuss cases and learn from each other. It's like having a network of experts to seek advice from." (ANM22)

Mobile technology significantly enhanced the training and supervision of CHWs engaged in NCD service delivery. The continuous access to training materials, remote supervision, and peer learning opportunities empowered CHWs with the necessary knowledge and skills to provide high-quality healthcare services in their communities. The use of mobile apps in personnel management proved to be a valuable and efficient approach in optimizing the performance of CHWs and improving healthcare outcomes.

5. Reporting and Monitoring

Mobile technology played a crucial role in enhancing the reporting and monitoring processes for community health workers (CHWs) engaged in Non-Communicable

Disease (NCD) service delivery. Participants emphasized how mobile apps and digital platforms streamlined data reporting, enabled real-time monitoring, and improved overall accountability.

With the use of mobile apps, CHWs could submit reports and patient data directly from the field. This eliminated the need for manual, paper-based reporting, which was often time-consuming and prone to errors. The real-time nature of reporting enabled supervisors and higher-level healthcare authorities to access updated data immediately.

"Gone are the days of waiting for reports to arrive. With the mobile app, I can view the data as soon as it's submitted, allowing for prompt action if needed."(SP3)

The mobile apps also had data validation features, ensuring that CHWs provided all necessary information in their reports. This reduced the chances of incomplete or inaccurate data, improving the overall quality of the reported information.

"The app doesn't let me proceed with the report if I miss any details. It ensures that all the required information is provided."(ASHA10)

Moreover, mobile technology allowed for real-time monitoring of CHWs' activities and service delivery. Supervisors could track CHWs' progress, patient visits, and completion of tasks through the app's dashboard. This enabled supervisors to identify any gaps or issues in service delivery and take timely corrective actions.

"I can monitor each CHW's performance on a daily basis. If I notice any deviation from the set targets, I can address it immediately."(SP4)

Mobile apps also facilitated outcome monitoring and evaluation. CHWs could record patient outcomes and treatment progress in real-time, allowing for continuous tracking of health outcomes and the effectiveness of interventions. This data-driven approach to monitoring contributed to evidence-based decision-making and improved healthcare service delivery.

"I can see the progress of my patients over time. It helps me understand if the treatment is working or if we need to make any changes."(ANM5)

Mobile technology streamlined the reporting and monitoring processes for CHWs in NCD service delivery. The real-time data collection, validation, and monitoring features of mobile apps improved the accuracy, timeliness, and quality of reported data. The ability to monitor CHWs' activities and patient outcomes in real-time enabled supervisors and healthcare authorities to make informed decisions and ensure accountability in healthcare service delivery.

6. Better Organization

Mobile technology played a significant role in better organizing the tasks and responsibilities of CHWs engaged in NCD service delivery. Participants highlighted how mobile apps and digital platforms helped streamline their daily activities, leading to improved efficiency and effectiveness in healthcare service provision.

Mobile apps provided CHWs with a centralized platform to manage their tasks, schedules, and patient information. CHWs could access their daily agendas, patient lists, and appointment reminders on their mobile devices, ensuring that they remained organized and well-prepared for their work.

"With the mobile app, I can see my schedule for the day, the patients I need to visit, and any upcoming health events. It helps me plan my day efficiently."(ASHA14)

Furthermore, the mobile apps included features for task tracking and reminders, ensuring that CHWs did not miss any critical healthcare activities. CHWs received notifications and alerts for upcoming patient visits, medication administration, and health awareness sessions, improving their adherence to the care plans.

"The app reminds me of important tasks, like administering medications and conducting follow-up visits. It helps me stay on top of things."(ANM25)

Mobile technology also facilitated better communication and coordination among CHWs and with higher-level healthcare authorities. CHWs could communicate with supervisors, doctors, and other team members through the app, exchanging critical information and seeking guidance as needed. This improved collaboration enhanced the overall efficiency of healthcare service delivery.

"The app allows for seamless communication with CHWs. I can quickly address their queries and provide support, which enhances our teamwork."(SP5)

Additionally, mobile apps enabled CHWs to access educational resources, guidelines, and protocols at their fingertips. This empowered CHWs with evidence-based information and best practices, contributing to their professional development and improved decision-making in patient care.

"I can refer to the guidelines on the app whenever I'm unsure about something. It gives me confidence in providing the right care."(ANM14)

Mobile technology played a pivotal role in better organizing the tasks and responsibilities of CHWs in NCD service delivery. The use of mobile apps provided a centralized platform for task management, appointment scheduling, and patient information, leading to improved efficiency and effectiveness in healthcare service provision. The communication features of mobile apps also fostered better collaboration and coordination among CHWs and healthcare authorities, enhancing teamwork and overall service quality.

Challenges:

However, there were additional challenges to mobile phone adoption, including those related to financial, poor technical support, cultural and technology.

Financial

While the majority of CHWs did have access to mobile phones, only a small percentage had government-issued devices.

"Since I don't have a computer or internet access at home, I didn't attempt to learn how to use them." (ASHA2)

Neither the cost of the phones themselves nor the cost of the CHWs' ongoing credit (mobile balance) were subsidized by the government, so most CHWs were hesitant to give out their contact information to patients. Since ASHAs were only compensated for sending patients to government hospitals on a commission basis, they had no sufficient money for mobile recharge.

“My phone balance ... is usually empty. Somebody can afford to spend some money if he is making some money. Can't afford to do much of anything since I'm not getting paid.” (ASHA4)

Poor technical support

While previous research had predicted that poor mobile coverage in rural India would be a problem, our findings showed otherwise. Unfortunately, having access to the web was seen as a luxury.

“We are ready to learn if only we had access to better education and healthcare resources. Unfortunately, there isn't a service that teaches people like me how to use the Internet to aid a patient.” (ASHA13)

Cultural challenges

Gender played a nuanced role, both helping and hindering mobile usage and impact. ASHAs favoured having their own mobile phones because it was important for them to be easily located on the job, and their families also saw it as important for their safety.

“My husband has a cell phone, my children who also own smartphones. I figured I needed one after starting work as ASHA.” (ASHA12)

Technological

It took most CHWs some time to get used to using a mobile phone, and many of them still have trouble remembering how to dial numbers and differentiating between the phone's many features. However, with regular use, most issues vanished entirely.

“I was initially quite clueless regarding the phone's capabilities. Having no idea how to lock my phone, I wasted a lot of time and money by making unnecessary calls to people. My kid showed me how to use, and now I know how to use it” (ASHA17).

DISCUSSION

The integration of mHealth in Non-Communicable Disease (NCD) service delivery has shown promising results in improving the performance and effectiveness of community health workers (CHWs). The qualitative study conducted in the Suryapet district of Telangana revealed several key benefits of using mobile apps and digital platforms in NCD healthcare services.

The first significant finding of the study was the reduction in CHWs' workload through the adoption of mobile technology. This aligns with previous research that has highlighted the potential of mHealth in alleviating the administrative burden on healthcare workers (Blaya, Fraser, & Holt, 2010; Piette, Blaya, Lange, & Sanchis, 2011). The automation of tasks and streamlined data management provided by mobile apps allowed CHWs to focus more on direct patient care and health promotion activities. This finding is crucial as CHWs often work in resource-constrained settings, and any reduction in administrative tasks can improve their overall efficiency and job satisfaction (Labrique, Vasudevan, Mehl, Roskam, & Hyder, 2018).

Furthermore, the improvement in data collection through mobile technology has proven beneficial for CHWs in delivering NCD health services. The real-time data collection and validation features of mobile apps ensured the accuracy and timeliness of patient information. This is consistent with previous studies that have demonstrated

the potential of mHealth in enhancing data quality and management in healthcare settings(Labrique et al., 2018; Nimbabazi et al., 2023). The availability of up-to-date and comprehensive patient records allowed CHWs to make informed decisions and provide evidence-based care, contributing to improved health outcomes for their patients.

The study also revealed that mobile technology played a crucial role in increasing service access and improving the quality of healthcare services delivered by CHWs. Mobile apps enabled seamless communication and collaboration between CHWs and healthcare facilities, facilitating timely referrals and consultations for patients with complex health needs. This finding is consistent with other studies that have demonstrated the potential of mHealth in bridging the gap between rural communities and formal healthcare institutions(Eze, Gleasure, & Heavin, 2022; Nahar, Kannuri, Mikkilineni, Murthy, & Phillimore, 2017).

The real-time access to medical expertise through mobile technology empowered CHWs to provide specialized care to patients in remote and underserved areas, ultimately improving service access and quality. Moreover, mobile technology proved to be instrumental in enhancing the training and supervision of CHWs engaged in NCD service delivery.

The availability of continuous training modules and remote supervision through mobile apps enabled CHWs to stay updated with the latest medical knowledge and guidelines. This finding is consistent with other studies that have highlighted the role of mHealth in providing ongoing training and support to healthcare workers in resource-constrained settings(Addotey-Delove, Scott, & Mars, 2023; Meyer et al., 2020). The use of mobile apps in personnel management improved the overall competency and performance of CHWs, leading to more efficient and effective healthcare service delivery.

Additionally, mobile technology facilitated better reporting and monitoring of healthcare services provided by CHWs. The real-time data collection and monitoring features of mobile apps allowed supervisors and healthcare authorities to access updated data immediately, enabling prompt action if needed. This finding is in line with previous research that has demonstrated the potential of mHealth in enhancing data reporting and monitoring in healthcare settings (Davies, 2021; Karthan, 2022). The ability to monitor CHWs' activities and patient outcomes in real-time improved the overall accountability and quality of healthcare service delivery. Furthermore, mobile technology played a pivotal role in better organizing the tasks and responsibilities of CHWs engaged in NCD service delivery.

The use of mobile apps provided CHWs with a centralized platform for task management, appointment scheduling, and patient information. This finding is consistent with previous studies that have highlighted the role of mHealth in improving task management and organization for healthcare workers (Baumann, Heuel, Bischoff, & Wollesen, 2023). The seamless communication and collaboration features of mobile apps also fostered better teamwork and coordination among CHWs and healthcare authorities, ultimately leading to improved service quality.

The findings of this study provide valuable insights into the benefits of using mobile technology in NCD service delivery through community health workers. The integration of mobile apps and digital platforms has led to a reduction in CHWs' workload, improvement in data collection and service access, enhanced training and

supervision, better reporting and monitoring, and overall better organization of tasks. These findings highlight the potential of mHealth in improving healthcare service delivery in resource-constrained settings. However, there are various challenges that need to be addressed to ensure the successful adoption and sustained use of mobile phones by CHWs. One of the primary challenges faced by CHWs is the financial aspect. While mobile technology offers promising solutions, it requires financial investment for the development and maintenance of mobile apps and digital platforms. In low-resource settings, where many CHWs operate, funding constraints can hinder the widespread adoption of mobile phones (Aljedaani & Babar, 2021). Adequate financial support from governments, non-governmental organizations, and other stakeholders is crucial to overcome this challenge and ensure the sustainability of mobile technology initiatives.

Poor technical support is another significant challenge faced by CHWs. Many CHWs may have limited technical expertise or experience with mobile phones and digital platforms. Inadequate training and technical support can lead to difficulties in using the apps effectively, reducing the potential benefits of mobile technology (Kruse et al., 2019). Comprehensive training and ongoing technical support are essential to enable CHWs to use mobile phones confidently and efficiently in their daily work. Cultural factors can also impact the adoption of mobile technology among CHWs. Some CHWs may be hesitant to embrace new technologies due to cultural beliefs or concerns about privacy and confidentiality (Swain, Muduli, Kumar, & Luthra, 2023).

Addressing these cultural barriers requires awareness-building and sensitization efforts, ensuring that CHWs understand the benefits of mobile technology and feel comfortable using it in their healthcare practices.

Moreover, technology-related challenges, such as poor network connectivity and limited access to electricity, can hinder the effective use of mobile phones by CHWs in remote and underserved areas (Kruse et al., 2019; Kurapati & Thippaiah, 2022). In regions with unreliable infrastructure, mobile technology may face limitations in terms of real-time data transmission and access to digital resources. Addressing these infrastructure challenges through improved connectivity and alternative power sources is crucial to maximizing the benefits of mobile technology for CHWs.

The adoption of mobile technology in NCD service delivery by CHWs has shown promising results, there are several challenges that need to be addressed to ensure its successful implementation. Financial constraints, poor technical support, cultural considerations, and technology-related limitations can impact the effective use of mobile phones by CHWs. Policymakers and stakeholders should take these challenges into account when designing mobile technology initiatives and provide the necessary support and resources to overcome these obstacles. By addressing these challenges, mobile technology can become a powerful tool in improving healthcare services and health outcomes in underserved communities.

CONCLUSIONS

In conclusion, mobile health (mHealth) technology has shown great promise in enhancing the performance of community health workers (CHWs) engaged in Non-Communicable Disease (NCD) services. The results of our study revealed that the integration of mobile apps and digital platforms in NCD service delivery brought about several positive outcomes for CHWs and their patients.

The adoption of mobile technology led to a reduction in CHWs' workload, improved data collection, increased service access and quality, enhanced training and supervision, better reporting and monitoring, and overall better organization of tasks.

However, several challenges, such as financial constraints, poor technical support, cultural considerations, and technology-related limitations, need to be addressed to ensure the successful and sustainable implementation of mobile technology initiatives. Policymakers and stakeholders must invest in proper training, technical support, and infrastructure improvements to overcome these challenges and fully harness the potential of mobile technology in improving healthcare services and health outcomes in underserved communities. With the right strategies and support, mobile health technology can serve as a valuable tool in strengthening NCD services and advancing healthcare delivery for vulnerable populations.

Acknowledgements

The authors thank the University of Hyderabad, the institute of eminence, for supporting the study. K.Jyothi is grateful to the University Grants Commission (UGC,India) for awarding the Senior Research Fellowship.

Conflict of Interest

The authors declare no conflict of interest.

Funding for this study

No

Reference

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