Healthcare Functionaries' Perceptions of Integration of Digital Health Technologies in Indian Public Health System: A Qualitative Descriptive Study

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Abstract

Despite their critical role in the design and implementation of new care practices, healthcare professionals' perspectives on the integration of digital technology in healthcare have rarely been taken into account in previous studies. This qualitative descriptive study aims to expand our understanding of healthcare professionals' views on digital health technologies by shedding light on their actual experiences using qualitative methods. Individual semi-structured in-depth interviews were conducted with healthcare professionals from three levels of healthcare settings: the policy/programme level, the district level, and the peripheral level. Participants were selected using both convenient and purposeful sampling to ensure a comprehensive representation of perspectives. Interviews were transcribed verbatim and analysed using inductive content analysis facilitated by the qualitative analysis software ATLAS.ti. Themes and sub-themes were identified to capture the nuanced experiences and opinions of the participants. Key findings indicate that healthcare professionals appreciate the enhanced connectivity and support provided by digital tools but also stress the need for improved technology infrastructure, user-friendly interfaces, and continuous training. Furthermore, participants highlighted the necessity of locally relevant information and a hybrid strategy that integrates digital and traditional training approaches to ensure effective implementation and utilization of digital health technologies. This study underscores the critical need for robust technology infrastructure, context-specific digital health solutions, and comprehensive training programs to support healthcare professionals in the digital age. Policymakers and stakeholders must prioritize these aspects to fully realize the potential of digital health technologies in improving healthcare outcomes.

Keywords: Digital Health, Healthcare, Healthcare Professionals, India, Mobile Health, Qualitative Research, Rural Healthcare, Telehealth; Technology Integration.

Introduction

The integration of digital technologies into healthcare systems, commonly referred to as digital health, has undergone significant advancements [1]. The concept of digital health is more expansive than the simple application of technology and instruments. It involves the critical role that radically functional data, artificial intelligence, and open and secure platforms play in providing consumer-centred and preventive healthcare. With the use of digital technology, digital health is starting to change the healthcare sector by improving data management, decision-making, and healthcare delivery.

Digital health, often known as eHealth, is defined by the World Health Organisation (WHO) as the application of digital technologies to health-related activities. This

catch-all phrase includes a wide range of technological innovations, including sensor-based monitoring, digital health games, telemedicine, telehealth, and mobile health (mHealth) [2]. Digital technologies with the potential to address major medical and clinical concerns include deep learning, cloud computing, blockchain technology, artificial intelligence, Internet of Things (IoT), big-data analytics, and cloud computing [3, 4]. By boosting patient-centred care, increasing adherence to clinical guidelines, improving care efficiency in hospital settings, and offering possibilities to enhance clinical practice, digital health services can fortify the healthcare system [5, 6].

The use of mobile technologies is booming in developing nations like India. Numerous fresh studies and advancements have been made in this field. These days, mobile is growing as an essential ICT tool in remote and rural locations as well as metropolitan areas. Due to its ease of use, rapidly advancing technologies, and decreasing device costs, mobile devices are a suitable and flexible instrument for closing the digital divide [7].

Numerous developing nations encounter obstacles in adequately monitoring and assessing the effects of peripheral occurrences and interventions within their healthcare systems. The deficiency of prompt feedback and data-informed decision-making poses a hindrance to the efficacy and productivity of healthcare provision. This study will try to investigate the potential of utilising low-cost mobile-based data-capturing approaches and other emerging digital technology-based tools and methods to tackle the challenges.

The data collected in interviews, will enable a comprehensive understanding of the current landscape, identify challenges, and inform evidence-based decision-making for the future design and implementation of mobile health strategies. To deliver morally and ethically sound treatment, healthcare practitioners must adapt to the digital age. Despite their critical role in the design and implementation of new care practices, healthcare professionals' perspectives on the integration of digital technology in healthcare have rarely been taken into account in previous studies. This study aims to expand our understanding of healthcare professionals' views on digital health technologies by shedding light on their actual experiences using qualitative methods. The study emphasizes the importance of incorporating digital solutions to address challenges in healthcare delivery, particularly in resource-constrained settings.

Data and Methods

Study Design

A descriptive qualitative design was chosen to explore the beliefs and perceptions of healthcare functionaries regarding the integration of digital health technologies in the Indian healthcare system [8]. This approach aimed to gain a deeper understanding of a relatively understudied topic using inductive methods. To collect data, individual semi-structured in-depth interviews were conducted with participants [9, 10].

Data Collection

In-depth interviews of key informants were conducted via telephonic medium from the respondents at all levels as selected for the study – the policy/programme level, district level, and peripheral level. The questions were formed into three levels: Policy/Programme, District, and Peripheral (Primary Health Centre (PHC)/Sub-centre) as follows: At the policy/programme level, the questions focus on the current state, goals, effectiveness, evidence, impact, integration, challenges, and feedback regarding mobile phone-based health solutions and telehealth services. At the district level, the questions inquire about implementation, uptake, outcomes, impacts on maternal and child health, barriers, facilitators, training programs, and challenges. At the peripheral level, the questions address adoption,

application types, effectiveness, challenges, usage frequency, patient satisfaction, training resources, impact on work, and suggestions for improvements and support needs.

Analysis

Audio recordings were made during the interviews, which were subsequently transcribed and cleaned to ensure accuracy. The transcriptions were thoroughly reviewed and translated when necessary to capture the exact meaning of the respondents' statements. Inductive content analysis was used to evaluate the data to uncover the complex experiences that digital health technologies bring to the local level and to give a general overview of the phenomena. The data was handled by AtlasTi software during the analysis. To familiarise the researcher with the perceptions of digital health technology, the data were first read through several times. Subsequently, the data were divided into meaning units, or codes, and one sentence was selected as the unit of analysis to begin the analytical procedure. Throughout the coding process, references to the study question were made. Every statement that answered the research question was categorised as an open code. The open codes were then grouped based on their contents and given suitable names. Additionally, verbatim quotes from the respondents were incorporated into the analysis to provide direct insights and support the findings. This approach ensured a robust and nuanced understanding of the data, enhancing the overall depth and validity of the research.

Ethical Considerations

Throughout the data collection and analysis process, we prioritized ethical considerations to ensure the protection and privacy of all participants. During the telephonic interviews, we provided a clear and thorough explanation of the interview's purpose to each participant. We obtained informed verbal consent from all participants before proceeding with the interviews. Throughout this process, we maintained strict privacy measures to keep the identities of the respondents confidential. The data collected was exclusively used for academic purposes, ensuring that participants' information remained secure and protected at all times.

Results

Thirty health professionals in all were questioned one-on-one for the in-depth interviews of key informants. Figures 1, 2, and 3 present the levels, locations, and professional roles of the varied participants of the respondents in the study. Most of the respondents were currently working at the national level (33%). The health system officers *(who were mainly involved in health policy and health infrastructure development)* made up the most prevalent profession among the participants who worked in a variety of healthcare settings, followed by district programme officers and national programme officers. Furthermore, the maximum of participants (83%) were working at the Policy/ Programme level, followed by 10% at the District level and 7% at the Peripheral level.
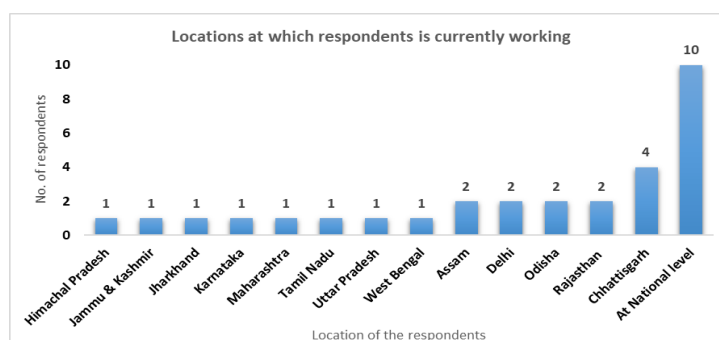
Figure 1. Locations at Which Respondents are Currently Working
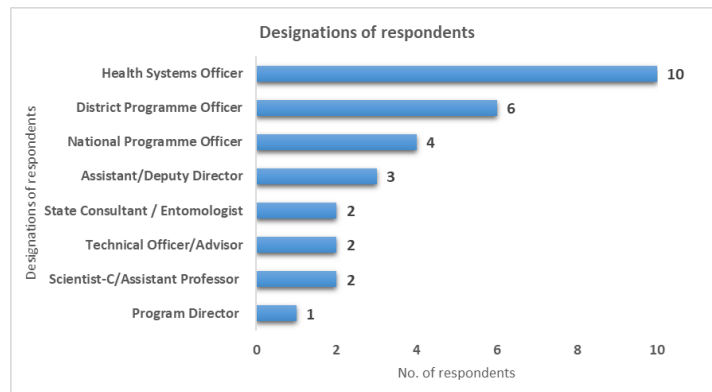
Figure 2. Designations of Respondents
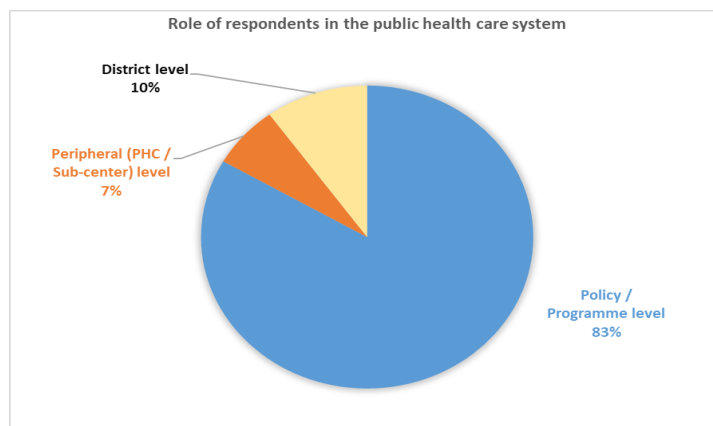
Figure 3. Role of Respondents in the Public Health Care System

The information about the in-depth interviews of key informants is given in Table 1. Following a content analysis, open codes were discovered in the data. Main categories (N=9), categories (N=16), and sub-categories (N=58) reflecting healthcare workers' perspectives on digital health technology, including their personal experiences and narratives, were then created from these codes. Although their integration is still developing, the creation and application of mobile phone-based solutions in India's national health programmes has substantially enhanced healthcare delivery. With their ability to improve accessibility, efficiency, and real-time decision-making, these digital technologies have become essential components of nearly all national health initiatives. Important initiatives like the Integrated Health Information Platform (IHIP), which was co-developed by the Ministry of Health and Family Welfare (MoHFW) and WHO, Arogya Setu for contact tracing during the COVID-19 pandemic, and eSanjeevani for telemedicine serve as examples of the broad application of mobile technology. Health professionals enter data, monitor patients, and monitor diseases using a variety of mobile applications, such as Nikshay, e-Aushadhi, and ANMOL. These solutions, which improve access to healthcare and offer quick medical advice, have proven especially helpful in rural and neglected areas.

Table 1. Healthcare Professionals'/Functionaries' Perceptions of Digital Technologies in The Public Health System

(An overview of main categories, categories, and sub-categories identified during content analysis)

Main Category	Category	Sub-category
1. Mobile-based solutions for the National Health Programs	Mobile-based applications to track the progress.	IHIP Portal. Arogya Setu App. NIKSHAY App. E-Aushadhi. HWC Portal. NCD Portal. ANMOL
2. Incorporation of mobile technologies in health services	Better data analysis for decision-making	Real-time reporting leads to timely actions. Effective monitoring and feedback. Efficiency in information gathering. Data-driven decision making
3. Evidence for the effectiveness of mobile solutions	Use of user-friendly applications	Real-time use of dashboards for the programs. Electronic family folders of patients. Referrals and follow-ups
	Usage of mobile phones at different levels	Connectedness of team members. Teleconsultations. Monthly report submission through phones
4. Accessibility and quality of telehealth services	Remote monitoring and continuous care	Providing access in remote, rural and underserved areas. Virtual consultations with populations with limited mobility/ transportation/infrastructure
	Timely interventions	Access to specialist opinion even on the last mile. Faster recovery of patients. Increase in specialist interventions
5. Impact of telehealth services	Ease of use of telehealth services	Accessibility. Reliability. Timeliness. Accuracy of data. Good quality data

	Improved quality of care	Timely medical advice. Reducing waiting time. Access to specialist services
6. Role of mobile technologies in disease surveillance systems	Integrated well into the system	App/portal for data entry. Easy analysis of data. Data for action and decision-making. Dashboards for tracking
	Real-time use of mobile technologies	Real-time data collection. Data reporting. Data analysis
	Monitoring	Surveillance. Prevention of outbreaks. Sending alerts. Timely recording and reporting of an event/outbreak. Case tracking. Distribution of health alerts.
7. Challenges in using mobile technologies for real-time disease monitoring	Network issues	Server down. Technical issues. Poor network/no network
	Digital illiteracy among health workers and the general population	Lack of awareness. ASHAs are not able to operate mobile phones properly. Lack of skill in using mobile phones by rural/ tribal/elderly population.
	Mobile applications	Tons of mobile applications. Lack of knowledge to operate a particular mobile app. Non-user-friendly apps.
8. Role of mobile phones in skill development and training of health functionaries	Capacity building and training	Use of local language. Use of audio notes. Mobile training modules.
9. Health workers' perspectives regarding mobile-based training programs	Flexibility and accessibility of training programs	Learning and upgrading skills at their own pace and convenience Interactive and engaging multimedia content. User-friendly interfaces. Relevant and practical training modules.

Nevertheless, there have been several difficulties with the implementation of these mobile-based solutions, particularly in rural and tribal areas. Their use is complicated by problems like poor internet and smartphone connectivity, reliance on personal mobile data, and the continued use of paper-based reporting systems. The strain placed on frontline staff members, who have to oversee the delivery of treatment in addition to data reporting across several platforms, emphasises the necessity for efficient procedures. According to one participant, "Online tools cause a lot of challenges, especially in rural and tribal states like Jharkhand." Health experts also stressed the need for improved technical assistance, capacity building, and high-quality mobile devices. Notwithstanding these barriers, there is still great promise for mobile phone-based solutions to enhance healthcare delivery, so attempts to overcome these implementation issues must continue.

Mobile-Based Solutions For the National Health Programs

Health experts viewed the inclusion of mobile phone-based solutions in India's national health programmes as a significant breakthrough and outlined several important advantages. The responsiveness of health interventions was greatly enhanced by near real-time reporting, which allowed for prompt responses and decisions. "Recording, reporting, tracking, feedback, and data-based analytics for decision-making" were all significantly improved by these mobile applications, according to one responder. Real-time data entry from the field was made easier by tools like the Kobo and ODK platforms, which improved the precision and promptness of the information acquired. This ultimately increased the reach and efficacy of healthcare services by improving programming interventions as well as enabling better monitoring and feedback on programme progress.

Additionally, these mobile-based solutions aided in the methodical collection of viewpoints on health-related matters and the profile of the active population, both of which were essential for formulating policy implications. Health professionals were more mobile literate because of user-friendly apps, which made data sharing quicker and more effective. This method, according to one key informant, will "enhance healthcare accessibility and equity, improve health outcomes, and strengthen health system efficiency and cost-effectiveness." These tools also had a significant impact on health education by providing people with timely information and support. In general, the use of mobile phone-based solutions was viewed as a revolutionary strategy for data-driven decision-making, to improve the oversight and implementation of community-level initiatives carried out by CHOs, ASHAs, and ANMs.

Incorporation and Efficiency of Mobile Technologies in Health Services

The efficiency of mobile phone-based solutions in enhancing the notification of important events like births and deaths was highly acknowledged by the health community. Numerous participants emphasised that these technologies facilitated instantaneous reporting and data gathering, hence markedly augmenting the precision and promptness of crucial information. To quote a respondent, "Mobile phone notification can enhance reporting, significantly improving birth registration rates and reporting of deaths." Real-time data was specifically mentioned as being collected through the Integrated Disease Surveillance Programme (IDSP) by the National Centre for Disease Control (NCDC) for the National Vector Borne Disease Control Programme (NVBDCP) and many more national programmes, as it helped predict early warning signals and battle public health threats. The solutions, according to the respondents, are "very effective since it removes the manual data

entry errors and delays," allowing for quick reaction to emergencies and epidemics.

Notwithstanding its efficacy, experts nevertheless recognised significant obstacles. The usability and user training of mobile phone-based notifications were critical to their success. According to another key informant, these methods are "very much effective; however, mobile users need easy apps and self-explanatory short training to share their vital information." Additionally, mobile solutions were thought to help report home births and deaths, particularly in rural locations, even though institutional birth registrations might not see much of an impact. One responder said, "Mobile phone-based solutions can be used to report deaths that occur at home." Overall, even if these technologies' promise and efficacy were acknowledged, appropriate.

Effectiveness of Mobile-Based Solutions

Health professionals largely agreed on the effectiveness of mobile phone-based solutions in improving vital event notifications, citing various pieces of evidence and data to support their claims. Monitoring indicators and real-time dashboards were mentioned as key tools used for gap analysis and performance tracking, which demonstrated the impact of these solutions. For instance, the Mother and Child Tracking System (MCTS) and the Reproductive and Child Health (RCH) portal were instrumental in ensuring the timely registration of births and maternal health events. These systems, utilizing mobile technology, significantly enhanced data accuracy and completeness, especially in rural and remote areas. One professional reported, "In India, several initiatives and pilot projects have demonstrated the effectiveness of mobile phone-based solutions in improving vital event notifications." Furthermore, the Solutions for Community Health Workers (SOCH), developed under the Malaria Elimination Demonstration Project in Mandla, provided

additional evidence of the benefits of these digital interventions.

Additionally, various mobile applications like Nikshay for TB reporting and ADR-PvPI for adverse drug reactions showcased the ease of reporting and data collection. Real-time data collection via mobile phones facilitated immediate interventions and improved the timeliness and reliability of mortality data, crucial for public health planning. Numerous research studies, including those conducted in Bangladesh, Zambia, and Rwanda, confirmed the positive impact of mobile phone-based systems on vital event registration and notification. However, some professionals pointed out the need for more localized studies to assess the effectiveness of these solutions in specific regions. One respondent emphasized, "Studies should assess the time spent on mobile solutions and whether the benefit is more," highlighting the necessity of continuous evaluation. Despite some challenges, such as digital literacy and gender disparity in access to technology, the overall consensus was that mobile phone-based solutions offered a substantial improvement over the traditional service delivery model.

Accessibility and Quality of Telehealth Services

Health professionals widely acknowledged the substantial impact of telehealth services on healthcare accessibility and quality at a national level in India. They highlighted various initiatives and evidence demonstrating these benefits. The eSanjeevani telemedicine platform, for example, facilitated over 25 million teleconsultations, significantly enhancing access to healthcare, especially in rural and remote areas. This platform bridged the gap between patients and healthcare providers, enabling consultations without the need for travel. One respondent noted, "Telehealth communication is very useful and widely used during the COVID-19 pandemic as well as Dengue case management."

Additionally, during the pandemic, telehealth became a critical tool, ensuring continuity of care when in-person visits were restricted. The National Telemedicine Service reported that around 80% of its users were from rural areas, indicating a significant reach among underserved populations. This access to specialized services that might otherwise be unavailable locally was seen as a major improvement in healthcare delivery.

Moreover, professionals pointed out that telehealth services enhanced patient outcomes through remote monitoring and continuous care, enabling timely interventions. One expert mentioned, "Telehealth has brought a much-needed revolution in healthcare delivery at the last mile." The use of telehealth reduced barriers to accessing care, particularly for populations with limited mobility, transportation options, or healthcare infrastructure. Despite some challenges, such as technological infrastructure and digital literacy, the potential of telehealth to bridge the rural-urban healthcare divide was widely recognized. As one respondent highlighted, "It has made healthcare reach the grassroots level. Decisions can be taken without wasting time in transport." However, professionals also noted the need for more robust support systems, such as dedicated resources, technological advancements, and proper motivation of staff to fully utilize telehealth services. Overall, the integration of telehealth services was seen as a transformative approach, enhancing healthcare accessibility and quality, particularly in underserved and rural areas.

Impact of Telehealth Services

Commentaries from medical professionals at the national level in India attest to the significant impact of telehealth services on healthcare quality and accessibility. The Ministry of Health and Family Welfare's eSanjeevani telemedicine platform was significant in reducing the distance between patients and medical professionals. Enabling more than 25 million teleconsultations to date, it greatly improved access to healthcare, particularly in isolated and rural regions. "Telehealth became a critical tool during the COVID-19 pandemic," according to one respondent, guaranteeing continuity of care while in-person visits were prohibited. According to the National Telemedicine Service, almost 80% of its users reside in rural areas, demonstrating the platform's wide appeal to marginalised groups. Healthcare professionals observed that telehealth enhanced the standard of treatment by offering prompt medical advice, cutting down on wait times, and facilitating access to specialised services that might not be available in their area. Thus, the inclusion of telehealth services improved the accessibility and equity of healthcare delivery throughout India.

Health professionals identified certain obstacles and opportunities for growth despite these gains. The successful introduction of telehealth was hindered by obstacles to virtual consultation and an inadequate technology infrastructure. Before switching to digital-first models, factors like patient trust and digital literacy also needed to be taken into account. A respondent stated, "Telehealth has lots of promise in improving the accessibility of care, especially the specialists' services, but awareness and demand need to be generated at the community level." The necessity of making the application technologically advanced to cater to the huge demand, ensuring the availability of network and hardware for providing these services, and motivating staff to use telehealth services were critical factors for its effective utilization. Even though there has been a noticeable improvement in access to specialised care, some people highlighted concerns about governance and quality issues that needed to be addressed. Even so, there was general agreement that telehealth services improved the quality and accessibility of healthcare nationally by offering remote consultations and ongoing monitoring,

lowering logistical and geographic barriers to care, and enhancing health outcomes through prompt interventions and effective use of resources, particularly in underserved and rural areas.

Role of Mobile Technologies in Disease Surveillance Systems

Health professionals highlighted the deep integration of mobile technologies into disease surveillance systems in India, significantly bolstering the country's public health infrastructure. The Integrated Disease Surveillance Programme (IDSP) was frequently mentioned as a prime example, utilizing mobile phone-based reporting to ensure timely and accurate data collection from across the nation. Health workers employed mobile apps for reporting infectious disease cases, which were then aggregated and analyzed at district, state, and national levels. This real-time data collection allowed for rapid identification and response to disease outbreaks. One professional noted, "Mobile technologies are integrated into disease surveillance systems by enabling real-time data collection, reporting, and analysis." The Arogya Setu app played a crucial role during the COVID-19 pandemic, aiding in contact tracing and monitoring the virus's spread, thus providing health authorities with essential information to manage the pandemic effectively. Moreover, mobile technologies were used for monitoring vector-borne diseases like malaria and dengue, with health workers uploading data directly from the field to enable swift public health interventions.

Challenges in Using Mobile Technologies for Real-Time Disease Monitoring

However, some respondents indicated that while mobile technologies were integrated well with existing systems, further modifications and enhancements were necessary. Despite their effective utilization in outbreak prediction and engagement of both public and private sectors, challenges remained in areas such as geographical information systems (GIS) and remote monitoring. One respondent mentioned, "It's started through IHIP but a lot of work is still pending due to which the disease surveillance has taken a hit." The use of mobile technologies in disease surveillance also included tools like the ADR PvPI app linked with Vigiflow software, highlighting their role in real-time data entry and case tracking. Other professionals emphasized the importance of mobile reporting, syndromic surveillance, and health information exchange (HIE) in enhancing detection, monitoring, and response to infectious diseases and public health threats. As one expert summarized, "Mobile technologies integrate into disease surveillance systems by enabling real-time data collection and reporting from healthcare providers, enhancing the speed and accuracy of outbreak detection and response." This integration facilitated timely communication, case tracking, and the distribution of health alerts, thereby improving overall public health management.

Role of Mobile Platforms in Skill Development and Training of Health Functionaries

Health professionals indicated that mobile platforms played an increasingly pivotal role in the continuous skill monitoring and training of health functionaries in India. Several initiatives, like the Extension for Community Healthcare Outcomes (ECHO) model, leveraged mobile technology to connect rural health workers with specialists through tele-mentoring and collaborative case-based learning. This approach significantly improved care quality in remote areas. The mobile academy initiative, an IVR-based training program, provided Accredited Social Health Activists (ASHAs) with flexible, accessible training on various health topics. Additionally, the mSakhi app offered comprehensive modules on maternal and child health, family planning, and other

health services using interactive tools, quizzes, and multimedia content to reinforce learning. One professional noted, "Mobile platforms are increasingly being utilized for continuous skill monitoring and training of health functionaries in various settings." These platforms collectively ensured that health functionaries received continuous, convenient, and effective training, enhancing their ability to deliver quality healthcare services across India.

However, despite these advancements, some respondents highlighted gaps and challenges in the widespread use and effectiveness of mobile platforms for training. While mobile platforms like Kilkari, which sends timely audio messages to pregnant women, new mothers, and health workers, were praised for their effectiveness, other professionals pointed out that many mobile training modules and platforms were still under development and not fully functional. One respondent mentioned, "Mobile platforms are just a medium, not a single-point solution. Physical skill monitoring and training along with refresher courses are much needed." Additionally, the field staff often preferred call centres or helplines and physical training as their methods for capacity building. Although mobile platforms had the potential to revolutionize health worker training, professionals emphasized the need for more localized content, better technological infrastructure, and a blended approach combining digital and physical training methods to ensure comprehensive skill development and monitoring.

Health Workers' Perspective Regarding Mobile-Based Training Programs

Health professionals noted numerous significant advantages and overwhelmingly provided good feedback about mobile-based training programmes. They valued the accessibility and flexibility these programmes offered since they allowed them to continue their education and improve their skills without interfering with their regular obligations. "Over

time, mobile platforms significantly reduced our work burden and helped maintain correct data," said one health worker. Particularly commended were programmes such as Mobile Academy and mSakhi, which were noted for their intuitive user interfaces and applicable, useful training programmes. They praised the interactive and multimedia information for being interesting and useful in improving their comprehension of a range of health-related subjects. Health professionals discovered that these platforms dramatically increased their knowledge, confidence, and capacity to deliver better healthcare, despite the early difficulties in adjusting to mobile learning.

But there were also some difficulties mentioned. Significant obstacles mentioned by health workers included sporadic technical problems, disparities in digital literacy, and uneven cell network availability in some places. "The intricacy of the application and technical issues can be frustrating at times," said one respondent. An additional hardship was the requirement to balance mobile training with their many field obligations, which included regular immunisation days, home visits, and field trips. "It's challenging to manage mobile training along with field visits and other programme days," stated an additional health worker. Despite these difficulties, the consensus was that mobile-based training programmes provided important benefits and helped India's health system become more effective and efficient. They underlined the platforms' ongoing need for improvement.

Health Functionaries' Perceptions of Digital Health Technologies

The accessibility, effectiveness, and quality of healthcare have been greatly improved by the incorporation of telehealth services and mobile phone-based solutions into India's national health programmes, especially in rural and underserved areas. This influence is best shown by the eSanjeevani telemedicine platform, which has enabled millions of consultations and

closed the communication gap between patients and medical professionals. With the use of mobile apps like IHIP, Nikshay, e-Aushadhi, and ANMOL, data entry and disease monitoring have become more efficient, resulting in better health outcomes and prompt interventions. Notwithstanding, certain obstacles continue to exist, such as inadequate technology infrastructure, obstacles related to digital literacy, and the requirement for ongoing technical assistance and capacity development. Health professionals have emphasised the need for improved technology infrastructure, locally relevant information, and a hybrid strategy that integrates digital and traditional training approaches. Notwithstanding these barriers, telehealth and mobile technologies are widely acknowledged to have the potential to revolutionise healthcare delivery; therefore, continued efforts are necessary to resolve implementation issues and optimise their advantages.

Discussion

The integration of mobile phone-based solutions into India's national health programmes represents a significant advancement in healthcare delivery, particularly in terms of enhancing accessibility, efficiency, and real-time decision-making. This study highlights the experiences and perspectives of healthcare workers on the use of digital health technology, providing valuable insights into both the benefits and challenges of these innovations.

Healthcare workers acknowledge the substantial benefits of mobile phone-based solutions in improving healthcare delivery. For instance, applications like Nikshay for TB reporting and eSanjeevani for telemedicine have demonstrated how mobile technologies can facilitate timely interventions and improve healthcare outcomes. Additionally, tools such as the Kobo and ODK platforms enhance data accuracy and promptness, leading to more effective healthcare programming and

monitoring. These technologies have shown particular promise in rural and underserved areas, where traditional healthcare services are often limited. A primary study conducted in 2023 used content analysis on 168 smartphone applications designed for health professionals, classifying them based on their diagnostic type and features. The study found that app features are closely related to ethical concerns of privacy and trustworthiness. It recommended that developers focus on creating useful apps for social good. Additionally, the study revealed that AI-based apps score higher in privacy and security features [11].

The efficiency of mobile phone-based solutions is well-recognized among healthcare professionals. For example, the Integrated Disease Surveillance Programme (IDSP) leverages mobile technology for real-time data collection, which is essential for predicting early warning signals and responding to public health threats. However, challenges such as poor internet connectivity, reliance on personal mobile data, and the continued use of paper-based reporting systems in rural areas complicate the implementation of these solutions [12]. Moreover, the burden on frontline workers to manage data reporting alongside healthcare delivery underscores the need for streamlined processes and enhanced support systems [13].

Telehealth services have had a profound impact on healthcare accessibility and quality in India. Platforms like eSanjeevani have facilitated millions of teleconsultations, bridging the gap between patients and healthcare providers, especially in remote areas. A review of the literature highlights that user-friendliness and low start-up costs make m-health an attractive option in the developing world. However, for m-health to be effective, the applications must be customized to fit the complexities of local healthcare delivery networks and appropriate financial models need to be developed [14].

During the COVID-19 pandemic, telehealth became a critical tool for ensuring continuity of care when in-person visits were restricted [15]. The success of telehealth in reaching rural populations demonstrates its potential to reduce barriers to healthcare access. In developed countries, it is common for patients to have routine appointments with their physicians via real-time teleconferencing [16]. During these sessions, physicians typically review the patient's electronic medical records, which include their medical history, laboratory results, imaging studies, and other tests conducted at medical centres. This exchange of data and real-time discussion allows for effective management and treatment of many routine and specific medical issues. With the addition of diagnostic tools on the patient's side, such as stethoscopes, cameras, blood tests, and skilled medical technicians, the range of medical services available through telemedicine has expanded significantly [17]. However, challenges such as technological infrastructure, digital literacy, and the need for robust support systems remain. Healthcare professionals emphasize the importance of technological advancements, resource availability, and staff motivation to fully leverage telehealth services [18].

Mobile technologies have become integral to disease surveillance systems in India, enhancing the country's public health infrastructure. The Integrated Disease Surveillance Programme (IDSP) and apps like Arogya Setu for COVID-19 contact tracing exemplify the effective use of mobile technology for real-time data collection and outbreak management [19]. These technologies enable rapid identification and response to disease outbreaks, improving overall public health management. Nonetheless, further enhancements are needed to address challenges in areas such as geographical information systems (GIS) and remote monitoring [20].

Mobile platforms play a crucial role in the continuous training and skill development of health functionaries in India. Initiatives like the Extension for Community Healthcare Outcomes (ECHO) model and the mobile academy provide accessible and flexible training opportunities for health workers. These platforms ensure that health functionaries receive ongoing education, enhancing their ability to deliver quality healthcare services. Despite the benefits, gaps and challenges in the widespread use and effectiveness of mobile platforms for training persist. Healthcare professionals highlight the need for localized content, better technological infrastructure, and a blended approach combining digital and physical training methods to ensure comprehensive skill development [21].

Healthcare workers overwhelmingly support the integration of digital health technologies into national health programmes, recognizing their potential to improve healthcare delivery. Mobile-based solutions and telehealth services have significantly enhanced the accessibility, efficiency, and quality of healthcare, particularly in rural and underserved areas [22]. However, barriers such as inadequate technological infrastructure, digital literacy challenges, and the need for ongoing support and training remain. In a country like India, it is not enough to simply offer services for a fee. Active community participation is essential to reduce the burden of preventable problems. Implementing such projects should include a sense of service and incentives for working with marginalized groups [23]. Empowering grassroots intermediaries to engage their communities is crucial for fostering local ownership. This is especially effective when culturally appropriate content and services are provided to meet the needs of the poor [24, 25]. Health professionals advocate for improved technology infrastructure, locally relevant information, and a hybrid approach to training to maximize the benefits of these digital health technologies.

Conclusion

The integration of telehealth services and mobile-based solutions has become imperative in India's healthcare system, as it enhances both the accessibility and quality of care, particularly in remote and rural areas. The real-time data collecting, prompt medical advice, and ongoing monitoring made possible by these digital tools have greatly improved the delivery of healthcare.

Even with obstacles like digital literacy and technology infrastructure, the benefits to health outcomes and the effectiveness of healthcare services are clear. Ensuring the successful integration and sustainability of these technologies will require sustained research and improvement, as well as focused efforts to remove current obstacles. All things considered, the use of mobile technologies and telehealth is a revolutionary approach to healthcare that promises to make India's healthcare system more accessible, equitable, and effective.

In conclusion, while the integration of mobile phone-based solutions and telehealth services has transformed healthcare delivery in India, ongoing efforts are necessary to address implementation challenges and optimize their advantages. Research studies supporting these points would further substantiate the findings and provide a more comprehensive understanding of the impact of digital health technologies on healthcare delivery.

Declarations

Conflict of Interest

The authors declare no conflict of interest.

Contribution

The corresponding author confirms sole responsibility for study conception and design, data collection, interpretation of results, and manuscript preparation. The second author (HS) did a literature search, data management and data analysis.

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Disclaimer

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