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ORIGINAL ARTICLE

PERCEPTIONS FROM FIELD-LEVEL HEALTHCARE PROVIDERS ON DIGITALIZATION OF HOME-BASED ANTENATAL CARE: A MIXED-METHODS STUDY IN KUNDRATHUR BLOCK, KANCHEEPURAM DISTRICT

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ABSTRACT

INTRODUCTION : Despite significant global advancements, maternal mortality remains a pressing public health issue, particularly in low- and middle-income countries like India. Effective antenatal care (ANC) is vital for reducing maternal deaths, especially in underserved areas.
OBJECTIVES : This study aims to explore the perceptions and experiences of field-level healthcare providers regarding the digitalization of home-based antenatal care in Kundrathur Block, Kancheepuram District.
METHODS : The study utilized both quantitative and qualitative approaches. A semi-structured questionnaire was administered to assess providers' knowledge, attitudes, and practices concerning digital tools. Focus group discussions (FGDs) complemented the quantitative data, offering deeper insights into the facilitators and barriers of digitalization in ANC services.
RESULTS: Our study revealed that 92.8% of participants were aware of digitalization initiatives, with 85.8% using mobile health apps and 14.2% using electronic health records (EHR). However, 90.5% reported challenges related to insufficient training, and 88% faced technical issues. Despite these challenges, 66.7% had a positive attitude towards digital antenatal care, while 33.4% viewed it negatively. Additionally, 61.9% believed digitalization improved the quality of antenatal care services, and 64.3% reported daily usage of digital tools. However, 59.5% identified a need for standardized data protocols. Participants highlighted the necessity of digital tools for monitoring pregnancies and reported partial digitalization, with some services still relying on manual methods. Common barriers included poor infrastructure, lack of training, internet connectivity issues, and community resistance.
CONCLUSION: The study highlighted practical challenges and benefits associated with digital tools. Addressing barriers such as training needs and digital literacy is essential for successful implementation. Enhancing healthcare providers' engagement and support will improve the effectiveness of digital interventions. Leveraging technology in maternal healthcare has the potential to significantly reduce maternal mortality rates and improve overall health service delivery in underserved communities.

KEYWORDS : Digitization, Antenatal care, Healthcare workers, Perceptions.

INTRODUCTION

The Sustainable Development Goals (SDGs) highlight maternal mortality as a critical global public health issue. One of the primary objectives of SDG-3 is to reduce the worldwide maternal mortality ratio (MMR) to fewer than 70 per 100,000 live births by 2030 (WHO, 2015). Despite significant global progress, maternal deaths remain alarmingly high, especially in low- and middle-income countries, with an estimated 800 women dying daily from avoidable causes related to pregnancy and childbirth (WHO, 2019)1. This emphasizes the need for comprehensive maternal health services, particularly in impoverished and rural areas where access to quality healthcare is often limited.

In India, maternal mortality has decreased significantly, with a remarkable 77% reduction in the MMR, falling from 301 per 100,000 live births in 2001–2003 to 97 in 2018–2020 (Government of India, 2022)2. This decline is consistent with the goal of reducing the MMR to 139 per 100,000 live births by 2015. India has made substantial strides in maternal health, driven by national initiatives such as the Pradhan Mantri Surakshit Matritva Abhiyan (PMSMA) and the Janani Suraksha Yojana (JSY), which have significantly contributed by providing free antenatal care (ANC) checks and promoting institutional births (National Health Mission, 2016).[3] Tamil Nadu, in particular reported an MMR of 54 per 100,000 live births, surpassing the SDG target (Government

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of India, 2022).[2] The Muthulakshmi Reddy Maternity Benefit Scheme (MRMBS) in Tamil Nadu has been a pivotal initiative in improving maternal and child health outcomes, significantly contributing to the increase in institutional deliveries and the reduction of maternal mortality in the state. Launched in 1987 and subsequently modified, the scheme provides financial assistance to pregnant women from economically disadvantaged backgrounds, encouraging timely antenatal care (ANC) registration, institutional delivery, and postnatal care.

The increased uptake of institutional deliveries has had a direct impact on the decline of Tamil Nadu's Maternal Mortality Rate (MMR), which dropped from 90 per 100,000 live births in 2005 to 54 per 100,000 live births in 2020.

Recognizing the value of digitization in healthcare, GoI and Govt of Tamil Nadu have initiated programs to enhance health outcomes through technology. Tamil Nadu has implemented the PICME (Pregnancy and Infant Cohort Monitoring and Evaluation) portal, designed to monitor the health of pregnant women and infants in 2008. This portal tracks vital health data to ensure timely interventions, improving maternal and infant health outcomes. Annually, it captures data from approximately 8,713 Village Health Nurses in rural areas and 1,846 Urban Health Nurses in urban areas. Building on these initiatives, Mother Life Antenatal Care, an application developed in 2023 to offer a comprehensive obstetric evaluation that includes vital parameters such as Weight of the Pregnant Mother, Hemoglobin Level, Fetal Heart Rate, Single Lead ECG Reading, Blood Glucose, Blood Pressure, SpO2, Temperature, HCT (Mean). The app aims to reduce maternal mortality and diagnose disease conditions early, featuring AI-based analysis, geofencing notifications, automatic trimester updates, EDD alerts, and teleconsultation capabilities, ensuring data security and compliance with HIPAA and ISO 27001 standards.

The application was pilot tested in Kundrathur Block, Kancheepuram District, among 495 pregnant women who were in their 10th week of pregnancy or above, and had no severe comorbidities or preexisting systemic illnesses over a period of 180 days with three follow up. All the 5 PHCs and 37 HSCs of the Kundrathur Block, Kancheepuram District were included. Healthcare workers (SHNs, VHNs, and ANMs) received training during March to May 2023 on app usage, interpretation of abnormal readings (e.g., high blood pressure), and appropriate escalation protocols to SHN/MO/BMO using the teleconsult feature.

During the pilot, tele kits were provided for data collectionduring home visits, SHN/VHN/ANM carried the kit along with them during home visits and recorded the health data of the pregnant mothers on the mobile application. The recording of vital parameters was done automatically but there was also a provision for manual entry by the healthcare workers. All data were saved automatically as long as the device is connected to the internet, minimizing manual entry errors common in existing portal like PICME. Weekly reports highlighting abnormal data were sent to officials, with operational support from app developer for a year.

Hence, this study aims to explore the perceptions and experiences of field-level healthcare providers regarding the digitalization of home-based antenatal care in Kundrathur Block, Kancheepuram District.

METHODS

A mixed methods study was conducted from March 2023 to February 2024. Initially we conducted a quantitative questionnaire- based survey to assess the knowledge, attitude and perceptions of field-level healthcare providers regarding the digitalization of home-based antenatal care and followed this up with a qualitative research method to gain a deeper understanding of the healthcare workers perceptions towards experiences, and challenges of digitalization in ANC services.

Study setting and population:

The study was conducted in the Kundrathur block, Kancheepuram district of Tamil Nadu, across five main Primary Health Centers (PHCs). The study was conducted among all the VHNs and SHNs in the Kundrathur block. Thus, 37 Village Health Nurses (VHNs) from 37 Health Sub-Centers (HSCs) and 5 Sector Health Nurses (SHNs) from the PHCs were involved in this study. VHNs and SHNs in Tamil Nadu are female healthcare providers, who work to deliver primary health care to the community and serve as a bridge between the community and the public health system. Their responsibilities include: Providing medical care, Educating the community on health, and working closely with the community. Village Health Nurses (VHNs) play a vital role in delivering maternal and child health care including antenatal care, postnatal care, family planning, immunisation and child health services, health monitoring and surveillance, referral and coordination.

Data collection:

A preliminary quantitative survey was conducted with all the 37 VHNs and 5 SHNs using a semi-structured questionnaire containing details on socio-demographic information, knowledge, attitudes, and practices (KAP) regarding digitization of antenatal care. After analyzing

the quantitative study findings, we obtained a broad understanding of the perceptions related to digitization of antenatal care. Based on the understanding, we wanted to explore their perceptions, experiences and challenges.

Focus group discussions (FGDs) served as the primary data collection method, for capturing collective understanding of the VHNs' experiences and perspectives on digital antenatal care. Participants were selected using convenience sampling.

Two FGDs each consisting of 9-10 participants, inclusive of 7 to 8 VHNS and 2-3 SHNs were conducted using interview guide that explored VHNs' knowledge, attitudes, and practices concerning digital ANC services across four key domains: individual-level factors (knowledge, attitudes, behaviors), interpersonal factors (peer, supervisor, and community interactions), community and social factors (societal views, community influence), and institutional factors (organizational support, infrastructure, access to digital tools). Entire discussion was recorded and transcribed verbatim with verbal consent. First author acted as facilitator for the discussion. She used probes in the beginning to elicit the discussions. When discussions went off track, the facilitator intervened, summarized the discussions and used specific probe questions to bring the discussions back to track. All the participants were given a chance to agree or challenge the interpretations and reflect on the key points summarized. Each discussion lasted around 1 hour.

Data analysis:

Quantitative variables were analyzed using frequencies and percentages. The data from the FGDs were transcribed as verbatim and analyzed using a deductive approach based on the Socio-Ecological Model (SEM). Atlas TI-23 software was used in organizing and coding the data, incorporating emerging themes into a comprehensive model that highlighted the multi-level influences on ANC digitization.

Ethical considerations:

Ethical approval was obtained from the Institutional Ethics Committee DPHPM/IEC/2024/012. Informed consent was obtained from participants, ensuring they understood the study's purpose, procedures, and their right to withdraw without consequences. Confidentiality and anonymity were maintained throughout the research process.

RESULTS

This study explores healthcare workers' views on the digitization of home-based antenatal care through quantitative survey and focus group discussions (FGDs).

Table 1: Socio-Demographic Characteristics of participants in the Kundrathur PHC Block, 2024

Socio-demographic data		Frequency (n=42)	Percentage (%)
Age in years	30-40 years	23	54.7
	>40 years	19	45.3
Marital status	Married	39	92.8
	Single		
	Widow	3	7.2
Education	Bachelors in nursing	26	61.9
	Diploma in nursing	16	38.1
Working experience	1-10 years	29	69.1
	>10 years	13	30.9
Place of residence	Urban	24	57.1
	Rural	18	42.9
Distance from workplace	<5 km	18	42.9
	>5km	24	57.1
Training on digital antenatal care provided by organization	Yes	39	92.8
	No	3	7.2

Table 1 provides a detailed overview of the socio-demographic characteristics of the 42 participants. Among the 42 participants, 54.7% are aged between 30-40 years, and 45.3% are older than 40 years. All participants are female, with 92.8% being married and 7.2% being widows. Regarding work experience, 69.1% have between 1-10 years of experience, and 30.9% have more than 10 years. Additionally, 92.8% of the participants received training on digital antenatal care provided by the, whereas 7.2% did not receive any training.

Table 2: Knowledge, Attitude, and Practice about digitalization of home based antenatal care

Knowledge		Frequency (n=42)	Percentage (%)
Are you aware of the digitalization initiatives for home-based antenatal care in Kundrathur block?	Yes	39	92.8
	No	3	7.2
What digital tools or platforms are used for antenatal care documentation and communication?	Mobile health apps	36	85.8
	Electronic health records (EHR)	6	14.2
How do these digital tools help in tracking and monitoring the health of pregnant women?	By providing real-time health data	40	95.3
	By enabling remote consultations with specialists	2	4.7
Attitude			
How do you feel about the shift from traditional to digital methods in antenatal care?	Positive	28	66.7
	Negative	14	33.4
Do you believe that digitalization can improve the quality of antenatal care services?	Yes	26	61.9
	No	16	38.1
What challenges do you face while using digital tools for antenatal care?	Technical issue	38	90.5
	Insufficient training	4	9.5
Practice			
How often do you use digital tools for antenatal care activities?	Daily	27	64.3
	Weekly	15	35.8
How do you ensure the accuracy and completeness of digital records for antenatal care?	Regularly cross-checking data	17	40.5
	Using standardized data entry protocols	25	59.5
Have you had any technical problems with digital tools?	Yes	37	88.0
	No	5	11.9

Table 2 shows that among the 42 participants, 92.8% are aware of the digitalization initiatives for home-based antenatal care, and 85.8% use mobile health apps for documentation. Most (95.3%) believe these tools provide real-time health data. While 66.7% feel positively about the shift to digital methods, 90.5% face challenges like technical Issues (enlist issues), and 88% encounter technical issues related to digital tools (Enlist issues). In practice, 64.3% use digital tools daily, with 59.5% using standardized protocols to ensure data accuracy.

The identified themes in FGDs under four levels of Socio-Ecological Model (SEM) include.

1. Individual Level.

a. Knowledge and Awareness of Digital Antenatal Care

Health care workers expressed they have received inadequate hands-on training and their knowledge of the specific features of these tools was limited. Some of their responses include:

I've heard about it from our training.
We received limited information.
Yes, I'm aware but haven't used it much & I don't fully understand how it works.
Some of my colleagues mentioned it during our meeting.
We haven't been briefed enough; it's still a bit vague.
I've seen posters in the PHC, but I need more information.
I am aware, but I have no hands-on experience.

b. Awareness of Content and Necessity

Most providers expressed that the app adds value to the antenatal services provided, but poses challenges in adapting. They also felt that certain antenatal care aspects, like mental health screening and nutrition, were underrepresented.

It is crucial for tracking pregnancies in remote areas.
It would definitely make our work faster in emergencies.
I think it's essential for tracking multiple pregnancies.
It's necessary but seems challenging for us to adapt.

2. Interpersonal Level:

a. Perception of Services and community views

Healthcare workers expressed that while digital tools improved service efficiency, especially in follow-ups, some providers felt the personal connection with patients had decreased. Responses were mixed, with older women often preferring traditional tracking methods over digital tools.

We are starting to implement it slowly.
Not all services are integrated yet.
Limited to basic record management & Only data entry is digitalized.
We use it, but the system is slow.
We've been given tablets, but we rarely use them fully.
The system needs to be more user-friendly for us.
Some of the services are digital, but there's no consistency.
We mostly still rely on paper-based records.
It's mostly used for documentation, not for the actual care delivery.

3. Organizational:

a. Challenges and barriers for providers

Providers faced issues like poor infrastructure, slow internet, limited devices, and technical glitches. The increased workload of entering data digitally added stress, and system failures delayed record updates. They recommended regular training and user-friendly platforms with better technical support.

Lack of training is a major issue.
We don't have enough infrastructures.
Internet connectivity is poor.
Not enough technical support.
We need more training on these tools & Frequent power cuts disrupt usage.
We lack the right training to use the devices efficiently.
Sometimes the systems freeze or don't load properly.
Internet issues are very common in our area.
There's no dedicated staff to help us with technical issues.
We face frequent disruptions due to power cuts.

b. Readdress mechanisms for provider challenges

Simplify the tools for rural health workers & Access to better devices is key.
We need refresher training on using the digital tools.
Technical support should be available, even remotely.
Simplifying the apps would make it easier for us.

4. Community level:

Rural communities, especially older women, struggled with mobile apps due to low digital literacy and concerns about privacy. Outreach programs to educate the public, simpler interfaces, and field worker assistance were suggested to improve engagement.

a. Challenges and barriers from the community side

Lack of awareness is a barrier.
People don't understand the technology & There's resistance due to unfamiliarity.
Some don't have access to smartphones & People fear losing their records.

Many people are not comfortable with technology.
There's a language barrier when using digital platforms.
Low literacy rates make it difficult for them to engage with digital tools.

b. Readdress mechanisms for community challenges

Community leaders should be involved & Education campaigns are needed.
We should use local languages for training & Digital literacy training is essential.
We should focus on educating them about the advantages.
Introducing digital tools in local languages would help.
Workshops and demonstrations could encourage them to use it.
Conducting awareness programs at the village level would be beneficial.

5. Policy Level: Strategies and Suggestions

Providers urged for better digital infrastructure, especially in rural areas, and more comprehensive training. They called for updated digital tools that cover all aspects of antenatal care and ensure that personal interaction remains central to care. Continuous training, improved privacy measures, and community sensitization were also recommended to build trust in digital systems.

We need tools for monitoring vitals.
Flagging high-risk cases is important & Maternity tracking should be included.
Include checklists for risk factors & Simplify recordkeeping tools.
We need tools that can track patients' progress easily. Make mobile apps for antenatal care.
It should include reminders for check-ups and follow-ups.
Vital sign monitoring should be integrated into the system.
It's important to have data analytics features for better care.
We need to manage both digital and manual systems.
We need to be trained properly before we can teach the community.
Health workers should have a say in how the tools are developed.
Improve internet access in rural areas. & More tablets for home visits would help.
Provide access to cloud storage for data. We need better devices for rural healthcare workers.

DISCUSSION

Our study found that 92.8% of the participants were aware of digitalization initiatives, with 85.8% using mobile health apps and 14.2% using electronic health records (EHR). Electronic Health Records (EHR) store all the information collected during antenatal visits and save it in an Excel sheet. This approach is especially helpful in situations where internet connectivity is low, ensuring that data remains accessible and organized for healthcare providers. This high level of awareness is crucial as it establishes a foundation for the successful implementation of digital health interventions. This finding aligns with a study conducted in Tamil Nadu where primary healthcare workers demonstrated similar awareness and reliance on mHealth tools for tracking maternal health data, highlighting the widespread acceptance of such technologies in improving maternal care across India. [4, 5] This consistent use of mobile platforms underscores the potential of digital tools to streamline healthcare processes and enhance maternal care services. Despite the high awareness, our findings revealed significant challenges related to insufficient training and technical issues, with 90.5% of participants reporting inadequate training and 88% mentioning technical difficulties. These challenges are mirrored in a study from Uttar Pradesh, where frontline health workers faced similar issues, including poor network connectivity and frequent technical glitches (internet connectivity, limited digital literacy, and inadequate infrastructure).[6] These obstacles highlight the need for comprehensive training programs and robust technical support to ensure that healthcare providers can effectively utilize digital tools. The study showed that 66.7% of the participants had a positive attitude towards the shift to digital antenatal care, though 33.4% viewed it negatively. This mixed response is consistent with findings from studies in Karnataka and Maharashtra, where healthcare workers acknowledged the benefits of digital tools but also raised concerns about increased workloads, usability issues, and device reliability.[7]

To foster a more positive attitude, it is essential to address these concerns through user-friendly designs and adequate support systems. A significant 61.9% of participants believed that digitalization improved the quality of antenatal care services. This belief aligns with a study in Odisha, which found that mobile health tools significantly enhanced the tracking of high-risk pregnancies and facilitated timely referrals8. Digital platforms contribute to better monitoring, improved data management, and enhanced communication between health providers and patients, which are crucial for quality care delivery. Our study indicated a daily usage rate of 64.3% for digital tools in routine antenatal care tasks, reflecting a relatively high integration of these tools. This finding is consistent with experiences from Andhra Pradesh, where similar digital health interventions showed increased daily usage among health workers9. However, the need for standardized data protocols to ensure accuracy,

as identified by 59.5% of participants, remains a persistent challenge across various studies in India. Participants had varying degrees of awareness but often lacked detailed knowledge about digital tools. A study in Himachal Pradesh noted similar findings, where healthcare workers were aware of digital health initiatives but had limited understanding due to insufficient training.[10] This emphasizes the need for ongoing education and support to bridge knowledge gaps and enhance the effectiveness of digital health interventions. Participants highlighted the necessity of digital tools for monitoring pregnancies, particularly in tracking high-risk cases. This aligns with a study in Jharkhand, which emphasized the importance of digital tools in improving antenatal care and maintaining accurate health records11. Ensuring that digital platforms are equipped to handle comprehensive care, including mental health and nutritional support, is crucial for holistic maternal healthcare. The study noted partial digitalization, with some services still relying on manual methods, and low demand from the community with resistance to digital tools especially among older women and those with lower digital literacy. This aligns with the study done in Rajasthan.[12] Similar challenges were observed in Gujarat, where community members preferred paper-based systems and were skeptical about digital records13. To address these issues, targeted outreach programs that educate communities about the benefits of digital health tools are essential. Participants reported challenges related to poor infrastructure, lack of training, and internet connectivity issues. These barriers were also highlighted in a study from Madhya Pradesh, where healthcare workers faced significant obstacles due to inadequate digital infrastructure.[14] Our participants suggested infrastructure improvements, ongoing training, and better technical support to overcome these barriers similar to study done in West Bengal.[15] Low literacy and unfamiliarity with digital tools were significant barriers to community engagement. A study in Bihar found that these issues led to resistance, particularly among older populations in rural areas.[16] Our study highlighted the need for awareness programs and local language training to improve digital literacy and community acceptance similar to study done in Karnataka.[17] Participants emphasized the need for digital tools that track high-risk pregnancies and monitor vital signs. This recommendation aligns with a study in Kerala that suggested digital health tools should focus on these critical aspects.[18] Additionally, empowering healthcare workers to lead community education on digital tools, as found in a study from Maharashtra, could enhance community trust and digital engagement.[19]

LIMITATIONS

The study was conducted in a single block (Kundrathur) within the Kancheepuram District, limiting the generalizability of the findings to other regions or districts. While FGDs provided in-depth insights, the qualitative data collection was limited to only two focus groups, which may not capture the full range of experiences and perspectives among all VHNs and SHNs in the state. Further studies with in depth interviews are required. The relatively short duration of the study may not capture long-term challenges and benefits associated with the digitization of antenatal care services.

CONCLUSION

The digitalization of home-based antenatal care in Kundrathur block represents a vital step towards improving maternal health outcomes in rural settings. By engaging field-level healthcare providers, this study sheds light on their perspectives, which are crucial for understanding the practical challenges and benefits associated with digital tools. Healthcare providers believed that digitalization improved the quality of antenatal care services that facilitated daily usage of digital tools. Community views and demands, such as less demand from community need to be focused. While the field level healthcare providers feel positively about the shift to digital methods, insufficient training, technical issues, poor internet connectivity, and inadequate infrastructure are the perceived challenges in digitizing home based antenatal care. Addressing the identified barriers such as training needs and digital literacy will be essential for successful implementation. As these healthcare providers play a pivotal role in delivering quality antenatal care, fostering their engagement and support will enhance the effectiveness of digital interventions. Ultimately, leveraging technology in maternal healthcare has the potential to significantly reduce maternal mortality rates and improve overall health service delivery in underserved communities.

RECOMMENDATIONS

To address the challenges identified in the study, it is recommended to implement comprehensive training programs for healthcare providers, improve technological infrastructure, develop standardized data protocols, and conduct community awareness campaigns. Establishing robust support systems and engaging healthcare providers in the development of digital tools can enhance usability and acceptance. Additionally, providing incentives and localized training materials, along with regular monitoring and

evaluation, will ensure the ongoing effectiveness of digital antenatal care services in the Kundrathur Block and beyond. Policy support is also essential for the integration of digital health tools into routine healthcare practices.

CONFLICT OF INTEREST

None

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