

An Examination of the Potentials and Limitations of Incorporating Digital
Technologies within Community Health Workers Systems in Western Kenya

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A thesis submitted
in partial fulfillment of the
requirements for the degree of

Master of Public Health
University of Washington

2024

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Program Authorized to Offer Degree:

Department of Global Health

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Abstract

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Implementing digital health technologies can significantly enhance maternal and child health (MCH) outcomes in low- and middle-income countries (LMICs). This study examines the integration of digital technology into Community Health Worker (CHW) systems in Western Kenya, focusing on the effects on MCH services. The research analyzes the strengths, limitations, and stakeholder perceptions of incorporating digital tools into CHW workflows and provides recommendations for enhancing digital integration in MCH programs.

Findings imply that digital health tools improved workflow efficiency, data accuracy, and job satisfaction among CHWs. Participants reported enhanced patient management, reduced physical burdens, and better communication with supervisors and patients. Nevertheless, significant challenges included technological access and reliability issues, usability and configuration problems, data security and privacy concerns, and the sustainability of digital health initiatives.

Despite the advantages, successful and lasting integration of digital health technologies in MCH services in Western Kenya demands that these challenges be addressed. The study recommends strengthening infrastructure, providing robust training and support, enhancing data security policies, and establishing sustainable financing sources. Overcoming these barriers will enable stakeholders to maximize the impact of digital health tools on MCH outcomes and healthcare delivery, supporting broader goals of universal health coverage and reduced maternal and neonatal mortality.

Acknowledgment

The process of finalizing this thesis has been fraught with numerous obstacles. From academic challenges to the realities of clinic wards and immigration offices, the experiences and people I have interacted with have profoundly shaped me. The true heart of this journey lies in the incredible support from my friends, professors, and the incredible UW community.

I would like to express my sincere appreciation to Dr. Keshet Ronen and Dr. Nancy Puttkammer. Despite their hectic schedules, they selflessly provided crucial assistance and opportunities and demonstrated exceptional patience.

To my spouse, whose unwavering support and countless sacrifices have been the cornerstone of my achievement: your belief in me has been my greatest strength and inspiration.

I would also like to thank the study participants and the members of the CHV-NEO team who collected and helped analyze the data. Their contributions have been essential to this work.

Lastly, I express my profound appreciation to the Fulbright Program for making my dream of studying at UW a reality. While words may not fully capture my gratitude, it is immense and enduring.

Introduction

Digital health can potentially advance maternal and child health (MCH) outcomes worldwide¹⁻³. By utilizing digital technologies such as mobile health apps, telehealth platforms, and electronic patient records, the field of digital health presents unprecedented opportunities to overcome barriers to healthcare access, particularly in low- and middle-income countries. These technologies enable more efficient health service delivery, real-time data monitoring and analysis, and improved patient-provider communication^{4,5}. For MCH services, this means the potential for early detection of complications, tailored health education, and enhanced antenatal and postnatal care. The global shift towards digital health promises to streamline healthcare processes and empower communities with the knowledge and tools necessary for promoting health and well-being¹. Hence, the thoughtful integration of digital health solutions into MCH programs is essential for achieving broader global health goals, including reducing maternal and neonatal mortality and pursuing universal health coverage^{2,6}. Digitalizing health systems can improve the efficiency, accessibility, and quality of healthcare services.

Nevertheless, it raises substantial challenges, such as privacy issues, the digital divide, and the possibility of depersonalizing patient care. Obtaining a comprehensive understanding of stakeholders' opinions and experiences is of utmost importance, as these insights can uncover fundamental obstacles, impediments to acceptance, and the varied effects of digital health projects. Maintaining this awareness is critical to developing, executing, and enhancing digital health solutions that are not solely technologically proficient but also culturally attuned, fair, and adaptable to the needs of every user. In doing so, one can guarantee the effective incorporation of digital instruments into healthcare methodologies.⁷⁻⁹

In Kenya, as in many low- and middle-income countries (LMICs), the challenge of delivering comprehensive maternal and neonatal healthcare is intensified by geographic, economic, and infrastructural barriers^{10,11}. Despite significant progress in reducing childhood and under-5 mortality rates in Kenya, improvements in neonatal mortality rates have been minimal, highlighting a vital area of concern within maternal and neonatal healthcare. The 2022 Kenya Demographic and Health Survey (KDHS 2022), released on January 17, 2023, revealed that while under-5 mortality decreased from 52 deaths per 1,000 live births in 2014 to 41 in 2022, neonatal mortality saw a marginal reduction from 22 to 21 deaths per 1,000 live births during the same period^{12,13}. Digitizing the health system, defined as the incorporation of Information and Communication Technology (ICT) into health service delivery, has the potential to enhance the efficiency of healthcare operations, thereby improving patient outcomes.

Kenya's eCHIS, the National Community Health Digitization Strategy for 2020-2025, aims to empower Community Health Workers (CHWs) with digital tools, training, and equipment^{14,15}. This initiative seeks to enhance the delivery of community health services and furnish accurate data to inform decision-making processes. Further, it concentrates on strengthening the ability of individuals and households to seek high-quality, equitable healthcare services¹⁵. CHWs are instrumental in closing these gaps by providing essential health services and information to underserved populations. Grasping the on-the-ground reality of large-scale digitization efforts, such as Kenya's eCHIS, is imperative to ensure that the digital empowerment of Community Health Workers (CHWs) translates into tangible benefits for healthcare delivery and access.

This study employs a qualitative approach to explore stakeholder perspectives on how digital technologies can be woven into CHW practices to bolster MCH in Kenya. Through focus group discussions (FGDs) and key informant interviews (KIIs) with peripartum women, CHs, healthcare workers, and policymakers, it aims to explore the role of digital tools in healthcare. The research has two main goals: firstly, to discover the benefits of incorporating digital solutions into CHW operations, focusing on how they can improve communication, adherence to care plans, and overall CHW job satisfaction and efficiency in MCH services. Secondly, it aims to explore the challenges of digital adoption, specifically barriers and concerns with digitization in healthcare contexts.

Aim 1: Identify and Analyze the Strengths of Digitization in CHW Workflows for Enhancing MCH Outcomes

Research Questions:

What are the perceived benefits of integrating digital technologies into CHW workflows by different stakeholders, including peripartum women, CHWs, healthcare workers, and policymakers?

In what ways do digital technologies have the potential to facilitate improved communication, follow-up, and care compliance between CHWs and peripartum women? To what extent has this potential been realized?

In what ways do digital interventions have the potential to contribute to the efficiency, effectiveness, and satisfaction of CHWs in delivering maternal and neonatal health services? To what extent has this potential been realized?

Aim 2: Examine the Challenges and Limitations of Integrating Digital Technologies into CHW Workflows

Research Questions:

What are the main challenges and limitations anticipated or faced by CHWs, healthcare workers, and peripartum women in adopting and utilizing digital technologies within MCH services?

What concerns do policymakers have regarding the sustainability and impact of digital technologies on existing MCH care delivery systems?

Aim 3: Formulate Recommendations for Enhancing Digital Integration in CHW Programs for MCH Outcomes. This aim synthesizes findings from the evaluation of digital technology integration's strengths and challenges to offer actionable recommendations. It targets the development of strategies aimed at improving the implementation and sustainability of digital interventions within CHWs workflows in Kenya.

Methods

Study setting

This study was structured as an exploratory qualitative study, employing a human-centered design methodology to comprehensively understand the impact of health system digitization on maternal and neonatal health outcomes. The fieldwork phase of the study spanned from April to August 2022, situated in Kisumu and Siaya Counties in Western Kenya. The study engaged five distinct groups: Community Health Workers (CHWs), CHW supervisors, facility-based nurses, policymakers, and peripartum women. Apart from policymakers, participants were recruited from six health facilities—three large facilities in Siaya County, each handling over 30 new antenatal clients monthly, and three medium-sized facilities in Kisumu County, each with 20-30 antenatal clients per month.

Participant Group	Activity Type	Number of Sessions
Community Health Volunteers (CHWss) now referred to as Community Health Workers (CHW)	FGDs	8
Peripartum Women (PPW)	FGDs	7
CHWs Supervisors	KIIs	4
Facility-based Nurses	KIIs	4
Health System Policymakers	KIIs	8

The study conducted 15 focus group discussions and 16 key informant interviews, offering insights from Community Health Workers, Peripartum Women, CHWs Supervisors, Nurses, and Policymakers, ensuring a comprehensive view of health system digitization impacts.

Participant Recruitment and Study Population Characteristics

The inclusion criteria specified that CHWs, supervisors, and nurses were 18 years or older and affiliated with one of the participating facilities. Peripartum women participants were at least 14 years old, pregnant or up to six months postpartum, receiving care from a participating facility, and had daily access to a mobile phone. Policymakers were at least 18 years old and involved in either national or county health departments.

To introduce the study, site staff engaged CHWs, CHW supervisors, and nurses directly in person. Policymakers were selectively approached through emails and phone calls tailored to their specific roles. All potential participants were reassured about the voluntary nature of their involvement and its independence from their job security. For peripartum women, study awareness was raised during antenatal care or routine child health appointments, where study staff explained the focus group's purpose, addressed inquiries and extended invitations to join.

Consent was digitally recorded by the study team in the participant's preferred language (English, Swahili, or Luo) at recruitment. Following an oral summary of the study, individuals were presented with the consent form in print or tablet for review. Those unable to read received assistance. Throughout the consent process, individuals had the liberty to seek clarifications to comprehend the study's scope fully. They were constantly reminded that their participation was purely optional, with no repercussions on their standard healthcare or job status, nor would it bar them from future research opportunities.

Data Collection

Data was gathered using key informant interviews (KIIs) and focus group discussions (FGDs), employing an iterative approach to enrich our insights. The study included 8 FGDs with CHWs and 7 with peripartum women. In addition, 16 KIIs were conducted with CHW supervisors, facility-based nurses, and health policymakers. Each FGD involved 8-12 participants, and was facilitated by a trained moderator fluent in English, Swahili, and Luo, using languages based on participant preference. COVID-19 safety protocols were followed as recommended by the Kenyan Ministry of Health. This included using spacious, ventilated rooms, wearing masks, and sanitizing all materials. Participants were only recruited if they were already visiting the study facilities, minimizing the need for extra visits. Key informant interviews with policymakers, nurses, and CHW supervisors were done in English by trained interviewers, in a private location chosen by the participant.

Anonymity was ensured through the use of computer-generated numbers, and sessions were audio-recorded, transcribed verbatim, and translated into English for analysis. FGDs and KIIs were conducted to be open-ended, focusing on critical questions outlined in the study protocols.

Ethical Considerations

Ethical approval for the study, which included field activities in Kenya and subsequent data analysis in both Kenya and Seattle, was obtained from the Kenyatta National Hospital/University of Nairobi (KNH/UoN) Ethics and Research Committee (ERC) and the Institutional Review Board (IRB) of the University of Washington. After receiving comprehensive information about the study's aims, their rights, and confidentiality protocols, all participants provided written informed consent. For individuals under the age of 18, parental consent was not required because pregnant and parenting adolescents in Kenya are regarded as emancipated minors and can provide their own consent independently.

Data Management and Analysis

All discussion and interview transcripts were transcribed and, where necessary, translated into English to prepare for analysis. A team of analysts developed a codebook, combining inductive codes generated by reading a sample of transcripts and deductive codes developed based on the discussion guides. After completing consensus coding to ensure all analysts consistently applied the codebook, each transcript was coded by two analysts using the Dedoose software. Disagreements were resolved through discussion. Given that the qualitative data coding had already been completed, the next step involved an in-depth analysis of the coded qualitative data to draw insights and understandings related to the impact of health system digitization on maternal and neonatal health outcomes. This analysis delved into the relationships between codes, the context of quotes, and the broader themes that emerged from the data.

I began by reviewing the coded data using code reports from Dedoose. I then synthesized individual codes and excerpts into overarching themes. I wrote thematic memos summarizing each emerging theme and providing illustrative quotes. I also examined the frequency and co-occurrence of codes using Dedoose to highlight significant patterns and relationships within the data. I reviewed the original transcripts when additional context was needed to ensure a comprehensive understanding. Subsequently, I synthesized the themes into a coherent narrative, linking them back to the research questions and objectives of the study. The final stage of my analysis involved drafting the results section of the study, where I presented the findings in a structured manner.

Results

Participant characteristics

The study included participants from Kisumu and Siaya across four groups: Community Health Workers (CHWs), Peripartum Women, Healthcare Workers, and Policymakers. In Kisumu, the Community Health Workers group consisted of 10 individuals (12% of the total group), predominantly female (86%). The Peripartum Women group in Kisumu comprised 11 participants (14% of the total group), all of whom had access to a mobile phone. In Siaya, the Community Health Workers group included 10 individuals (12% of the total group), with a similar gender distribution. The Peripartum Women group in Siaya consisted of 11 participants (14% of the total group) with full mobile phone access. The Healthcare Workers group had equal representation in both Kisumu and Siaya, with one healthcare worker from each site, and the majority were female. Policymakers from both Kisumu and Siaya included individuals with diverse backgrounds in women's health, maternal and child health, neonatal health, mHealth, and universal health coverage (UHC).

Characteristic	Peripartum Women (N = 76) %	Community Health Promoters (N = 86) %	Healthcare Workers (N = 8) %	Policymakers (N = 8) %
Site				
Ahero	8 (11%)	11 (13%)	1 (13%)	
Siaya	11 (14%)	10 (12%)	1 (13%)	
Akala	11 (14%)	19 (22%)	2 (25%)	
Uyawi	23 (30%)	15 (17%)	2 (25%)	
Nyang'oma	12 (16%)	21 (24%)	1 (13%)	
Kisumu	11 (14%)	10 (12%)	1 (13%)	
Age	25 (21, 29)	46 (38, 53)	41 (39, 42)	42 (37, 44)
Has access to mobile phone	73 (96%)			
Sex				
Female		73 (86%)	5 (71%)	4 (57%)
Male		12 (14)		
Field of Expertise				Women's Health (13%), Maternal and Child Health (13%), Neonatal Health (13%), mHealth (13%), UHC (13%), CHV/Healthcare Workforce (88%), Preventive and Promotive Health (13%)

Overview of themes

Table 2 summarises the themes identified in our data, illustrative quotes, and which stakeholder groups reported each theme. Each theme is explored in detail below. CHWs, supervisors, and policymakers identified most themes. Some were only identified by CHWs or CHWs and supervisors. Facility-based healthcare workers shared fewer perspectives on digitization, contributing to only one theme.

Theme	Key Findings	Quotes	Stakeholders
Improved Workflow Efficiency	Digital tools streamline patient management, reduce unnecessary physical visits, and enable real-time updates and tracking. Automated task management ensures consistent follow-ups and comprehensive care.	"The digital system helps me stay on track. As a human, I can forget things, but the task reminders in the system show me what I need to do, making my work easier. I just check the tasks, see the reminders, and don't have to worry about whether I've made any mistakes," (CHW)	CHW Policymakers Supervisors
Improved Data Quality	Digital platforms enhance supervision with instant data verification and detailed oversight through dashboards.	<i>"Once CHWs register a pregnancy, they receive monthly tasks to follow up with the woman, ensuring she has attended her clinic visits. They document details from the mother-child booklet, continuing this process until the mother reaches her EDD (Expected Date of Delivery)."</i> (Policymaker)	CHW Policymakers Supervisors
Improved Job Satisfaction	Reduces the physical burden of carrying paperwork, enhances communication	"The digital platform has simplified my work significantly. Now, I can instantly see which community health worker is active and which isn't, unlike before when we used analog methods like the 514 book, where CHWs could falsify or make mistakes on data without any way for us to verify." (Supervisor)	CHW Policymakers Supervisors
Technology Access	Persistent technology access and device reliability issues. Rural infrastructure shortcomings and connectivity problems frequently disrupt digital tool usage and service delivery.	<i>"Having a phone in a rural setup is challenging since people struggle to meet basic needs. A phone is not seen as essential. For digital tools to work, clients need a phone, access to charging, and reliable network coverage. In places like [name of place], power outages can last for two weeks, complicating phone use".</i> (HCFW)	CHW Policymakers Supervisors Health Care Facility Workers

Usability/ Configuration Issues	Configuration issues cause user frustration and data inaccuracies. Managing complex schedules and frequent updates complicates consistent usage.	<i>"I have another challenge. There is one that happened to me like that, so it (app) keeps reminding me of pregnancy follow up daily. I tried till I had to say that the woman miscarried so that it clears. Help us on that." (CHW).</i>	CHWs
Data Security & Privacy	Community mistrust and privacy concerns about data collection. Challenges in communicating data safety to build trust.	<i>"Like last week, I was in the field and there is a woman who refused to give me details on a two month old baby who I was supposed to treat claiming I was going to eat using her child's name/ details but putting in my devise, you see. Those are challenges we encounter in the villages as CHVs." (CHW, FGD 6)</i>	CHWs Supervisors
Sustainability	- Financial constraints hinder the long-term maintenance and updating of digital tools. Dependency on initial partner support raises concerns about the viability of projects post-support. Issues with software reliability and frequent changes in reporting requirements affect sustainability.	<i>"Yes, think we ventured into it without thinking of how we were going to maintain it, yes and the phones... the phones are also too expensive for the county government to buy and too expensive for the CHW also to buy with the 3,000 stipends" (Policymaker)</i>	CHW Policymakers Supervisors

Improved workflow

CHWs and policymakers reported that digital health tools have transformed how CHWs manage patient care, significantly improving workflow efficiency and data accuracy. According to respondents, these tools enable CHWs to track patient visits more effectively, reducing the need for manual documentation and physical visits. A CHW shared how the app simplifies patient management:

"I started with (name of the app) because when you go to a household then you click that household and you find that Eunice (nickname) is currently pregnant so you follow her through the app and when Eunice delivers I update on the medic app that Eunice has delivered. Then now it will ask me whether Eunice has gone to the clinic and it will start following this baby so the (name of the app) can tell me all those." (Respondent 92 86 CHW FGD 5)

Another CHW highlighted how the [name of the app] assists in maintaining close contact with pregnant women by providing timely reminders for clinic days, ensuring continuous support from the first to the fourth ANC (Antenatal Care visit).

"Then when she is approaching her clinic day, the (name of the app) reminds me, so this makes me stay close to the pregnant woman. I will pick her from the first ANC to the fourth and I will go with her like that... CHV FGD 5

Digital tools also support detailed monitoring, including medication adherence and health status checks:

"...first I check if she went to the hospital (using the app) secondly I check if her weight is okay and if maybe drugs are prescribed in her book if she has been prescribed then I encourage to take the medication so that her life and that of the baby will be okay." (CHW, FGD 1)

Furthermore, policymakers reported that automated task management features in these tools ensure no patient is overlooked: *"Once a pregnancy is registered, the system automatically schedules and reminds us of monthly follow-up tasks. We input details from each visit into the system, maintaining a continuous record until the delivery date (PM KII 4)."*

CHWs noted that digital tools enhance the quality of healthcare delivery. *"It [app] reminds me. As a human being, I can forget when I was to go, but when I check on tasks it reminds me on what I ought to be doing. It makes my work easier because I just look at the tasks and see the reminders"*. CHV FGD 4s.

Improved Data Accuracy

Policymakers, supervisors and CHWs noted that digital platforms have enhanced the supervision process and data integrity within community health programs. A CHW supervisor explained, *"The digital platform has made my work very simple, and at a glance, I can say, CHW so and so is working, CHW so and so is not visiting household, unlike before when we were doing the analogue, the book, the 514, one would just sit somewhere and cook data, and you have no way of verification."* (PM KII 7)

Reportedly, digital tools have also improved the scope and accuracy of health reporting. A policymaker noted, *"The system [eCHIS] begins by identifying which pregnant mothers need visits, focusing on households with the greatest needs within their area. This feature allows for enhanced visualization of CHV activities, even at my level at the sub-county. At the start of each month, and again at the two-week mark, I can review the dashboard to understand why certain CHVs may not be completing the expected number of household visits.."*(PM, KII 4)

When discussing data quality, CHWs emphasize the benefits of digital tools that facilitate quick access to client details and enhance data collection capabilities:

"It has improved the quality of visiting households because when I go to a client, I just click that name so details which I want to use, I'll find there... Data collection is also incorporated inside. The names of all the households are inside. And the total population also...everything," (FGD 2, CHW)

These enhancements in digital oversight and data accuracy are perceived as transforming how health services are managed and delivered, providing a clear, real-time picture of community health dynamics.

CHW Job Satisfaction and Work Environment.

The integration of digital tools into community health work has significantly eased the physical demands traditionally associated with CHW roles. CHWs reported a notable reduction in the physical materials they need to carry, streamlining their workflow and making their operations less visible and burdensome. One CHW illustrated this change:

"It has been easy because now when you meet me; the tablet is just in small bag, and you cannot even tell what I am going to do. But before I had to carry an excessively big bag, and everyone would tell that I am going for field work. So, it had reduced the load because now it has incorporated everything, so I just fill and send my work, so it is easier" (CHV, FGD 5)

"This App has helped me because previously, we used to write on books and you know when you write for long you will feel some chest pains so on that part it has helped us. It keeps references because you can see us here in [name of place], for example; number 69, he used to keep records in books but when floods came in this area, floods took his things, so this App has helped us it keeps the references". (CHV, -FGD 6)

These tools have also improved communication between CHWs, patients, and supervisors, enhancing overall management and service delivery. A CHW explained, "We use something called [name of the app] that we update monthly. This significantly aids our communications, allowing us to manage patient information more efficiently." Additionally, the digital approach supports more effective patient follow-ups, reducing the need for face-to-face visits. Moreover, digital health tools have proven crucial in maintaining reliable patient records, especially in challenging conditions. A CHW remarked:

"The app has been a lifesaver; especially when physical records were lost due to flooding. Now, everything is stored digitally, and I don't have to worry about losing important patient data or suffering physical strain from carrying heavy paperwork." CHW, FGD 6.

Limitations of digitization

Despite the optimism surrounding digital tools, participants highlighted the challenges CHWs face using digital tools in the field. These themes encompass training and capacity building, technological access and literacy, data management reliability, system usability, data privacy concerns, communication and coordination challenges, and the sustainability of digital health programs.

Technological Access

CHWs frequently encounter technical problems with their digital tools. As one CHW noted during a focus group discussion, *"If you say that it should be placed in an app, you will find that some phones and devices are always hanging or glitching, and not everyone has access to these tools."* This highlights common issues with device malfunctions that many CHWs face.

The durability and accessibility of these devices also pose significant challenges. A CHW expressed frustration in another discussion: *"Even the devices we were given have broken down. We asked if it's possible to receive replacements. If not, we might have to use our own, which isn't fair to those who don't have access."*

As repeatedly highlighted by policymakers and HCWs, infrastructure shortcomings, particularly in rural areas, significantly impact the deployment and effectiveness of digital health tools. One policymaker emphasized the difficulties posed by the rural setting: *"Having a phone in a rural setup is tough. People struggle with basic needs, and a phone is seen as a luxury. Additionally, frequent power outages, like the two-week stretches without electricity we sometimes experience due to transformer issues, complicate the use of these digital tools"* HCW, KII 5.

In a discussion about the functionality of a digital health tool, Respondent 4 highlighted significant network-related issues that impacted its effectiveness: *"the system is bad, there is no bundles, the support we get because of this App is not there as compared to previously."* - CHW, FGD 4

Another policymaker underlined the importance of a robust infrastructure: "For this service to be effective, three crucial elements must be in place: a phone, a reliable power source to charge it, and adequate network coverage. Network availability is often a challenge in rural areas. When these conditions are met, the service can significantly benefit the CHV, the client, the healthcare worker, and the linked healthcare facility."

Usability/configuration issues.

CHWs, their supervisors, and policymakers identified challenges in the usability and configuration of current digital tools. Some CHWs identified configuration issues that led to undesired features, for example, problems with task persistence:

"I have another challenge. There is one that happened to me like that so it keeps reminding me of pregnancy follow-up daily. I tried till I had to say that the woman miscarried so that it clears. Help us on that." (CHWs FGD 4).

Other CHWs expressed the need for enhanced app functionalities to improve service delivery and reporting. During CHWs FGD 3, participants discussed the limitations of the current app, specifically its inability to provide cumulative reports on key metrics such as the number of households visited or children seen. One CHW described the complexities of managing multiple clinic schedules within a digital platform, saying:

"Sometimes we manage clients who need to attend different clinics, such as gynecological and antenatal care, scheduled in the same month. This can complicate scheduling within our system. I suggest enhancing the system to handle appointments for multiple clinics simultaneously, or perhaps you could guide how best to manage this scenario given that these are distinct types of appointments." (FGD 3, CHW)

Some community health workers (CHWs) have expressed frustration with the restrictive nature of electronic data entry systems. *"Sometimes, it's necessary to record more specific information. For example, if a client declines family planning, I can't note that directly, and the system incorrectly schedules follow-ups."* (CHW).

CHWs highlighted that the challenges with configurations and features of digital tools led to interpersonal difficulties and frustration on the part of their clients: *"I just wanted to add, so that there is no friction between us and the household, like when the app tells me that today I should visit household two, and when I call her and tell her that you are supposed to go to clinic, and they are like 'Uh! Which clinic? I was given to go on 16th.' And they will be like 'You do not understand what you are doing'."* (CHW 185, gender, age).

Inconsistencies and frequent updates to digital tools pose significant challenges. A CHW described the confusion:

"There's often inaccuracy when reporting indicators. For instance, if a pregnant woman is incorrectly reported for her first antenatal visit, I have to clarify and correct the information. Furthermore, we received a new tool last year that differs from previous versions, requiring us to adapt once more. Although we will eventually adjust, the constant changes to the tools can be disruptive and require ongoing adaptation."

Data Security, Privacy, and Trust in Community Health Programs

CHWs reported challenges regarding mistrust within communities about the usage and purpose of collecting personal data in digital applications. During Focus Group Discussion (FGD) 1, a CHW relayed community concerns:

"some people also think that you are just writing their names as source of income for me to eat from, meaning we are eating from their names, you get it? Even if you go requesting for someone identity card, phone numbers, things like that; they ask, "you always ask for my phone number what do you use it for, you are always eating from our names and these and we never see these things that you write" - (CH, FGD 1)

The necessity for CHWs to effectively communicate the purpose of data collection to build trust was highlighted. Another participant in FGD 1 stated:

"For example, you can ask how many children you have, what is the age of your first child, your identification card number, phone number, things like that; so, he (the head of the household who is usually a man) assumes that there is something behind, you asking him so many questions like that and putting [the answers] in your device. Now as a CHW you must have a language that can bring him closer, so that he can understand the reason why you are asking those questions."

Privacy concerns related to the applications used by CHWs were significant. A CHW expressed during FGD 6: "It is very true that there are some things that should be kept secret but ... when I open this App, for example, I open it at the door and let's pretend this is my house, it will say this is [Name]'s house and when it says this is [Name]'s house, it will be seen up to the county office, the county will see it so how can we claim confidentiality under such conditions? "

Sustainability

A common theme emerged from the discussions indicating that while digital health projects often start strongly, they struggle with maintenance in the long term. A CHW remarked, *"To start is normally so good, but maintenance is always hard. That has happened to... many [apps]."* This statement reflects a pattern where initial project success is not sustained due to ongoing maintenance challenges.

Participants highlighted several barriers to maintenance. Financial issues were highlighted as a major barrier to maintaining and updating digital tools. A policymaker discussed these challenges: *"Yes, I think we ventured into it without thinking of how we were going to maintain it... And the phones... the phones are also too expensive for the county government to buy and too expensive for the CHWs also to buy with the 3,000 stipends."*

Software reliability was another significant challenge. During CHWs FGD 1, a health worker raised concerns about the functionality of an app: *"What is usually the problem with the app? It hangs."* This issue affects the usability of critical health applications.

Healthcare workers expressed frustration with frequent changes in reporting requirements, complicating training and adaptation processes. One healthcare worker mentioned, *"You'd find, like, someone tells you today, like, this is what you're supposed to be reporting, and then the next time, telling you no hey, this one was different; this is how it's supposed to be."*

The challenge of sustaining digital health initiatives post-partner support is significant. *"We've had pilot programs for these digital platforms, but the real test is sustainability. Once the initial support ends, we must consider if we can afford the ongoing costs within our budgets. If it's not feasible, the programs risk collapse. We need to find cost-effective methods to integrate these technologies that align with our budgeting processes,"* detailed a policymaker (KII 8), emphasizing the need for financial planning and budget approval in sustaining digital health innovations.

Discussion

Key Results and Main Contributions

This study explored the perspectives of CHWs, supervisors, facility-based healthcare workers, and policymakers on integrating digital technologies within CHW workflows in Western Kenya, with a particular focus on MCH services. The findings highlight the perceived strengths of digitizing community health services and concerns about the strategy's limitations. Strengths identified by stakeholders include improved CHW workflow efficiency, allowing for better patient management and reducing physical documentation burdens; enhanced data accuracy and supervision through digital platforms, ensuring more reliable health reporting and oversight; and increased job satisfaction for CHWs due to reduced physical strain and improved communication capabilities. Challenges included technological access issues, such as inconsistent internet connectivity and lack of devices; usability problems related to the complexity of digital tools; data privacy concerns, particularly regarding the protection of patient information; and questions about the sustainability of digital health initiatives, including long-term funding and maintenance. Most of these observations were consistently expressed across CHWs, supervisors, and policymakers. In the context of Kenya's ongoing expansive community health digitization effort, these perspectives offer critical insight into benefits, challenges, and potential recommendations for the coming years.

Comparison to Other Literature

The positive impacts of digital health tools on CHW workflows that our respondents named align with existing literature and with the Kenyan Ministry of Health's stated goals in prioritizing the digitization of community health services^{14,16}. Studies have shown that digital health interventions can streamline healthcare delivery, improve data quality, and enhance communication between healthcare providers and patients¹⁷. Similarly, our findings on improved data accuracy and supervision are consistent with previous research, which emphasizes the role of digital tools in enhancing data management and oversight¹⁸. The challenges identified in our study, such as technological access issues and data privacy concerns, are also well-documented in the literature, highlighting the need to address these barriers to maximize the benefits of digital health interventions^{7,9,12}.

Deeper Discussion and Interpretation

The study found that digital tools revolutionized CHWs' workflows by automating task management, enabling remote consultations, and decreasing the necessity for in-person visits. CHWs can promptly update patient information, monitor patient visits, and provide necessary follow-up care, greatly improving their efficiency and efficacy. This aligns with previous research, which found that digital health tools can reduce workload and improve service delivery in resource-limited settings¹⁹.

However, the enthusiasm for digital tools must be tempered with a critical look at the infrastructure requirements. As highlighted in our study, issues with app reliability and device accessibility were significant barriers. Technical problems such as inconsistent network connectivity and device malfunctions can disrupt workflows and diminish the potential efficiency gains. Addressing these issues through robust infrastructure development and reliable technical support is crucial for optimizing the impact of digital health tools. The literature corroborates these findings, emphasizing the necessity of stable technological infrastructure for successful digital health implementation^{19, 21}. In almost all FGDs and interviews, participants highlighted the critical need for technology access, network reliability, and adequate training. Without addressing these foundational issues, the potential benefits of digital integration may remain unrealized²².

Digital platforms improved data accuracy by enabling real-time data entry and monitoring, reducing the risk of errors and data falsification. Supervisors could track CHW activities and verify the accuracy of reports, leading to more reliable health data. This finding supports existing evidence that digital tools can enhance data integrity and oversight in healthcare systems^{1, 23}.

Conversely, the dependency on digital tools introduces data security and privacy risks^{24, 25}. Participants expressed concerns about the confidentiality of patient information and the potential for misuse. Ensuring robust data protection measures and building trust within communities are essential for the sustained success of digital health initiatives. CHWs reported encountering skepticism from patients when collecting data, with individuals questioning the purpose and use of their information. This skepticism was frequently mentioned in various focus group discussions, where patients expressed concerns such as, "You always ask for my phone number - what do you use it for?" and "You are always using our names, but we never see the results of what you write." These concerns underscore the importance of clear communication and transparency regarding data usage to build trust and enhance cooperation between CHWs and the communities they serve. This concern is echoed in global health discussions that stress the importance of data and trust in the digital age²⁶. The fear of data breaches or misuse could undermine the trust in health systems, which is crucial for their effective functioning. Therefore, while the technological enhancements are notable, they must be paired with stringent data protection policies and community engagement efforts to build and maintain trust.

The integration of digital tools into CHW workflows contributed to increased job satisfaction by reducing the physical demands of their roles and enhancing coordination with patients and supervisors. CHWs reported feeling more empowered and effective in their work, which is consistent with a study conducted among CHWs in Ethiopia that highlights the positive impact of digital health interventions on healthcare worker satisfaction and performance²⁷.

Although our study did not specifically address compensation, CHWs, supervisors, and policymakers often mentioned income supplementation as a significant factor in their work. Several factors can demotivate CHWs and diminish their interest and optimism in digital technologies. CHWs pointed out other issues, such as insufficient pay and benefits, limited opportunities for education, and lack of supportive supervision. Similar issues were found globally; a recent study across 28 countries showed that CHWs are often underpaid or unpaid despite being essential to global healthcare delivery ^{24,25}. Nevertheless, the transition to digital tools requires comprehensive training and continuous support to maintain high job satisfaction levels. Inadequate training can lead to frustration and reduced effectiveness. Investment in ongoing professional development and technical assistance is necessary to ensure CHWs are fully equipped to utilize digital tools efficiently ³⁰. This raises a critical question about the sustainability and scalability of such training programs, especially in resource-limited settings like the counties where the current study was conducted. The initial enthusiasm for digital tools can wane if ongoing support is not guaranteed, potentially leading to a decline in their effective use.

Strengths and Limitations

Strengths

A strength of this study is its comprehensive approach, involving multiple stakeholder perspectives, including CHWs, peripartum women, supervisors, nurses, and policymakers. This provided a holistic view of the impacts of digital health tools on maternal and child health (MCH) services. Additionally, the use of qualitative methods allowed for an in-depth exploration of experiences and perceptions, offering rich insights into the benefits and challenges of digital integration. While digital health is a rapidly growing field, there have been very limited studies focusing specifically on the integration of digital tools from the perspective of CHWs or other frontline workers ^{28,31,32}.

Limitations

A limitation of this study is its geographic constraint, as it was conducted solely in Kisumu and Siaya Counties. The findings may not be representative of other regions of Kenya, particularly urban settings, or other countries, which could have different technological infrastructures and healthcare challenges. Additionally, there was variability in technology usage across the study region at the time of data collection. Participants had been exposed to different types and functionalities of digital tools, leading to variability in their responses. This variability may complicate the interpretation of the results. Finally, the rapid evolution of digital technologies means that the tools and systems evaluated in this study may quickly become outdated, necessitating ongoing research to keep pace with technological advancements.

Program/Policy Implications and Future Work

Policy Implications

The findings of this study have several implications for policymakers and program designers. To maximize the benefits of digital health tools, it is crucial to address the technological access issues and infrastructure challenges that hinder their practical use. Policymakers should allocate a sufficient budget for reliable and durable digital devices, ensure adequate training for CHWs, and develop robust data privacy and security systems. Sustainable funding models are essential to maintain and scale digital

health initiatives beyond pilot phases^{33 34}. The sustainability of digital health initiatives often depends on continuous funding and support, which can be difficult to secure in low-resource settings. This calls for innovative financing strategies and partnerships to ensure long-term success.

Future Work

Future research should focus on longitudinal studies to assess the long-term impacts of digital health interventions on MCH outcomes. There is also a need for comparative studies across different regions and contexts to understand the variability in frontline workers' experiences of digital tools. Similarly, exploring the integration of emerging technologies, such as artificial intelligence and machine learning, could provide new opportunities for enhancing healthcare delivery and outcomes³⁵. Nonetheless, these advanced technologies bring their own set of challenges, including ethical considerations, the need for specialized skills, and the risk of exacerbating existing inequalities³⁶. Future research must address these complexities to harness the full potential of digital health innovations.

Conclusion

Ultimately, this study stresses the capacity of digital technology to enhance CHW workflows and MCH outcomes in Western Kenya. Ensuring the successful and sustainable integration of digital health tools into community health systems demands addressing these identified barriers, notwithstanding their immense advantages. By leveraging digital innovations and addressing barriers, stakeholders can enhance healthcare delivery, improve maternal and child health, and move closer to achieving universal health coverage.

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Abbreviations

1. **ANC:** Antenatal Care
2. **CHVs:** Community Health Volunteers
3. **CHWs:** Community Health Workers
4. **EDD:** Expected Date of Delivery
5. **eCHIS:** National Community Health Digitization Strategy for 2020-2025
6. **HCFW:** Health Care Facility Workers
7. **ICT:** Information and Communication Technology
8. **LMICs:** Low- and Middle-Income Countries
9. **MCH:** Maternal and Child Health
10. **PPW:** Peripartum Women