

Experiences of community health workers on adopting mHealth in rural Malawi: A qualitative study

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Abstract

Background: The use of mobile health technology (mHealth) by community health workers (CHWs) can strengthen community-based service delivery and improve access to and quality of healthcare.

Objective: This qualitative study sought to explore experiences and identify factors influencing the use of an integrated smartphone-based mHealth called *YendaNafe* by CHWs in rural Malawi.

Methods: Using pre-tested interview guides, between August and October 2022, we conducted eight focus group discussions with CHWs ($n = 69$), four in-depth interviews with CHW supervisors, and eight key informant interviews in Neno District, Malawi. We audio-recorded and transcribed the interviews verbatim and organized them for analysis in Dedoose V9.0.62. We used an inductive analysis technique to analyze the data. We further applied the six domains of the socio-technical system (STS) framework to map factors influencing the use of *YendaNafe*.

Results: User experiences and facilitators and barriers were the two main themes that emerged. mHealth was reported to improve the task efficiency, competence, trust, and perceived professionalism of CHWs. CHWs less frequently referred to cultural factors influencing app uptake. However, for other social systems, they identified relationships and trust with stakeholders, availability of training and programmatic support, and performance monitoring and feedback as influencing the use of *YendaNafe*. From the STS technical domain, the availability and adequacy of hardware such as phones, mobile connectivity, and usability influenced the use of *YendaNafe*.

Conclusions: Despite the initial discomfort, CHWs found mHealth helpful in supporting their service delivery tasks. Identifying and addressing social and technical factors during mHealth implementation may help improve end users' attitudes and uptake.

Keywords

mHealth, community health workers, Malawi, maternal health

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Introduction

Mobile health (mHealth) is the use of mobile devices to support the delivery of health services.^{1,2} The development and deployment of mHealth solutions in the past decade have been unprecedented,³ with increasing availability and affordability of mobile devices⁴ and expansion of network connectivity, including in rural and remote locations.⁵ Mobile health has been particularly important in low and middle-income countries where its role in supporting health service delivery has been emphasized. mHealth has found multiple uses in these contexts, including clinical

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decision support, health information systems improvement, behavior change interventions, and improved communication among healthcare workers and patients.^{6–9} mHealth solutions have also been shown to bridge health inequalities by facilitating information exchange and remote training of frontline healthcare workers in rural and remote settings.¹⁰

Community health workers (CHWs) are vital to health systems.¹¹ Serving as a bridge between the community and the formal health system, CHWs provide promotive, preventive, and limited curative services.^{12,13} CHWs also extend care to rural and marginalized communities, allowing health services to be delivered in areas that are not easily accessible to the mainstream healthcare workforce.¹⁴ Through CHWs, achieving a comprehensive community health system may be possible, making it easier to achieve Universal Health Coverage and Sustainable Development Goals in many settings.^{15,16}

Evidence is rife with how mHealth has been used to support the activities of CHWs^{17,18} through, for example, the use of messaging to provide education either to CHWs themselves or the communities they serve. Other examples include behavior change interventions and facilitating adherence to clinic visits.^{19,20} For example, CHWs sharing animated videos with pregnant women in a resource-limited setting in South Africa to promote exclusive breastfeeding was reported to have replaced most of the face-to-face counseling while achieving the same breastfeeding rates, freeing up time for CHWs to focus on other tasks.²¹ CHWs have also used mHealth to communicate with their peers, supervisors, and clients.²² In some programs, mHealth has enabled real-time communication with CHWs, resulting in accurate and timely decisions on clinical care.^{8,23} In another example from Ethiopia, CHWs used a CommCare-based application to register and follow up pregnant women, educate clients, and communicate with primary care facilities in case of missed visits or emergencies. A qualitative review of this program showed that CHWs appreciated how mHealth facilitated real-time exchange of information between CHWs and primary care facilities, and program results showed early initiation of antenatal care (ANC) among pregnant women.²⁴ In Kenya and Ghana, mHealth use by CHWs improved data completeness and timeliness, reducing the cost and time associated with paper-based community information systems.^{25,26}

Despite these potential benefits, contextual and other factors determine the adoption and success of mHealth programs. Hence, introducing digital technology in new contexts must be preceded by a multifaceted analysis of influencing factors that could affect how these solutions are viable in different settings.²⁷ Acceptability and positive outcomes require adapting mHealth programs to work around the context-specific gaps.²⁸

Malawi has prioritized CHW programs to increase access to quality health services and achieve Universal

Health Coverage.²⁹ The CHWs in the country are mandated to offer integrated care services that include preventive, promotive, curative, rehabilitative, and surveillance activities. To enhance the work of CHWs, Malawi has been advocating for the use of mHealth in CHW programs.³⁰ In the Neno district, Malawi, Partners In Health, an organization that is closely partnered with the Ministry of Health, has been implementing a CHW program since 2007 in 12 facilities and two hospitals.^{31,32} Covering a rural population of about 150,000 people,³³ these CHWs provide routine home visits to all households in their catchment areas, delivering education, screening, case identification and referrals, and defaulter tracking across multiple clinical conditions.

One approach that has been taken to enhance the work of CHWs involved introducing an offline, open-source, and integrated smartphone-based mHealth platform called *YendaNafe* (meaning “walk with us” in Chichewa, a local language in Malawi). The program was introduced in the Neno district in May 2019. *YendaNafe* was programmed in the Community Health Toolkit (CHT), one of the digital global health goods used in community health systems.^{34,35} The *YendaNafe* platform supports longitudinal patient-centered care, data storage, clinical decision support, routine monitoring, mentorship and supervision, task scheduling, and reminders for CHWs. The front end comprises an Android-based application used by CHWs and their supervisors—senior CHWs. Other senior CHW staff also use *YendaNafe* information for decision-making informed by data stored in a cloud-based system. A 5-day training was provided to CHWs before they started using *YendaNafe*. CHWs also received free equipment (smartphones, chargers, power banks, solar chargers), monthly internet bundles, and airtime to facilitate communication and data synchronization. By the end of 2022, *YendaNafe* had been rolled out in seven out of 14 catchment areas, with about 51% of CHWs (629 of 1233) using the platform (Figure 1).

Between August and October 2022, we conducted a qualitative study to (a) understand the experiences of CHWs using *YendaNafe* and (b) identify factors influencing the use (or non-use) of *YendaNafe* by CHWs. Although the app covers other clinical workflows such as non-communicable diseases, HIV, and tuberculosis, we focused on the functions of *YendaNafe* that relate to providing a maternal health continuum of care. We focused on maternal health as this was the district’s priority.

Materials and methods

Design

We collected qualitative data by a combination of focus group discussions (FGDs), in-depth interviews (IDIs), and key informant interviews (KIIs).

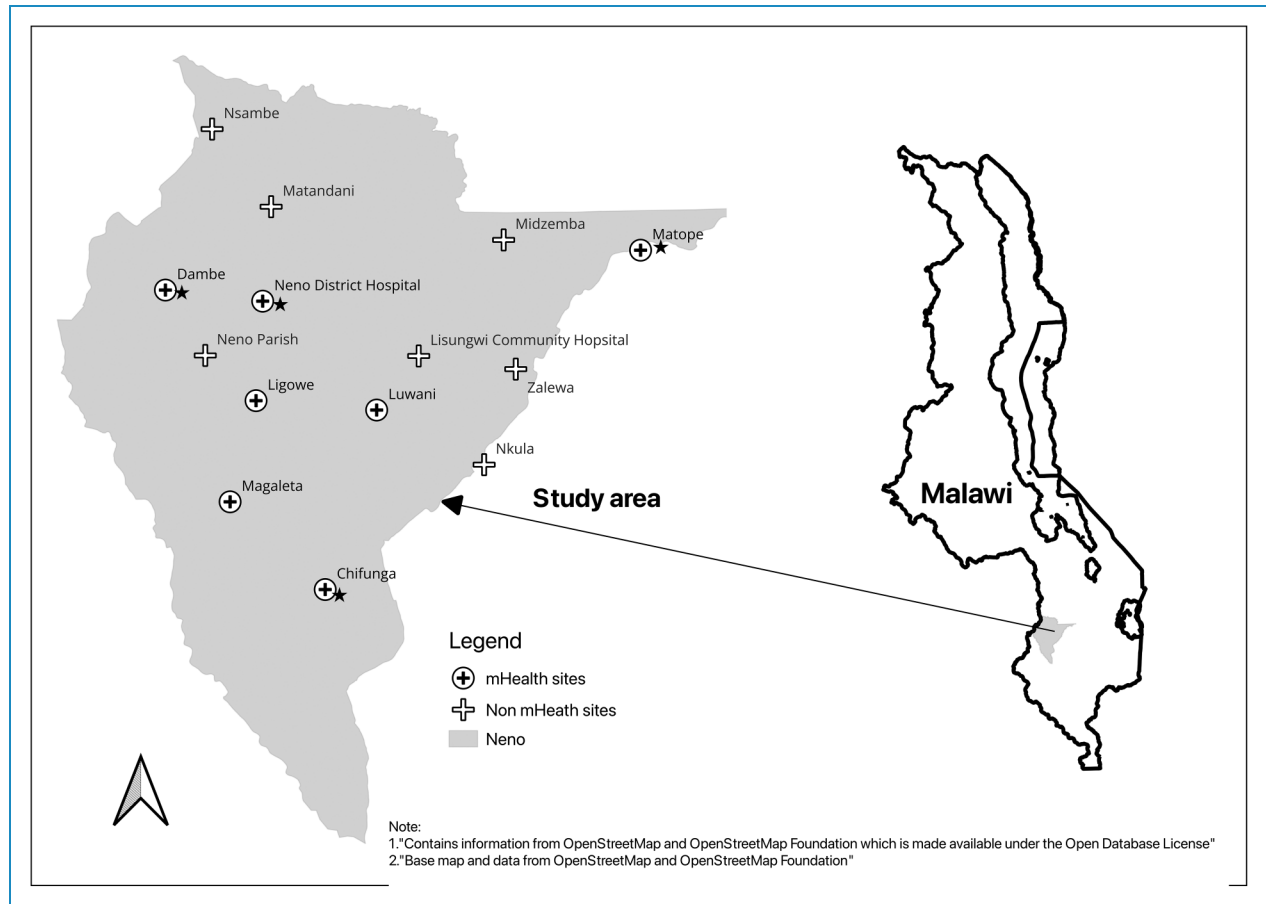


Figure 1. Map of Neno district in Malawi.

NB: * Facilities where the study was conducted.

Program overview

YendaNafe application is used by CHWs and their supervisors, senior CHWs. The CHW program is a dual-tier program where two levels of CHWs offer services. The first level is the CHWs, who are assigned to between 20 and 40 households conducting regular monthly home visits. The second level of services are delivered by senior CHWs, who in addition to their work as regular CHWs for at least 20 households, are also promoted to serve as peer supervisors and mentors for up to ten fellow CHWs. CHWs are selected by communities using predetermined criteria, while senior CHWs are selected due to high performance by program staff. Details of the dual-tiered system, including recruitment and onboarding of CHWs, are thoroughly explained elsewhere.^{36,37}

YendaNafe was implemented to support maternal health activities, among other conditions using existing CHWs within the various communities. CHWs visited pregnant women at their homes monthly, accompanied women suspected of being pregnant to the first ANC, reminded women to attend regular ANC visits and give

birth at health facilities. They also conducted two post-natal visits at 3 and 5 days postpartum.

During home visits, *YendaNafe*-supported phones were used by CHWs to screen for pregnancy using built-in pregnancy screening questions. If women were suspected to be pregnant, *YendaNafe* reminded CHWs to accompany the women to health facilities for pregnancy confirmation. For confirmed pregnancies, the application supported CHWs in screening for danger signs every month using the applications' clinical decision support tools and to follow-up whenever (based on the in-built calculator) women were expected to have given birth. For scheduled ANC or post-natal visits, *YendaNafe* reminded CHWs if women were due for facility visits, and reminders were created to confirm that women attended the facility. Additionally, the application supported senior CHWs in ensuring they conducted supervision and spot checks on time. These application-related activities aimed to increase the timely utilization of maternal health services and contribute to the reduction in mortality and morbidity due to pregnancy and childbirth. By December 2022, over 5200 pregnancies had been registered and followed up using *YendaNafe*.

Sampling and sample size

A purposive sampling technique was used to recruit study participants to ensure respondents could contribute diverse perspectives to the research objectives. We selected only four of the seven participating catchment areas as these were the only locations that had been implementing *YendaNafe* for over a year (Figure 1). The three other sites had transitioned to *YendaNafe* for 6 months or less (two facilities for 6 months and one facility for 1 month only) at the time of the data collection. We decided that the intervention had not matured enough in these locations for the CHWs to be included in the evaluation, since they were still new to the use of *YendaNafe*. Within each catchment area and for FGDs, we purposefully selected CHWs or senior CHWs based on how long they had been using *YendaNafe* (<2 years vs ≥ 2 years). Due to differences in CHWs and senior CHWs, CHW FGDs were conducted separately for each group. For IDIs and KIIs, we selected participants who had interacted with *YendaNafe* for over a year.

Eight FGDs, which allowed detailed insights into perspectives on *YendaNafe*, were conducted with 36 CHWs and 33 senior CHWs. For FGDs, the target number was between 48 and 88 respondents (each FGD had a target of 6–11 participants). Additionally, four IDIs with facility-based supervisors and eight key informant interviews (KIIs)

(four mHealth programmatic staff and four representatives from the technology partner, Medic) were also conducted to supplement the information provided by the CHWs. Details of the distribution of participants are presented in Table 1.

Data collection

We developed interview guides for the data collection (see Appendices 1 and 2). For CHWs and senior CHWs, we developed the guides in English and translated them into Chichewa. The IDIs and KIIs were conducted in English language due to the higher English communication skills of the targeted participants. We pre-tested all the data collection tools through two CHW FGDs and one KII with CHW program staff on people who were not included in the final data collection. The tools were amended following feedback from pre-testing to create the final interview guides.

Data collection was conducted by two experienced research assistants (fluent in both English and Chichewa) who were trained for 5 days and supervised by CK, MKN, and MM throughout data collection.

FGDs were conducted in an open, quiet space at health facilities nearest to the communities. FGDs were conducted in Chichewa by two research assistants, one moderating the FGDs and the other taking notes. After each FGD, the data

Table 1. Distribution of study participants.

Type of interview	Catchment area	Participants group	Number of participants
FGDs (<i>n</i> = 8)	Chifunga	CHWs < 2 years	10
		SCHWs < 2 years	6
	Matope	CHWs < 2 years	10
		SCHWs < 2 years	10
	Dambe	CHWs 2+ years	9
		SCHWs 2+ years	9
	Neno district hospital	CHWs, 2+ years	7
		SCHWs, 2+ years	8
In-depth interviews	N/A	Site supervisors	4
Key informant interviews	N/A	CHW programmatic staff	4
	N/A	App developers	4
Total			81

NB: CHWs community health workers; SCHWs: senior community health workers; N/A: not applicable; FGDs: focus group discussions.

collection team had a debriefing session. IDIs were conducted face-to-face in English at the participants' nearest health facility/workplace. Four KIIs with CHW programmatic staff were conducted face-to-face as the staff were based at the implementing site. However, four KIIs with App developers were conducted virtually using Microsoft Teams since the App developers' were based in Kenya at the time.

No other personnel besides the research assistants and all participants were present during the interviews. We did not have repeat interviews. The FGDs and interviews took approximately 90 and 35 minutes, respectively. We did not share transcripts with participants.

Data analysis

All interviews were audio-recorded and transcribed verbatim. The recordings were transcribed verbatim to Chichewa, translated into English and then uploaded into Dedoose version 9.0.62 for data management and subsequent analysis. Transcription was done by the research assistants and double-checked by MKN and MM. We used the thematic analysis method to analyze the data.³⁸ After reviewing a sample of six transcripts, MM and CK independently developed a codebook inductively using open coding by assigning codes to similar concepts that repeatedly emerged from the data.³⁹ These codebooks were later reviewed and discussed until a final version was created by joint consensus. Using the finalized codebook, CK and MM coded the rest of the transcripts. Afterwards, CK, MKN, and MM reviewed the coded data, identifying and discussing the relationships between codes and merging similar codes if necessary, following an axial coding approach and defining themes and sub-themes during this process.

Theoretical framework

To understand factors influencing the use of *YendaNafe*, we mapped the themes and subthemes using the Socio-technical system (STS) framework⁴⁰ by Davis et al. (Appendix 3). STS posits that a mHealth ecosystem is an interplay between the social system (people, processes and procedures, goals and culture) and the technical aspects of mHealth (infrastructure and technology).⁴¹ STS recognizes that outcomes are not produced by the technology alone but rather by the interaction between technical and social systems. Further discussion on the dimensions of STS and the mapping process is discussed in the "Results" section.

Reflexivity

The research assistants and MM had no prior involvement with the *YendaNafe* program. MKN worked with the

CHW program as a research fellow prior to the introduction of *YendaNafe*, while CK was the supervisor of the CHW program before and after the introduction of *YendaNafe*.

Ethical considerations

Neno District Health Research Committee and the National Health Sciences Research and Ethics Committee approved this study (protocol #1059). All participants provided informed consent. Interviews were conducted privately, and serial numbers were used instead of names on interview notes. All data were kept on password-protected computers. Access to de-identified datasets was password protected, and authorization was granted only to approved study personnel.

Results

The themes and sub-themes identified in this study are presented in Table 2. Facilitators and barriers to *YendaNafe* were mapped to the STS framework, as shown in Table 3. In presenting our findings, we chose quotes that best supported the main messages of the themes and sub-themes.

User experiences

Shifting perspective overtime. After being informed of the transition to *YendaNafe*, most CHWs reported feeling afraid and anxious. For many, this was their first time using a smartphone, and they had fears of not being able to use the app, which they perceived could result in being terminated from their roles as CHWs. Participants also shared that they thought their clients would reject *YendaNafe* as clients would have concerns regarding who would use the data and how data would be used. Some CHWs wondered if *YendaNafe* would really enhance the

Table 2. Themes and sub-themes identified during data analysis.

Themes	Sub-themes
User experiences	<ol style="list-style-type: none"> 1. Shifting perspectives over time 2. User competence
Facilitators and barriers	<ol style="list-style-type: none"> 1. Stakeholder relations and trust 2. Training and programmatic support 3. Performance monitoring and feedback 4. Language and Information Disclosure 5. Equipment support and connectivity 6. Usability

Table 3. Mapping barriers and facilitators to the socio-technical system framework.

STS category	Sub-themes	Facilitators	Barriers
People	Stakeholder relations and trust	<ol style="list-style-type: none"> 1. Improved working relationships with client and their families 2. Improved working relationships with their supervisors 3. Improved working relationships with local leaders 	Poor working relationship with some supervisors
Processes	Training and programmatic support	<ol style="list-style-type: none"> 1. Availability of help desk to support in case of challenges 2. Provision of training, mentorship, and supervision 3. Availability of well-defined standard operating procedures 	Few opportunities for refresher training.
Goals	Performance monitoring and feedback	<ol style="list-style-type: none"> 1. Ability to use the dashboard to monitor their progress against a set target 2. Supervisor ability to plan supervision based on their built-in application 	Unrealistic expectations from clients
Culture	Language and information disclosure	The design of the application in local language	<ol style="list-style-type: none"> 1. Refusal to be registered in <i>YendaNafe</i> 2. Failure to disclose some information
Infrastructure	Equipment support and connectivity	<ol style="list-style-type: none"> 1. Provision of free smartphone and associated equipment (phone chargers, power banks, and solar charging system) 2. Provision of free airtime and internet data bundles 	<ol style="list-style-type: none"> 1. Poor quality phones and associated equipment 2. Equipment malfunctioning after some time of use 3. Delays in replacing equipment 4. Insufficient data 5. Poor network connectivity
Technology	Usability	<ol style="list-style-type: none"> 1. Easy graphical user interface 2. Ability to use the app when not connected to Internet. 3. Built-in application scheduling and reminders 4. Well-designed clinical decision tools 5. Ability to sync and send reports using the phone 	<ol style="list-style-type: none"> 1. Failure to navigate the phone 2. Some poor maternal health workflows

work they had already routinely performed in the community without the app.

“There was fear that we [CHWs] might not be able to manage YendaNafe and when we fail, they will dismiss us” (CHW, Matope Health Center)

CHWs’ attitudes, comfort, and trust in the app gradually improved. The initial 5-day training supplemented by subsequent peer-to-peer support, mentorship, and supervision by senior CHWs was reported to have improved CHWs’ attitudes toward *YendaNafe*. During this study’s data collection period, most CHWs had a positive attitude toward *YendaNafe*. *YendaNafe* gave credibility to CHWs as communities began to recognize them as professional healthcare

workers. In some cases, CHWs saw the phone as a symbolic reward for their excellent performance.

“YendaNafe made me feel like I have been promoted at work. YendaNafe made me stand out among others and be recognized that I am a health worker.” (CHW, Matope Health Centre)

Furthermore, CHWs felt *YendaNafe* simplified their work. Before the introduction of *YendaNafe*, all CHW tools were paper-based. Challenges with the paper-based system included bulky registers, loss of registers due to theft or “wear and tear,” community health workers’ delays in receiving replacement registers, and reduced data security and privacy (e.g. family members of CHWs

could access patient information through paper files they kept at home). Furthermore, data compilation and reporting were complicated as CHWs had to travel away from their villages to submit data.

The CHWs explained that with *YendaNafe*, all information is currently kept in one place, the phone is not bulky, and they have never run out of space or lost data. They also felt *YendaNafe* is secure and data submission is now convenient—done easily from their home.

“YendaNafe made my work easy and simple. I no longer spend much of my time writing. I just click the phone.”
(CHW, Neno District Hospital)

User competence. CHWs appreciated how *YendaNafe* improved their competence to perform various tasks during a household visit.

“YendaNafe helps to remind CHWs of some of the questions we are supposed to ask for different diseases. We do not face challenges. Every [phone screen] page we open, we find the right information.” (Senior CHW, Dambe Health Centre)

Examples were given on how the platform facilitated the identification and follow-up of pregnant women throughout pregnancy, birth, and early postnatal care. For example, CHWs alluded to the fact that *YendaNafe* uses basic demographic characteristics stored in the system to automatically identify women aged 15 to 49 years and initiate mandatory screening workflow during monthly visits as being helpful to identify and refer possible early pregnancies. Other competencies that improved with *YendaNafe* included prompt follow-up of ANC visits and other referrals through task creation and reminders, adherence to clinical protocol like danger sign screening questions on every visit for pregnant women, and automatic reminders for PNC follow-up at three and five days after birth.

“Upon arriving at each household and if there is a woman of childbearing age, a question in YendaNafe will always pop up. If she is not using any form of family planning, YendaNafe prompts, ‘When last did you have your monthly menses?’ This is the starting point for pregnancy screening. If she says, ‘I have missed my menses this month’, we are required to accompany her to the hospital to confirm if she is pregnant.” (CHW, Neno District Hospital)

“When following up with a pregnant woman, YendaNafe brings a page that asks about danger signs, and it has a list of those danger signs, such as swollen legs and vaginal bleeding. If the woman is showing any of those signs, we have to refer the woman to the hospital for medical help.” (CHW, Dambe Health Centre)

Facilitators and barriers

Under the second theme, we identified several social-technical factors that existed either pre-implementation or emerged as a result of implementing *YendaNafe*, which served as facilitators or barriers to its uptake by CHWs. These are summarized in Table 3 and presented in narrative format under each STS domain—people, processes, goals, culture, infrastructure, and technology.

People. In STS, this dimension refers to individuals in a system (including stakeholders) and their characteristics (like behavior or attitudes). In this study, this dimension encompassed relationships and trust between CHWs using *YendaNafe* and other stakeholders. Improved relationships and trust were seen as a facilitator to using *YendaNafe*; many CHWs reported that it improved the frequency and timeliness of visits to their clients and families and the comprehensiveness of home visit tasks. Some CHWs explained clients’ trust in *YendaNafe*—community members believed the tool was designed by health authorities to guide the delivery of health services. Additionally, CHWs felt *YendaNafe* made them have a stronger relationship with each other due to improved peer-to-peer communication and support when they faced simple technical challenges with using the app.

Due to easy and regular communication between CHWs and their supervisors and supervisors’ technical support to CHWs who were struggling with the app, CHWs’ relationship with their supervisors also improved. One CHW commented how it was easy for the supervisor to take over her catchment area when she was sick for three months, and this was only possible due to a good relationship built when *YendaNafe* was introduced. Finally, introducing *YendaNafe* to local leaders and updating them regularly on how the app enhances their work improved their relationship with them.

“What excites me most is when I find a pregnant woman and follow her up using YendaNafe. YendaNafe tells us to follow up on her if she went to the hospital; if she did not, we should remind her to do so. So we end up visiting that household many times. Furthermore, we build a good relationship with the client at the end of everything. There is another household that even calls me, ‘Your friend has gone to the hospital’, meaning that they know that my client and I have an excellent relationship”
(CHW, Matope Health Center)

Although uncommon, few participants mentioned poor working relationships between CHWs and their supervisors as a barrier. One CHW commented how it was challenging to work with the supervisor as the supervisor did not have sufficient technical knowledge of *YendaNafe* to provide the support the CHW needed. This competence gap, in

turn, affected their relationship. Another supervisor commented that other CHWs are rude to them. However, the CHWs did not mention any poor relationships with local leaders or clients.

Processes. This dimension speaks to the operational procedures and practices employed in a system. This was manifested by procedures and processes that were put in place to enable CHWs to use *YendaNafe*. CHWs appreciated the tangible and intangible systems created to support them in their use of *YendaNafe*, noting that they felt “accompanied” along this journey.

“During the time we have been using YendaNafe, the office has not left us alone. The office has been following us, and it is one of the things that has made us comfortable with YendaNafe. The office has been asking, ‘How is it going? What are your challenges?’ (CHW, Matope Health Center)

Such procedures included initial training followed by regular refresher training scheduled every 3 to 6 months, mentorship and supervision visits, and the utility of a dedicated help desk to support all their technological challenges with *YendaNafe*. Finally, CHWs found it easier to work and follow procedures due to the availability of standardized operating procedures. The most mentioned procedures by CHWs and corroborated by their supervisors and program implementing team included how to manage phones and equipment, how to report challenges, and how and when to submit reports.

Despite most CHWs commending the initial training and mentorship and supervision as part of the program, some CHWs noted that they needed an increase in the frequency and regularity of refresher training to improve their capacity to continue using the *YendaNafe*. Despite the promise to conduct the refreshers every quarter, CHWs noticed that refreshers were happening less frequently, mainly during COVID-19. They requested that the refreshers should happen regularly, at least every 2 to 3 months. Refresher training was described as a way to build capacity on mHealth-specific issues, build CHWs’ confidence in using mHealth, encourage peer support, and learn other emerging topics outside of mHealth.

Goals. This dimension refers to objectives and metrics used to assess the performance of the people and the system. This manifested as how perceived positive outcomes, performance, and feedback influenced CHWs’ use of *YendaNafe*. *YendaNafe*’s dashboards allowed users of *YendaNafe* to monitor CHW performance against set targets. CHWs improved their performance as they could view their performance at any time within their *YendaNafe* application. Senior CHWs reported that the dashboards helped them plan for spot checks by identifying CHWs who may require additional supervisory support. Before the

introduction of *YendaNafe*, senior CHWs did not have the chance to review each CHW’s performance at any time.

“YendaNafe gives us percentages of the households we have screened that month. This is special because once you have screened everyone, YendaNafe gives you 100%. So, if you did not get 100%, you are forced to start looking back and see what happened for you not to attain 100%. This helps you to know where you made a mistake; for example, you didn’t follow up on a certain child or pregnant woman.” (CHW, Matope Health Centre)

There was a perceived positive effect of using *YendaNafe*, which was further supported by recorded improvements in health outcomes in their catchment areas. For example, one CHW commented that they noticed a decline in child deaths once they started using *YendaNafe*.

Despite the majority of CHWs commenting on positive outcomes as a facilitator, some CHWs pointed out unrealistic expectations from their clients as a barrier to using *YendaNafe*. Using a smartphone signaled that the program could do other things they had not done before. For example, one CHW pointed out that other pregnant clients expect CHWs to provide transport, which could easily be included in the overall *YendaNafe* program.

Culture. This dimension reflects how culture—values, ethics, morals—influence the implementation of a system. In general, very few participants reported on this dimension. The app’s design in the local language was seen as an enabler for the use of *YendaNafe*. Information disclosure and refusal to be registered in *YendaNafe* were, on the other hand, seen as barriers to its use. A few CHWs reported that some clients would keep some health information private from CHWs for cultural reasons. As an example, some pregnant women were afraid to disclose information in the first trimester as they did not want other women to know they were pregnant. Reluctance to share reproductive history was also linked to cultural sensitivity from discussing this with male CHWs.

“There are some women that are not open with us. Even on the issue of pregnancy, they often lie to us, and we end up realizing very late that she is pregnant.” (Senior CHW, Neno District Hospital)

Infrastructure. This dimension refers to tangible (e.g. buildings) and intangible (e.g. a business model in the finance sector) assets that are used in a system. This manifested as the influence of equipment and mobile connectivity on using *YendaNafe*. As an enabler, many CHWs appreciated free equipment, data bundles, and airtime. Although the equipment and supplies were adequate in the early phase of introducing *YendaNafe*, most CHWs reported phone

challenges within a year. Complaints included malfunctioning phones, failure to charge the phone, rapidly draining batteries, or slow charging. CHWs also complained about delayed equipment replacement. Interestingly, none of the respondents complained of phone loss due to theft.

“Phone batteries are one of the barriers to using the phones. Some of the batteries drain quickly. We can charge them for the whole night. The power is depleted by 10 am the following day, so working becomes very difficult.” (CHWs, Matope Health Centre)

“It has been happening to us that we have been fortunate that day to have our phone battery full, but upon visiting only one household, you find that the battery is at 90%, and you say, let me switch off the phone to save power so that I can use it on another household and by the time I am switching it on I find that it has drained down to 35%.” (CHW, Dambe Health Center)

Challenges were reported regarding inadequate data bundles. Initially, the data bundles were enough, but as they registered more clients, the demand for internet data outpaced the data provided by the program. Finally, the CHWs complained about the poor network in some areas of the districts.

“On my side, I feel like the bundle finishes quickly (before the next month).” (Senior CHW, Neno District Hospital)

“Internet connectivity is somehow difficult. Sometimes the internet does not even work, making it difficult to send reports timely.” (CHW, Neno District Hospital)

Technology. This dimension refers to technologies used in a system. In this study, the technology dimension referred to the application’s usability. Several built-in functionalities of *YendaNafe* improved the CHW’s ease of use: app in the local language, offline capability, easy graphical user interface, built-in scheduling, and task reminders, easy clinical decision workflows, and ability to send reports.

“YendaNafe reminds us if we have not worked and if we are supposed to go and work somewhere. So, the task reminder makes us not to be idle but to go and do the work.” (Senior CHW, Chifunga Health Centre)

Despite these positive features of the application, CHWs commented on the need for continuous improvement. Some CHWs experienced persistent failure with navigating the application. The most common navigation challenges were failure to load all or some sections of the application, the long duration of updating the app, and unintended changes to the interface, for example, automatic switching of language from local to English.

Due to their experience using the application over a relatively long period, CHWs identified some maternal health workflows that needed improvement. For example, CHWs noticed that the pregnancy screening recommended age was between 15 and 49 years. However, they had cases where adolescents less than 15 years were pregnant. CHWs were able to report these challenges to their supervisors for improvements in the workflow.

Discussion

This study aimed to understand the experiences of CHWs with using a mHealth application and identify factors influencing the use (or non-use) of the mHealth. In this study, most CHWs had a positive attitude, trusted the app, and were comfortable using the app, all of which developed over time. The shifting perspectives were influenced by improved task efficiency, strengthened relationships and communication channels, and elevated professional standing in the communities they served. Additionally, *YendaNafe* improved CHW tasks and made their work easier. The ability of mHealth to improve efficiency has been reported in other studies in low and middle-income countries.^{42–44} For example, in a mHealth application for CHWs designed to improve maternal health in India, CHWs reported that mHealth improved their performance and ability to perform tasks by supporting the ability to adhere to protocols (e.g. adherence to the correct number of required ANC visits) and ability to deliver consistent information and this has been reported in this study.⁴⁵

Compared to a paper-based system, the portability of smartphones was one of the most cited advantages of using *YendaNafe*. This was reported to be helpful when walking under challenging terrains and during the rainy season, an advantage also reported by a study on CHWs in Brazil.⁴⁶ In the Brazil study, CHWs who were using mHealth to support data collection liked the mHealth tool because it was portable and less bulky compared to a paper-based system, and this was an advantage as CHWs had to work for long hours and visit households located in challenging terrains. Despite this advantage, there is a risk of damage and theft with portable mHealth devices, which poses a danger from loss of collected data - a recognized risk of mHealth.^{47,48} While theft was not reported in our study, the reality of this risk requires a mitigation and response plan should it occur.

The positive attitude and the perceived usefulness of *YendaNafe* developed over time as CHWs became more comfortable using *YendaNafe*. As reported in other studies, CHWs require time to adapt to mHealth due to the novelty of mHealth.^{49,50} Based on this finding, mHealth implementers need to be aware of these early mHealth challenges and identify ways to address them as early as possible.

An unintended effect of using *YendaNafe* was the community's perception of the CHWs. By introducing *YendaNafe*, CHWs' status changed as they were seen as more professional and recognized by the health system. This is similar to other studies.^{51–53} For example, Chang et al.⁵⁴ report improved morale, job satisfaction, and a sense of empowerment among CHWs in a mHealth CHW program in Uganda. In Tanzania, where CHWs used mHealth to collect data, CHWs felt that mobile phones improved their credibility and legitimacy as communities believed they offered accurate information when using mHealth tools.⁵⁵

Most mHealth programs encounter challenges that, if not addressed, would impede the implementation, outcomes, and eventual mHealth scale-up.⁵⁶ Successful localization of mHealth projects requires capitalizing on facilitators while addressing challenges identified during implementation. Applying the STS framework helped frame the facilitators and barriers that could influence the uptake of *YendaNafe* as a social and technological system.

We found themes around the influence of relationships, training, programmatic support, and performance monitoring and feedback on using mHealth. The literature has widely reported these themes.^{57–59} For example, Mwendwa et al.⁶⁰ found that good working relationships with clients and health providers enabled CHWs to continue using mHealth in Rwanda. In this study, mHealth helped CHWs improve their client relationship through improved communication. However, a mHealth study in Uganda showed that poor working relationships with supervisors acted as a barrier to mHealth.⁵⁸ Poor relationships affect communication, and if CHWs and their supervisors or clients communicate effectively, it will be easier to implement mHealth programs. Although many CHWs reported good working relationships in this study, we also acknowledge perspectives from a few CHWs who reported poor working relationships.

Due to the novelty of mHealth and poor digital literacy, CHWs require appropriate training in mHealth.⁴⁹ Lack of training in digital health has been reported as a barrier to mHealth. For example, CHWs felt more comfortable using mHealth to support pregnant women after receiving initial training, and refresher training was used to address challenges arising from time to time in a mHealth program in Mozambique.⁶¹ As found in this study, CHWs required regular refresher training in both mHealth and non-mHealth topics.

We also found that clients refusing to be registered in *YendaNafe* and failing to disclose information due to cultural reasons were barriers to using mHealth. This was particularly common in early pregnancy as women do not disclose pregnancies, mainly during the first trimester. However, very few CHWs commented on cultural facilitators or barriers. A previous scoping review found that most studies inadequately investigate the influence of culture on mHealth use.⁶² As incorporating cultural values, norms, ethics, and morals improve acceptability, user experiences,

and positive outcomes on mHealth,⁶³ we propose further studies to explore the culture domain of STS.

Regarding the technical aspects of STS, this study identified barriers and facilitators to equipment, connectivity, and usability. The challenge with the availability of phones, airtime, and internet connectivity is among the most prevalent barriers to mHealth, especially in sub-Saharan Africa.^{64,65} In a mHealth program used by CHWs to increase the use of maternal health in Ethiopia, free equipment was identified as a critical factor in the program's success.⁶⁶ Another mHealth study in Tanzania also supports the idea that providing free airtime and reliable connectivity is an enabler of mHealth use.⁶⁷ Provision of equipment is crucial as CHWs have low socioeconomic status in these settings and, hence, cannot afford to procure and maintain mHealth equipment. As exemplified in this study, challenges with equipment will eventually manifest as the phone and other equipment require maintenance/replacement, and airtime needs increase over time.⁶⁸ There have been concerns about the sustainability of providing free mHealth equipment, and there have been proposals to let either CHWs, communities, or target users procure or maintain the phones and other equipment.⁶⁹ This has been suggested as one way of increasing ownership.⁶⁹ Currently, most CHW programs decide how to handle equipment ownership and other supplies based on their contexts and available funding.

Usability of mHealth technology is also a common barrier encountered in mHealth programs.⁷⁰ CHWs using mHealth in Rwanda and Tanzania have reported that properly designed workflows in a language understood by CHWs improve the acceptability of mHealth use and the effectiveness of mHealth,^{60,67,71} these findings were also reported in this study. In our study, CHWs reiterated the need to continuously improve the usability of *YendaNafe* in order to address challenges like failure to load some sections of the application or generally poor application workflows. This suggests that mHealth programs should have a way of routinely collecting challenges encountered in implementation and must have well-trained technicians who work with CHWs to address technology barriers identified routinely during mHealth implementation.

This study has two main limitations. Firstly, we explored *YendaNafe's* experiences only from the views of CHWs, their supervisors, and App developers. Whilst we recognize that clients' and communities' views are important in understanding mHealth tools, these were not included in our study. Additionally, we focused the exploration on program implementation, excluding the broader policy enablers and facilitators of mHealth.

Conclusion

This study explored the experiences of CHWs using mHealth in a limited resource setting. Findings show that

CHWs find mHealth helpful in improving their task efficiency. Additionally, we found that the *YendaNafe* app was perceived as an incentive and served to improve the trust and perceived professionalism of CHWs. Despite the overall advantage of mHealth, CHWs also identified persistent barriers that need to be addressed to ensure the successful use of mHealth. This study's findings provide practical information that implementers can use when designing and implementing mHealth in limited resource settings.

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