Challenges and prospects for implementation of community health volunteers' digital health solutions in Kenya: a qualitative study

Pauline Bakibinga
African Population and Health Research Center
Eva Kamande (eva.kamande@gmail.com)
African Population and Research Center https://orcid.org/0000-0003-3826-5963
Lyagamula Kisia
African Population and Health Research Center
Milka Omuya
African Population and Health Research Center
Dennis J Matanda
Population Council
Catherine Kyobutungi
African Population and Health Research Center

Research article

Keywords: Digital health, Challenges, Prospects, Implementation, Kenya

Posted Date: January 8th, 2020

DOI: https://doi.org/10.21203/rs.2.20398/v1

Version of Record: A version of this preprint was published on September 21st, 2020. See the published version at https://doi.org/10.1186/s12913-020-05711-7.

Abstract

Background: The value of digital health technologies in delivering vital health care interventions, especially in low resource settings is increasingly appreciated. We co-developed and tested a decision support mobile health (m-Health) application (app); an integrated data capture tool running as a mobile app with selected reporting forms for Community Health Volunteers (CHVs) in Kenya and connected to health facilities. This paper explores the experiences of CHVs, health workers and members of Sub-County Health Management Teams following implementation of the project.

Methods: Data were collected in December 2017 through in-depth interviews (health workers and CHVs) and key informant interviews (health managers) and focus group discussions (CHVs) working in Kamukunji sub-County of Nairobi, Kenya. Data coding and analysis was performed in NVivo 12.

Results: Regarding users and health managers' perceptions towards the system; three main themes were identified: 1) variations in use, 2) barriers to use and 3) recommendations to improve use. Health workers at the private facility and some CHVs used the system more than health workers at the public facilities. Four sub-themes under barriers to use were socio-political environment, attitudes and behaviour, issues related to the system and poor infrastructure. A prolonged health workers' strike, the contentious presidential election in the year of implementation, interrupted electricity supply and lack of basic electric fixtures were major barriers to use. Suggestions to improve usage were: 1) integration of the system with others in use and making it available on users' regular phones, and 2) provision of extra financial motivation for users as well as performance based remuneration.

Conclusions: The findings reveal the importance of considering the readiness of information and communication technologies (ICT) users before rollout of ICT solutions. The political and sociocultural environment in which the innovation is to be implemented and integration of new solutions into existing ones is critical for success. As more healthcare delivery models are developed, harnessing the potential of digital technologies, strengthening health systems is critical as this provides the backbone on which such innovations draw support.

Background

There is growing evidence of the value of digital technologies in promoting access to healthcare. The World Health Organisation (WHO) defines digital health as 'a discrete functionality of digital technology that is applied to achieve health objectives' [1]. The value of digital health is appreciated in patient management, research, and support to low cadre health workers, including community health workers, data collection and analysis, disease surveillance, among other uses. This is particularly important in low resource settings [2]. The value of digital technologies is appreciated for its ability to transcend geographical barriers while allowing real-time access to vital health services [3, 4].

There are national, regional and global guidelines and strategies towards utilisation of digital health to promote the achievement of universal health coverage. The WHO recently released the first set of

guidelines [5], to this end, noting that digital health cannot replace non-functional health systems. Electronic health (e-health) readiness, is defined as 'preparedness of healthcare institutions or communities for the anticipated change brought by programs related to information and communications technology' [6]. Without e-readiness, implementation of programs is challenging. The current East African Community (EAC) Health Sector Investment Priority Framework (2018–2028) [7], in all the nine priority areas, stresses the regional block's commitment to harness the potential of e-health on the road to universal health coverage. The EAC is composed of six partner states: Burundi, Kenya, Rwanda, United Republic of Tanzania, South Sudan and Uganda. The EAC health secretariat, through the ministers' of health has called on countries to implement e-health strategies, with a recommendation that the East African Science and Technology Commission conduct a regional e- health readiness assessment [8].

Kenya launched its first National e-health Strategy in 2011(2011–2017) [9] with a rallying call to strengthen the health system and subsequently extend equity in health care to the poor and marginalized population. Five key areas were identified: telemedicine; electronic health records (health information systems); information for citizens; m-health (mobile technologies in health); and eLearning or distance education for health professionals. The strategy was followed by the National e-Health Policy (2016–2030) reiterating the creation of an enabling environment that promotes adoption, implementation and use of e-Health at all levels of service delivery. The e- Health strategy and policy were supported by the Kenya Health Policy (2014–2030) that in one of its objectives aims to plan, design and install ICT infrastructure and software for the management and delivery of essential healthcare. Although Kenya, and a few other countries in the EAC have implemented their national e-health strategies, lack of scientific evidence on the benefits of e-health interventions, how they work under different conditions within health systems remain major limitations to evidence-based policy and programming.

Kenya, is a leading economic and technology hub in the East African Community, contributing to 40% of the region's Gross Domestic Product [10]. The country has one of the highest mobile phone penetration rates, worldwide [11]. Kenya's growth in ICT has enabled the implementation of various digital innovations for the wellbeing of Kenyans. Such include mobile money–a vital financial solution to Kenyans across socio-economic groups. The health system has attempted to unlock the potential of technology in health. Numerous e-health innovations have been developed and implemented in the country but very few, if any, have gone to scale due to numerous challenges[11, 12]. There is need to identify and address the gaps in order to have clear directions on where to focus investment, in a coordinated manner. With limited research on technological innovations, the "quiet revolution" being experienced in Kenya faces the risk of wasted resources and potential creation of a digital health divide in health care.

Several digital pilot projects, involving low cadre health workers such as community health volunteers (CHVs) have reported improvements in services rendered by CHVs and the related health outcomes for communities [13]. In sub-Saharan Africa (SSA), most of the interventions have demonstrated improvements in the CHVs' delivery of maternal, newborn and child health services, among others [13,

14]. In spite of the many pilot digital health projects implemented in SSA and in Kenya in particular, there is limited data on lessons learned especially in urban poor settings.

Building on lessons learned across SSA and in a bid to improve the health management information system, an innovative digital health application, was developed. The application was developed as an integrated data capture tool running as a mobile application with selected reporting forms for CHVs in Kenya [15]. It operates in an interconnected network of CHVs and health facilities within a defined local system. It is designed to replace the numerous paper-based forms that do not allow integration of patient data from the community to the health facility and back for better referral and management of patients. This system has been seen to improve the reporting abilities of CHVs as it is less cumbersome than the paper-based system. It also has enhanced data quality as it has a function that limits submitting data until all necessary fields are filled in [16]. In addition, the community health assistant (CHA) can access a CHV's data remotely without having to wait for the end of the month for the CHV summaries. The desire to improve the functionality of the system to include a decision support function provided the basis of this project. Throughout its development and implementation CHV views were included. The system utilizes the tools approved by the Ministry of Health (MoH). The decision support system is developed from open source tools.

Conceptual Framework, Theory of Change

The inputs and processes described in Fig. 1 delivered the short and long term outcomes in addressing the delay in seeking maternal, newborn health (MNH) services. The digital application (m-PAMANECH) was developed to strengthen Kenya's community health referral system using a mobile phone and web-portal solutions that link the demand and supply of maternal and neonatal health services. The application had the official MoH 513 (household register), MoH 514 (service delivery log book) and MoH 100 (referral tool) used by the CHVs and the MoH 515 (CHA Summary) used by the CHAs. To improve the functionality and the utility of m-PAMANECH, a community decision support tool (DST) was integrated in the application. The DST helped the CHVs in the identification of high risk facing pregnant women, new mothers in the immediate postpartum and newborns (up to 28 days old) with complications, and to make timely and correct decisions on referral for cases that need intervention. Following customization of the application, m-PAMANECH was operationalized at the community and the five health centres providing MNCH services, by the recruitment and training of CHVs and health care workers. At the community level, a dedicated team of 50 trained CHVs accessed the m-PAMANECH application on the mobile handsets

With the different access levels created for every user, the CHAs and the facilities accessed the submitted data remotely through the web. Allowing clinicians to treat referred patients and record their treatments and the sub-county community health strategy focal person and the CHAs, to follow-up on the CHVs through the system. The use of the application by the CHVs and the follow up by the CHAs ensured the intervention was delivered as expected, support was sustained and non- adherence to the intervention captured and documented. The effects of the inputs and immediate outputs were assessed by examining

the results in the population that the application was intended to serve. These results include improved MNH knowledge and skills of the CHVs, improved decision making and enhanced care seeking behaviours ultimately increasing the utilization of MNH services, reduced complications and deaths.

Methods

Study Setting and Design

Kamukunji sub-County served as the intervention site while Embakasi sub-County provided the control site. The intervention and control sites are comparable as they cover informal settlements in the two sub Counties, which, like other slums, are characterized by poverty, poor coverage of social services and poor health outcomes. The project worked with seven community units (CUs) and five health facilities from which a group of 50 CHVs served as the intervention group in Kamukunji, and three CUs and nine health facilities plus a group of 30 CHVs served as the control in Embakasi sub-County. The CUs in Kamukunji were Airbase, Eastleigh south, Kosovo, Sagana, Vihiga, Majengo and Okoa Maisha while in Embakasi we had Bamuka, Falcon, Gikipa, Kwapi, Motomoto, Mucesha, Riverbank, Sisal and Vuka. The CUs and health facilities in the control group are geographically distant from the intervention site to limit contamination.

Following one year of implementation, qualitative assessments of CHVs' and CHAs' current work experiences after the introduction of the mobile-based system were conducted in Kamukunji. The assessment covered ease of use, challenges experienced and opportunities for improvement.

Study population

The CUs in the intervention and control groups were purposively selected based on discussions with the sub-County community health strategy coordinators[15]. We selected CUs with the worst health indicators, including those serving informal settlements, and with more likelihood to benefit from the intervention. Health care workers in the selected health facilities and members of the sub-County Health Management teams (sCHMTs) were purposively selected and interviewed. Participants in the qualitative data collection, that is, focus group discussions (FGDs) and in-depth interviews (IDI) were conducted among the direct project beneficiaries and CHVs, and key informant interviews with key actors (sCHMTs, health providers, and CHVs). These participants were purposively selected to represent the different stakeholders as well as different health service. Some respondents were identified based on their position in the role in the project.

Data collection

The qualitative interview guide was developed in English and translated to Swahili. Back translation was done to ensure that meaning was not lost in translation. The data were collected through focus group discussions (FGDs) with purposively selected CHVs and women who met the inclusion criteria, whereas in-depth interviews (IDIs) were only conducted with selected CHVs. FGDs and IDIs were conducted by a moderator in Swahili, assisted by a note taker. Key informant interviews (KIIs) were conducted in English with health care workers, CHAs and sub-County health management teams. The discussion notes were

supplemented by observational notes for each interview. Each interview took approximately 60 minutes. The interviews were tape recorded and held in privacy, in spaces that were free of attentive eyes, eavesdroppers, threat of sanctions, and pressure from non-participants. A total of 5 IDIs, 11 KIIs, and 6 FGDs were conducted.

Analysis

In order to describe and interpret the participants' experiences, views, and perceptions, audio recorded discussions conducted in Kiswahili were translated to English and transcribed by an experienced transcriber into word files and imported into NVivo 12 software for coding and analysis. The transcribed discussions and interviews were coded using a preliminary coding scheme developed based on themes from the discussion and interview guides. The coding frame agreed by all researchers was used to systematically assign the data to the thematic categories. The transcripts were analysed using content analysis, by reading through the transcripts to code important information. One member of the research team reviewed and coded the transcripts. After coding the transcripts, three members of the research team identified patterns from the coded data and made connections to recurrent themes. Data were coded using QSR International's NVivo 12 software to identify primary and meta-codes and major themes. The themes were identified with attention to contradictions and diversity of experiences, perception and attitudes across different interviewees. The interpretation was undertaken by at least two members of the research team to ensure objectivity and consistency of coded information. Findings from the CHVs were triangulated with in-depth interviews data from health workers and key informant interviews from the community strategy coordinator and CHAs. The discussion notes were further supported by observational notes made during field visits.

Table 1

Group Composition and Discussion Guide for the Qualitative Interviews

INTERVIEW TYPE	DETAILS	
	Participants	Issues discussed
FGDs CHVs	57 (3 male)	Data collection experiences (electronic versus manual) and role in the provision of community health services
IDIs CHVs	5 (1 male)	
KIIs (CHAs, sCHMTs)	11 (4 male)	Access to and quality of and data collection experiences (electronic versus manual)
Total participants	73	

Key Findings

In assessing the usability of the system, three main themes 1) variations in use, 2) barriers to use, and 3) recommendations to improve use, were identified (Table 2).

1. **Variation in use:**

The private facility and some CHVs used the system more than health workers at the public facilities. Generally, the system was well received by those who used it and appreciated for its benefit.

1. Users' experiences

1. Positive experiences and or benefits of using the system

The system was appreciated as beneficial in improving work-life experiences as highlighted below:

'I would like to use that phone even somewhere else leave alone this one for the phone even somewhere else I would like to use it because it makes my work easier. I see the work is good because right now I would be carrying around that big book of 514 and that 514 is on my phone so I think it is easy. I would be carrying the 100 for a referral I see it in my phone. The 513, I would still….so that one makes my work easier because carrying these 3 books, they are heavy carrying with a bag because they can't fit in this bag. And now the phone, I will put it in my bag and walk with it you see now that makes my work easier.' IDI CHV

'…early submission of reports I would say because immediately they visit a household you can actually get the information right where you are. Personally, I can use my phone to actually check on what they are doing, by the fact that you can put in the GPRS coding, you can know that this person actually was doing this at a particular area at this particular time and not in their own household. So, when it comes to report transmission it is very prompt and you can actually make a decision concerning that particular house hold in good time. KII CHA

1. Negative experiences in using the system

On the other hand the processes surrounding use were a deterrent to effect use as exemplified below:

'*…it has a negative because at the moment, okay there is a time I lost my phone. It was stolen and it had that line of (**organisation name**) and it took a lot of time 3 months for them to return for me the line, so there is no data I have been checking. Because you cannot check without bundles, that's one thing because if I check for that one that desktop in the office, that one the bundles you find that it's not even there. Another thing since they returned for me that line, it was last month I have not been able to access any data because the password I am using and anything it doesn't open it keeps telling me your password is wrong or your password is wrong every time every time*'. KII CHA.

1. Non users' experiences

Among those who failed to effectively use the system were the public health facility and some CHVs.

1. Type of facility

Insufficient human resource, the perception that the application was additional work brought forth by lack of appreciation of ICT.

"*On the other side on the man power I had one clinician who was trained that clinician stays on the other side. After seeing the clients maybe after some hours it is when she comes and opens the computer this is the computer for [Name of organisation] you see that movement something else to be done. Either one person to be assigned maybe the partner to provide the human resource it was consuming a lot of time for me the facility in fact if it one clinician she cannot manage that. Eh that's what I can say*." KII Health care worker

1. CHV attributes

At the beginning of the interventions, CHV who had never used an e-health application, those not accustomed to using smart phone were not able to use the system adequately and these led to some drop out of CHVs.

"*At first it was a challenge, 'because some of them had never used smart phones before. Okay it was excitement; it was (laughing) what do I say, excitement and mmm… anxiety at the same time. We had many when we were starting they were 11 or 13 but they dropped out coz others saw it as a challenge because others had a GPS and someone wants to report in their own house so others dropped out but those who took it they are positive.... the response is good, they are liking it "* KII CHA

2. **Barriers to use:**

Several barriers to use of the system emerged. These were categorised into three sub-themes: (a) socio-political environment, (b) attitudes and behaviours of the users, (c) issues related to the system and (d) poor infrastructure.

1. The socio-political environment

A prolonged industrial action by health workers, the contentious presidential election in the year of implementation, interrupted electricity supply and lack of basic electric fixtures were major barriers to use. This being a slum setting, it is affected by the intermittent power supply. Lack of security for gadgets resulted in the computers being kept in a store, inaccessible to a clinician.

1. Attitudes and behaviour

From the observations made during implementation as well as discussion held with various key stakeholders such as health managers, healthcare worker attitudes towards the system limited use. Many development partners have in the past provided extra financial motivation to system users. Without this, the intended users preferred not to use the system. Most of the clinicians at the public facilities saw the system as additional work and not something to improve their work experiences. In addition, we observed that a number of users lacked basic ICT knowledge and skills which may have contributed to poor attitudes and behaviour.

1. Issues related to the system

For some users, issues inherent to the system, including network connectivity and the phone model were major sources of concern:

'Sometimes you get to a house and the phone hangs, you are like wah! Now what to do? You remove the battery and when you start again, before they put for us that draft input, you start adding information from the beginning. You start again'. FGD CHVs Kamukunji

1. Poor infrastructure

In general, power failures were frequent and the internet coverage was weak in some of the facilities.

"*….Like right now we have been having power problems in Gikomba market from the previous fire. Now it is two weeks down the line and they haven't gotten power coz a transformer busted something major happened ….*" KII_CHA

3. **Recommendations to improve the use of the system:**

In many of the public health facility rooms that the clinicians used, there were no power sockets. In addition, the public facilities were not securely enforced and as a result, the desktops had to be placed in secure areas of the facilities which were different rooms from the clinician rooms.

Participants suggested strategies to improve usage.

First, integrate the system with others in use and make it available on users' regular phones.

'*If they could send that app to our phones…we just use one phone. Either they just unlock those apps; I can also use my sim card'*. FGD CHVs

Second, provide extra financial motivation for users as well as performance based remuneration together with using local languages in the system.

'*Yes! But it will only solve part of the problem, the other part is how do you make them stay? So yes you can make them…you can digitize the referral tool you can digitize the coordination mechanism but how*

do you make them stay you must pay. So the tool needs…the tool is necessary but the tool will not succeed without additional support, yes.' KII Sub-County Medical Officer of Health

Thirdly, there was concern that the system was in English thus limiting its usage by users who are not so conversant with the language.

'*…the tool was easily adopted by the CHV's after subsequent trials that was done but maybe further we can also improve on the language because we work with CHV's some are very illiterate, semi illiterate and some just never went to school so when you use the system is only in English, it blocks a huge number of people who could have utilized it. So the language barrier issue should also be taken into consideration because there are those aspects that you can easily select which language you want to use whether Kiswahili or English so that everybody is accommodated.*' KII CHA

The health managers also recommended inclusion of a course in the basics of computer use, prior to the introduction of such innovations. It was noted that the CHVs who were very good at their daily work did not possess knowledge and skills to interact with the phone. In addition, some clinicians were not conversant with the use of computers, including powering on the device.

To facilitate adoption of the system, there was a recommendation from both the uses and health managers to provide extra motivation for users, including performance based remuneration.

Table 2: User perspectives on implementing the CHV DST

Theme	Categories	Codes
Variation in use	Users' experiences	Positive experiences/benefits of using the system
		Negative experiences in using the system
	Non users' experiences	Type of facility
		CHV attributes
Barriers to use	Socio-political environment	Infrastructure available
		Health workers' strike
		Electioneering period
	Attitudes and behaviour	Expectations
		Lack of knowledge and skills-ICT
	Issues related to the system	Network coverage
		Nature of the gadgets
		Nature of the system
Recommendations to improve the system	Suggestions for enhancing usage	Integrate the system with others
		Provide extra motivation for users, including performance based remuneration
		Provide basic ICT skills for users
		Strengthen ICT infrastructure

Discussion

In spite of the many pilot m-health projects implemented in Kenya, there is limited data on lessons learned especially in urban poor settings. Our study uses qualitative methods to broaden our understanding of the experiences of users of an innovative m-health solution targeted at improving decision support for CHVs, residents of some of the least developed urban slums, in Kamukunji Nairobi, Kenya.

Overall, we found that adoption of the innovation was high at the community level compared to health facility level. The CHVs had been exposed to digital health solutions through previous interventions thus making it easier for them to embrace the innovation as it made their work easier. The mobile phone was lighter to carry and less cumbersome as compared to the paper register and it gave them a higher perceived social status in the community. The inverse was observed at the facility level, health care

workers, especially at the public facilities, were of the view that the web solution gave them extra work and was cumbersome resulting from minimal or no exposure to digital interventions at the workplace.

This study highlights prevailing operational challenges and barriers to using digital health innovations in this setting [12]. Lack of basic literacy ICT skills among the health professionals was observed. To improve uptake, we offered continuous technical support, through on-job training. This was critical to increasing confidence, promoting acceptability, and utilization at the community level. Yet, due to the industrial action and infrastructural issues as well as lack of ICT readiness, on-job training did not work at health facility level.

Whereas the study highlights the potential of digitization and mobile phones as a way forward for strengthening the community health information system and decision making for lower cadre health providers, it stresses some key challenges affecting implementation of digital health solutions in Kenya and related settings in SSA[4]. These include scarcity of steady power supply, lack of basic ICT skills by users, weak health systems, among others [3, 4]. Acceptance and utilization of ICT at the health facility level depended on the attitude of healthcare professionals. Poor attitudes at the health facility level were observed which may have been due to the introduction of a new and specialized concept which the health care workers were not accustomed to due to lack of skills. However, we equally observed that health workers in the setting were overwhelmed by workload – one health worker serving very many patients. This had implications on the way they viewed the system. This finding reiterates the WHO's call to invest in strengthening health systems before investing in digital health solutions as these too rely on functioning health systems[5]. Kenya, like other countries in sub-Saharan Africa, needs a healthcare workforce that is not only motivated but empowered with skills sets that meet the current epidemiological and demographic needs of its population. Inasmuch as infrastructure, vaccines, medicines and technologies are important; investing billions of dollars in health technologies, commodities and facilities is counterproductive, to improving population health if there are no skilled, motivated and adequate in number personnel to operate and deliver the services.

As Kenya and other countries in the SSA region progress to ICT revolution in health, there is an urgent need to ensure that the basic support is met. Lack of ICT equipment, sporadic electricity supply and lack of power outlets in the public facility coupled with insecurity in the environs were major hurdles faced by the intervention. Failure to create an enabling environment will always be an impediment to the successful implementation of such interventions. Some of the users experienced mobile network interruptions. As such, engaging mobile service providers and have them on board to address infrastructure sustainability is critical to successful implementation. Heavy investments are required in equipment acquisition and maintenance as well as internet solutions.

Among the barriers to effective utilisation of the system was the socio-political climate at the end of 2016 and in 2017 which adversely affected the utilization of the system at the health facility level. A long electioneering period in the country characterised by uncertainty and bouts of insecurity as well as a nationwide health workers' strike affected the full implementation of the activities.

During the implementation, it was noted that weak support for the health systems in general and for the community health strategy in particular, continues to affect implementation of healthcare services in Kenya [17]. This also had an impact on the activities implemented. This observation is in agreement with existing reports that despite being clearly defined on paper and its growing role in delivering vital primary health care services, there is limited government support [18, 19]. Several users expected extra financial motivation while others could not comfortably use the phones and desktop computers provided. In this light, the study further stresses the necessity of considering the behavioural determinants of data collection activities in the strengthening of health information systems. There is also need to explore sustainable models of to motivate users to utilize the system. This will include other methods of motivation that may also include monetary.

On the recommendations, there were calls for integration of new solutions with existing ones. The CHVs were using the provided handset, strictly for work and this proved challenging as they had to carry their personal phones as well as the work one. On the other hand, the health facilities have other programmatic systems for electronic medical records such as HIV/AIDS, Tuberculosis that are supported by different partners. With the introduction of mPAMANECH, users had to switch from one system to another. As the country embraces digital solutions, there is a need to debate on whether proposed systems should interoperate; the ability to exchange data between two or more systems) or integrate; joining distinct systems into one to facilitate smooth implementation, operation and efficient use these technologies. The EAC health secretariat has recommended that the EAC Partner States develop common platforms to facilitate interoperability. This is necessary to promote learning from best practices.

Study limitations

While our study provides a rich context to m-health implementation in this setting (in the Nairobi slums), we only elicit the perspectives of individuals resident and/or working in this community. This may limit our application of our theory of change, and ability to make recommendations for digital and public health interventions. Furthermore, the short implementation period needs to be taken into account, especially in relation to the socio-political environment that prevailed during the period.

Conclusions

The study demonstrates the feasibility and acceptability of this type of research in a previously under-researched sub-population. It serves as a basis for future work that could highlight opportunities to respond to the persistent challenges surrounding m-health implementation in low resource settings. Before countries move towards the use of digital technologies in health, it is important to assess the e-health readiness of institutions, including health facilities in order to save time and money. Lastly, as more healthcare delivery models are developed, harnessing the potential of digital technologies, strengthening health systems is critical as this provides the backbone on which such innovations draw support.

Recommendations

Based on the lack of ICT skills observed, we recommend that the government and its partners invest in empowerment of in-service health workers through capacity building on ICT and continuous technical support. This may include integrating e-health into existing curricula, continuous professional training and promote the use of distance learning for continuous education. In this way, the health professionals will acknowledge and appreciate the value of e-health in strengthening the health system.

In the development and deployment of digital health solutions, continuous support is required at all levels from the development of user-friendly and easy to use the application to implementation. Where possible, development should involve the users from the development of the concept and be flexible to the changing needs of the users.

Subnational health departments, with assistance from the national government, need to explore modalities to operationalize and enforce the e-health policy and strategies to create and sustain an enabling environment for ICT in health. As one of the major challenges of rolling out e-health solutions is lack of commitment from the county governments whose mandate is to implement already existing policies, there is a need to develop solutions. In addition, the County health department ought to strengthen coordination and joint efforts to achieve greater impact by involving all stakeholders to avoid overburdening the users and duplication of efforts.

In addition, adoption of ICT is a complex process and will require strategic partnerships. There is need to strengthen public-private partnerships and inter-ministerial engagement to ensure that the pillars in ICT in health are adequately supported for successful implementation and efficient utilization of investments. Joint efforts involving academia, industry, policymakers and practitioners are necessary to drive digital health technology agendas within countries.

Lastly, there is a need to invest in research to promote evidence-based solutions and decision making at all levels and develop solutions in the contexts that they apply.

Declarations

Ethics approval and consent to participate

Amref-Health Africa's Ethics and Scientific Research Committee (Amref ESRC), which is accredited by the Government of Kenya granted ethical approval for the end line survey. The study protocol number is P279/2016. All participants recruited into the study signed an informed consent form administered in either Kiswahili or English (for Key informants) after being sufficiently briefed on the study aims, the procedures, benefits and potential harms as well as their voluntary participation. Moreover, the contact details of at least one of the investigators, as well as the Amref ESRC were availed, if participants had specific concerns

Consent for publication

Not applicable.

Availability of data and material

All data will be made public and available after two years on the APHRC Microdata portal: http://aphrc.org/catalog/microdata/index.php/what-is-this

Competing Interests

None declared

Funding statement

This work was supported by the County Innovation Challenge Fund for Kenya (with funds from the UK Department for International Development). The opinions expressed in this manuscript are those of the authors and do not necessarily reflect the views of the funding organization.

Authors' contributions

PB conceived and designed the study on which the project was based. EK, LK, MO, and CK supported implementation of the project. PB drafted the manuscript. EK, LK, MO, DM, and CK reviewed the manuscript. All authors read and approved the final manuscript.

Acknowledgements

The authors gratefully acknowledge the contributions of the communities of Kamukunji and Embakasi, who gave their time and energy to this project. We are also grateful for the assistance of the sub-counties (Kamukunji and Embakasi) and county (Nairobi) health management teams, as well as the field workers who supported the project activities.

Abbreviations

AMREF ESRC; Amref Health Africa's Ethics and Scientific Research Committee,

App; application,

CHA; Community health assistant,

CHV; Community health volunteer,

CU; Community Unit,

DST; Decision support tool,

EAC; East African Community,

E-Health; Electronic health,

FGD; Focus group discussions,

ICT; Information and Communications Technology,

IDI; In-depth interview,

KII; Key informant interview,

M-Health; Mobile health,

MNH; Maternal and Newborn Health,

MoH; Ministry of Health,

mPAMANECH; Mobile Partnership for Maternal, Newborn and Child Health;

sCHMT; sub-County Health Management Team,

SSA; Sub-Saharan Africa,

WHO; World Health Organisation

References

1. WHO. *Classification of digital health interventions v1.0: a shared language to describe the uses of digital technology for health*. 2018 [cited 2019 27.11.2019]; Available from: https://apps.who.int/iris/bitstream/handle/10665/260480/WHO-RHR-18.06-eng.pdf.
2. Blaya, J.A., H.S.F. Fraser, and B. Holt, *E-Health Technologies Show Promise In Developing Countries.* Health Affairs, 2010. **29**(2): p. 244-251.
3. Betjeman, T.J., S.E. Soghoian, and M.P. Foran, *mHealth in Sub-Saharan Africa.* International Journal of Telemedicine and Applications, 2013. **2013**: p. 7.
4. Folaranmi, T., *MHealth in Africa: Challenges and opportunities.* Perspectives in public health, 2014. **134**: p. 14-5.
5. WHO, *WHO guideline: recommendations on digital interventions for health system strengthening* 2019, World Health Organization: Geneva.
6. Rezai-Rad, M., R. Vaezi, and F. Nattagh, *E-health readiness assessment framework in iran.* Iranian journal of public health, 2012. **41**(10): p. 43-51.
7. EAC, *East African Community (EAC) Health Sector Investment Priority Framework (2018-2018)* E.-H. Secretariat, Editor. 2018: Arusha, Tanzania.

8. EAC. *Harnessing science, technology and innovation to transform healthcare delivery and accelerate the attainment of Sustainable Development Goals in East Africa*. in *The 2nd EAC regional e-health and telemedicine workshop, ministerial conference and international exhibition* 2018. Kigali Convention and Exhibition Village Kigali, Republic of Rwanda
9. GOK, *Kenya National e-Health Strategy 2011–2017*, M.o.M.S.M.o.P.H.a.S.G.o. Kenya-GOK), Editor. 2011: Nairobi.
10. ADB, *East Africa economic outlook 2019: Macroeconomic developments and prospects, Political economy of regional integration*. 2019, African Development Bank (ADB). p. 66.
11. Mitra, P., *Challenges and Opportunities for mHealth in Kenya*. 2014: Washington DC.
12. Kariuki, E.G., *Adoption of M-Health and Usability Challenges in M-Health Applications in Kenya: Case of Uzazi Poa M-Health Prototype Application*, in *School of Science and Technology*. 2016, United States International University-Africa: Nairobi.
13. Källander, K., et al., *Mobile health (mHealth) approaches and lessons for increased performance and retention of community health workers in low-and middle-income countries: a review.* Journal of medical Internet research, 2013. **15**(1): p. e17.
14. Braun, R., et al., *Community health workers and mobile technology: a systematic review of the literature.* PloS one, 2013. **8**(6): p. e65772.
15. Bakibinga, P., et al., *The role of a decision-support smartphone application in enhancing community health volunteers' effectiveness to improve maternal and newborn outcomes in Nairobi, Kenya: quasi-experimental research protocol.* BMJ Open, 2017. **7**(7).
16. Bakibinga, P., Kamande, E., & Kyobutungi, C, *Harnessing Public-Private Partnership to improve Maternal, Newborn and Child Health (MNCH) services and outcomes in Nairobi slum settlement: End of Grant Report*. 2016, African Population and Health Research Center: Nairobi, Kenya.
17. Boakye, M.D.S., et al., *Challenges of achieving sustainable community health services for community case management of malaria.* BMC Public Health, 2018. **18**(1): p. 1150.
18. Wangalwa, G., et al., *Effectiveness of Kenya's Community Health Strategy in delivering community-based maternal and newborn health care in Busia County, Kenya: non-randomized pre-test post test study.* The Pan African Medical Journal, 2012. **13**(Suppl 1): p. 12.
19. McCollum, R., et al., *Exploring perceptions of community health policy in Kenya and identifying implications for policy change*. Health Policy and Planning, 2016. **31**(1): p. 10-20.

Figures

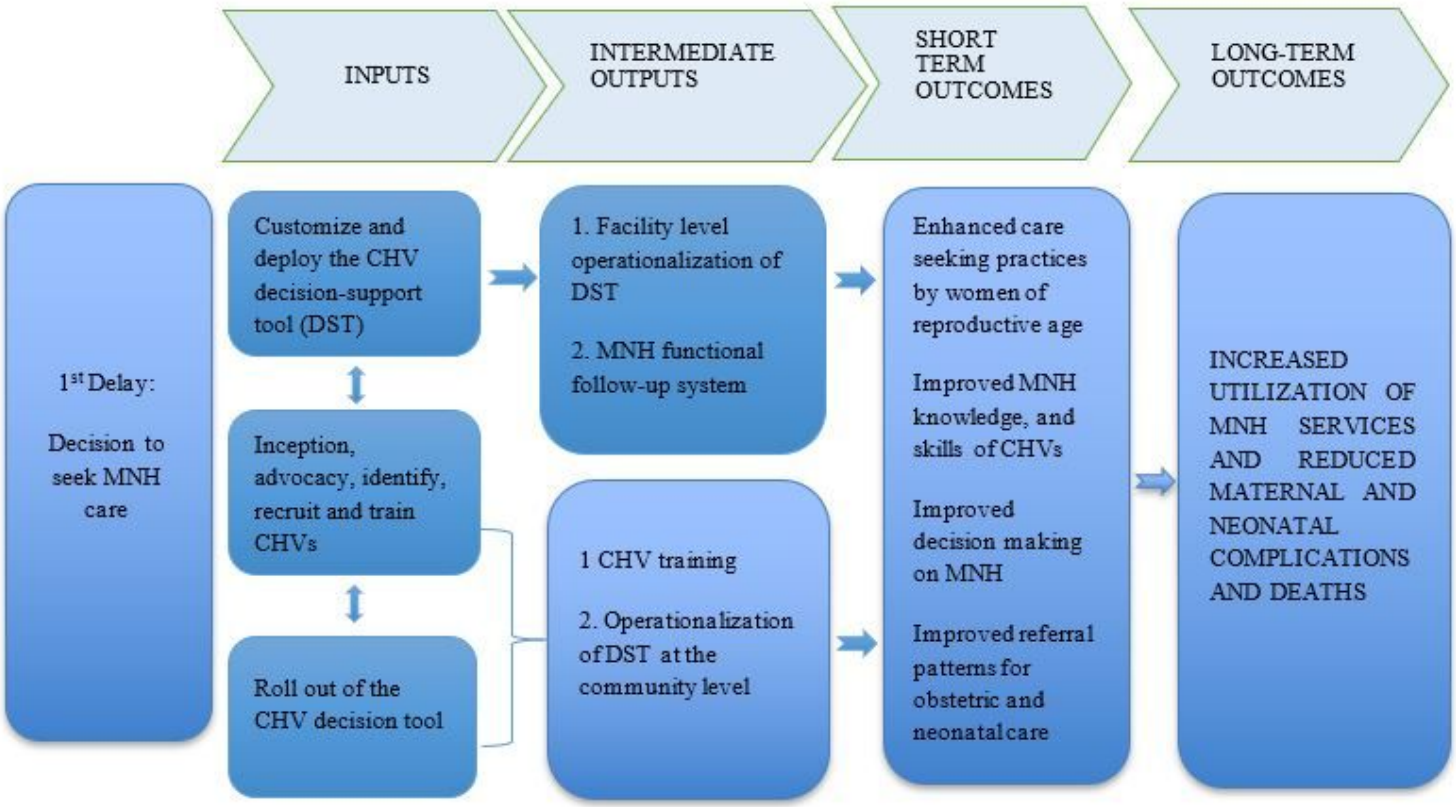

Figure 1

Intervention Theory of Change