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Use of Mobile Phone to Promote Governance and Equity within the Health System: Experience of Rural Health District in Burkina Faso

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Abstract

Background: Mobile phone has been described as offering a remarkable potential to deliver primary health care. It is widely used in low-and middle-income countries to support health care delivery. In Burkina Faso, high maternal mortality rates and persistent numbers of people living with HIV are priorities to address by government. Here we described an innovative mobile phone platform that helps to overcome barriers of access to health service by community members in rural health district.

Methods: A mobile phone project was implemented to enhance better access to health information and care delivery for mother, and people living with HIV. An interactive messaging and voice system was developed and incorporated major local languages to overcome literacy barrier. In addition, a patient's reminder system for follow-up appointments was incorporated.

Results: Overall 423 pregnant women, 319 new-born mothers and 116 HIV/AIDS patients were followed-up by the system in 2015 by community health workers. An average 177 patient's reminder for appointment was completed. There was an 8% increase of antenatal care uptake and better compliance of HIV patients to antiretroviral services.

There was also a reduction of about 84% of loss of followed-up from HIV patients (P<0,05), and an increase of 41% of assisted deliveries. However, running mobile devices in a hard to reach population is challenging.

Conclusion: Use of mobile phones at a community level is a powerful tool to increase their equitable access to health care information and participation to local health care governance. However challenges must be anticipated.

Keywords: Mobile phone; Maternal and child health care; Equity; Access to care; Governance; Nouna; Burkina Faso

Abbreviations: BCG: Bacille Calmet Guerin; CHW: Community Health Worker; GSM: Global Messaging System; HIV: Human Immunodeficiency Virus; ICT: Information Communication and Technology; IDRC: International Development and Researches Centre; ITU: International Technology Union; IVR: Interactive Voice Messaging System; LMIC: Low and Middle Income Country; MOS@N: Mobile Santé Nouna; MT: Mobile Technology; NEPAD: New Partnership for Economic Development of Africa; NHD: Nouna Health District; NHDSS: Nouna Health and Demographic Surveillance Site; SMS: Short Message Service; TAM: Technology Assessment Model; WHO: World Health Organization

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Background

Nowadays, the most accessible technology among the most disadvantaged populations in the world remains the mobile phone. Statistics released by the International Technology Union (ITU) indicate that over the past 15 years, information and communication technologies (ICTs) have grown up in an unprecedented way, providing huge opportunities for social and economic development.

Nearly 5 billion mobile phones are connected worldwide and over 85% of the world population is now covered by cell phone networks of which two billion live in developing countries [1]. A recent World Bank report noted that more Africans now have a mobile phone than have a toilet [2, 3].

According to Van [4], service and care providers, researchers and national governments are excited at the opportunities mobile health (mHealth) has to offer in terms of improving access to health care, engagement and delivery, and health outcomes. mHealth is seen as one of the great opportunities at providing targeted interventions to poor populations living in remote areas [5].

The World Health Organization (WHO) has defined mHealth as "Medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices" [6]. Although Africa has experienced a delay in adopting information and communications technology (ICT), there is more and more interest in its possible role in enhancing access to health care information and related opportunities.

Like several other African countries, Burkina Faso has recently increased its use of mobile phones for various purposes. A recent estimate of the Nouna Health and Demographic Surveillance Site (NHDSS) showed that the household ownership of mobile phones in this rural area increased from 3.8% in 2006 to 46% in 2009. In 2010, 28.13% of rural households and 63.80% semi-urban households owned at least one cell phone [7]. At national level, cell phone coverage is estimated at about 70%.

In the context of poverty, low educational level and high rate of maternal and infant mortality in Africa, the New Partnership for Economic Development of Africa (NEPAD) in 2002 adopted a resolution to tackle health issues through use of ICTs among its 10 priorities [8]. Therefore, many pilot projects have begun to emerge in a number of countries such as Senegal, Rwanda, Mauritania, and Mali [9, 10].

Indeed, maternal, newborn and child mortality and morbidity in developing countries remain high despite efforts undertaken by most countries. It is the main source of public health inequity [11]. Many systemic, economic, socio-cultural and geopolitical factors contribute to this situation. To address this health challenge, the use of ICT is increasingly seen as a promising solution [12-15].

The contribution of mobile phones in particular, earlier referred to as "mHealth," promises to provide remote access to health services, and to facilitate training and sharing of knowledge between health workers [16]. mHealth can also contribute to diagnosing disease in rural and marginalized areas where health services are often scarce or nonexistent [15, 17].The deployment of mobile devices may well be decisive in the prevention and control of diseases by promoting health behavior change in population and health workers [18].

The mobile phone is also appreciated as a work tool that can help to take decision and promotion of good health practices and behaviors among populations [19]. As part of a study in Gambia, a mHealth project was implemented to connect the community health workers in villages with the hospital through mobile phone technology. In cases of emergencies related to pregnancy and child health, the health worker in rural areas immediately contact the ambulance service in charge of the maternity for rapid transfer [20].

In Bangladesh, in the face of significant shortages of highly trained health care personnel, there has been a growing interest in the possible ways that the use of mhealth, can improve access to safe, effective and affordable health services and advice in low and middle income countries [21].

A number of ehealth and mhealth initiatives have already been implemented since the late 90's. These have mainly focused on mobile phones, especially important amongst the rural and underserved communities for their potential to overcome geographical boundaries. In 2011, WHO reported Bangladesh as one of the 15 countries using mHealth to raise health awareness [22].

In Kenya, mHealth was used in several initiatives. Indeed, the effect of mobile phone text-message reminders on Kenyan health worker's adherence to malaria treatment guideline was assessed through a cluster randomized trial. Adherence on malaria treatment guideline in intervention area was higher than control area where health workers did not receive text-message reminders [23].

India has a long standing experience in the use of mobile phone to support health care delivery. With greater avaialability of cheaper phones in the market, the user base mobile phones in India is increasing rapidly [24].

Mobile phone was also adopted across various sector in India such us Banking, telemedicine and governance.

From the health program manager's perspective in India, the direct benefit of mHealth for healthcare consumers and healthcare providers yield overall program benefits such us early case identification, better quality of health care and improved compliance to treatment.

mHealth is being used in many forms in health related programs in India. Currently, Mother and Child Tracking System (MCTS) is arguably the biggest such program in India, operational since 2009.

Sending mobile based SMS to beneficiaries to alert them regarding services due to them, or services which have become overdue, communicating with other health care providers are some examples of how the mHealth system is being utilized in MCTS [24].

In early 2016, Government of India launched a nationwide mobile health program « MOTECH » designed to train community

health workers and to directly reach millions of women within three years. With the funding from the Bill & Melinda Gates Foundation, Grameen Foundation created MOTECH as an open-source platform that works across key areas for health services: behavior change, managing patient data, improving worker performance, strengthening last-mile supply chain, and improving patient adherence.

Nevertheless, as it was reported in much systematic review on mHealth, the impact of mobile health in developing countries remains relatively understudied [11, 25, 26]. Moreover, the few studies investigating the issue show that the impact of mobile health projects on population health are not always directly perceptible in terms of cost-effectiveness. However, the rapid proliferation of mobile telephony is widely considered as a promising opportunity to improve health services and benefits in developing countries [19, 25].

According to Labrique et al [19], there is a need for more evidence, as the current results are usually limited to pilot phases, and are more focusing on the process of mHealth implementation. The question of how much mHealth can be seen as a health system-strengthening tool and better integrated within the health system, remains open and to be better addressed. Challenges in process implementation also need more attention.

This viewpoint was shared by Tomlison [27] for whom despite hundreds of pilot studies; there has been insufficient programmatic evidence to inform implementation and scale-up of mHealth. The example of Uganda reported by the author translates better the difficulties in moving forward with a specific initiative. Indeed, approximately 23 of 36 mHealth initiatives implemented across the country between 2008 and 2009 did not move beyond the pilot phase.

In a review of empirical studies related use of ICTs, many studies focused on SMS. Some studies investigate in mobile ring tones, paying for parking, mobile gaming, mobile ticketing, and mobile insurance. Others are more generic and are related to advertising (SMS advertising, mobile social advertising), mobile commerce, mobile shopping, Internet mobile banking, mobile payment, mobile brokerage etc.

According to Diniz [28], mobile technology, viewed as a payment or banking channel, has the potential to allow two important questions to be addressed at the same time: on the demand side, it represents an opportunity for financial inclusion among a population that is underserved by traditional banking services. On the supply side, it opens up possibilities for financial institutions to deliver a great diversity of services at low cost to a large clientele of the poorest sections of society and people living in remote areas.

Mobile banking is becoming a new paradigm in developing countries where a majority of Banks branch is offering Mobile Financing Services (MFS) to users.

MFS is an umbrella term, often referred to as mobile money. MFS uses a “mobile wallet” or a separate electronic money account used for payments other than prepaid or post-paid mobile airtime. Within MFS, there are three main categories: mobile payments, mobile credit/savings/insurance and mobile banking [29].

As Miller [30] noted it, in countries where access to traditional banking services is limited, more and more people are utilizing cell phones to send money to family members, pay bills or keep track of savings.

In Kenyan, the M-Pesa system is the largest mobile phone banking platform in the world. It has exploded in popularity over the last decade and now serves more than 13 million active customers.

Developed by Vodafone and launched commercially by the company’s Kenyan affiliate Safaricom, M-PESA is a small-value electronic payment and store of value system accessible from ordinary mobile phones. Once customers have an M-PESA account, they can use their phones to transfer funds to both M-PESA users and non-users, pay bills, and purchase mobile airtime credit for a small, flat, per-transaction fee. The affordability of the service has been key in opening the door to formal financial services for Kenya’s poor [31].

Similarly in Ethiopia, the M-Birr service was operational since 2014.

M-Birr is a mobile money service that enables the banked and unbanked people of Ethiopia to conduct financial transactions from the convenience of their mobile phone. The launch of the services, which allow customers to make payments or receive money via a mobile that is linked to a bank account, mirrors technology used in other African nations that has drawn millions of people into the financial system [32].

Many other LMIC are using mobile financial services such as Burkina Faso since 2010 with airtel-money, mobi-cash in partnership with local Banks.

However, as noted Beshouri, although there are more than 120 mobile money projects being undertaken in about 70 emerging markets [33], mobile payment has only become a normal practice in a few countries, despite its huge potential.

The introduction of ICT in the field of health, however, is not done without difficulty. Obstacles to the implementation of mobile technology in the field of health remain both technical and financial. One of the main challenges is the development of digital networks for communication between the various health actors and various equipment used [13, 34]. Another major obstacle is the lack of competence and expertise for the development and implementation of projects tailored to health problems especially in rural areas [35].

The existing literature on mobile health pilot projects shows that in Africa many external barriers are responsible for failures [36]. In addition other obstacles are related to the design of individual projects and their adaptation to the local contexts in which they are implemented. Unlike external factors, the factors associated with projects themselves can be monitored and controlled during the implementation phases.

Another important challenge is related to gender issue and mhealth interventions.

Indeed, as noted some authors, the gender divide in access to and use of mobile phone technologies is well documented in developing countries [32, 37].

In a systematic review conducted by Jennings [37], he concluded that the current mHealth literature described several positive transformations in the interaction of men and women. One finding was that the provision of mobile-based health information empowered couples to discuss health. Despite evidence on the positive effects of mHealth interventions on women's health and care-seeking, there is growing concern that mobile-based programs geared towards women may exacerbate gender inequalities [37].

In this same line some evidence suggests that while mHealth programs hold the potential to shift gender roles by empowering women through improvements in knowledge, decision-making, and economic gain [16, 38], and some mHealth interventions may exacerbate gender inequalities by reinforcing existing power differentials [37].

In this context, Burkina Faso has been engaged in the implementation of several mHealth projects. One of these projects, MOS@N, was implemented over the last two years by the Nouna Health Research Centre in the rural health district of Nouna. The implementation was supported by the International development research centre (IDRC/Canada).

The mHealth project (MOS@N) is an interactive mobile phone communication system deployed at community and health facility levels. The platform was developed using open source software and allow access to health information related to maternal and child health care and to patient living with HIV. The platform has a reminder component so that to increase compliance with planned visits and follows up patients in remote area without access to health information.

The key actors for the project are community health workers located in the project selected area and health workers in the project catchment area. All actors were provided with cell phones that allow communication. In addition all health facility was provided with laptops allowing patients registration at the point of care. There is an automatic synchronization of patient's information with a central server based in project headquarters.

The main aim of the mHealth project is to increase awareness in the use of health facilities related services by community member via interactive mobile communication system. As such, pregnant women, HIV patients are regularly informed about the importance of seeking care and the necessity to follow planned visits through tailored education messages.

The mHealth project implemented in 2013 and running until 2017 has brought together local healthcare providers, community health workers, ICT technicians, and public health researchers in an interactive communication system tailored for the specific health information needs of an underserved area. This research project aimed at interconnecting a network of health facilities in the Nouna Health District through an innovation technology to improve access to information and care.

The objective of the study was to document and analyze an innovative mobile phone platform that aims to help in overcoming barriers experienced by community members in accessing health services. Special emphasis was given to gender related inequalities. Furthermore, this article examines lessons learned that should be considered for possible similar technology implementation by other countries.

Methods

Study site

The study was conducted within the Nouna Health District (NHD), in rural Burkina Faso. The NHD is located at about 300 km in the northwest of Ouagadougou, the capital of Burkina Faso. It is one of the six districts of Boucle du Mouhoun Health Region and covers the geographical area of the Kossi Province in the western part of the country. Nouna is the capital of the Kossi Province. The health district comprises of the town of Nouna with a total population of 29,297 inhabitants and a rural area of about 331,020 inhabitants.

The health infrastructure of the NHD consists of one District Hospital in Nouna, and over 43 dispensaries. Due to deficient road infrastructure, only 69.13% of health facilities are accessible all over the year with a mean distance of 8.48 km [39]. The **Figure 1** shows the NHD map and study areas.

Study design and methods

The study used a quasi-experimental design with pre- and post-intervention study comparison between two groups of health facilities (HF) with one arm assigned for the intervention and the other as control. Overall, 10 HF within the Nouna Health and Demographic Surveillance System (NHDSS) were included in the study, among which 5 were randomly allocated for the control.

The study combined both qualitative and quantitative methods to collect baseline data among community members and health service providers. Baseline HF was collected prior to the mHealth intervention implementation in 2013 and over the project course in order to document the change between pre-intervention and post intervention. For that purpose, key health indicators related to maternal and child health care, as well as to HIV patients, were collected and monitored quarterly. They were also compared with baseline data after 24 months of implementation.

The conceptual framework in **Figure 2** describes the logic of the mHealth technology implementation and interaction within the health system and the potential expected outcomes.

mHealth technology development

The mHealth platform was developed locally based on an extensive review of the diversity of mHealth solutions implemented across different countries.

An interactive voice messaging system (IVR) was developed and incorporated five local languages (Bwamu, Dafing, Dioula, Mooré and French) to overcome literacy barriers. In addition, an automated patient reminder system for follow-up appointments was incorporated in the technology that was developed by local experts familiar with mobile health technology. For ease of deployment, open software developed under PHP Symphony Framework was adopted. The **Figure 3** shows the

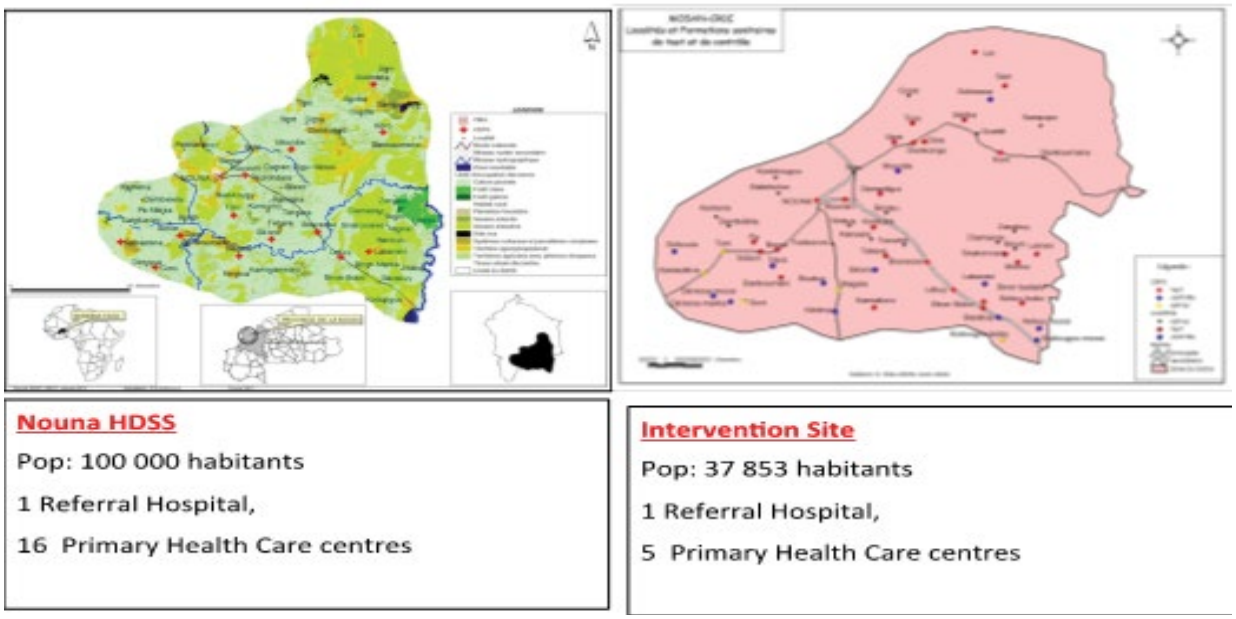

Figure 1 Map of the study area.

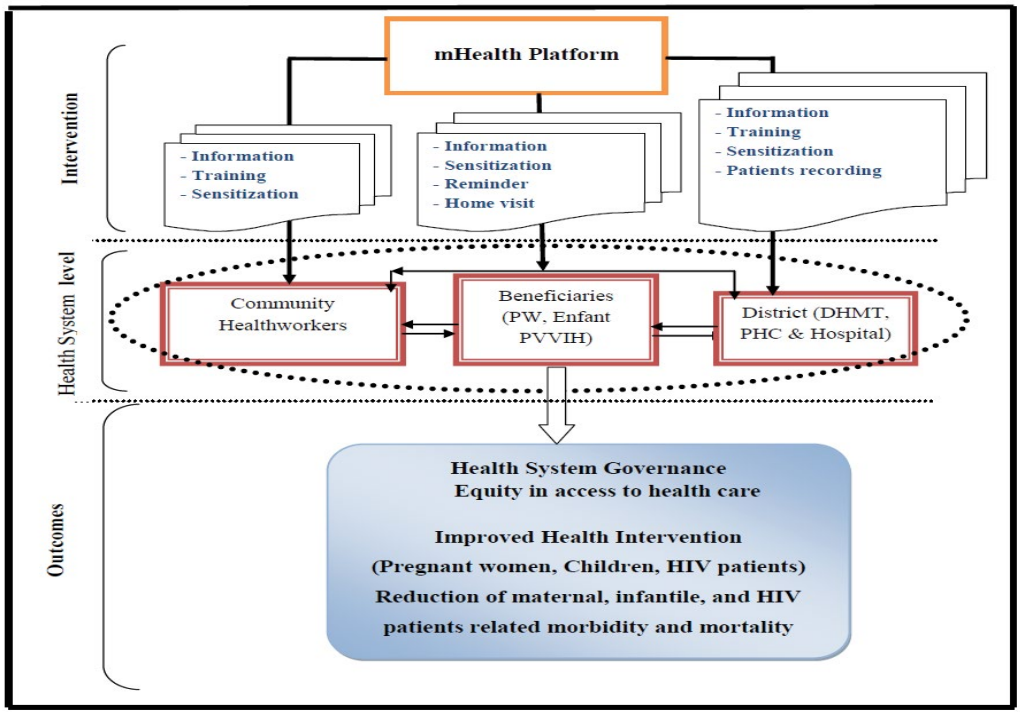

Figure 2 Conceptual framework of the mHealth project.

technical features of the platform developed and its interaction with health facilities and community members.

The mHealth technology incorporated the following components: a GSM internet connexion, an Interactive Voice Messaging System, an automatic patient reminder system, and an automated backup system including data synchronization with a central server hosted in Nouna. In addition, a core health information system was developed and incorporated within the district health facilities to collect data relevant for decision-making. The **Figure 3** describes the key components of mHealth platform deployed.

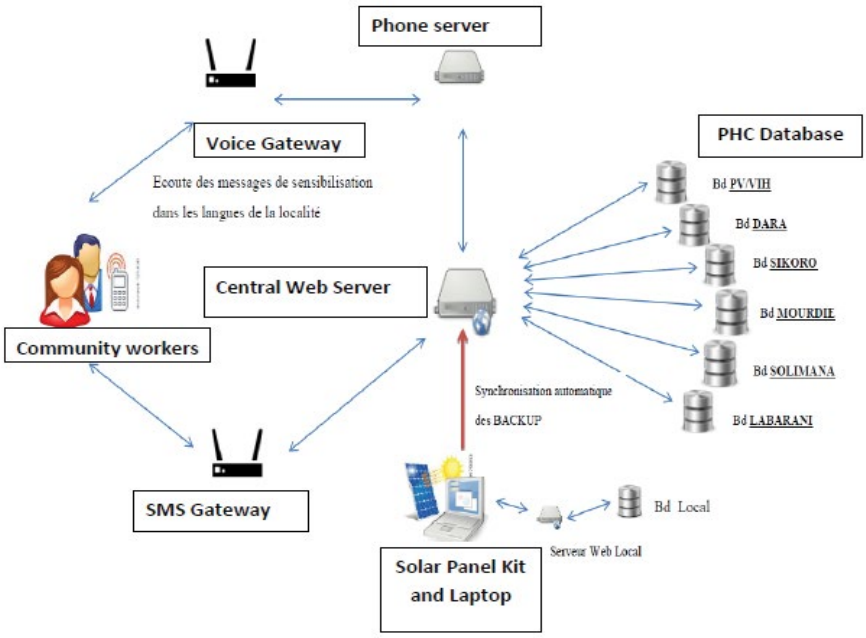

Figure 3 mHealth platform deployed in Nouna.

Ethical consideration

The research protocol was approved by the National Ethic Committee and an institutional review board approved in 2013.

Results

The results section is structured in three components: The acceptability of the technology by key stakeholders; the effects of the mHealth project; and the challenges related to its implementation.

Acceptability of mHealth according to in-depth interviews

In-depth interviews were conducted with different actors purposely selected — 15 health workers out of 30 and 25 community health workers out of 52 — involved in the project just before it was launched. The interviews aimed to document the acceptability and usefulness of the technology according to these actors.

Overall all actors noted that the mobile phone already played an important role in their daily activities. At a health facility level, the phone is used to convey routine health information data at each level of the system; it is often used to call an ambulance in case of emergency. Community members value the mobile phone as a symbol of wealth, and tend to consider that it can empower women and encourage their use of health services. It is also perceived as a tool to get information from relatives, from health facilities and stay in touch with family abroad. Its role in reducing unnecessary visits to health facilities was mentioned by a respondent:

"The mobile phone contributes to reducing distance and inconvenience due to road traffic. Also in case of a death, the bereaved families no longer need to walk or travel to inform the neighbouring villages. We can make calls instead of moving to the village" (woman in the village of Sikoro).

Technology acceptance assessment

WHO technology assessment model (TAM) was used to assess community and health workers acceptance toward the mobile phone.

Acceptability of MT by community health workers

A total of 48 community health workers (CHWs) were interviewed for technology assessment using the WHO standard structured questionnaire on the acceptability of mobile phone technology. Overall mobile phone possession was about 35% among CHWs. Mobile phone was used mainly for voice calls by 94% of phone owners.

Regarding the perceived usefulness of mobile technology (MT), the majority of CHWs (94%) perceived it useful with 100% intention to use it for communication and sensitization for pregnant women and children.

Acceptability of MT by health workers

A total of 19 health workers were interviewed in five health

facilities using the WHO TAM. 100% of health workers had a mobile phone and 4 others had in addition a laptop.

The most common application used by health workers are voice calls in 100% of cases and SMS for 63% of respondents. In terms of acceptance, 74% agree that the use of mobile phones could help make patient care more quickly and convey routine health information to management levels.

Effects of mHealth project in health care utilization

The effects of the mHealth project were measured through key performance indicators in line with those used by the Ministry of Health. The measure was done at pre-intervention in 2013 and at mid-intervention in 2015 based on the listed indicators:

1. Antenatal care 1 (ANC1)
2. Antenatal care 4 (ANC4)
3. Tetanus Toxoid vaccine (TT2)
4. Intermittent Preventive Treatment of Malaria (IPT2)
5. Pregnancy at risk referred (PAR)
6. Infant to Mother Transmission of HIV (IMCT)
7. Assisted delivery (AD)
8. Postpartum care (PPC)
9. Contraceptive prevalence (CP)
10. Oral Polio Vaccine (OPV)
11. BCG vaccine (BCG)
12. Loss of followed up HIV (LFU)

Results linked to mHealth implementation process

Overall more than 100 health workers and 62 community health workers were trained to mHealth platform use as well as mobile phone use. This was found fundamental to make the project functioning well.

The involvement of CHWs was determinant for the project to achieve substantial results among which: 181 pregnant women newly registered, 992 pregnant women referred to antenatal care (ANC) services, 826 women followed-up for postpartum care; more than 2318 access to voice messages for sensitization; 413 home visits performed and 811 automatic reminders for visits received by CHWs.

Effects of the mHealth project on maternal and child health, and people living with HIV

The effects of the mHealth intervention were measured against selected performance indicators. The comparison was made between the intervention and control sites performance at baseline and mid-intervention in 2015 as in **Table 1.**

The data showed that there was a gain of 12.6% in the intervention area compared to the control area, which is equivalent to 8% increase of antenatal care uptake. Similarly, there was a gain of 13.75% in PMTCT coverage in intervention area compared to control area. Both differences were found statistically significant (P-value<0.0001). However, some indicators such as assisted delivery and TT2 didn't change between the two sites.

The effects of the project were also measured in intervention sites and compared between baseline and mid-intervention mean performance as shown in **Table 2.**

When considering the intervention area alone between 2013 and 2016, there is an improvement in a majority of the indicators selected. For example, for the ANC4, we noted a 10% increase from the baseline to mid-intervention in 2016 (P<0.001). There was also a 41% increase in assisted delivery, a 36% increase in TT2 coverage and a reduction of about 84% in lost to follow up of HIV patients. These results were statistically significant (P<0.0001).

Overall, of the 971 HIV patients followed-up by hospital, 262 were registered via the mHealth platform and followed up. Indeed, with the automated system implemented through CHWs, patients were reached easily and were informed about the benefits to seek care in formal health facilities.

Table 1 Performance between intervention and control sites in 2015.
Legend: ANC4: Antenatal Care4; TT2: Tetanus Toxoid2; IPT2: Intermittent Preventive Treatment of Malaria; PMTCT: Prevention of Mother to Child HIV Transmission; AD: Assisted Delivery; PPC: PostPartum Care; CP: Contraceptive Prevalence; OPV: Oral Polio Vaccine; BCG: Bacilli Calmette Guerin

Indicators	Intervention site	Control site	Difference (%)	P-value
ANC4	58.07	45.47	12.6	P<0,001
TT2	84.04	79.50	4.54	
IPT2	87.92	95.60	-7.68	
PMTCT	97.32	83.59	13.73	P<0,001
AD	87.93	89.97	-2.04	
PPC	49.35	64.36	-15.01	
CP	66.85	65.93	0.92	
OPV	100	89.08	10.92	
BCG	100	89.08	10.92	
Combined p-value				

Table 2 Comparative mean performance in intervention site between 2013 and 2015.
Legend: ANC4: Antenatal Care 4; TT2: Tetanus Toxoid2; IPT2: Intermittent preventive treatment of Malaria; PMTCT: Prevention of Mother to Child HIV Transmission; AD: Assisted Delivery; PPC: Post-Partum Care; CP: Contraceptive Prevalence; OPV: Oral Polio Vaccine; BCG: Bacilli Calmette Guerin; LTFU/HIV: Lost to Follow up HIV Patients

Indicators	2013	2016	Difference%	Progress (%)	P-Value
ANC4	52.8	58.07	5.27	10	P<0,0001
TT2	62	84.04	22.04	36	P<0,0001
IPT2	85	87.92	2.92	3	P<0,0015
PMTCT	78.33	97.32	18.99	24	P<0,0001
AD	62.5	87.93	25.43	41	P<0,0001
PPC	62	49.35	-12.65	-20	
CP	50.8	66.85	16.05	32	
OPV	100	100	0	0	
BCG	100	100	0	0	
LTFU/HIV	10	1.6	-8.4	-84	P<0,0001

However, as many health interventions were ongoing in both health facilities led by the Ministry of health, such us the subsidized care for maternal and neonatal care; this could explain the non-difference in some indicators.

Challenges linked to mHealth implementation and solutions

MOS@N experienced important challenges, related to both technological implementation and human resources.

The technological challenges were posed by the lack of robustness of the mobile phone devices used in the project. Despite the choice of relatively robust phones, over 65% of the phones was out of service after 24 months of implementation, and was replaced. In the meantime, 21% of solar recharging systems were also replaced. The fact that, most users were not familiar with phone use could explain the high rate of damaged cell phones.

The other technological challenge was the poor Internet connectivity within the intervention zones. The high penetration of mobile phones in the study area contrasted with the low accessibility to reliable network (both mobile and Internet) access, and this, despite efforts made by the national supplier. The project was designed around an interactive system, which required data synchronization via a central server. This synchronization, however, was not possible due to a lack of access to Internet in most of the peripheral health facilities. However, alternative solutions were developed to download data in an USB stick and to update later the central server based in the project's headquarters by simple loading the data in the server.

Concerning the human resource challenges, the main issue was the high turnover of health workers, moving toward other health facilities, or national level for training purpose. The turnover was estimated at 30% after two years of project implementation. One consequence of that is a continual renewal of the staff and the need to train health workers newly appointed to participating health facilities. This provoked discontinuity in the project. There were also challenges related to changes within the group of participating (CHWs), for personal purpose or conflict with husband regarding their participation in the project. In terms of gender representativeness in the project, 54 CHWs were female and 8 were male.

Notwithstanding these issues, the mHealth project was able to mobilize local community members with the ultimate goal to increase their access to health facilities and their involvement in local health governance. Some lessons were also learned in terms of reinforcing the feasibility and acceptability of such a mHealth project and this, right from the implementation stage.

Discussion

The study showed that the use of mobile phones at community level could improve their access to health care and ensure that equity dimension is fully considered for those who otherwise cannot access to health services by their status.

MOS@N, a mHealth project implemented over two years, shows that the intervention is feasible technically and acceptable by health workers and community members. It has led to substantial improvement in healthcare access, whether it is for maternal and child health, or for people living with HIV.

These results are consistent with the findings of other projects such as MobiSan (Mobile Santé) [40] that aims to improve maternal and child health through the development of service based on mobile and implemented in the eastern part of Burkina Faso. Indeed, this mHealth initiative implemented in 2010 registered more than 3 million users and led to an increase of child survival (1.7 points) in 5 months and threefold increase of health service utilization by mothers.

A mHealth project in Mali which targeted data transmission through routine health information systems among under five years showed an increase in health service use by beneficiaries compared to control group who does not benefit of the mHealth intervention [41].

The fact that ICT, and the mobile phone in particular, has been used as a means to convey health information, is well documented elsewhere. Indeed mHealth and other applications can contribute to remote diagnosis in places where health services are scarce or non-existent in marginalized rural communities [15, 42]. The deployment of mobile devices may be decisive in the prevention and control of diseases by promoting health behaviour change among the population [17].

mHealth is also appreciated as a powerful tool that can enhance the promotion of behaviour and good health practices among the population [26]. A similar study in the Gambia aimed at connecting community health workers with the hospital through mobile phone devices yielded tremendous results in emergency management related to high-risk pregnancies [20].

However, what could be the effects of mHealth interventions on the health of populations? As part of improving the health of populations, several health interventions may be needed to produce the expected changes.

After 24 months of implementation, MOS@N has contributed in increasing some key health indicators. Indeed, with a 10% increase of antenatal care uptake in 2016 compared to the baseline 2013, 41% increase of institutional deliveries and 24% increase of PMTCT services, mHealth is a promising tool to complement on-going health strategies.

Our results are consistent with those reported by Bagayoko [9], according to whom the use of mHealth and eHealth initiatives implemented in Mali contributed in improving medical diagnosis in cardiology and obstetrics (92.6%), as well as the patient management system on site (96.2%). In Rwanda too, an SMS-based system was developed to improve maternal and child health (MCH) using RapidSMS, a free and open-sourced software development framework launched in 2011. RapidSMS led to a 27% increase in facility-based delivery from 72% twelve months before to 92% at the end of the twelve-month pilot phase [10].

In Bangladesh, WHO reported that the Ministry of Health reached 98% of its target population through SMS on health education but did not provide messages in Bangla, which is the first language of the majority of the population posing a problem of equitable access to health information [24].

A systematic review [25] conducted in LMICs on seven mHealth projects also shows that SMS reminders have improved patient participation rates to appointment visits compared to patients not included in the projects. Overall, participation in appointments was 67.8% for the group without reminders, and 78.6% for the group with SMS reminders.

However, as noted some authors, if the contribution of the mobile phone in the provision of care is a new paradigm largely adopted by most developing countries[42, 43], the literature also reveals that the results are sometimes mixed and often lack of evidence [44]. Some have indeed argued that the impact of mHealth in developing countries remains relatively understudied [3, 44]. Moreover, the few studies that investigated the issue show that the impact of mobile health projects on population health is not always directly perceptible in terms of cost-effectiveness [19, 26].

Challenges linked to mHealth implementation

Despite many reported benefits associated with the use of mobile phones in the provision of care, some challenges also arose in most projects implemented that need to be overcome at the beginning and through the process. These challenges are mainly due to technological issues and human resource capacity to use this technology.

Indeed, as reported by several authors, even successful mHealth programs in low-resource settings face particular challenges [3, 27]. While in MOS@N major challenges were posed in terms of cell phone robustness, weak energy availability and poor network connectivity, other authors have noted the inadequacy of mobile phones in LMICs who can only accommodate voice and SMS text messages [3]. The fact that the majority of cell phones were replaced in our project was also documented in a mHealth pilot project implemented in Rwanda [10].

Moreover, system integration and interoperability was identified as a challenge in most mHealth projects implemented in LMICs. Indeed, many mHealth interventions were implemented in a parallel way, without being integrated within the national health information system [45].

Challenges such as the scarcity of reliable energy source, confidentiality of patient data and integration into a standard information system and technology were also commonly reported elsewhere [9, 27, 46].

In terms of human resources, running a mHealth project requires highly qualified information technology workforce, right from the design of the technological platform. This expertise is very often missing in LMIC and this poses a problem of transfer of technology [15].

Managerial, policy implications and recommendations

In terms of managerial aspects related to the mhealth intervention, there is a need to involve health managers and health workers at all stages of the technology development and deployment for more ownership. Beneficiaries need also to be more informed about the potential benefits of mHealth and the way their rights are protected and their access to storage data.

In terms of policy implication of mHealth intervention, researchers should raise policy makers about the importance of mHealth solution and potential benefits to improve population access to health information and oriented health care. The adoption of mhealth policy at countrywide rely on the perceived usefulness by policy makers.

We recommend therefore that:

1. Policy maker adopt mHealth intervention as part of health system strengthening tool.
2. Integrate mHealth intervention within health care delivery system in health facilities.
3. Ensure scaling up of mHealth intervention at country level and facilitate access to reliable cell phone network.

Conclusion

The contribution of mHealth in the access to health information and to improve population health is undeniable. In the context of a high penetration of mobile telephony within communities, it offers as an opportunity for improving health outcomes in many different ways.

Mobile phones can also strengthen the role of the community in their participation to local health governance and empower women regarding their access to antenatal care and healthy childcare service.

However, it is essential to anticipate at the early stage the challenges linked to mHealth implementation and to identify ways to avoid failure during the implementation process.

The main challenges due to weak phone connectivity, unfamiliarity of community health workers need to be further assessed before the implementation of this kind of project in order to improve the sustainability of the project.

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