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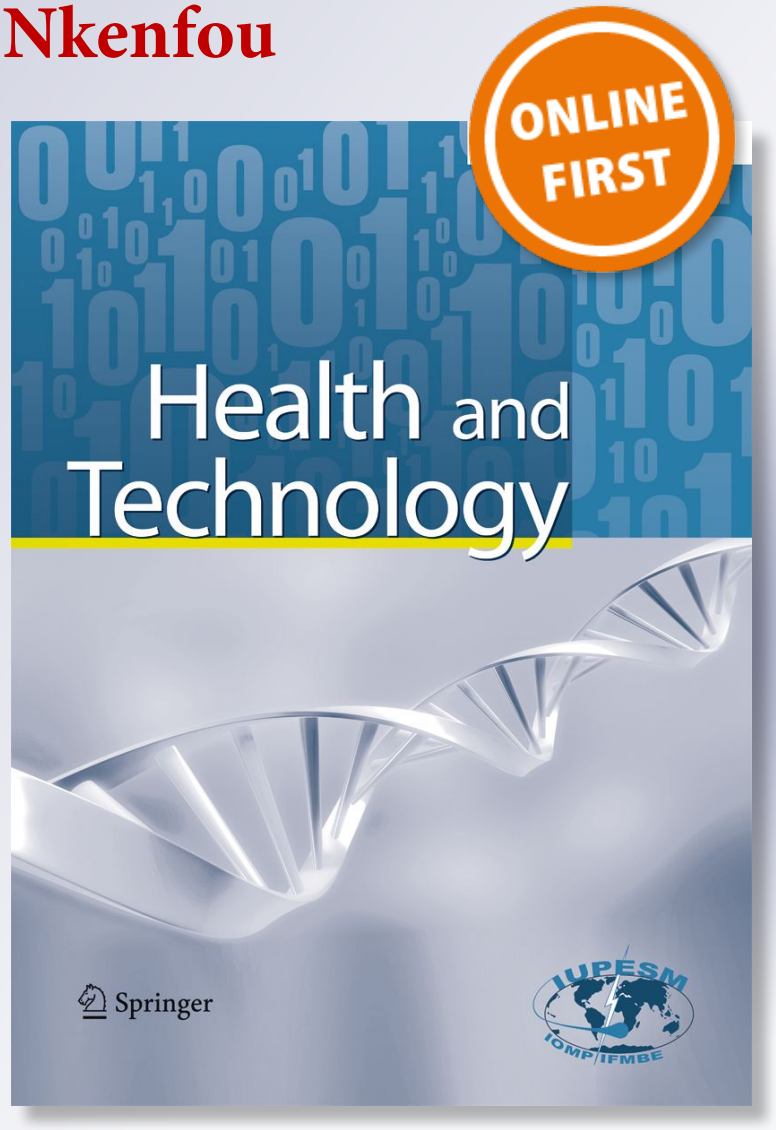

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REVIEW

Mobile applications: effective tools against HIV in Africa

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Abstract Mobile phone applications (apps) provide a new platform for delivering tailored services especially applied to Human Immunodeficiency Virus (HIV) infection prevention and care. To review mobile phone apps currently available related to the prevention and care of HIV infections as well as other diseases. The articles were systematically identified and the research was indexed with the following keywords: Africa, Telephone, Mobile App, SMS, associated with the word Health, HIV, or PMTCT. Research papers published between 2006 and 2016. In Africa, many mobile health applications have been developed, in different domains such as: disease knowledge, risk reduction/safer disease, health promotion, HIV/AIDS testing information, resources for HIV-positive persons and focus on key populations. Use of SMS and call of mobile phone have the potential of improving adherence to medication in outpatient setting by reminding patients of dosing schedules and attendance to scheduled appointments through SMS and voice calls. Mobile phone apps should be extended to all health facilities, community to increase the impact of new development in the field of HIV testing, Prevention and Treatments.

Keywords Mobile phone · SMS · HIV · Health

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1 Introduction

Africa claims to be the mobile continent even stronger than previously thought, with researchers predicting internet use on mobile phones on the rise [1]. As a result, internet use started from 0,78% in 2000 to 20.71% in 2014 [2]. Today, most mobile phone users are using their devices for a variety of activities; in addition, mobile phones are and are becoming more affordable.

Mobile phone usage in Africa have affected the society in various ways [3], Cell phone improve communication and give people access to a broad range of information no matter where they are [4]. Mobile phones are also playing a vital role in health. They are an important tool to spread prevention

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messages against disease as well as to educate the populations not only in Africa [5–8] but elsewhere [5, 9–11]. Cell phones offer unprecedented possibility to African who before could not have access to medical care or health services [12]. Free and easy to use, mobile applications have been an important tool to provide services and educate the public on how to stay healthy [10]. Also, The increase in cell phone use has raised a growing interest in this technology for the promotion of health [12]. Research states that there is an increase of mobile applications in maternal and child health [13–18]. These mobile apps could save millions of lives throughout Africa [13, 17, 19, 20]. Therefore, in developing countries, these applications cover a wide range of activities including data collection, diseases monitoring, health promotion and monitoring of patients [21–26]. In Kenya, mobile phone and the use of SMS is ubiquitous among health workers in the public sector [27]. SMS technology has been shown to be a possible method for the administration of health education messages. A study found broad agreement that 90% of people open and read the SMS sent to them [28].

The mobile phone use in health is a strategic tool for prevention and fight against the disease, but it is also used for prevention of HIV, and is an effective tool for the prevention of HIV transmission from mother to child (PMTCT). Use of mobile phone will enable to reach one of the Millennium Development Goals (MDGs). to stop the spread of HIV / AIDS, with indicators such as the 25% reduction of the infection among young people aged 15 to 24, and also measure their knowledge of HIV/AIDS [29].

The objective of this paper is to review the literature on mobile applications as an effective tool to fight HIV in Africa “. It is actually a narrative review to report pre-established conclusions in order to stimulate more interest for the approach.

2 Method

2.1 Search for relevant publications

Databases such as PubMed, BioMed Central, ScienceDirect were searched. International websites of health mobile application were examined. Relevant publications were searched using keywords: Africa, Telephone, Mobile App, SMS, associated with the words Health, HIV, or PMTCT.

2.2 Exclusion and inclusion criteria

Research papers published between 2006 and 2016 were included as well as articles on the use of mobile technologies in Africa and those with the following keywords: mobile phone, health, HIV and PMTCT. The study excluded articles published before 2005.

3 Results

3.1 Mobile applications for the promotion of maternal and child health: A challenge met in Africa

Mobile phones in Africa play a vital role, they are an important tool to inform people about the prevention of heath care as well as educate the public [5, 9–11] mainly in Africa [5–8]. Increased use of cell phones has sparked growing interest in the development of mobile applications for health promotion [12]. Free and easy to use, mobile applications have been an important tool to help and educate the public to stay healthy and provide access to health services [10]. The research state that there is an increase of mobile applications in maternal and child health [13–18] that could save lives throughout Africa [13, 17, 19, 20]. These applications cover a wide range of activities including data collection, diseases monitoring, health promotion and monitoring of patients [21–26]. SMS technology has been shown to be a possible method for the administration of health education messages., In Kenya, mobile phone and the use of SMS is ubiquitous among health workers in the public sector [27].

3.2 HIV: Short message system (SMS) reminders

Kenya has boasted the mobile technology in health, especially in HIV with application development that can significantly improve the management of people living with HIV [30]. For example mobile message system WelTel, helps People Living with HIV (PLHIV) for treatment adherence leading to increased viral suppression rates [31]. PLHIV could receive text messages a day before to remind them to take their medication on schedule [32, 33], in many African countries like Malawi [34], Kenya, South Africa and Ethiopia. In Ethiopia, a study showed a high proportion of patients on ARV using cell phones as a reminder tool to take their treatment [32]. In a study conducted in rural Uganda, over 60% of PLHIV were donated a mobile phone as support for adherence to ARV [35]. SMS messaging has proved useful in improving access to primary health care [36].

PMTCT also benefits from mobile telephones for the care and management of HIV positive pregnant women. In South Africa and Nigeria, a mobile phone service encourages HIV testing and adherence to PMTCT programs. Another example of a mobile application project is the MAMA SMS, where pregnant women and breast feeding mothers were granted free messages to heath care giver until the baby age of three months [37]. Mobile interventions are not only possible in

HIV-positive pregnant women but are useful in the prevention of HIV transmission from mother to child (PMTCT) [38].

Given the wide spread of mobile phones in Kenya and current health-related uses of mobile phones, a PMTCT mobile communications platform holds considerable potential. This pre-intervention assessment of community and health worker preferences yielded valuable information on the complexities of design and implementation [39]. Testing (TextIT) to improve health uses mobile phones to provide interactive two-way text messaging for HIV-positive pregnant women in the Nyanza Region of Kenya, to encourage them to attend postpartum clinics and have their infants tested for HIV [40].

Studies showed several advantages or real impact of mobile application among people living with HIV / AIDS as they could receive text messages a day before to remind them to take their medication on schedule, in the case of Malawi [34] and in Kenya.

The percentage of patients infected with HIV with treatment adherence and viral suppression had increased [31] as well as the proportion of ARV patients using cell phones as a reminder tool to take their treatment [32].

60% of Ugandan patients were donated a mobile phone as support for adherence to ARV [35], Mobile phone allows adherence improvement to antiretroviral interventions [41].

Studies on the effectiveness of SMS as a reminder of appointments to improve adherence to antiretroviral treatment for patients infected with HIV were conducted in Nigeria [42] Kenya, Cameroon [31, 42–48] and South Africa [49].

In Cameroon, a primary outcome was adherence measured by the visual analogue scale, self-report, and pharmacy refill data [43].

In Kenya, 53% of participants receiving weekly SMS reminders achieved adherence of at least 90% during the 48 weeks of the study, compared with 40% of participants in the control group [47].

3.3 Projects design on mobile applications usage in health: A challenge for the Republic of Congo

HIV transmission from mother to child stills remain a major public health problem in many African countries; [50–52], because the strategies for the prevention have low coverage [53–55] and the Republic of Congo is not an exception [56]. To curb HIV and achieve zero transmission of HIV from mother to child, a series of interventions need to be implemented [57–59].

Mobile telephony could alleviate several factors preventing or blocking the implementation of PMTCT in Congo as described by Ghoma et al., (2015) [56]. SMS reminder messages can be sent to pregnant women to get prenatal care, to consult and to encourage HIV-positive pregnant women to seek treatment; or simply messages of recommendations to comply with treatment guidelines [10, 15, 22, 60]. Health workers are secondary beneficiaries of the innovative use of mobile phones, by receiving information on new or updated guidelines [6, 20], especially for PMTCT [39, 61]. SMS could be sent to health workers in a timely manner for warnings about the stock-out of drugs [62, 63]. SMS4Women and EduVIH/AIDS are two projects on the mobile telephony that could be experienced in the Republic of Congo (personal communication, 2016).

3.4 Barriers to mobile phone technology to improve health in the Republic of Congo

Although mobile communication in the country is affordable, using the mobile phone as a health tool is a challenge for the Congo, giving the limited access to electricity. There are also cultural issues: men controlling all phones in the house whole, denying women's access and limiting their privacy around issues such as contraception and HIV status. The extension of the use of mobile communication applications beyond the support of the membership under the national program could be done relatively inexpensively [64]. A study in Kenya has set up a mobile platform effective for PMTCT engaging men and women to reflect on the non-disclosure, spousal phone sharing, and links between people and Community services [35].

4 Discussion

Smsaude, is a research project carried out among ART patients who received regular reminder SMS, improving retention in care for HIV patients in Mozambique [65]. A similar study in Kenya indicates that patients who received weekly SMS reminders were much more likely to adhere to their treatment regimen than those who did not receive reminders [31].

The results of the project Care4TodayTM suggest that when patients were contacted by a mobile application for reminding them of their medication, there was a positive change in their behavior [37]. Two countries affected the HIV/AIDS use this application: Lesotho has one of the highest infection rates for HIV/AIDS, with 23% of the population living with HIV/AIDS; Kenya, in this country young students are a group "at risk" for HIV/AIDS. In both cases, the mobile phone was used to address these public health problems, which have improved the traditional means of fighting against HIV/AIDS [31, 39, 66–69].

A study in Guatemala suggest that using SMS reminders to improve child immunization coverage [70], but also in Bangladesh [71]. SMS represent a new approach for rapid dissemination of information, for education on HIV / AIDS, counseling and HIV testing [72]. In a rural area access to mobile phones was associated to improved attendance

Table 1 Summary of some projects on mobile applications in selected African countries

Name of mobile application and Country	End results	Size of the study (number of subjects)	Brief narrative of how the success	Ref.
"MAMA" Tanzania	To make progress in preventing deaths from complications related to childbirth. To boost care of mothers and newborns by text message, which increased significantly qualified health assistance.	2550 pregnant women (1311 interventions and 1239 controls)	The wired mothers' mobile phone intervention significantly increased the proportion of women receiving the recommended four antenatal care visits during pregnancy	[15, 76]
"App Safe Delivery" Ethiopia (*randomized studies*)	To Improve the quality of emergency obstetric and neonatal care and strengthen health workers' skills and quality of care in developing countries. Help health workers to identify basic obstetric complications during childbirth;.	3601 women in active labor were included at admission and 176 health care workers	The App Safe Delivery was an effective method to improve and sustain the health care workers' knowledge and skills in neonatal resuscitation as long as 12 months after introduction	[77–80]
"mHEALTH "South Africa	To reduce mortality and maternal and infant morbidity.	583,929 pregnant women were registered on MomConnect	The improvements in the quality of services, e.g. decreased drug stock-outs and change of behaviour of some health workers.	[17, 81–84]
"Mobile Midwife", Ghana	To send quick messages in local languages to pregnant women and mothers.	7370 women were enrolled in MM during pregnancy and 14,867 women were enrolled postpartum	Among the recommendations, there was the need for more timely use of data to mitigate delivery challenges and improve exposure to health information.	[85, 86]
"Gifted Mom" Nigeria and Cameroon	To Reduce the number of women living in rural areas who die during childbirth, by giving them mobile phones, with possibility to call free of charge in case of emergency delivery for transport to a maternity.	13,300 pregnant women and newborns registered	The antenatal attendance rates in those communities have increased on average of 20%. 500,000 + SMS and 520 community health workers engaged currently.	[4, 87, 88]
"Abiye Safe Motherhood Initiative", Nigeria	To Improve services consumption of maternal health through the use of cell.	The programme has witness 1031 deliveries out of about 3000 registered women	The Abiye programme has reduce infant and maternal mortality rate in Ondo state	[4, 87]
"SMSaude", Mozambique *(multisite randomised clinical trial)*	To Evaluate whether regular mobile phone text reminders improved patients' retention in antiretroviral therapy (ART) care	830 eligible HIV-infected patients	Text messages improved retention in care of urban patients and those who recently started ART and received text reminders	[47, 65, 89]
"Care4TodayTM" South Africa *(Randomized Controlled Trial)*	To Improve treatment adherence and positive behavior change.	60 HIV+ participants	Most participants stating that it had become a part of their lives, and not a burden, or additional task, suggesting the supportive role the app played in participants' lives that felt distracted, chaotic, and faced with multiple barriers.	[37]

services of clinical care for HIV/AIDS [73]. A study done on sending SMS results of HIV testing of newborns has significantly reduced the time between sample collection and reporting of results at the health centers [74].

4.1 The financial sustainability of mobile for reproductive health (M4RH): Example in Tanzania

When looking for ways to cover the costs of a mHealth program, three possible strategies can be distinguished. One of these strategies is user pay-for-service, which means that the user pays for all or a portion of the cost of the service they receive. A second strategy is SMS cost reduction; when reduced SMS rates can be negotiated with mobile network operators. The third strategy is the leveraging of key partnerships. Cost-sharing arrangements with other communication campaigns can reduce a large part of promotional costs.

For the M4RH program, possible due to funding and grants, a break-even point between costs and revenues seemed only possible when all SMS costs were transferred to users and the lowest per-SMS cost was negotiated with telecom partners. While this strategy would be financially sustainable, it also raises questions about its consequences: When users are paying for the mHealth service, the health information is still not accessible for anyone, i.e. those who lack the means. Such a threshold would drastically limit the reach and impact of the program.

4.2 Considering long-term solutions

Financially sustainable mobile health programs are highly desirable, but user pay-for-service or SMS cost reduction seemed not to fulfill the requirements of sustainability, scalability and high-impact. Strategies to recover costs alone may not be sufficient for sustainability, although they can help to reduce the total amount of required donor funding.

In the short-term, donor funds are likely to remain an essential component of mHealth services that target the poor and underserved. For long-term sustainability, a discussion is needed to incorporate successful and socially desirable business models that can lead to profit that can be reinvested in the programs, as there is always need of improvement and innovation. Only then, health impact in general can be increased. Over all, the cost of communication is coming down year by year view the number of people who own a mobile telephone nowadays.

4.3 Problems of sustainability and scaleability can it be overcome?

There is reason to hope that the issues of sustainability and scalability can be overcome.

Portable wireless devices (PWD) represent a particularly promising media for social marketing because of the extensive worldwide reach made possible by their expanding global adoption. Equally important, there is growing evidence illustrating the viable application of PWDs in health promotion activities targeting behaviors such as outpatient appointment adherence [75].

People who have used their mobile phones for health related activity have reported that they are, in general, satisfied with using their mobile phone in these types of interventions. However, many of the studies perform only short-term follow-ups, making it difficult to determine if the influence of and engagement with these interventions are sustainable. Since the focus of the most of these interventions is clinical outcomes, the use of theory in intervention design and implementation is often lacking (Table 1).

5 Conclusion

Mobile applications can be tools of health development in the significant prevention of HIV by 2025.

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Authors' contribution Laure Stella Ghoma Linguissi (University Ouaga I Prof. Joseph KI-ZERBO) conceptualized and designed of the study, collected, analyzed data, and coordinated the writing of the manuscript. Erick Kamangu Ntambwe and Charles Gombé Mbalawa participated in the revising of the manuscript. Céline Nkenfou critically reviewed and revised subsequent versions.

Both supervisors were involved in the write-up and preparation of the manuscript.

Compliance with ethical standards

Competing interests The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article.

Conflict of interest The authors declare that they have no conflict of interest.

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