

**ELIMINATION OF BOTTLENECKS IN HIV PREVENTION, CARE AND TREATMENT: THE  
MOBILE HEALTH OPPORTUNITY IN KENYA**

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Elimination of bottlenecks in HIV prevention, care, and treatment: The mobile health opportunity in Kenya

A thesis submitted in partial fulfillment of the requirement for the degree of Master of Science in Public Health

By

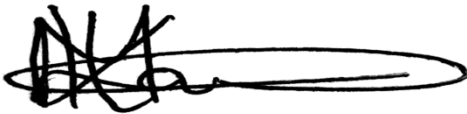
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**Declaration:**

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## **LIST OF ACRONYMS AND ABBREVIATIONS**

**HIV**-Human Immunodeficiency Virus

**AIDS**-Acquired Immunodeficiency Syndrome

**ART**-Antiretroviral treatment

**TB**-Tuberculosis

**MCH**-Maternal and child health

**PLHIV**-People living with HIV

**FSW**-Female Sex Worker

**MSM**-Men having sex with men

**MSW**-Male sex worker

**PWID**-People who inject drugs

**KP**-Key population

**VCT**-Voluntary Counselling and Testing

**UNICEF**-United Nations Children's fund

**GDP**- Gross Domestic Product

**SSA**-Sub-Saharan Africa

**ICT**- Information Communication Technology

**WHO**-World Health Organization

**EMR**- Electronic Medical Record

**eHealth**- Electronic health

**mhealth**-Mobile health

**LMIC**- Low-and-Middle income countries

**ANC**- Antenatal coverage

**PNC**-Postnatal coverage

**mLearning**- Mobile learning

**SMS**- Short Messaging Service

**IVR**-Interactive Voice Response

**MMS**-Multimedia Messaging Service

**MOH**- Ministry of Health

**RCT**-Randomized control trial

**NRS**-Non-randomized control trial



**PHW**-Peer health worker

**UNAIDS**-Joint United Nations Programme on HIV/AIDS

**FP**-Family planning

**CHW**-Community health worker

**INGO**-International non-governmental organization

**WHO**-World health organization

## **ABSTRACT**

**Background:** HIV/AIDS is a leading cause of death and disability. Around 1.5 million Kenyans are living with HIV, with over 100,000 AIDS-related deaths occurring annually. Access to good quality HIV services is crucial in reducing the HIV burden. With increasing mobile phone penetration in remote areas and near-100% penetration elsewhere, mobile health (mhealth) opportunities that provide solutions to health services access barriers need exploration.

**Methodology:** Literature review was from Kenya and other low- and middle-income countries. The Levesque model of access to health service and the mhealth and ICT application framework by Labrique et al. were used to guide the literature search and structure the findings section.

**Results:** Findings showed that several key demand and supply factors influenced access to HIV services. Varied mhealth applications were found to improve sexual behavior and treatment adherence. They also increased antenatal and postnatal clinic attendance, improved provider training, communication among providers for improved care, and enhanced supply chain management. Mobile financial services were found to improve healthcare savings and provide medical loan assistance.

**Conclusion/Recommendations:** Mhealth applications can be used to motivate behavior change and improve treatment adherence. They also reduce treatment delays, case referrals, and facilitate remote training of health workers. Technical, infrastructural, and design challenges affect the acceptability, feasibility, and scalability of mhealth interventions. The alignment of mhealth interventions with the national health strategy and addressing design and implementation limitations are vital to the success of mhealth interventions.

**Keywords:** HIV/AIDS, tuberculosis, electronic health, mobile health

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## **INTRODUCTION**

HIV/AIDS is a massive public health problem, both nationally and globally. Almost 2 million Kenyans are currently living with HIV, with more than 100,000 AIDS-related deaths occurring annually. HIV affects all age groups; however, young women are the most affected demographic. The impact of HIV is grave-socially, financially, and economically. Therefore, the goal of this thesis is to explore the potential role of mobile health in addressing these barriers in the context of HIV and other sexual and reproductive health settings.

Interest in the field of HIV stems from my background as a health care provider in Kenya. Before arriving at KIT Royal Tropical Institute, I was working as the deputy head of the dental department of a level four hospital in Kenya. As a certified dental practitioner, HIV/AIDS is ubiquitous in my profession. Over the last four years in clinical practice, I witnessed firsthand the detrimental effects of AIDS on families, couples, and communities. However, one case stuck with me. In 2016, a 23-year-old patient presented to the clinic with a severe case of Kaposi Sarcoma. She was also an orphan. After starting her on antiretroviral therapy, her prognosis improved significantly. It was then that I realized that young people, such as herself, lacked the knowledge and awareness about HIV prevention, spread, and management. I was motivated to get involved in community outreach programs to promote oral health education, with a focus on HIV.

The field of mobile health (mhealth) has been explored to address barriers in family planning, adolescent sexual and reproductive health services, and HIV. Due to the tremendous burden of HIV, it is crucial to identify the factors that influence health-seeking, health utilization, and service delivery. By learning these barriers, interventions can be tailor-made to address them. This thesis explores the role of mhealth interventions in addressing these barriers.

Since most mhealth interventions are in the pilot phase, they lack the potential for scalability. Before the recently published WHO Digital Health Intervention Guidelines, evaluation guidelines for mhealth evidence in low- and middle-income countries (LMIC) was limited. This thesis is also relevant as it explores existing mhealth projects in Kenya and other LMICs and evaluates the certainty of evidence from mhealth studies. Mhealth is a rapidly changing and promising field that can serve as an adjunct to existing health systems in Kenya. However, for mhealth interventions to be successful, more studies need to be done.

## CHAPTER 1: BACKGROUND OF KENYA

This chapter gives background information on Kenya. It reviews the geography, socio-cultural, socio-economic, and educational context of Kenya. Also, it examines the health system structure in Kenya regarding HIV, maternal, and child health.

### 1.1 GEOGRAPHY, DEMOGRAPHY, AND POPULATION OUTLINE



**Figure 1: The map of Kenya (1)**

Kenya, a country in East Africa, is located on the coast of the Indian Ocean (2). Five countries border it: Ethiopia in the north, Uganda to the west, Sudan to the northwest, Tanzania in the south, and Somalia in the East (Refer to figure 1). It has a surface area of approximately 580,000 square kilometers, with an estimated 2019 population of 52.2 million people. Three-quarters of the population is below 30 years, with a median age of around 20 years (2). An elected president governs Kenya. It is divided into eight provinces and further subdivided into 47 administrative counties headed by an elected governor. The Kikuyu, Luhya, and Luo communities are the most dominant ethnic groups (3). Nairobi is the capital of Kenya, with a population of more than 2 million (3). It houses one of the largest informal settlements, Kibera slum, where an estimated 60% of the Nairobi urban population resides. The slum dwellings are overcrowded, have poor sanitation, and the rate of insecurity is high (3).

### 1.2 SOCIO-ECONOMIC CONTEXT

Agriculture is the main contributor to the economy of Kenya (4). Other industries that aid in economic growth include the manufacturing industry, the tourism and service industry, forestry, fishing, and international trade (4). In 2013, more than 60% of the population was found to live in rural areas, whereas more than half of them were living below the poverty line (5). Rapid urbanization has resulted in rural to urban migration, creating wealth disparities, and widening the income gap (5). Hence, rapid population growth in major cities such as Nairobi, Kisumu, and Mombasa (Refer to figure 1) has resulted in high unemployment rates (5).

### 1.3 SOCIO-CULTURAL CONTEXT

Norms, values, and relationship networks play a pivotal role in the way of life of individuals and communities (6). Gender beliefs on the roles of men and women in society influence the right of ownership and decision-making capabilities (6,7). In most Kenyan communities, women have limited rights to inheritance, access to higher education, and employment opportunities (6). Also, the decision-making power over financial and health matters lies with the men. They have difficulty negotiating for safe sex (7). Hence, they are prone to gender-based violence and ill health. Young men have more freedom of choice hence are prone to engaging in high-risk behaviors (7).

### 1.4 EDUCATION CONTEXT

In 2018, the adult literacy rate in Kenya was 79% (8). There was a marked decrease in school attendance with higher levels of education, from 85% to 36% at primary and secondary school levels, respectively (8). Gender disparities influence access to higher education. The frequency of school dropouts is higher among girls than boys. Literacy levels are higher in urban areas than in rural areas as a result of differences in educational facilities and social amenities between urban and rural areas (9).

### 1.5 HEALTH SYSTEM AND SITUATION

The Kenyan healthcare system consists of both formal and informal sectors (10). The informal sector includes herbalists, traditional healers, religious healers, and drug peddlers. The formal sector includes both private and public health facilities (10,11). Government facilities are the primary service providers in rural areas. Two decades ago, Kenya began the process of decentralization of health services to the district level (10). The leading causes of death and disability in Kenya are AIDS, diarrheal diseases, lower respiratory diseases, neonatal disorders, and tuberculosis (11). The key health indicators are as follows (Refer to figure 2). Health financing is from three primary sources: out of pocket expenditure, government expenditure, and donors (12). Almost 40% of the total health expenditure (THE) comes from out of pocket spending. This is among the main barriers of access to health services (12).

**Table 1 : Key health indicators, Kenya 2017 (12)**

<b>KEY INDICATORS</b>	<b>FIGURE</b>
Life expectancy	68.8 years (Females), 63.2 years (Males)
Fertility rate	3.8 births per woman
Adolescent fertility rate	80 births per 1000 women
Maternal mortality rate	510 deaths per 100000 live births
Under-5 mortality rate	46 deaths per 1000 live births
Crude Birth rate	31.3 births per 1000 people
Crude death rate	5.7 deaths per 1000 people

### 1.6 SRHR CONTEXT AND SERVICES

There is an unmet need for sexual and reproductive health (SRHR) services in Kenya (13). Services are mostly offered by the government, non-governmental organizations (NGOs) and faith-based organizations. In most regions, government facilities offer maternal and child health (MCH) services, namely family planning (FP), antenatal care (ANC), skilled birth delivery, post-natal care (PNC) and HIV services. However, service provision is poor, with long queues and waiting time (13,14). More than 300,000 adolescents have no access to SRHS. Every year, more than 80% of unintended pregnancies occur as a result (13). Also, every year, almost 200,000 adolescents that give birth do not have access to MCH services.

The ANC coverage is less than 60% (13). Low-quality services, issues of confidentiality and privacy, stigma, and healthcare provider attitude are among the top barriers of access to SRHR services (13,14).

## CHAPTER 2: PROBLEM STATEMENT, JUSTIFICATION OF THE STUDY, OBJECTIVES, AND METHODOLOGY

This chapter has three sections. The problem statement explores the global and local context of HIV, the impact of HIV and the potential of mobile technology in addressing the barriers in HIV prevention and treatment. General and specific objectives of the study are mentioned, together with the study justification and methodology of the study.

### 2.1 PROBLEM STATEMENT

#### 2.1.1 GLOBAL CONTEXT OF HIV

HIV/AIDS is an enormous public health problem, not only in Kenya but worldwide. HIV (Human Immunodeficiency Virus) is a highly infectious agent that is spread through fluid contact with an infected individual (15). It occurs in two strains; HIV-1 and HIV-2 (15,16). There are several ways of contracting HIV:

- Unprotected sexual contact - It is the most common mode of transmission
- Exposure to contaminated blood during a transfusion
- Use of contaminated instruments
- Vertical transmission

With increased immune suppression, HIV progresses into AIDS (Acquired Immune Deficiency Syndrome). If no treatment is administered, death often results (16). Globally, in 2017, 36.9 million people were living with HIV, with an estimated 1 million deaths from HIV-related complications (17). The United Nations Joint Program on HIV/AIDS (UNAIDS) in 2017 reported that around 1.5 million people in Kenya were living with HIV, with 10% being below the age of 15 years (18).

### Adult HIV Prevalence, 2017

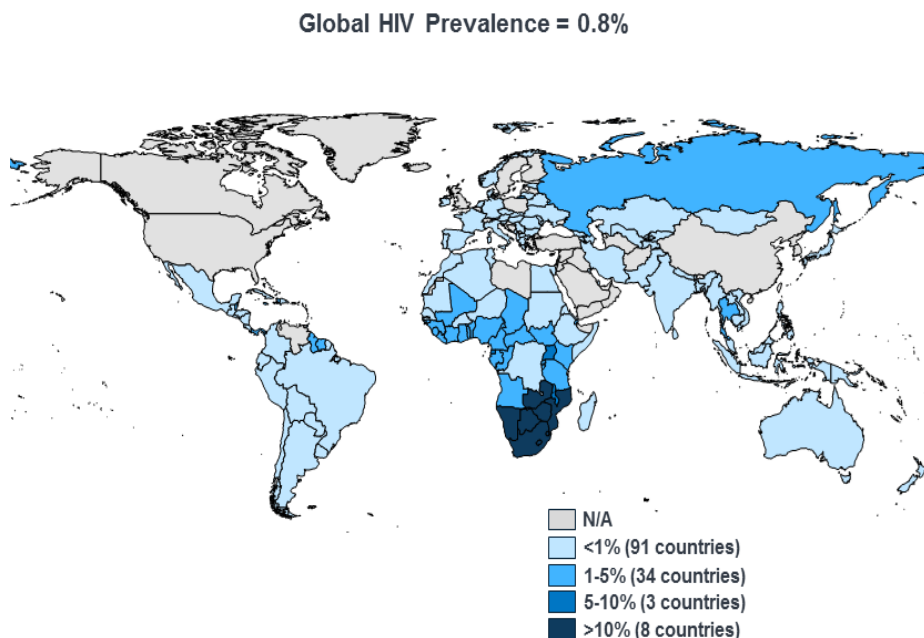
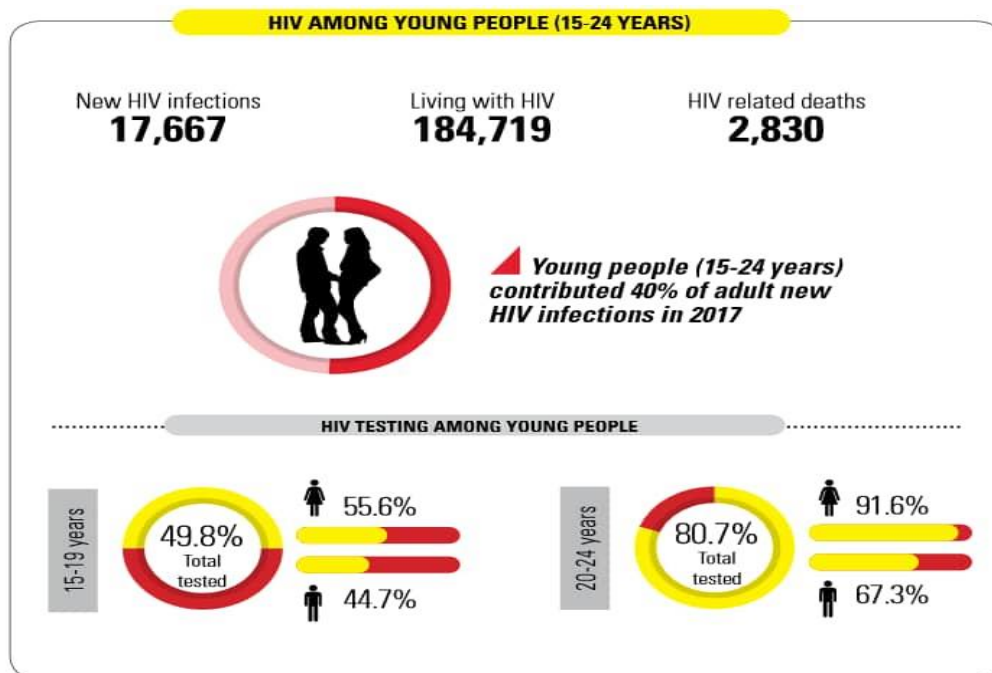


Figure 2: Adult global HIV prevalence, 2017 ( 19)

### 2.1.2 HIV IN THE KENYAN CONTEXT

Kenya has a generalized HIV epidemic with concentrated epidemics among key populations (KPs) (20). In 2007, the national HIV prevalence was 7.4% (20). By 2017, it had decreased to 4.6% (Refer to figure 2). This significant decline over the last decade was partly attributable to expanded access to antiretroviral therapy (ART) and scale-up of Voluntary Counseling and Testing (VCT) services (20). In Kenya, young women (15-24 years) have a higher risk of acquiring HIV (Refer to figure 3). In 2018, the prevalence of HIV among adolescent girls aged 15 to 24 years was 2.5 % higher than that of boys. The prevalence gap was wider among those aged 20 to 24 years- 6 % higher among the girls than boys (21). Those living in major cities and towns have a significantly higher risk of HIV infection (7.2%) than those in rural areas (6.0%). However, HIV prevalence among the urban poor population in slum dwellings is higher than non-slum urban dwellers (22).



**Figure 3: HIV and HIV testing among young people (15-24 years), Kenya 2017 (21)**

### 2.1.3 HIV IN KEY POPULATIONS

KPs constitute female sex workers (FSW), men having sex with men (MSM), people who inject drugs (PWID) and male sex workers (MSW) (23). In 2016, it was reported that the likelihood of contracting HIV was more than twenty times higher among PWIDs and MSMs when compared to the general population. Also, the risk of contracting HIV for FSWs was ten times higher in comparison to the general population (23). This was majorly attributed to stigma and discrimination, poverty, gender, and an unmet need for HIV services (23).

### 2.1.4 HIV AND TUBERCULOSIS CO-MORBIDITY

Tuberculosis (TB) co-infection is the principal cause of death among PLHIV (24). In 2017, the TB-related AIDS mortality rate was 37% (24). The TB incidence in men was twice higher than in women. In 2017, there were 45,000 new TB infections among PLHIV. This was partly as a result of poverty and lack of access to TB services (24).



## **2.1.5 IMPACT OF HIV IN KENYA**

### **2.1.5.1 INDIVIDUAL AND HOUSEHOLD IMPACT**

HIV-related consequences are not only borne by the individual, but also the members of his/her family and community (25). Ill-health causes absenteeism from work and subsequent loss of employment. Furthermore, it also results in high medical expenses and funeral costs in the event of death. High financial lead to household poverty (25).

### **2.1.5.2 BURDEN ON THE HEALTHCARE SYSTEM**

When more resources are put into addressing HIV, other diseases such as diabetes, hypertension, and cancer, whose contribution to the disease burden is high, are overlooked (26). This results in higher mortality rates (26). Also, as a result of poor funding and infrastructural setbacks, most government hospital systems are strained by the rising HIV burden (26). Despite the advances in HIV management, significant gaps exist in access to quality HIV services. Therefore, access barriers to quality HIV services need to be addressed at every stage of the HIV treatment cascade (27). These barriers range from individual-level factors to cultural, economic, structural and health system-related factors (Refer to chapter 3). Understanding their role in access to quality HIV services is central to developing effective interventions (27).

### **2.1.7 THE POTENTIAL OF MOBILE HEALTH IN ADDRESSING BARRIERS IN HIV PREVENTION, CARE AND TREATMENT**

Researchers, governments and health professionals have become more interested in the field of mobile health (mhealth) to improve service delivery, point of care diagnosis, education, drug adherence support and monitoring (28). Mhealth is the application of medical and public health through mobile communication devices (29). Currently, there are around 7 billion mobile phone subscribers globally. More than 80% of them reside in low- and middle-income countries (LMICs) (30). Mobile phones are portable, with ease of access and sharing capabilities, hence can reach more people (30). Despite the rapid growth in the information communication technology (ICT) industry in Kenya, mobile phone ownership and usage is influenced by other factors such as age, gender, literacy, socio-cultural and socio-economic factors (30).

## **2.2 JUSTIFICATION OF STUDY**

LMICs encounter major setbacks in healthcare provision as a result of limited funding and poor infrastructure (30). This has prompted most governments to explore the role of mobile health as an adjunct to existing healthcare systems (30,31). In the context of HIV/AIDS, mhealth strategies can be used to create HIV awareness, promote HIV testing and improve the level of ART adherence among PLHIV (31). Moreover, such interventions can also be applied in community sensitization and the reduction of vertical transmission of HIV (30). Although m-health interventions can be applied to improve health outcomes in resource-constrained settings, there is limited published evidence on the effectiveness (30). Significant gaps exist in the evaluation and implementation of mhealth interventions due to limited evidence evaluation guidelines (30,31). Most mhealth initiatives are carried out as independent projects' and rarely progress beyond the pilot phase (30). Limited evidence on the impact of mhealth interventions has discouraged the adaptation of mhealth into national health strategies. Most government, stakeholders and policymakers in LMICs are unconvinced of the benefits of mhealth interventions over conventional interventions already in use (30,31). Therefore, unless there are evidence-informed recommendations that can justify the need for scale-up of mhealth interventions, most mhealth interventions will remain in the exploratory phase (30,31).

## **2.3 OBJECTIVES**

### **2.3.1 General objective**

To assess the potential of mobile health in strengthening HIV prevention, care and treatment interventions in Kenya, to improve access and quality of HIV-related services.

### **2.3.2 Specific objectives**

- I. To analyze the main demand and supply barriers to HIV prevention, care and treatment.
- II. To review the range of mhealth applications in HIV prevention, care, and management in Kenya and other similar context settings.
- III. To analyze available evidence of mhealth application in HIV prevention, care and treatment and other relevant SRHR areas in Kenya and other relevant context settings.
- IV. To provide recommendations to policymakers and other stakeholders to promote the use of effective mhealth intervention in HIV prevention, care, and treatment to improve access to and quality of services.

## **2.4 METHODOLOGY**

A literature review was done. Original articles in English from bibliographic databases (Medline, Cochrane Library and Scopus) were searched for. An open search was also done on websites of reliable institutions such as the Vrije Universiteit (VU) Amsterdam, the Public Library of Science (PLoS), and Bio Med Central (BMC). Government and international organizations websites such as WHO, UNAIDS, International Telecommunications Union (ITU) and Ministry of Health (MOH) Kenya were also searched. Each category of search terms was used as a single item or in combination using the Boolean operators "AND", "OR" and "NOT". Snowballing was used to identify similar articles to strengthen the literature base.

### **2.4.1 LITERATURE SEARCH**

First and foremost, search terms were identified. To formulate a uniform search strategy, search terms were unified using the Medical Subject Headings (MeSH) when needed. The search terms were grouped into three broad categories (Refer to table 2 in annex)

- HIV/AIDS-related terms
- Mhealth- related terms
- Geographical terms

### **2.4.2 INCLUSION AND EXCLUSION CRITERIA**

The year 2010 was chosen as the publication year limit due to the rapid advancement in the ICT industry in the last decade. However, earlier mhealth and HIV studies until the year 2005 were also included to increase the evidence base. The inclusion criteria were as follows:

- All journal articles, government, NGO reports, web reports, peer and nonpeer-reviewed studies published from the year 2010
- Literature published in English

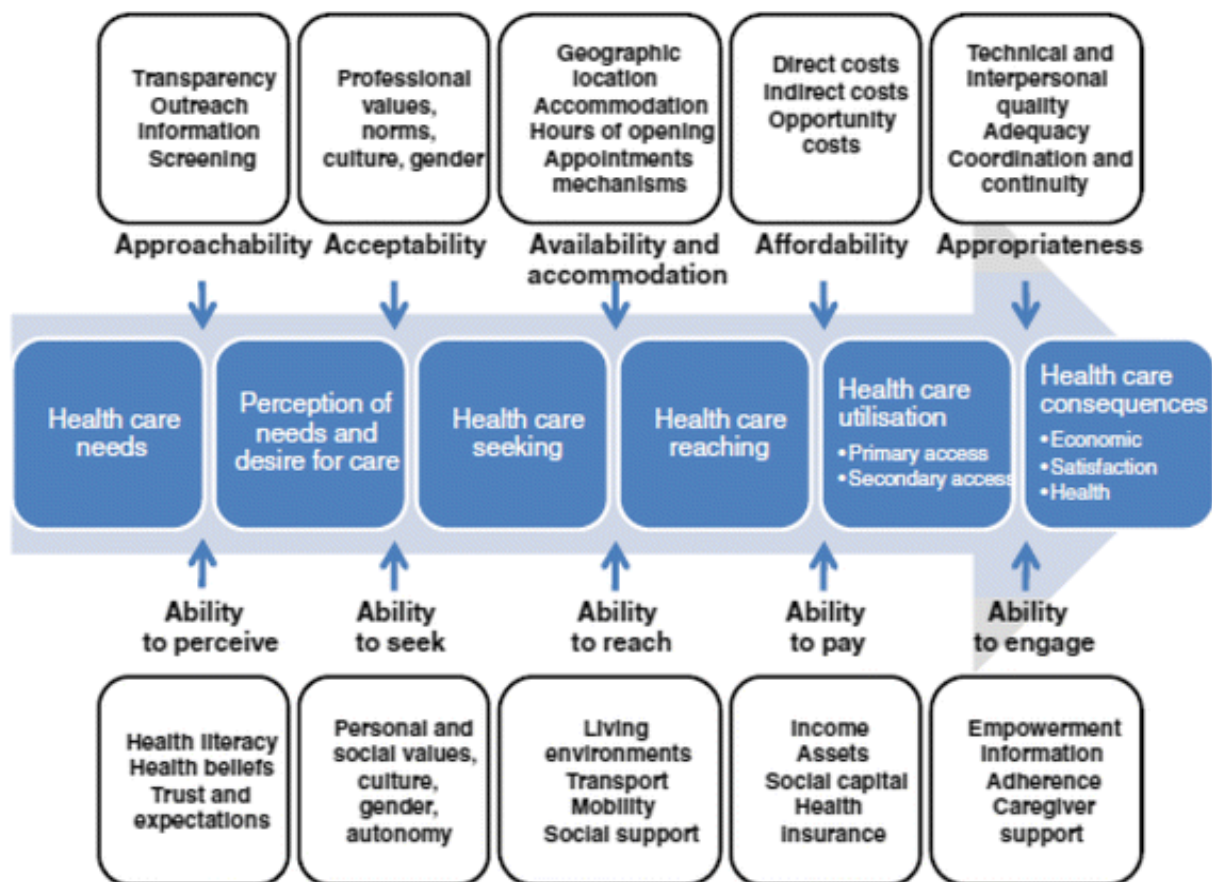
The exclusion criteria were as follows:

- All literature published before the year 2010 except articles on HIV/AIDS and earlier mhealth studies
- Studies with abstracts only
- Publications in other languages other than English

## 2.5 CONCEPTUAL FRAMEWORK

### 2.5.1 LEVESQUE MODEL OF ACCESS TO HEALTH SERVICES

The Levesque model of access to health services was chosen to explore the different dimensions of access to health services (32). It classifies various factors that have an impact on access to healthcare services at different levels, which is individual, community and country-level (Refer to Figure 4). It focuses on the 5As of access and how they influence the demand for and supply of health services. On the demand side, the model defines the factors that influence the capacity of an individual to recognize a health need, seek and pay for the healthcare service. On the supply side, it describes the factors that influence the capacity of health care providers and health institutions to provide good quality care (32).



**Figure 4 : Levesque model of access to health services 2013 (32).**

### 2.5.2 M-HEALTH AND ICT FRAMEWORK

This framework by Labrique et al. (Refer to figure 5) was selected as it describes the different applications of mhealth. Eight out of the twelve ICT applications were chosen for this thesis. The remaining four (Human resources, registries/vital events tracking, data collection/reporting and provider work planning and scheduling) were excluded (33). Since their focus is broad, the four ICT applications have the potential to stand alone as a thesis subject.

- **Client education and behavior change communication**

Mhealth applications can be applied to encourage behavior change. Different mobile phone communication tools can be used to reach individuals and communities to educate, motivate, and encourage better health-seeking behaviors and medication adherence.

- **Sensors and point of care diagnostics :**

In remote clinical settings, mhealth applications can be applied in the diagnosis of diseases. Low-cost mobile phone microscopy allows prompt diagnosis and dissemination of test results in resource-limited settings.

- **Electronic health records (EHR)**

Compared to traditional health record keeping, EHR allow easy retrieval and effective management of patient files. They also allow continuity of care outside of the hospital setting.

- **Electronic Decision Support: Information, Protocols, Algorithms, Checklists**

Mhealth applications aid in patient information management and disease surveillance. Hence, improve the efficiency of existing systems.

- **Provider to provider communication**

Mhealth applications enable remote supervision and facilitate easier communication between the different levels of the healthcare system.

- **Provider training and education**

Mhealth applications can be applied in remote training and education of health workers. Hence, resources for in-person training are saved.

- **Supply chain management**

To avoid stock-outs and improved supply-chain transparency, mHealth applications can be applied in reporting, tracking and re-ordering of stock supplies.

- **Financial transactions and incentives**

Mobile financial services improve ease of payments of healthcare services. They allow health savings and provide medical assistance loans. Financial incentives encourage behavior change.



**Figure 5: Mhealth and ICT applications (33)**

## **CHAPTER 3: KEY COMMUNITY AND HEALTH SYSTEM-RELATED BARRIERS TO HIV PREVENTION, CARE AND TREATMENT**

In this chapter, the Levesque model of access of health services has been applied to deduce the main demand and supply side barriers to access of quality HIV services.

### **3.1 DEMAND SIDE BARRIERS**

#### **3.1.1 POVERTY**

In SSA, women and girls are most affected by poverty (34). Studies show that people of high socio-economic status have more access to information on HIV. They are also prone to engage in high risk behavior such as alcoholism and multiple sexual activities (34). Living in poverty increases the likelihood of migration in search of employment opportunities in nearby towns or countries. Some women engage in sexual trade or enter polygynous marriages, placing them at high risk of contracting HIV (34).

In Kenya, poverty plays an enormous role in teenage marriages (35). Daughters are viewed as a financial burden to the family. They are usually married off to older wealthier men, in exchange for dowry, and to improve social standing in the community. In most situations, these older men are HIV positive (35). Early marriage also denies girls the right to education and hence have limited power in decision making. Low literacy and limited sexual negotiation power increase their risk of acquiring HIV (35).

#### **3.1.2 HEALTH LITERACY AND KNOWLEDGE**

Studies done in SSA show that the level of education affects the earning capacity of an individual. In turn, this affects his sexual, marital and health-seeking behaviors (34). Low educational attainment and its association with lack of knowledge about HIV transmission are both linked to higher rates of risky sexual behavior and HIV infection. Studies show that individuals with higher literacy have knowledge of HIV and can prevent themselves from acquiring it as opposed to those who are illiterate (34).

#### **3.1.3 INDIVIDUAL LIFESTYLE FACTORS**

HIV transmission is associated with high-risk activities such as intergenerational sex, commercial sex work and injecting drug use (36,37,38). Intergenerational sex is one of the major causes of high HIV prevalence among adolescent girls (36). Young adults, particularly those in tertiary institutions and colleges, engaged in sexual activity with older married men in exchange for gifts and school fees (36). Decision-making on sexual matters is transferred to the dominant older partner. Hence, negotiating for safe sex becomes a challenge (36). Due to a large clientele, sex workers are at a high risk of contracting HIV (37). As they are highly mobile, their rate of HIV transmission is high (37). Injecting drug use is another major risk factor of HIV. PWIDs are at high risk for HIV transmission through unsafe needle sharing practices (38).

#### **3.1.4 GENDER**

Gender refers to the roles, responsibilities, and expectations placed by a society based on being a man or woman (39). Hence, gender roles not only influence risk behavior and disease exposure, but also treatment-seeking behavior and drug adherence(40). Gender perceptions also influence how women and men are treated by the health-care system during HIV diagnosis and treatment (39). In many communities, women play a subordinate role to men in the household. They have limited decision-making power over their health and financial resources, which affects their health-seeking behavior (39,40). Feelings of vulnerability and fear of abandonment by their partners cause difficulties in negotiation for HIV-prevention strategies, such as condom use (40).

Women are prone to physical, verbal and sexual violence (39,40). Following assault, access to SRHR services is difficult due to fear of stigma and discrimination. Moreover, discussing

their experiences with their spouses and seeking social support is very difficult. Women are often the main care givers to PLHIV (39). In rural areas, where most women have low literacy levels, they are at a high risk of acquiring HIV as they lack the knowledge and resources to take necessary precautionary measures (39,40).

Social norms on masculinity influence the behavior and health-seeking tendencies of men (40). From boyhood, society expects boys to be self-reliant and act like a 'real man'. During adolescence, many young boys engage in unsafe sexual activities to prove their manhood. They also engage in high risk behaviors such as alcoholism and drug use (40). Men tend to be self-reliant, so they seldom seek the necessary healthcare assistance when ill. Studies show that men have low HIV testing rates and ART therapy adherence compared to women(40).

### **3.1.5 SOCIO-CULTURAL FACTORS**

Marital HIV infections contribute significantly to the number of new HIV infections (41).A study done in Kenya, Zambia and Zimbabwe showed that most heterosexual couples do not use condoms as it is viewed as a sign of mistrust (41).Since consistency of condom use is very low, the risk of contracting HIV is high. Widow cleansing and inheritance are customs that have been practiced for centuries in SSA (42).As a form of cleanse, a widow is expected to engage in sexual intercourse without a condom, after her husband's death. Nyanza province, where widow inheritance is prevalent, has the highest HIV prevalence in Kenya, 26% (42).Studies show that inherited widows have a higher prevalence of HIV than those who are un-inherited (42).

## **3.2 SUPPLY SIDE BARRIERS**

### **3.2.1 PROFESSIONAL VALUES AND ATTITUDE**

Stigma and discrimination against PLHIV in the health care system is a great hindrance to ART therapy adherence and access to HIV services (43).Health care providers face the challenge of providing HIV care without bias and discrimination. Service provider attitudes range from a personal point opinion regarding HIV to the client receiving treatment (43,44). Because of the former, clients experience blatant refusal to administer services, disparaging remarks, contempt towards PLWHIV and offering less care and support to HIV-affected individuals as compared to those with other ailments (44).As a result, PLWHIV experience fear and rejection, and view HIV services as intolerant and unfriendly. This perceived stigma may discourage individuals from accessing needed health services, contributing to the number of new infections (44).

### **3.2.2 PROVIDER CAPACITY**

Substantial financial and human resources are required to establish and maintain an effective HIV care system (45). According to the 2010 Kenya service provision assessment survey, HIV services are irregularly distributed throughout Kenya (46). Healthcare worker shortage in rural areas is high. This has resulted in an increase in the workload for present healthcare workers, hence causing an increase in stress levels, poor performance and high rates of attrition (45). Many health workers have left government positions for better-paying jobs in HIV research and the private sector. Hence, a significant gap exists in the human resources sector (45).

### **3.2.3 ACCESS AND DISTRIBUTION OF HIV-RELATED SERVICES**

In Kenya, the proportion of health facilities that offer HIV services vary between urban and rural areas (47). In major cities such as Nairobi, Mombasa and Kisumu, HIV services are readily available as compared to semi-arid areas such as Eastern and North Eastern provinces. HIV emergency services, ART, Antenatal care (ANC) and post-exposure prophylaxis (PEP) services are fully available in less than 30 percent of health facilities

nationwide (47). They are mostly accessible at tertiary level hospitals and most private health facilities (47). HIV surveillance and ART stock management systems are weaker in remote areas due to limited resources and poor infrastructure (47).

### **3.2.4 QUALITY OF HIV SERVICES**

Public health facilities are the most accessible, cost-friendly point of care for PLHIV in Kenya (47,48). However, delays in service delivery and long queues deter most from seeking healthcare services. They opt to remain in their homes, and this has led to an increase in the number of AIDS-related deaths (47,48). Most public health facilities are poorly managed, and supervision is low. The staff to patient ratio is low and the rate of absenteeism is high. These inefficiencies result in low quality service provision (48).



## **CHAPTER 4: THE SCOPE OF MOBILE PHONE COMMUNICATION**

Within this chapter, the scope of mobile phone ownership and use is discussed. Cross-cutting issues such as the mobile gender gap and barriers to mobile phone ownership and usage are also described. In addition, mobile health application in Kenya is also illustrated.

### **4.1 MOBILE PHONE USAGE AND OWNERSHIP**

As of 2016, there were more than 5 billion people with mobile phone subscriptions (49). Ninety three percent of Kenyans are currently mobile phone users (50). As the network coverage grows, mobile phones have the potential to transform the scope of access and dissemination of information (49,50). This will create the potential use of mobile technology applications to address barriers in access to high quality healthcare services (50).

#### **4.1.1 MOBILE GENDER GAP**

By 2019, SSA had the highest gender gap globally (51). Sixty nine percent of women were found to own a mobile phone, as compared to 82% of men. The gap was larger when internet use was compared between men and women. The gap in urban and rural mobile phone ownership was also found to be large (51). Women from rural settings had the least access to mobile technology and constituted the largest proportion of phone-sharing individuals (51,52).

There are several barriers that hinder women's' access to mobile phones. These range from individual factors to socio-economic, socio-cultural and literacy factors (52). Firstly, some women prefer not to own a mobile phone, either out of a personal choice or misunderstanding of the benefits of a mobile phone (52). Moreover, in low resource setups, most women have low literacy levels which make it difficult to comprehend the use of a mobile device (51,52). Due to many responsibilities at home, which constitute household chores and caring for the family, rural women rarely find time to learn how to operate a mobile device.

Another setback to the women is their low earnings (51,52). A study by Susan Wyche et al. reported that even in formal employment, women were paid less than their male counterparts, hence their financial means was limited (53). Purchasing and sustaining the use of a mobile phone is a costly task. In some communities, social norms prohibit women from owning a mobile phone. This creates difficulty in accessing mobile phone shops to purchase airtime or using mobile phone services (52,53).

#### **4.1.2 BARRIERS TO MOBILE PHONE OWNERSHIP AND USAGE**

Inequalities in gender, age, literacy and income hinder the access to mobile phone technology in SSA countries (52). The main barriers reported include:

- **Affordability**

Studies show that the penetration of mobile phones in low resource setups is high due to the low cost of a SIM card and relatively cheap mobile handsets (52,53). However, with erratic increases in tariff charges and the costs of maintaining a mobile phone, most individuals prefer not to have one or opt for phone-sharing. Furthermore, access to an electricity source also influences the use of mobile phones (53).

- **Literacy and digital skills**

Low levels of literacy can prevent individuals from using the multiple ranges of applications on a mobile phone (52,53,54). For instance, to send a short messaging service (SMS), one needs to have basic reading and writing skills and an understanding of the language of

command (53,54). Where content is unavailable in local languages, mobile phone usage becomes a challenge.

- **Perceived lack of relevance**

Most low-educated individuals lack familiarity with the internet or its benefits, hence, have little or no incentive to own a mobile set (54). Most elderly individuals and those with low literacy may feel it's too late to acquire mobile phone skills. Therefore, they are unmotivated to purchase a mobile phone (52,54).

- **Safety and security concerns**

In most Kenyan households, due to shared ownership of mobile phones, unauthorized access is one of the main security concerns (54). One can become a target when confidential and sensitive information such as mobile money receipts or family secrets are accessed by others (52,54). These situations have the potential to ruin one's credibility or reputation in the community. Harassment of female mobile phone owners also deters them from using mobile phones (54).

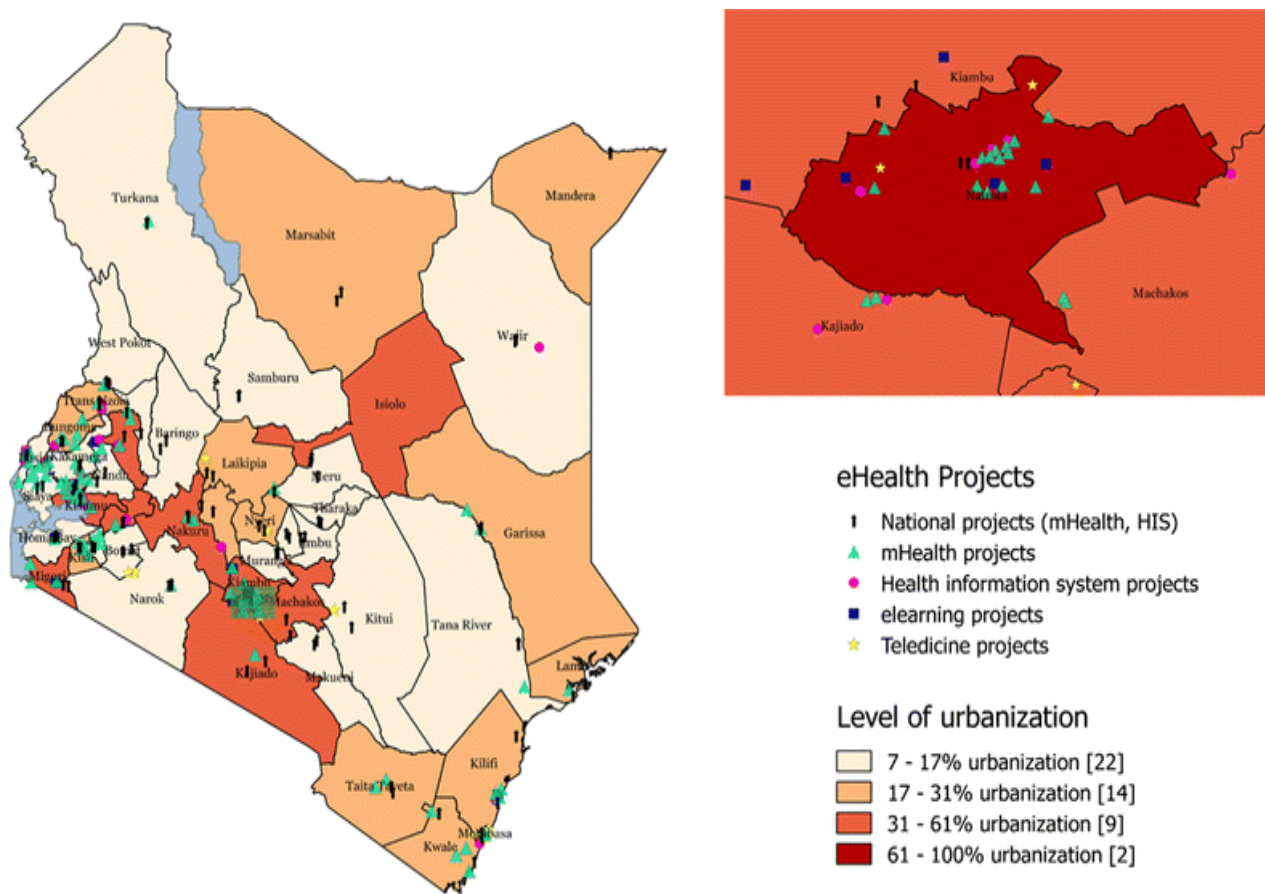
- **Access-related barriers**

Lack of physical access to a mobile phone shop can hinder one from purchasing a mobile handset or the airtime (52,54). In households where mobile phone sharing is the norm, regular access to a phone charger may be difficult. In some communities, women are not allowed to own a mobile phone due to traditions or are only allowed to use it under the supervision of their partners (54).

## **4.2 SCOPE OF MOBILE HEALTH**

Due to the rapid advances in mobile application technologies and an increase in the range of coverage of mobile cellular networks, the field of mHealth is a promising approach to improving access and quality of health services (28,55). Mhealth applications have the potential to support the coordination of care among the urban poor, women, the elderly, and the disabled (55). Due to the rapid infiltration in rural, hard to reach-communities, mhealth offers optimism in the provision of public health services. It also provides an opportunity for targeted healthcare outreach and education (55). Mobile phone functions include short message services (SMS), multimedia messaging services (MMS), voice calls, interactive voice response (IVR), video calls, cameras, web browsers and other internet features (56).

Apart from national mhealth projects, majority of mhealth interventions are funded and implemented by international non-governmental organizations (INGOs) and international development agencies (57). National mhealth projects are present in almost all regions of Kenya (Refer to figure 6). Non-state mhealth projects are more prevalent in major cities such as Kisumu, Mombasa and Nairobi where urbanization is high (61-100%). In less densely population areas, such as the northern and eastern parts of Kenya, the rate of urbanization is below 30%. Mhealth projects are non-existent in those areas. In addition, most mhealth projects are concentrated within the capital city, Nairobi. (Refer to figure 6).



**Figure 6: Map A: Distribution of mhealth, elearning and telemedicine projects in Kenya. Map B Projects in Nairobi and its neighboring counties, 2017 (57).**

### 4.3 FORMS OF MOBILE PHONE FUNCTIONS

The different ranges of mobile phone functions are described in detail in this chapter. These are SMS, MMS, voice messaging, voice calling, beeping (missed call) and IVR. The benefits and limitations of each function are also highlighted.

#### 4.3.1 SHORT MESSAGING SERVICE (SMS)

SMS is the most widely used mobile phone communication feature. It can either be applied in mass broadcasting or as for interaction (58,59) .

- **Mass broadcast SMS**

These types of SMSs are sent out to the masses simultaneously. They are often used to convey information to specific groups of individuals. The recipient can easily subscribe to receive alerts and other information and have the option to opt-out at will. They are very convenient, easy to use and free for the recipient (58).

- **Interactive SMS**

Text messages are used as a forum for interaction between two parties. It is a very cost-effective method of communication and allows instant feedback. Messages sent out are personalized, usually in a question and answer format (58).

## **PERCEIVED BENEFITS OF SMS**

- **Ease of access to information and services**

SMSs are a convenient way of accessing and receiving information. They are especially beneficial as a mode of communication among healthcare providers, or between a client and a healthcare provider (58).

- **Cost-effective**

The cost of sending one SMS is less than one US dollar. Hence, if the intended audience is large, the use of SMS becomes very cost-effective (58).

## **DISADVANTAGES OF SMS**

- **Lack of enough funds**

Due to fluctuating tariff charges due to market changes and service provider competition, lack of funds to purchase airtime can be a huge detriment. Where multiple exchanges are required, it can be very costly for the sender and receiver (59).

- **Uncertainty of receipt of information by intended user**

In the case of bulk SMSs, there is low certainty that the message reaches the recipient. In spite of a notification to the sender that the SMS has been sent out, one cannot be certain the recipient has opened the text message and read it unless it is an interactive SMS (59).

- **Incorrect data entry**

When individuals are not well-conversant with the operations of typing and sending an SMS, distortion of the message is very common (58,59).

- **Challenges in privacy**

Mobile phone users face privacy and security challenges when using SMS. In the event the message is read by an unintended individual, sensitive and confidential information may leak (59). If the mobile phones security features are flawed, unintended people can gain access to private messages.

- **Inconsistency in the reading of SMS messages**

The success of mass SMSs is short-lived in the event the recipients find the message repetitive and opt out of reading them (58,59)

- **Limitation in the relay of complex messages**

SMSs have a limit of 160 characters. Therefore, when the interaction is long and the messages are compact, SMS usage becomes daunting (59).

### **4.3.2 VOICEMAIL**

It is a mobile phone feature that allow one to leave a pre-recorded message for the recipient without placing a call or after an unanswered call (60). The recipient is then notified via SMS and can listen to the message when they access their mobile device. It is a benefit when the recipient is illiterate as messages can be conveyed in local dialect(60). The drawback, however, is some service providers charge for voicemail access and it may be challenging for the recipient to access the message (60).

### **4.3.3 VOICE CALLING**

The preference of voice calling over SMS is common (61).Voice calling is advantageous as it is easy to use, information is conveyed in present time and a dialogue is easy to start. SMS, however, requires input of information into the phone which can be time-consuming, and prone to information distortion and errors (61) .The limitation of voice calling is that the message can only be conveyed if the recipient picks the call. In the event of absence of the recipient, other methods of communication are warranted (61).

#### **4.3.4 MISSED CALL OR 'BEEPING'**

Due to high tariff rates and airtime costs, senders can intentionally place a call to the recipient and hang up before the call is received. The recipient is notified of the missed call and the name and details of the caller appear in the call log (62). No costs are incurred by the sender. Beeps differ from SMSs as they are free of charge and while they carry no message, their use is limited to familiarity with the recipient (62).

#### **4.3.5 MULTIMEDIA MESSAGING SERVICE (MMS)**

Whereas SMSs are restricted to 160 characters, MMS allows mobile phone users to send longer messages and include a picture, a voice recording or videos (63). One of the limitations of MMS messages is that they can only be sent to another mobile device that supports the same features to enable easy viewing of videos and pictures (63). In addition, it is also difficult to send MMS messages in bulk. These challenges have limited its usage (63).

#### **4.3.6 INTERACTIVE VOICE RESPONSE (IVR)**

IVR is an automated system that receives calls or messages from a sender and provides an automated reply depending on the programmed subject (64). These responses can be in the form of a text message, voice message or contact referral. To save on resources, an IVR system can be programmed to perform the task of answering phone calls. Generalized automated responses prevent backlog of calls and messages (64). A major drawback of IVR is that it is very impersonal and does not offer flexibility when follow-up information is required, resulting in caller frustration (64).

## **CHAPTER 5: RANGE OF MHEALTH APPLICATIONS IN HIV AND OTHER RELEVANT SRHR SETTINGS AND EVALUATION OF EVIDENCE**

This chapter focuses on the available evidence of mhealth applications in HIV and other SRHR settings. Under each subheading, eight ICT applications by Labrique et al (33) are described, including evidence from Kenya and other LMICs. The GRADE approach from the World Health Organization (WHO) Digital Health Intervention Guidelines 2019 has been used (65). The GRADE approach evaluates the certainty of evidence on the effectiveness of mhealth interventions (65). Evidence is either qualified as high or low based on the population size, type of intervention, use of comparison group and outcome. The classification is as follows:

- High certainty- Randomized controlled trials (RCT), cluster-RCTs.
- Low certainty -Non-randomized controlled trials (NRS), observational studies and exploratory studies.

### **5.1 CLIENT EDUCATION AND BEHAVIOUR CHANGE**

Emerging evidence suggests that m-health applications can be applied to provoke behavior change in the general population and within targeted groups such as pregnant women and adolescents (66,67,68,69) .

#### **5.1.1 ANTIRETROVIRAL THERAPY AND TUBERCULOSIS TREATMENT ADHERANCE**

The use of mHealth to improve ART adherence in Kenya and other similar context settings has a large evidence base (66,67,68,69). Two RCTs have been done in Kenya to investigate the effect of SMS text messaging on ART adherence. An example is the WelTel program initiated in 2010 (66). The trial involved sending weekly SMS messages to study participants with an option to request for assistance from CHWs when necessary. The SMS messages were either in English or Swahili (Refer to figure 7). After the trial, 95% of participants who received the SMS reminders reported self-adherence (66). After 12 months, more participants in the SMS intervention group had undetectable viral loads as compared to those who did not receive any SMS. More than 90% of the participants were willing to continue receiving the SMS reminders (66).

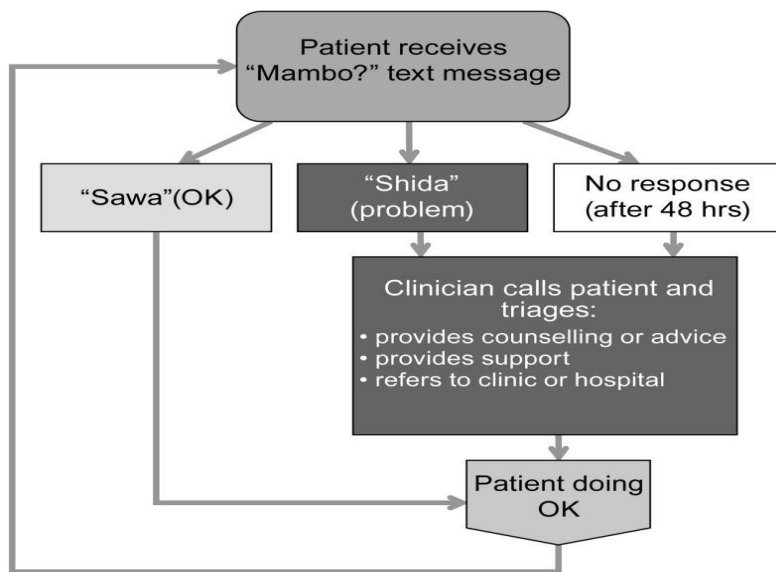
Mbuagbaw L et al. also conducted a RCT in 2012 to evaluate the 'Cameroon Mobile Phone SMS' (CAMPS) intervention on ART adherence (67). Unlike the WelTel trial, the SMS text messages contained a motivational and reminder component. A helpline was also included. HIV was not referenced in the SMS. Trial results showed no marked improvement in ART adherence among the participants after 6 months (67). Moreover, the inclusion of a motivational component in the SMS text message had no additional impact on the ART adherence (67). This is contrary to a RCT by Eleches P et al. in 2011 that found that weekly SMS reminders with a motivational component increased the percentage of participants achieving ART adherence by almost 16% compared to those who did not receive a reminder (68). This was indicative that motivational messages incorporated within the SMS reminder encouraged adherence among the participants (68).

In India, a quasi-experimental study done by Rodrigues R et al. in 2012 combined the use of IVR and SMS text messaging for a 6-month duration. Improvement in ART adherence was noted after the intervention (69). In 2015, Ahmed H et al. conducted a RCT in two hospital centers in Pakistan to investigate the use of SMS text message reminders to improve adherence to TB medication (70). In the first two months, daily SMS reminders were sent to the participants' mobile phone or that of a relative (70). The acceptability of the SMS reminders was assessed through interviews and semi-structured questionnaires (70). Ninety

percent of participants reported TB drug adherence. Over 95% of the participants found the SMS reminders useful. However, challenges of phone sharing and illiteracy were noted (70).

In 2006, a one-year pilot study was done in South Africa to assess the efficacy of 'SIMpill' a wireless pill bottle that sends an SMS message informing the patient on when to take their medication (71). In case of errors in sending, the system automatically contacted the patient through the phone and reminded them to take the medication. One hundred and fifty-five patients participated in the study (71). Over 10 months, the rate of drug adherence and treatment success was more than 90%. This was higher compared to those who received direct observation therapy (71).

A RCT was done in Argentina in 2012 to evaluate the efficacy of 'TEXTTB', a tailored SMS text message reminder on TB drug adherence (72). The SMS reminders were sent in three capacities; To remind patient to 'text-in' after taking the TB medication, as a reminder if they failed to do the former and to educate them on TB (72). After the 60-day trial, those who received the reminders reported a higher treatment adherence as compared to those who did not receive the SMS (72). More than 80% of the participants found the intervention helpful. Drawbacks of phone sharing, security, privacy and mobile phone coverage were identified (72).



**Figure 7: The WelTel intervention, Kenya 2010 (66).**

**Summary of evidence and evaluation:** Based on the GRADE approach, the certainty of evidence from the RCTs (66, 67,68,70,72) is high as opposed to the evidence from the quasi-experimental and observational study (69,71), which is low. Therefore, it is certain that the use of SMS reminders increased ART and TB drug adherence. It is however uncertain whether the SMS interventions reduced the viral load of the participants (66, 67). There is no evidence of unintended consequences from all the RCT interventions.

### **5.1.2 PREVENTION OF MOTHER TO CHILD TRANSMISSION**

In 2014, Odeny A et al. conducted a qualitative study in Nyanza, Kenya to assess community preferences with regards to the content of SMS reminders to be used in the promotion of PNC clinic attendance (73). Most participants were found to prefer a

personalized, appealing message with no reference to HIV. They reported that inclusion of HIV information would perpetuate stigma from others and instill fear among the women (73). In addition, they also felt that the intervention would concurrently increase child immunization clinic attendance (73).

In Western Kenya, Mushamiri et al. did a study in 2010 to assess the role of SMS text messaging in the improvement of ANC attendance. It was focused on the reduction of vertical transmission rates in the area (74). A software system was used by CHWs to input patient information after every appointment. HIV positive women were identified, and their status noted in the system (74). Three days before the next appointment, CHWs received an SMS text message reminding them of the upcoming home visit. During the visit, the CHW advised the women and reminded them of their ANC appointments. This led to an increase in the uptake of ANC services (74). CHWs were able to keep track of the women. Nonetheless, CHWs found the input method time-consuming and feared a high error rate (74).

Jennings L et al. conducted a study in Nyanza, Kenya to investigate the perceptions of the community and healthcare workers on the use of mhealth technology in PMTCT (75). The study also focused on male involvement in PMTCT. The study participants included HIV positive pregnant women, their partners, nurses and CHWs (75). It was found that most of the couples shared a mobile phone (75). However, this was not the case for CHWs and nurses. CHWs reported the use of SMS messages to reach their clients and other CHWs. The women reported ease of communication with a CHW and the ability to refer other women to the CHW (75). As for content, the women preferred an SMS message containing HIV education, breastfeeding and PNC information (75). The men proposed that the SMS should encourage men to take up their role as partners and community leaders. In addition, it should also emphasize the importance of HIV testing, ANC and PNC. The men preferred the SMS late in the day whereas the women opted for early in the morning (75).

**Summary of evidence evaluation:** Despite positive findings on the use of SMS text message reminders in PMTCT, based on the GRADE approach, the certainty of evidence from all the above studies (73,74,75) is low (65). Therefore, it is inconclusive whether SMS interventions reduce PMTCT.

### **5.1.3 EDUCATION AND OUTREACH**

Over the years, outreach campaigns on HIV/AIDS have been done using print media, radios, televisions and door to door visits (76,77,78,79). Despite this, majority of people remain untested and still engage in high-risk behaviors. Studies have been done to investigate the efficacy of mass SMS text messages as a campaign tool for HIV/AIDS. However, in Kenya, this intervention has only been applied in adolescent SRHR outreach (76).

The 'Mobile for Reproductive Health' (M4rH) study was a 17-month pilot carried out in 2011 in Dar es Salaam, Tanzania and Nairobi, Kenya. Its purpose was to evaluate the effectiveness of SMS text messages in the dissemination of FP information (76). A free SMS was sent on request to the participant. The user was then required to respond with information about their sex, age and type of FP method used. Responses provided were analyzed to assess the acceptability, access and impact of FP. Only a quarter of the intended 4,000 participants responded to the SMSs (76). Results showed that participants felt that the SMS information would be beneficial in learning about different contraceptives, FP myths and where to access FP services if required (76).

In 2012, Arul C et al. conducted the 'Text to Change' study in rural Arua, Uganda. The study involved sending a 13-question quiz on HIV/AIDS to randomly selected mobile phone



subscribers (77). The correct answers were provided at the end of the quiz. Despite the promise of a free HIV test after quiz completion, less than 3,000 mobile subscribers participated. It was found that more men responded to the intervention than women (77). The highest scorer had 68% whereas 600 participants provided incorrect answers to all questions (77). Several limitations noted were high illiteracy levels in Arua, poor uptake of the incentive offered, challenges in phone-sharing and a gender gap in mobile phone ownership (77).

A study by Kliner L et al. was done in 2012 to investigate the use of a beep (missed call) to increase clinic attendance in Luwombo, Swaziland (78). After their HIV test, patients were required to return to collect their CD4 results. Those without a mobile phone were excluded from the study (78). Each participant's phone number was saved in the hospital database under the group 'Go to hospital'. A day before their appointment, a missed call was made to the participant, which appeared in their call log as 'Go to hospital'. Despite the intervention, a before and after comparison reported no major changes in clinic attendance (78).

In 2008, project masiluleke was initiated in South Africa to promote HIV testing and TB outreach (79). The information was automatically inserted in every 'please call me' message sent by a user to another. At the bottom of the SMS, a link to the National AIDS helpline was provided. Within the first 6 months, there were four times more calls made to the National AIDS helpline than before the intervention (79).

**Summary of evidence evaluation:** The certainty of evidence on the efficacy of SMS text messages (76,77,79) and missed calls (78) as a HIV education and outreach tool is low (65). Despite positive reviews on the effectiveness of M4rH program in FP, due to methodological limitations such as small sample size and low response rate, the efficacy of the study could not be established (76). There is limited evidence on the use of mhealth applications in targeted education and outreach interventions for KPs in LMICs (80,81)

## **5.2 SENSORS AND POINT OF CARE DIAGNOSTICS**

Light microscopy and digital imaging have enabled prompt diagnosis of diseases. Good image capture and rapid transfer tools have reduced delays in consultation and enabled faster dissemination of results, particularly in high income countries (82,83,84). However, such technology is lacking in LMICs, especially in rural areas. For endemic diseases such as TB and malaria, fluorescence microscopy is crucial for diagnosis (82,83).

In 2009, Breslauer et al. reported on the potential of mobile phone-mounted fluorescent microscopy use for TB diagnosis in LMICs (82). Healthcare workers were able to capture digital images of blood and sputum samples on their specialized camera phones, analyze, store or send the images to other healthcare facilities (82). In Peru, a study by Z.Mic et al. also reported that a low-cost mobile-based microscope is beneficial for TB diagnosis in low resource setups (83).

In 2011, Chin et al. did a study in Rwanda to explore the role of mobile phone technology in the diagnosis of HIV in rural settings (84). They developed the 'mChip', a battery powered low- cost handheld tool with diagnostic and remote communication capabilities. It facilitated rapid HIV testing, with high sensitivity and specificity (84). After testing, the result was sent either by email or SMS to a designated phone number in the participating hospitals in Kigali. The device was found to be superior to current HIV rapid screening tests used in remote areas. Moreover, the dissemination of results via mChip was faster and more effective than other method in use (84). It was concluded that the mChip had superior qualities such as

high potential for scalability, location tracking capabilities, portability and was cheaper than other HIV screening devices (84).

**Summary of evidence evaluation:** Despite the study conclusions that mobile phone microscopy improves HIV and TB diagnosis in low resource setups, the certainty of evidence from the above-mentioned studies (82,83,84) is low (65).

### 5.3 PROVIDER TRAINING AND EDUCATION

Due to the rapid infiltration of mobile phones, more rural healthcare workers have access to a mobile phone. Access to health information, dissemination of educational material and training sessions has become possible (85,86,87). Supervisory staff and specialists can offer remote guidance and feedback without in-person consultations (85,87).

The mCHW was a mobile learning platform created by the University of London in collaboration with AMREF Health Africa in 2016 (85). It was piloted in a semi-arid rural area in Makueni and Kibera slum in Kenya. The digital interaction platform was created to provide 41 CHWs and their supervisors with professional training sessions, team building activities and educational material (85). More than 1000 posts were shared, with pictures as the main form of media. CHWs reported satisfaction with the platform as they were able to interact closely with their peers and foster trust and open communication. The supervisors reported easier monitoring of CHWs activities and remote training (85).

The txt2MEDLINE, an SMS-based learning platform, was created in 2012 for Botswana healthcare professionals (86). It was used by clinicians, nurses, CHWs and medical students. The healthcare professional would request an article through SMS. After registration in the data server, the query was transmitted to the National Library of Medicine (86). Results of the article abstract summary were then sent back to the health worker through SMS. On request, the full article link was also emailed to their mobile phones (86). Participants reported use of the service daily or on a weekly basis. They mostly used txt2MEDLINE for queries on treatment guidelines. They reported challenges in reading article summaries via SMS and difficulty in using search commands. Failure to use the exact search terms yielded no results (86). Most participants did not own a JAVA-enabled phone, hence could not receive emails. The intervention was found to be cost-friendly as sending SMS messages was free. However, it was noted that changes in the design would address some of the barriers highlighted (86).

In 2011, Chen Y et al. conducted a 2-year RCT to evaluate the use of SMS text messaging as an education tool for health workers in rural China (87). The comparison group received standard in-person training by senior officers. One hundred health centers were randomly selected from the Gansu province of China for participation (87). A baseline telephone survey was conducted to assess existing knowledge and practice. Mass SMS messages in local Chinese dialect were sent three times a week to healthcare workers containing recommendation guidelines for various diseases (87).

The comparison group received the recommendations through a one-day seminar at the tertiary hospital. Telephone interviews were then carried out to assess the healthcare worker's knowledge, treatment practices and use of the recommended guidelines (87). One fifth of the health workers reported adopting the recommendations in their daily practice. A follow-up survey also showed that more than 90% of healthcare workers were willing to continue receiving the SMS messages (87).

**Summary of evidence evaluation:** Based on the GRADE approach (65), there is strong certainty of evidence from the RCT (87) that mobile technology aids in the training and education of health workers. Nonetheless, the certainty of evidence from the other studies (85,86) is low.

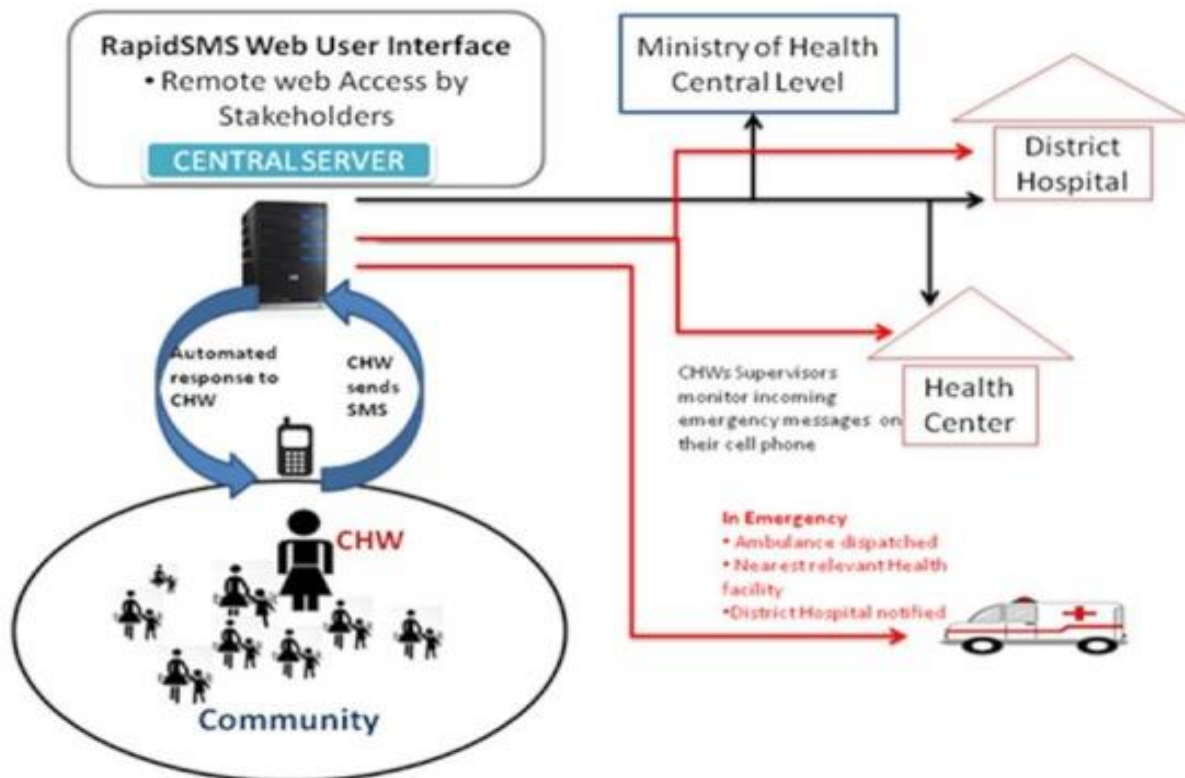
#### **5.4 PROVIDER TO PROVIDER COMMUNICATION**

Studies show that mobile phones improve communication between healthcare workers at different levels of healthcare (88,89). CHWs can consult and refer patients to secondary and tertiary level hospitals with ease through an SMS or voice call. This improves health worker efficiency, facilitate prompt diagnosis, decreases errors in treatment regimens, and reduces the number of referrals (88,89).

In 2010, a cluster-RCT by Chang L et al. in Rakai Uganda was done to assess the effect of mhealth applications on the efficiency of peer health workers (PHW) (88). PHWs are PLHIV that take on the role of a CHW. Over a 2-year period, PHWs could call nurses and CHWs with patient-specific inquires or for emergencies (88). They were also required to send an SMS message regarding patient vitals and medication adherence after every home visit. In the control group, PLHIV followed the normal standard of care (88). After the trial, it was reported that ART adherence in patients linked to a PHW was more than two higher that of patients receiving normal standard of care (88). Moreover, those linked with a PHW had experience less treatment failure than those receiving the normal standard of care. Challenges reported included maintenance and access to mobile phones due to phone sharing, concerns over confidentiality and privacy and high costs of phone calls (88).

Another study by Ngambo F et al. was done in 2012 to assess the potential of 'Rapid-SMS' , an SMS text messaging system, in improving MCH in Rwanda (89). An initiative by United Nations Children's Fund (UNICEF) and the MOH, the pilot was conducted over a 12-month period. The intent of the Rapid-SMS intervention was to provide a link in communication between CHWs with doctors, nurses and ambulatory staff in the district hospitals (Refer to figure 8). The MOH provided each participant healthcare worker with a mobile phone. CHWs recorded all pregnancies into the system. SMS text message reminders were then sent at specific dates for appointments and deliveries (89).

In case of emergencies, an alert was triggered in the system and instructions on case-management sent to the CHW through SMS. Ambulatory requests made by the CHW were also linked to the nearest hospital and pick-up details sent to the CHW. By the end of the study, more than 30,000 reports had been made by CHWs (89). All CHWs were reported to use the intervention regularly. The percentage of home deliveries increased by 20% after the intervention. CHWs reported ease of follow-up of pregnant women and ability to handle more emergencies without assistance from health facilities (89).



**Figure 8: Rapid-SMS intervention flowchart, Rwanda 2012 (89)**

**Summary of evidence evaluation:** Based on the GRADE approach (65), the certainty of evidence from the RCT (88) is high, while it is low for the observational pilot study (89). Evidence on the effect of Rapid-SMS on HIV-related maternal mortality rates is lacking (89).

### **5.5 ELECTRONIC HEALTH RECORDS AND DECISION SUPPORT: INFORMATION, PROTOCOLS, ALGORITHMS, CHECKLISTS**

Traditional methods of patient file storage make file retrieval and management difficult. Synchrony retrieval of information is very time-consuming (90). With increased access to internet connectivity, most government health facilities are leaning towards electronic file management. However, the transition is slow. High costs of digital training of healthcare workers, large amounts of information to input and erratic internet connectivity are among the challenges faced (90).

The AMPATH Medical Record System (AMRS) is an example of an EMR system developed in 2007. It was created to aid in HIV surveillance and research in resource-constraint settings in Kenya (90). It consists of a data management software that enabled easier retrieval of patient information as compared to traditional paper-based record systems (90). Components of the data management software include: Patient registration, appointment scheduling, follow-up and research entry forms. It was primarily piloted in a rural center in Western Kenya but has since undergone rapid scale-up to include provincial referral hospitals and other subsidiary government facilities (90). AMRS is affordable and allows standardized collection and analysis of HIV data, therefore improving the efficiency and quality of care for PLHIV. Studies reported limitations such as erroneous data entry, limited

trained staff to handle large data sets and poor supervision (90). Due to high amounts of erroneous data, drawing comprehensive conclusions on HIV trends was difficult (90).

To assess the adherence of healthcare workers to malaria treatment guidelines in Kenya, D Zurovac et al. conducted a RCT in 2011 over a 6-month duration (91). A baseline survey was conducted in more than 100 rural health centers to establish the current guideline adherence rate. Only health workers with a mobile phone were included in the study (91). During the intervention, two automated SMS text messages were sent to each healthcare worker daily at a predefined time (91). The SMS contained key malaria treatment guidelines, a symptom checker and malaria drug regimens. Six months after the study, a second survey was done. It reported a 32% increase in the use of the national malaria treatment guidelines. SMS text message reminders were reported to be cost-friendly and were widely accepted by the health workers (91).

**Summary of evidence evaluation:** In line with the GRADE assessment, the certainty of evidence on the effectiveness of AMPATH Medical Record system is low (65). However, the certainty of the RCT evidence that SMS text messages improved adherence to national treatment guidelines is high (65).

## 5.6 SUPPLY CHAIN MANAGEMENT

In LMICs, challenges in the supply chain of medications, vaccines and equipment are very evident. In Kenya, constant ART shortages and subsequent HIV treatment interruption is a common phenomenon in most government health facilities (92,93). In remote areas, geographical barriers and infrastructural drawbacks inhibit access to healthcare supplies at the point of care. Moreover, the rapid rise in counterfeit drugs has also affected case-management and consumer trust. Studies done have shown that mhealth applications can be applied in reducing access barriers and facilitating supply-chain transparency (92,93).

Githingi S et al. conducted a study in 2013 to evaluate the use of 'SMS for Life', an SMS text messaging system, in stock reporting of anti-malarial drugs (92). The participants were government health facilities in Kenya. Weekly stock count SMSs were sent out by registered healthcare workers into a web-based system. Thereafter, district health management officials (DHMT) were able to access the information and organize re-stocks (92). The study reported a 95% response rate from every facility. District officials were found to access the system more than five times a week. In comparison with other facilities, facilities using 'SMS for Life' had less stock-outs of anti-malarial drugs (92).

In 2010, the MOH in Malawi in collaboration with the community supply chain management team designed 'cStock' (93). The study was carried out across several districts to assess the role of cStock in the improvement of supply chain transparency and stock management (93). At the beginning of every month, stock management staff in the health facilities sent stock updates to cStock via SMS (Refer to annex 2). The cStock database then analyzed the data and sent a report to the DHMT and national-level officials. At the end of the trial, it was reported that more than 90% of the participants used cStock to report on stock levels (93). In addition, restocks ordered through cStock took 13 days from time of order to receipt of stock. This was two times faster than the normal restock time of 27 days. The health facilities also reported that cStock was easy to learn and was their first choice for stock management (93).

**Summary evaluation of evidence:** In line with Argwal S et al (94) and the GRADE approach (65), despite optimistic findings, the certainty of evidence on the effectiveness of 'cStock' and 'SMS for Life' interventions in improving stock management is low (92,93).

## 5.7 FINANCIAL TRANSACTIONS AND INCENTIVES

Few studies have been done in LMICs to investigate the efficacy of using financial incentives in HIV prevention (96,97,98). However, high income countries have done studies to explore the potential of financial incentives in HIV prevention and improving linkage to care (95). In 2011, Kohler P et al. conducted a study in rural Malawi to explore the role of conditional cash transfers in the prevention of HIV (96). Financial incentives were promised to participants if they upheld their negative HIV status for a year. The reward amounts were as high as an average 3-month salary. After receiving the reward, men were found to still engage in risky sexual behavior. However, high risk activity in women had reduced by 7% (96).

In 2012, an observational study was done in South Africa to examine the efficacy of monthly financial incentives on risky sexual activities in adolescents (97). More than 3000 adolescents from rural and urban KwaZulu-Natal participated. A baseline survey was done at the beginning of the study, to identify the current situation (97). After the study, it was found that, in households where no financial incentive was given, there were twice as many girls engaging in transactional sex. It was also noted that financial incentives had no effect on the boys' sexual behavior (97).

Walque D et al. conducted a cluster-RCT in 2009 to explore the role of conditional and unconditional financial incentives on the prevention of STIs and HIV among the Malawian youth (98). More than 1200 households in Zomba region were randomly selected and assigned to receive a conditional (only awarded if one attends school) or unconditional (no condition attached to incentive) monthly incentives (98). The incentive ranged from between 5-10 US dollars. After 12 months, sexual activity was found to be lower among those receiving the incentives as compared to youth in other regions. Also, there was a 6% increase in school enrollment rate and a 35% increase in re-enrollment rate for those who had dropped out (98).

Mobile financial services have revolutionized small-scale mobile banking in LMICs, especially in rural areas. One can send, receive, save and pay for services through a mobile phone (99). MPESA is a leading mobile money financing service in Kenya. As of 2018, there were more than 35 million subscribers (99). MPESA allows access to financial assistance for medical loans and provides a health savings account option. In addition, it also offers medical bill contribution services (99).

**Summary evaluation of evidence:** Based on the GRADE approach (65), the certainty of evidence from the RCT that financial incentives reduces risky sexual behavior is high (98). However, the certainty of evidence from the observational studies (96,97) is low.

## **CHAPTER 6: DISCUSSION, CONCLUSION AND RECOMMENDATIONS**

### **6.1 DISCUSSION**

There are more than one million PLHIV in Kenya. With a national prevalence of 4.6%, Kenya faces a generalized HIV epidemic, with a concentrated epidemic among key population groups-FSWs, MSMs, MSWs, PWIDs and migrant populations. Young adults are the most affected demographic, while women and girls bear the largest burden of HIV. HIV not only affects individuals and households, but it also puts strain on an already burdened Kenyan healthcare system. Although efforts at scaling up HIV and ART services have helped reduce the HIV burden in the last decade, access to good quality HIV services remains a formidable challenge. The main demand-side barriers to access of HIV services are stigma and discrimination, poverty, low literacy levels, socio-cultural factors and lack of education. In addition, healthcare system factors such as scarce resources, poor infrastructure, low funding and poorly trained staff also play a major role. This thesis assessed the potential role of mobile communication technology in addressing these barriers.

#### **6.1.1 USEFULNESS OF CHOSEN FRAMEWORKS**

The Levesque model of access to health services was valuable in identifying the main demand and supply barriers to access of health services (32). This guided my literature search in the context of HIV/AIDS. The mhealth and ICT application by Labrique et al was beneficial as it enabled identification of different mhealth applications in health (33). In combination, both frameworks provided guidance on how mhealth applications can be used to solve the barriers of access to quality HIV services.

#### **6.1.2 MOBILE COMMUNICATION IN KENYA**

- **Coverage**

Within the last decade, Kenya has undergone rapid expansion in mobile communication coverage. As of 2018, 93% of Kenyans had access to a mobile phone. Low-cost mobile phone penetration is high, particularly in remote areas where internet connectivity is limited. Hard to reach areas now have access to network coverage. This has increased the potential use of mobile phone technology to improve access to healthcare services in resource-limited settings.

- **Acceptance**

In SSA, mobile phones are the more widely accepted means of communication. They are highly portable, and their maintenance is low. Electronic shops are now readily available in most urban and rural areas; hence one can easily purchase a mobile phone. Despite these benefits, issues of gender, culture and socioeconomic disparities influence ownership and use. In Kenya, more men own mobile phones than women. Women, especially in rural areas, tend to have lower literacy levels. Coupled with their responsibilities as carers and household maintainers, they have limited time to learn the operations of a mobile phone.

The main barriers to mobile phone ownership for both men and women are affordability, literacy and digital skills, relevance, safety and security and accessibility-related barriers. Due to socio-cultural reasons, some communities do not allow women to use or own a mobile phone. Some women require permission to use a mobile phone due to their subordinate role in the household. Moreover, most rural women are either unemployed or run informal businesses. Hence, cannot afford to purchase or maintain a mobile phone. Phone sharing is also very common in many rural households. Different members of a family/household share a mobile phone to save on costs.

### **6.1.3 FORMS OF MOBILE COMMUNICATION**

- **SMS text messages**

In comparison to other forms of communication, SMSs are cost-effective, convenient for mass communication, have high scalability and broad reach. SMS have the potential to be incorporated in all aspects of the HIV treatment cascade. These features can be used in the design of mhealth projects .For example, mass SMS messages can be used to increase coverage of HIV education and outreach campaigns. They can target almost all mobile subscribers. In addition, interactive SMSs can be used to link CHWs and nurses to the community. They provide a platform for addressing questions. Also, SMSs can serve as appointment reminders to improve linkage to care and reduce treatment failure by serving as a reminder to take ART medication. A major setback to SMS usage is its inability to be used by the illiterate. Therefore, this barrier should be addressed in the design of mhealth interventions.

- **Voice calls**

Unlike SMSs, voice calls allow 'real-time' communication and instant feedback. They can be a powerful tool in improving communication between patients and healthcare workers, and healthcare workers in different levels of the healthcare cadre. CHWs can be able to make consultations with senior level officers, hence reducing the delay in provision of care, long hospital queues and waiting times. They can also be effective in targeted PMTCT interventions for pregnant women. An open line of communication between CHWs and pregnant women improves follow-up and subsequently increases ANC and PNC coverage. A disadvantage of voice calls is that they can be expensive. Therefore, the design of mhealth interventions should consider the cost of voice calls.

- **Voice messages**

Voice messages can be used to improve ART adherence and improve ANC and PNC. A pre-recorded voice message can be sent directly to patients on ART therapy and pregnant mothers to remind them of clinic appointments or important drug regimen changes. The message could be personalized depending on the targeted individual. Since accessing the voicemail box may be challenging for some users, their voice messages could follow a beep or missed call to ease retrieval.

- **Beeping (Missed call)**

Since beeping is popular among many households in Kenya, it can be applied in appointment reminders. This is evidenced by a study in Luwombo Swaziland where a missed call appeared as 'Go to hospital' in the call log of patients, instantly reminding them of their next day clinic appointment (78).

### **6.1.4 EVIDENCE AND EVALUATION OF MHEALTH APPLICATIONS**

Evidence shows that certain mhealth applications effectively improve ART and TB drug adherence. Low-literacy levels, phone sharing restrictions, disregarding of messages and privacy issues are the main barriers to the acceptability and scalability of mhealth applications. SMSs can be difficult to comprehend, especially when one is illiterate. Over time, SMSs may be ignored or disregarded as most people find them repetitive and lacking new information. Interventions targeting ART adherence in women should also use SMS messages to educate their partners and community leaders on the importance of women health and their rights to communication. Exploring these barriers to mobile phone ownership and use is important to ensure success of the intervention in low-resource setups. Interventions targeting ART adherence in women should also use SMS messages to educate their partners and community leaders on the importance of women's health and their rights to communication.

In the reduction of vertical transmission, several studies showed that mhealth applications can be used to improve ANC and PNC coverage. It is important that interventions are



designed with the soci-cultural, socio-economic and literacy barriers to women's access to health services in mind. Some studies reported that SMS message reminders increased stigma and discrimination against the pregnant women. In most communities, financial and health-seeking decisions lie solely with the men. To access ANC and PNC clinics, some women require permission from their fathers, brothers or male partners. Therefore, mhealth interventions addressing PMTCT should also target men partners, community and religious leaders. Tailored SMS and voice messages should educate men on their role in pregnancy, safe delivery and post-natal care. Moreover, they should also be sensitized on spousal HIV testing and the importance of early ART initiation. In addition, PMTCT targeted interventions should also incorporate HIV community sensitization to address communal stigma and discrimination.

Most studies found that mlearning applications were beneficial to healthcare workers, especially those in remote areas. In areas where internet coverage is limited or lacking, mlearning increases access to educational materials and remote training of health workers in hard-to-reach areas. For example, the mCHW learning platform enabled CHWs to actively engage with their peers and supervisors. This created an open line of communication between the different levels of healthcare. Such mhealth interventions are feasible and scalable in remote areas. Healthcare workers are also able to access journals and guideline recommendations remotely. Most of the studies reported digital illiteracy and challenges in intervention design as the main drawbacks. Therefore, government hospital budgets should include funds for digital training of health workers and refreshment courses every few years to increase acceptability.

Evidence from most studies showed that SMSs and voice calls improve communication between healthcare providers in different cadres of care. Mhealth applications can be used to empower CHWs and nurses at lower levels of care. Through frequent consultations and supervision by senior colleagues, CHWs and nurses become more effective at community level. This reduces delays in patient treatment, long queues and the number of referrals to tertiary hospitals. Hence, tertiary hospitals are left to handle more serious emergencies. This overall improves the effectiveness of the healthcare system, subsequently saving resources. Most of the mhealth studies provided mobile phones to their participants. Therefore, to ensure feasibility and scalability, mhealth interventions should consider that not all healthcare workers own a mobile phone. Therefore, a budget to avail low-cost mobile phones to CHWs and nurses at health centers should be in place at every health facility.

Almost all government health facilities are in the process of transition to EMR. Most studies showed that EMR are superior to paper-based systems as they ensure easier patient file retrieval, patient tracking and follow-up. Patient files can also be accessed outside hospital settings. The transition has been slow as EMR require constant electricity supply, digital training of health workers and inputting decades of paper records into the system is time-consuming and tedious. To ensure the efficiency of EMR systems, training of health workers is mandatory. Electronic Decision Support applications improve information retrieval, patient tracking, appointment scheduling and data surveillance. These systems can be used by health workers. Patient data can be inputted remotely and transferred to a central hospital database. However, high error rates in data imputing are common. Successful implementation and scalability of EMRs will only be possible if resources are available to fund staff training and supervisory systems are in place to ensure efficiency.

Mhealth applications have been used to improve supply-chain transparency and reduce stock-outs. Facility stock use can be monitored electronically. Therefore, facilities with the most and least stock are easily identified. Hospital managers, district and national officials are able to evaluate stock trends and make evidence-based decisions on stock purchases,

distribution and restocking. When stock supplies are made based on facility need, a lot of money and resources is saved. Secondly, stock-out of essential drugs is avoided. Thirdly, corruption is eliminated due to transparency in supply-chain management. Studies have shown that financial incentives can serve as a tool to promote behavior change. Where cash incentives have been used to reduce the involvement of youth in transactional sex, studies have reported a positive influence on behavior change. Adolescents and youth engage in transactional sex for various reasons. The main motivation for most is to escape poverty. Therefore, financial incentives interventions target poverty and encourage self-sustenance. In low-resource setups, more cost-friendly mhealth interventions such as beeping (missed call) should be explored.

In Kenya, mobile money banking platforms such as MPESA have revolutionized banking. MPESA provides healthcare savings accounts, access to medical emergency loans and facilitates medical bill contributions. Therefore, out of pocket spending is reduced significantly. With healthcare savings, households can better plan for future medical emergencies without facing the risk of bankruptcy. Almost all Kenyans have an MPESA account, therefore the feasibility and scalability is high. However, more studies are required to explore the role of MPESA in HIV care and management.

#### **6.1.5 QUALITY OF STUDIES/DATA**

Evidence from a mixture of RCT, cluster-RCTs, observational, quasi-experimental and exploratory studies have been examined. Most studies are observational and exploratory, hence remain in pilot phase. There is lack of evidence from LMICs on mhealth interventions targeting KPs. This is despite their large proportion in the HIV epidemic and unmet need of HIV services.

#### **6.1.6 STUDY LIMITATIONS**

One of the main limitations was that evidence used was from different LMICs, whose geographical, social and population context is different. Hence, the findings could not be generalized. Also, most of the mhealth studies did not include comparison groups, that is, participants who are not mobile phone users. This limited the pool of perspectives on the acceptability and usability of some of the mobile technology in health.

### **6.2 CONCLUSION**

Barriers to access of quality HIV services are either individual, community or health system related. Poverty, gender, stigma and discrimination remain the main community barriers to seeking HIV services. Poverty and gender factors have an influence on HIV knowledge, condom use and sexual behavior. Socio-economic disparities further impact on education, service affordability and high-risk sexual behavior. Stigma and discrimination affect health-seeking behavior and medication adherence. Health system related barriers include provider attitude and behavior, infrastructure, quality and availability of services. Provider attitude influences health-seeking behavior and community attitude towards HIV services. Moreover, scarcity and low-quality services affects uptake and patient retention.

To address the poverty barrier, most mhealth interventions use free SMS text messages as the main form of communication. SMSs are free hence people from all walks of life can be reached, provided they own a mobile phone. To address behavior change, financial incentives address poverty, so as discourage high-risk sexual activity. The youth engage in transactional sex in exchange for money and other commodities. Therefore, monthly incentives deter them from risky sexual activities.

Targeted mhealth interventions have led to an increase in ANC and PNC coverage, especially in rural areas. Although more evidence is needed to ascertain the effect of mhealth applications in the reduction of PMTCT and HIV-related maternal mortality. The mlearning platform has improved training and supervision of CHWs. Hence, they can reach pregnant mothers in rural areas, where access to a formal health facility is difficult. Mhealth applications have also helped to reach health workers working in remote areas and save on healthcare resources needed for in person training.

EMR and AMRS systems have also improved access to remote areas. Patient data from facilities in hard to reach areas can be inputted and sent to the main database. Remote access of health facility records can also be done outside hospital vicinity. However, digital, design and infrastructural limitations are still a challenge in most mhealth interventions.

### **6.3 RECOMMENDATIONS**

After careful consideration of study objectives and examination of the findings, with focus on the background and current health situation in Kenya, the following recommendations were made:

#### **I. GOVERNMENT**

- The government should address infrastructural challenges such as electricity supply coverage, poor quality roads and poor human resource allocation, in order to allow easier integration of mhealth interventions into the existing healthcare system.
- The current national e-health strategy should incorporate mhealth evidence evaluation guidelines, with reference to the WHO Digital Health Intervention Guidelines. This will ensure prioritization of studies whose certainty of evidence is high.

#### **II. MINISTRY OF HEALTH KENYA**

- The MOH should use its stewardship role in health and collaborate with NGOs and donors to create better alignment of mhealth interventions with the national health strategy. This will enable better uses of resources and evidence collection. Moreover, it will also ensure a starting point for later scaling-up of mhealth interventions.
- Since the MOH may not have the financial resources to buy mobile phones for all health care workers, it should provide low-cost incentives to assist the health workers to buy for themselves. This will encourage provider-to-provider communication, timely referral, client responsiveness and accountability.
- The MOH should budget for digital skills training workshops for all healthcare workers and refresher courses every 2-3 years. This will improve efficiency of use of mhealth interventions, subsequently reducing error rates in data entry.

#### **III. TARGET GROUP**

- Ministry of Health and NGO mhealth interventions targeting PMTCT clients should incorporate male partners and community and religious leaders, to address challenges related to stigma and discrimination.
- In communities where phone sharing is common, mhealth interventions should incorporate privacy features such as codes and passkeys to ensure sensitive and highly confidential information is accessed by the intended individual.

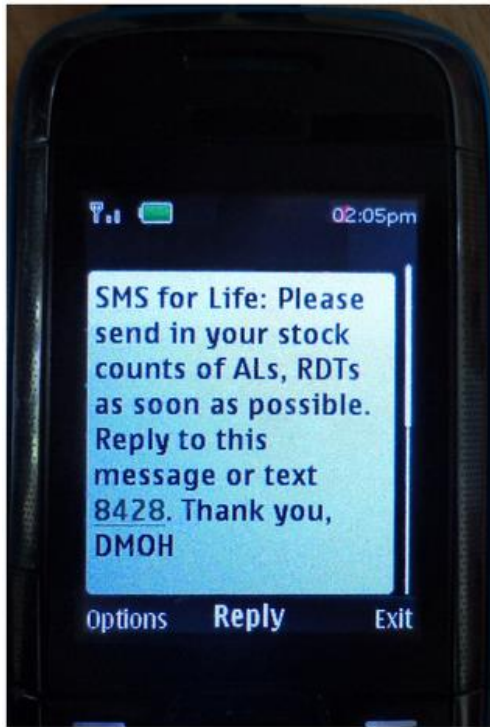
#### **IV. AREA OF RESEARCH**

- More mhealth intervention studies should be done for KPs such as FSWs, MSMs, MSWs and PWIDs. Promising interventions such as mass SMS messages and financial incentive driven interventions to promote behavior change, education and outreach.

## ANNEX

**Table 2: Illustrative table of search terms**

CATEGORY OF INTEREST	SEARCH TERMS
<b>Geography</b>	Africa, Sub-Saharan Africa, Asia, Europe, East Africa, West Africa, South Africa, Kenya, Zambia, Zimbabwe, Ghana, Uganda, Ethiopia, Tanzania, Lesotho, Malawi, Ghana, Burkina Faso, Argentina, Swaziland, Rwanda, India, Pakistan
<b>HIV, AIDS</b>	HIV, acquired immunodeficiency syndrome, tuberculosis, education, literacy, economy, healthcare services, healthcare utilization, poverty, teenage marriage, condom use, sexual and reproductive health services, family planning, sexually transmitted infections (STIs), age, sex, gender, sociocultural, socioeconomic, transactional sex, commercial sex work, injectable drug use, behavior, polygamy, polygyny, wife inheritance, widow inheritance, religious, lifestyle factors, health services, healthcare access, healthcare utilization, health-seeking behavior, key populations, men having sex with men, male sex workers, provider attitude, stigma, discrimination
<b>Mhealth</b>	Information communication technology, mobile phone, mobile health, electronic health, gender gap, coverage, phone sharing, phone ownership, phone usage, SMS text messaging, Multi-Media Messaging (MMS), Interactive Voice Response (IVR), voice calls, voice messaging, beeping (missed call), mlearning, electronic decision support, sensor and point of care diagnostics, fluorescent microscopy, evidence evaluation guidelines, Electronic health records, Supply chain management, financial transactions, cash vouchers, financial incentives, Mpesa



**Figure 9: An example of a stock request message using cStock in Malawi, 2010 (93)**

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