A MOBILE HEALTH COMMUNICATION FRAMEWORK

FOR POSTNATAL CARE IN RURAL KENYA

By

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2016446920

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DECLARATION

I, Florence Mbuthia, declare that the thesis (interrelated published and publishable articles) that I hereby submit for the Doctoral degree in Nursing at the University of the Free State is my independent work and that I have not previously submitted it for a qualification at another institution of higher education. I waive the copyright of this product in favour of the University of the Free State. In the event of a written agreement between the University of the Free State and the student, the written agreement must be submitted in lieu of the declaration by the student (Addendum A).

_____ June 2020

FW MBUTHIA

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DECLARLATION BY LANGUAGE EDITOR

Declaration

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I confirm that I edited this thesis, checked the references, and made recommendations for changes to the text.

DEDICATION

This work is dedicated to all women in rural areas who struggle to bring up their children amidst the challenges that they have no control over. I encourage them to be hopeful.

“Things always get better with time, just wait and see”- Clavel Nelson

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ABSTRACT

Background: Maternal and neonatal health remains a major challenge in low- and middle-income countries, resulting in the burden of a high rate of maternal and neonatal deaths. Postnatal care is an intervention recommended by the World Health Organization to promote maternal and neonatal health. In spite of this recommendation, uptake of postnatal care in Kenya, as in many other sub-Saharan African countries, has remained low, particularly in rural areas, despite targeted postnatal care services being implemented. Mobile health communication is proposed to promote the uptake of postnatal care; however, no theory-based framework has been developed in this regard to date. This study, therefore, aimed to develop a mobile health communication framework for postnatal care in rural Kenya.

Methods: A multi-method research design guided the development of the framework through a multi-phased approach. The first phase systematically reviewed literature to gather the best available evidence on how mobile health communication could strengthen postnatal care in rural areas. The second phase of this study used a visual-based narrative inquiry to explore the experiences of postnatal mothers with health care providers and their views on mobile health communication in a rural area in Kenya. In the final phase, the findings of the preceding phases were used to draft the framework, which was validated by policymakers from the same rural area where data had been gathered. The theoretical underpinning of the study was provided by both the integrative model of behaviour prediction and the theory of change logic model. The integrative model of behaviour prediction was used to identify determinants of postnatal care uptake, while theory of change logic model underpinned the development of the mobile health communication framework by describing what the framework comprised.

Results: The findings of the systematic review reveal that one-way messaging is the most common type of mobile health communication that is used in an attempt to strengthen postnatal care in rural areas. Evidence reveals that mobile health communication can be used to improve uptake of postnatal care by influencing the critical determinants that predict behaviour uptake, which are, according to the integrative model of behaviour prediction, intention, skills and environmental factors. The findings also reveal that changing beliefs related to attitudes, perceived norms and self-efficacy can enhance the intention to use postnatal care. Mobile health communication can enhance the skills necessary to use postnatal care, such as breastfeeding, cord care, thermal care, delayed bathing of babies, safer sleep practices, care-seeking and problem-solving. The environmental factors that are considered

to hinder uptake of postnatal care in rural areas, and which can be reduced by use of mobile health communication, were inaccessibility, unavailability and unaffordability. The findings of the visual-based narrative inquiry reveal that postnatal mothers had expectations of health care providers, with some expectations being met, and others not. The postnatal mothers reported having positive experiences with their health care providers as a result of the physical and emotional support they received. The positive experiences had various outcomes for both mothers and their children. The findings also reveal that postnatal mothers had expectations of mobile health communication, viewing it as a way in which health education and psychological support in relation to postnatal care could be provided. In addition, they expressed positive attitudes towards mobile health communication – they regarded it as useful for improving access to health care providers, and the availability of and access to the health facility. From the validation exercise, guided by theory of change logic model, a mobile health communication framework for postnatal care in rural Kenya was developed. The model helped to address the problem caused by the absence of a mobile health communication framework in rural areas, by linking postnatal mothers' needs, the desired results, influential factors and strategies. In addition, the assumptions behind the effectiveness of the framework were highlighted. The framework that was developed integrated the integrative model of behaviour prediction and theory of change logic model. In addition to the models, both users and policymakers' inputs were incorporated, as was additional literature, which strengthened the framework.

Conclusion: In this study, a theory-based mobile health communication framework for postnatal care in rural Kenya was developed on the basis of the best evidence available on mobile health communication, and users' and the policymakers' inputs. Given that the mobile health communication framework was developed on the basis of the contextual realities of rural Kenya, its piloting and implementation is recommended, as it is likely to improve the uptake of postnatal care, as well as both maternal and neonatal health, thereby helping to address the high rate of maternal and neonatal mortality, especially in rural settings and in low- and middle-income countries.

Keywords: Mobile health, communication, framework, postnatal care, rural, Kenya, logic model

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LIST OF ABBREVIATIONS AND ACRONYMS

CHW	Community health worker
eHealth	Electronic health
HIV/AIDS	Human immunodeficiency virus/Acquired immune deficiency syndrome
IMBP	Integrative Model of Behavioural Prediction
LMIC	Low- and middle-income country
mHealth	Mobile health
MMR	Maternal mortality rate
NMR	Neonatal mortality rate
PNC	Postnatal care
SMS	Short message service
SSA	Sub-Saharan Africa
UNICEF	United Nations International Children's Emergency Fund
WHO	World Health Organization

CONCEPTUAL AND OPERATIONAL DEFINITION OF TERMS

Mobile health(mHealth) communication

mHealth is a component of electronic health, and is defined as using mobile wireless technologies for health (WHO, 2019a, p. ix). mHealth is defined as the use of mobile communications for health information and services, to improve health outcomes (Nacinovich, 2011, p. 1). In this study, mobile health communication will refer to the use of mobile phones to disseminate health information and services during the postnatal period, with the aim of improving health outcomes for both the mother and the baby.

Framework

A framework is a basic structure that underlies a system, concept, or text. Frameworks helps the researcher to organise the study and provides a context in which a problem is examined (Brink, Van Der Walt and Van Rensburg, 2012, p. 19). All frameworks are based on the identification of key concepts and the relationships among those concepts (Nalzaro, 2017:Online). In this study, framework refers to the output of this study, which is a mobile health communication framework for postnatal care in Kenya.

Logic model

The logic model provides a picture or a description of how a programme works (University of Kansas, 2020:Online). It is defined as an iterative tool that is useful for planning and evaluation purposes. Logic models communicate the intended relationship between programme goals, activities, outputs, and intended outcomes (Berry, 2016, p. 4). In this study, the theory of change logic model underpinned the development of the mobile health communication framework for postnatal care in rural Kenya.

Postnatal care

Postnatal care encompasses all the services provided by health care providers to both the mother and the baby from birth, to promote health and to reduce the incidence of complications and death (WHO, 2014a, p. 6). In this study, postnatal care will refer to care given by health care providers to the mother and the baby from birth, up to 6 weeks.

Rural

According to Kenya National Bureau of Statistics (2018, p. 18), rural area refers to a large and isolated part of an open or agricultural area, including trading, market and service centres with relatively low population concentrations. In this study, rural was used to refer to areas in Laikipia county, Kenya, which are located outside towns.

PREAMBLE

The format of this thesis is in accordance with the recommendations for a PhD through interrelated publishable articles, as presented by the Faculty of Health Sciences of the University of the Free State, South Africa. This format includes the submission of a collection of interrelated publishable or published articles in conjunction with introductory, literature review and concluding chapters, as opposed to the traditional monograph format. This thesis has seven chapters.

The first chapter is an introductory chapter that presents an overview of the study. Chapters 2 and 3 present a review of literature related to mobile health communication and postnatal care respectively. Chapter 4 comprises an article that presents the best available evidence on how mobile health communication has been used to strengthen the uptake of postnatal care in rural areas. The evidence was aligned with critical determinants of the integrative model of behaviour prediction, which was considered as part of the theoretical underpinning. Chapter 5 presents an article that describes the experiences of postnatal mothers with health care providers and their views on mobile health communication in rural Kenya. Chapter 6 presents an article that describes the development and validation of a mobile health communication framework for postnatal care in rural Kenya, guided by the theory of change logic model. Chapter 7 presents conclusions, recommendations and contributions of the study.

Information of each article is provided, including the specific details of the journals to which an article was submitted, the publication status of each article and the associated addenda relevant to the article. The researcher followed all the processes for research, including planning, conducting and preparing the research for examination, by considering the same key milestones as a traditional thesis.

The methodology used in the development of this framework is described thoroughly in Chapter 1. Each article, furthermore, describes a certain aspect of the entire methodology, as guided by journal requirements. Due to the interrelatedness of the articles and their contribution to the development of the framework, there may be some issues and concepts that occur throughout the thesis.

Articles are presented in the format required by the specific journals; hence, there are stylistic differences with respect to font, line spacing, headings and even the reference list. For the rest of thesis, the Harvard 10th edition referencing style was used.

SCHOLARLY CONTRIBUTIONS OF THIS WORK

PHASE	CONTRIBUTION OF THIS WORK
PHASE 1: SYSTEMATIC REVIEW	***Publication*** Mbuthia, F., Reid, M. & Fichardt, A. (2019) mHealth communication to strengthen postnatal care in rural areas: a systematic review. *BMC Pregnancy and Childbirth,* 19**,** 406. doi:10.1186/s12884-019-2531-0. ***Presentation*** Mbuthia, F., Reid, M. & Fichardt, A. (2019) mHealth communication to strengthen postnatal care in rural areas: a systematic review. Oral presentation at the *2nd African Neonatal Nursing Conference in College of Health Sciences, University of Nairobi, Kenya*, 14-15 November 2019.
PHASE 2: VISUAL-BASED NARRATIVE INQUIRY	Mbuthia, F., Reid, M. & Fichardt, A. Experiences of postnatal mothers with health care providers and their views on mHealth communication in rural Kenya: Mmogo Method®. Submitted to *PLOS One*. Under review.
PHASE 3: FRAMEWORK	Mbuthia, F., Reid, M. & Fichardt, A. Development and validation of a mobile health communication framework for postnatal care in rural Kenya. Submitted to *African Journal of Reproductive Health*. Under review.

CHAPTER 1: OVERVIEW OF THE STUDY

1.1 BACKGROUND OF THE STUDY

Maternal and neonatal health makes a key contribution to the general health of an entire population (WHO, 2014a, p. 1). Moreover, maternal and neonatal mortality is a global public health concern. Maternal and neonatal health remains a major challenge in low- and middle income countries (LMICs), resulting in a high burden of maternal and neonatal deaths(WHO, 2016a, p. 44). The World Health Organization (WHO) estimates that 295 000 maternal deaths occur globally every year, with 94% of these deaths occurring in LMICs (WHO, 2019b, p. 2). Every day, an estimated 810 women die as a result of complications of pregnancy and childbirth, despite the fact that some of the complications are preventable and treatable (WHO, 2019b, p. 2).

Though sub-Saharan Africa (SSA) and southern Asia account for approximately 86% of the estimated global maternal deaths, SSA alone accounts for roughly 66%, with southern Asia accounting for 20% of these deaths (WHO, 2019b, p. 3). There has been global reduction in maternal deaths since the year 2000, but the decline in SSA, as in many other LMICs, has been less than 50% (WHO, 2019b, p. 3). In addition, the high lifetime risk of maternal mortality, of 1 in 45, in SSA is significantly higher than that of 1 in 5400 in high-income countries (WHO, 2020a:Online). Kenya is one of the SSA countries with a high maternal mortality ratio, of 362 maternal deaths per 100 000 live births (Kenya National Bureau of Statistics, 2015, p. 327). Kenya's ratio is higher than neighbouring countries, such as Uganda and Sudan, which have maternal mortality ratios of 343 and 311 respectively (WHO, 2016a, p. 110). This means that Kenya has five times the number of maternal deaths stipulated by the Sustainable Development Goals' global target of no more than 70 maternal deaths per 100 000 live births (United Nations, 2015:Online). Maternal health is closely related to neonatal health.

Globally, the number of neonatal deaths has declined from 5.0 million in 1990 to 2.5 million in 2018 (WHO, 2020b:Online). However, despite this declining trend, global neonatal mortality stands at 18 per 1000 live births (UNICEF, 2019, p. 17). Neonatal mortality contributes significantly to statistics for deaths among children under five years old. The share of neonatal deaths among children under five years old has been increasing; for instance, it increased from about 40% of all deaths of children younger than five in 1990, to 47% in 2018 (UNICEF, 2019, p. 4). SSA lags behind other regions in reducing neonatal mortality, and has

the highest neonatal mortality rate in the world, that of 28 deaths per 1000 live births (UNICEF, 2019, p. 4). A child born in SSA is 10 times more likely to die in the first month of birth than a child born in a high-income country (WHO, 2020b:Online). It is reported that the neonatal death rate has stagnated in a number of sub-Saharan African countries (UNICEF, 2019, p. 17). Kenya is one of the sub-Saharan African countries that shows little progress in reducing neonatal mortality.

The neonatal mortality rate in Kenya stands at 22 deaths per 1000 live births. This is higher than the global target of Sustainable Development Goal 3, of no more than 12 neonatal deaths per 1000 live births (United Nations, 2015:Online). In addition, the neonatal mortality rate in Kenya is the indicator that has exhibited the slowest rate of decline, namely, 33%, of all early-childhood mortality rates, such as post-neonatal, infant and under-five-years mortality. In Kenya, deaths occurring within the first month of life make up 56% of deaths in the first year of life (Kenya National Bureau of Statistics, 2015, p. 132). This implies that the neonatal period, which includes the first month of life, is a critical phase, which requires quality health care to be provided.

The postnatal period, which begins immediately after childbirth and ends at six weeks after birth, is the most neglected period for the provision of quality health care. The majority of maternal and neonatal deaths, as well as long-term complications, occur during this period (WHO, 2014a, p. 1). Neonates who die during this period suffer from conditions that are preventable and treatable by proven, cost-effective interventions. The fatal conditions are generally complications that are related to preterm birth, birth asphyxia, infections and birth defects (WHO, 2020b:Online). The main causes of maternal death are severe bleeding and infections after childbirth (WHO, 2020a:Online), which are preventable and treatable during the postnatal period. The postnatal period is, therefore, a critical phase in the lives of mothers and babies (WHO, 2015a, p. 1). Furthermore, health interventions that are required to protect maternal health are closely related to those needed to prevent neonatal mortality.

Postnatal care (PNC) is a intervention that is recommended by the WHO to promote maternal and neonatal health (WHO, 2014a, p. 1). It improves the chances of survival of both the mother and the neonate. PNC is important for both the mother and the neonate, to prevent and treat complications arising from the delivery, and provides the mother with important information on how to care for herself and her neonate. While improving uptake of PNC is considered a major intervention that will improve the health of both the mother and the neonate, globally,

the uptake of PNC stands at only 58% (WHO, 2016a, p. 46). The uptake of PNC in SSA is still low, at 45% (Trading Economics, 2020:Online). Strengthening uptake of PNC in SSA is necessary to address the still unacceptably high maternal and neonatal mortality and morbidity in this region (Duysburgh *et al.*, 2015, p. 9). In Kenya, the uptake of PNC was at 46% in 2006, which had increased to 57% in 2015 (Kenya National Bureau of Statistics, 2015, p. 133). However, PNC provision exhibited disparities between regions. In rural areas, only 49% of women received a postnatal check-up, compared to 72% of urban women (Kenya National Bureau of Statistics, 2015, pp. 132–135).

To strengthen the uptake of PNC, the Ministry of Health in Kenya recommends using the targeted PNC strategy that was launched in 2011 as one of the pillars of maternal and neonatal health in the country (Ministry of Public Health and Sanitation, 2011, pp. 11–53). Targeted PNC describes a comprehensive postnatal package that is recommended as a key strategy for reducing maternal and neonatal deaths. The WHO (2014a, p. 3) recommends a postnatal check-up within the first 24 hours after birth, and at least three additional postnatal contacts for all mothers and neonates. The three postnatal contacts should take place on Day 3 (48–72 hours), between Days 7 and 14 after birth, and six weeks after birth. Kenya's targeted PNC guidelines recommend a minimum of four PNC contacts, spread over the first six months. The first contact should be within 48 hours after birth, followed by contacts at 1 to 2 weeks; 4 to 6 weeks and 4 to 6 months. The contact schedule ensures regular follow-up of both mother and neonate, thereby increasing the provision of PNC (Ministry of Public Health and Sanitation, 2011, p. 29). However, Kenya's PNC provision is at only 57%, and solutions to increase provision are therefore necessary.

Mobile-phone-based PNC contacts between mothers and the health system have been proven to affect PNC positively (WHO, 2015a, pp. 1–2). Mobile health (mHealth) is a subset of electronic health (eHealth), and refers to the use of mobile communication technologies to promote health by supporting healthcare practices, such as health-data collection, delivery of health care information, patient observation and provision of care (Ryu, 2011, p. 12). In 2009, 83% of WHO regions used mHealth initiatives, with most countries having four or more types of mHealth initiatives. The African region reported the fewest initiatives, and south-east Asia region had the most. The rate of use of mHealth initiatives in low-income countries was close to that of high-income countries (Ryu, 2011, p. 12). This is a clear indication that mHealth is an approach with global appeal and, in the light of continuing health needs and a growing

global penetration of mobile technologies, mHealth is likely to play an increasingly important role in the provision of healthcare (Lee *et al.*, 2016, p. 2).

The availability and use of mobile phones is increasing rapidly, with 96% of the entire world having mobile-cellular subscriptions (International Telecommunication Union, 2018, p. 5). Findings of a systematic review indicate that increased access to mobile phones has the potential, via mHealth, to improve healthcare delivery in Africa (Aranda-Jan, Mohutsiwa-Dibe and Loukanova, 2014, p. 10). In Kenya, mobile-phone penetration has reached the 100% mark, with mobile subscription reaching 52.2 million people in 2019 (Communication Authority of Kenya, 2019, p. 7). Kenya, thus, has a strong base for implementing mHealth projects. In addition, Kenyans are familiar with using mobile phones for functions other than merely making and receiving calls such as mobile money transactions (Mitra, 2014:Online).

Kenya has recorded considerable improvement in mobile phone use for health promotion purposes. It is, therefore, important to make maximum use of this technology to enhance the health of citizens. A study done in Ethiopia demonstrates that using a locally customised mHealth application during the antenatal period significantly improves hospital delivery and PNC service utilisation (Shiferaw *et al.*, 2016, p. 11). Generally, mHealth communication interventions are proposed as effective solutions to problems relating to maternal and neonatal health (Shiferaw *et al.*, 2016, pp. 10–12; Sondaal *et al.*, 2016, pp. 21–23). These interventions have the potential to address a variety of health challenges, especially in LMICs.

The Kenyan government is committed to addressing health challenges facing citizens, as stipulated in Kenya's constitution (Government of Kenya, 2010, pp. 24-38,124). However, in many LMICs, including Kenya, much of the population, especially in rural areas, lacks access to the healthcare system, due to resource constraints, system inefficiencies and lack of awareness about services that are on offer. The inadequate presence of health facilities and providers in many communities creates opportunities for using modern communication technologies to improve health services and education, as well as to improve providers' ability to deliver services (Vital Wave Consulting, 2011, p. 33). Interventions utilising mHealth could offer solutions for these health challenges.

Few studies have addressed mHealth in Kenya. Studies that do report on mHealth are related to HIV/AIDS. mHealth proved to enhance prevention of transmission of HIV/AIDS from mother to child (Jennings *et al.*, 2013, p. 1), improve adherence to treatment (Lester *et al.*, 2009, p. 2), and retain patients in the HIV/AIDS treatment programme (Nyatichi, 2015, p. 14).

Other areas where mHealth intervention has been shown to improve healthcare is involving village elders in monitoring the weights of infants (Gisore *et al.*, 2012, p. 5).

1.2 PROBLEM STATEMENT

The increasing use of mobile phones by diverse populations offers promise that mHealth interventions could be used to deliver increased and enhanced healthcare services to individuals and communities, while helping to strengthen health systems (Källander *et al.*, 2013, p. 9). One of these health care services is PNC. mHealth interventions could strengthen the uptake of PNC, improve the health and wellbeing of the entire population, and help Kenya to achieve Every Newborn Action Plan's goal of a neonatal mortality rate below 10 deaths per 1 000 live births by 2035 (WHO, 2014b, p. 6). In working to achieve this target, the Kenyan government, through Ministry of Health, has launched various initiatives, such as free maternity services, elimination of user fees for primary care, and the Beyond Zero Campaign, to improve uptake of PNC (Ministry of Health, 2016a, p. 5). However, mHealth communication has not been included in these initiatives. There is little evidence of the use of mHealth communication for improving the uptake of PNC in rural areas. Moreover, the WHO (2014a, p. 34) has identified knowledge gaps in the area of mHealth, and recommends more research to evaluate the role mHealth could play to improve the uptake of PNC, and thereby contribute to the improvement of maternal and perinatal health.

During the postnatal period, postnatal mothers in rural areas are required to have contacts with their health care providers, who play an important role in promoting the health of both the mother and the baby (Panagopoulou *et al.*, 2018, p. 169). During these contacts, the relationship between the mother and health care provider is of the essence, as it may greatly influence the uptake of PNC services (Corr, Rowe and Fisher, 2015, p. 64). Therefore, it is critical to explore the experiences that postnatal mothers in rural areas have with their health care providers, as well as mothers' views on mHealth communication. These experiences and views are necessary to develop mHealth communication initiatives within health systems.

Health systems need theory-based frameworks to strengthen delivery of health services, particularly in rural areas in Kenya, where uptake of PNC is poor (Akunga, Menya and Kabue, 2014, p. 1455). Therefore, in addition to a need to address the knowledge gap and the current global enthusiasm for mHealth applications (Vodopivec-Jamsek and Jongh, 2012, p. 19), there is a need to establish a theory-based framework that incorporates stakeholders' views and

expectations regarding mHealth, as well as the best evidence available on the role mHealth could play in strengthening uptake of PNC. This study, therefore, sought to develop an mHealth communication framework for PNC in rural Kenya.

1.3 AIM AND OBJECTIVES

The aim of this study was to develop an mHealth communication framework for PNC in rural Kenya. The objectives of each phase of study were as follows:

PHASE 1: To gather the best available evidence regarding mHealth communication to strengthen uptake of PNC in rural areas [systematic review]

PHASE 2: To explore experiences of postnatal mothers with HCPs and their views on mHealth communication in rural Kenya [Mmogo-method®]

PHASE 3: To validate a draft mHealth communication framework for PNC in rural Kenya [validation exercise]

1.4 RESEARCH QUESTION

The research question that this study sought to answer was, what should an mHealth communication framework for PNC in rural Kenya constitute?

1.5 THEORETICAL UNDERPINNING OF THE STUDY

To answer the research question of this study, the researcher incorporated two theoretical frameworks, namely, the integrative model of behaviour prediction (IMBP) (Fishbein and Yzer, 2003, pp. 166–170), and the theory of change logic model (W.K. Kellogg Foundation, 2004, p. 28). These frameworks were chosen as they are considered to be relevant for developing an mHealth communication framework for strengthening uptake of PNC in rural Kenya.

The uptake of PNC – the behaviour referred to in this study – was interpreted in the **IMBP** (Figure 1.1). The IMBP predicts and aids understanding of behaviour by identifying the most important variables that determine uptake of a behaviour by any given population (Yzer, 2008, pp. 23–24). The distal variables in the model primarily play an indirect role in influencing the performance of a behaviour, while the rest of the variables have a direct role in influencing a behaviour (Fishbein and Yzer, 2003, p. 168). The variables with a direct role in influencing a

behaviour are few, and are regarded as the critical determinants to the performance of a behaviour. These critical determinants are intention to act on a behaviour, necessary skills, ability to perform the behaviour, and absence of environmental factors that can prevent the performance of the behaviour (Vaala, 2014, p. 284). The intention to act on a behaviour is considered to be the most important determinant, given that it is influenced by beliefs related to attitude, perceived norms and self-efficacy with respect to performing the behaviour (Fishbein and Yzer, 2003, p. 167). This model helped to structure the determinants of the uptake of PNC in Phase 1 of this study.

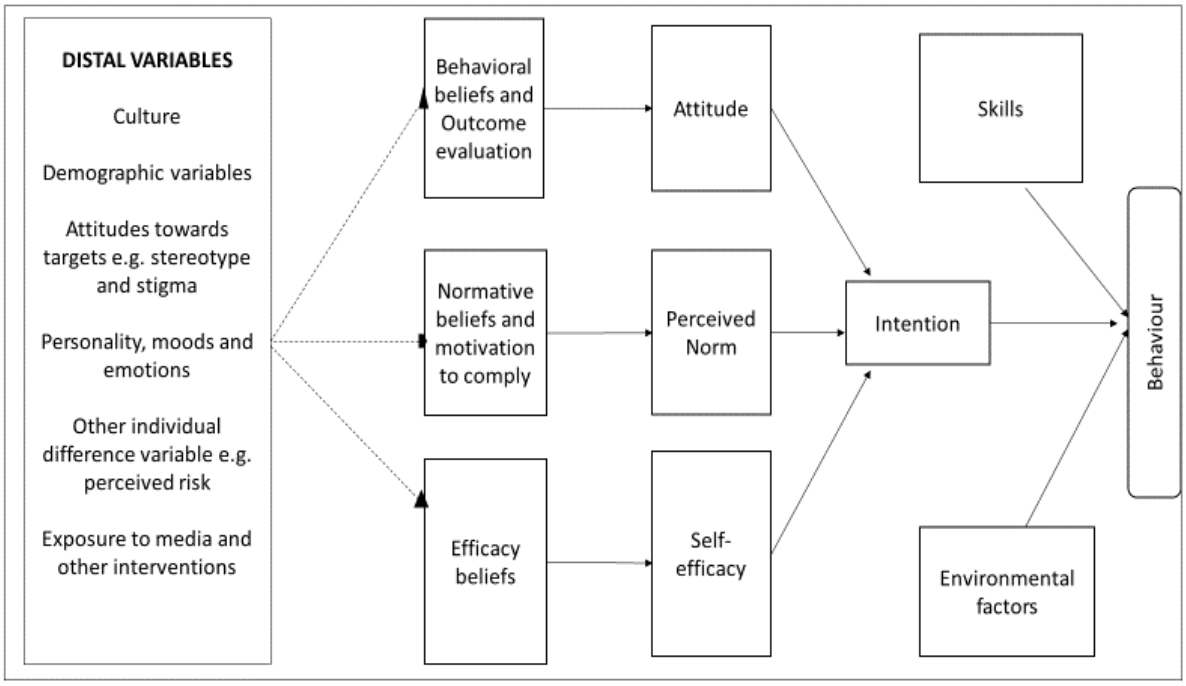

Figure 1.1 Integrative model of behaviour prediction

Source: Fishbein and Yzer (2003, p. 167)

To develop an mHealth communication framework that could assist policymakers to address the uptake of PNC, the **theory of change logic model** (Figure 1.2) was used. This is a policy-informing model that describes the cause-and-effect processes through which an intervention is expected to work, and how these activities flow together or are integrated to achieve outcomes (Gooding *et al.*, 2018, p. 3). The model visually relates resources, activities, and the intended changes or impacts that a programme is expected to create (W.K. Kellogg Foundation, 2004, p. 1; Hamilton and Bronte-Tinkew, 2007, p. 1). The theory of change logic model links

key elements, namely, the problem, community needs, desired results, influential factors and strategies (W.K. Kellogg Foundation, 2004, p. 28). In addition, the model highlights the assumptions behind the effectiveness of the interventions that a programme plans to implement (W.K. Kellogg Foundation, 2004, p. 28). The problem is recognised as the issue to be addressed by the intervention, while the needs or assets are the issues identified from the community, whose members are the recipients of the intervention. The desired results are the short- and long-term effects of the intervention, while influential factors are either supportive or unsupportive aspects that may influence the achievement of the desired results. Strategies are described as best practices that have been used to help solve problems in other communities. Assumptions are statements explaining how and why the strategies will work. These elements in the theory of change logic model assisted to structure the mHealth communication framework that was developed in Phase 3 of this study.

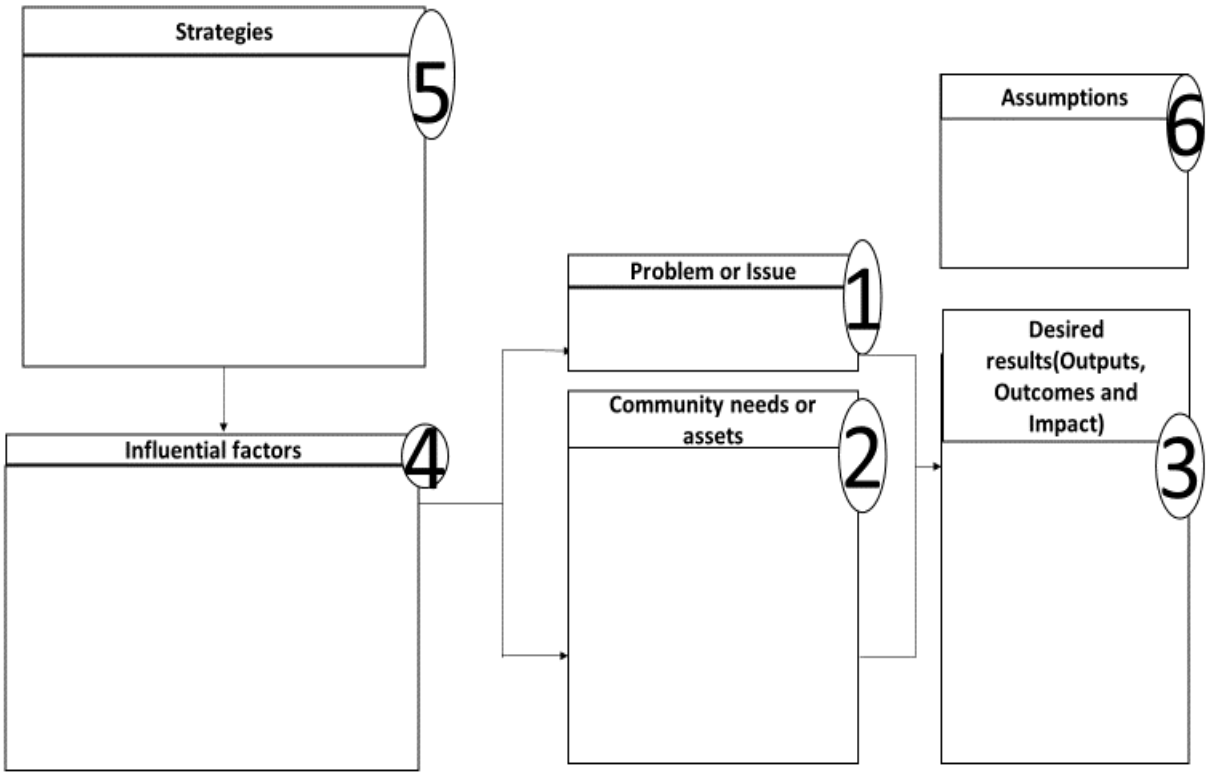

Figure 1.2 Theory of change logic model

Source: W.K. Kellogg Foundation (2004, p. 28)

The IMBP determinants were incorporated in the development of mHealth communication framework, which was structured according to the theory of change logic model. The use of the two models ensured an integrative approach, to highlight the interaction between the uptake of PNC as a desired behaviour, and mHealth communication as an intervention to improve the uptake of PNC.

1.6 RESEARCH PARADIGM

A research paradigm is the conceptual lens through which the researcher examines the methodological aspects of a research project, to determine which research methods will be used (Kivunja and Kuyini, 2017, p. 26). A research paradigm provides assumptions about the state of the world before research is undertaken (Brown and Dueñas, 2020, p. 550). These assumptions are important, as they influence what should be studied, how it should be studied, and how the results of the study should be interpreted (Kivunja and Kuyini, 2017, p. 26). In conducting this study, the researcher adopted a pragmatic paradigm. A pragmatic paradigm advocates the use of methods that work best in practice to answer specific research questions (Brown and Dueñas, 2020, p. 550). This paradigm was the most appropriate for this study, and enabled the researcher to choose methods that helped to answer the research question, which was, "what should an mHealth communication framework for PNC in rural Kenya consist of?".

Based on the pragmatic paradigm, the researcher adopted the recommended philosophical foundations associated with the paradigm, namely, relational epistemology, a non-singular reality ontology, mixed methods methodology and value-laden axiology (Kivunja and Kuyini, 2017, p. 35). *Relational epistemology* is based on the belief that relationships in research are best determined by what the researcher deems appropriate for that particular study (Loan Nguyen, 2019, p. 7). Therefore, the researcher in this study developed insights in relation to study participants and the literature that was available, thereby ensuring the best conceptualisation of the study. *A non-singular reality ontology* assumes that there is no single reality and all individuals have their own and unique interpretations of reality (Kivunja and Kuyini, 2017, p. 35). In this study, multiple realities were acknowledged through interactions between the researcher and the study participants. *A mixed methods methodology* allows use of a combination of different methods (Loan Nguyen, 2019, p. 7). In this study, the researcher combined systematic review, visual-based narrative inquiry and a validation exercise to generate data that was useful in developing the framework. *A value-laden axiology* allowed the

researcher to conduct a research that benefits people (Kivunja and Kuyini, 2017, p. 35). The benefits of this study are expressed in the framework that was developed, which is meant to strengthen the uptake of PNC in rural Kenya. The framework incorporated users' and stakeholders' input in addition to having a theoretical foundation, thereby making it valuable for informing policy and for implementation in rural areas.

1.7 STUDY DESIGN

This study followed a multi-method research design, which is defined as a research approach or methodology that combines data gathering and analysing techniques from two or more methods (Seawright, 2016, p. 2). A multi-method research design has the advantage of being flexible, and allows interaction between different strands of data at different points in time during the research (Busetto *et al.*, 2017, p. 2). The design was appropriate for this study, which aimed to develop an mHealth communication framework for PNC in rural Kenya. In developing the framework, the researcher used different methods to gather data that was needed to answer the research question. To answer the research question, a rigorous systematic review was done; in this way, data was gathered on the best evidence available on mHealth communication for strengthening uptake of PNC in rural areas. Then, a visual-based narrative inquiry facilitated the gathering of data on experiences of postnatal mothers in rural areas with health care providers, as well as on their views of mHealth communication. The data was analysed separately and later used to develop an mHealth communication framework for PNC in rural Kenya. Therefore, three phases were involved in this study: 1) Systematic review, 2) Visual-based narrative inquiry, and 3) Validation exercise.

1.7.1 Phase 1: Systematic review

A systematic review is defined as a review of research literature using systematic and explicitly accountable methods (Gough, Thomas and Oliver, 2012, p. 5). The review answers a defined research question by collecting and summarising empirical evidence that fits pre-specified eligibility criteria (MacGill, 2016:Online). A review provides summaries of past research on a topic of interest, acquired by applying the same principles and rigor that is expected of primary research. The methods that are used are pre-planned and documented in a systematic review protocol (Joanna Briggs Institute, 2017:Online). Systematic reviews provide a summary of the best available evidence, using rigorous methods and because more than one person is usually required to undertake the process, biases are minimised.

To improve the uptake of PNC in Kenya, it was important to identify, appraise, synthesise and interpret research-based evidence in order to incorporate it into healthcare decisions. Systematic reviews have been identified as a major source of medical research findings and are used in health policy decision-making (Wieseler and McGauran, 2010, p. 1240). In this study, a systematic review was carried out to establish the best evidence available on mHealth communication, as a way to strengthen uptake of PNC in rural areas. Systematic review methodology is particularly appropriate, because it uses explicit, systematic methods that are selected with a view to minimising bias, thus, providing reliable findings, from which conclusions can be drawn and decisions made (Higgins and Green, 2011:Online; Uman, 2011:Online).

1.7.1.1 Steps of a systematic review

The first six methodological steps, as described by Higgins and Green (2011:Online), were used to perform the systematic review in this study as outlined in Table 1.1.

Table 1.1 Summary of steps of the systematic review process followed in the study as described by Higgins and Green (2011:Online)

Step 1	Identification and formulation of a focused review question
Step 2	Generation of a search strategy
Step 3	Execution of the search and selection of the relevant studies
Step 4	Performing the critical appraisal and evaluating the methodological quality of selected studies
Step 5	Extracting data
Step 6	Analysing and synthesising

The second phase of the study involved a visual-based narrative inquiry.

1.7.2 Phase 2: Visual-based narrative inquiry

The second phase of the study adopted visual-based narrative inquiry to explore experiences of postnatal mothers with health care providers, and their views on mHealth communication in rural Kenya. Visual-based narrative inquiry is a derivative of narrative inquiry, which is a qualitative methodology that uses storytelling as a means to study individuals' experiences

(Mattern *et al.*, 2015, p. 2). It is an intentional, reflective, active human process, in which researchers and participants explore and make meaning of experience, both visually and narratively (Bach, 2012, p. 2; Bowler, Knobel and Mattern, 2015, pp. 5–7). Visual narrative inquiry adds a layer of meaning to research, so that photographs and other visual images become ways of living and telling people's stories related to their experiences (Bach, 2012, p. 2; Jackson, Richter and Caine, 2013, p. 4). This type of qualitative research recognises that an individual enters a context with a personal perspective that shapes and is shaped by perceptions; therefore, this type of research uses visual methods as meaningful constituents of the social world (Mason, 2007, p. 107).

To obtain insight into the experiences, perceptions and views of any population, a qualitative approach was appropriate, since its main purpose is to learn about facets of the social world within the natural world, and to answer the research question posed by the study in the real world (Rossman and Rallis, 2012, pp. 3–9).

1.7.2.1 Research question in visual-based narrative inquiry

The question for the participants in this phase was: Would you please use the material supplied to create a picture that would explain your relationship with the personnel at the postnatal clinic? Data obtained during discussions directed the researcher to posing specific sub-questions that explored views on mHealth communication with postnatal mothers.

1.7.2.2 Population and sampling

To answer the research question, the study population consisted of women of childbearing age, who reported for services in rural health care facilities in Laikipia County, Kenya, which is one of the counties with low uptake of PNC. Women who use antenatal care services and who have prior PNC experiences in Laikipia County were the best suited to share their experiences and possible challenges associated with PNC, as well as their views on mHealth communication.

The population of pregnant women in the county was estimated to number 13 724 in 2017 (Government of Kenya, 2013, pp. 17–18).

Qualitative research usually involves purposive sampling (Shenton, 2004, p. 65). The main rationale for purposively selecting participants was that it would help the researcher understand the problem and the research question (Creswell, 2014, p. 239). Purposive sampling is used to select "information rich" respondents who are able to provide an in-depth understanding of the

area under study. According to Godia (2012, p. 103), “information rich” respondents are considered to possess extensive knowledge about a particular behaviour, experience or phenomenon of interest. Purposive sampling of women attending antenatal services at various rural health facilities in Laikipia County was done with the help of reproductive health coordinators in the county according to inclusion criteria. The recruitment of women continued at four sampled health facilities until saturation of data was achieved.

1.7.2.3 Data collection: Mmogo-method®

To achieve data collection within the context of the study population described above, the researcher adapted a visual projective data-collection method, referred to as the Mmogo-method® (Roos, 2016, p. 3), which is a South African trademark of North-West University. This method was used to collect both visual and textual data. Visual data was derived from visual representations that the participants constructed to express their postnatal experiences. This visual data served to elicit discussions among individuals and the group. Photos of the visual representations were taken and used with the verbatim discussions to conduct further analysis (Roos, 2016, p. 19). The method was appropriate for this study, because data was collected from both individual participants and groups thus, providing multiple perspectives of experiences. The process was conducted in Kiswahili by a trained facilitator in a hall within each of the health care facility, until data saturation was achieved after the fourth sampled health facility.

1.7.2.4 Data analysis

Individual and group data was organised and analysed thematically. Audio recordings, field notes and transcriptions of field notes were used for data analysis.

The third phase of the study involved a validation exercise.

1.7.3 Phase 3: Validation exercise

The third phase of the study involved a validation exercise of a newly drafted mHealth communication framework for PNC in rural Kenya. This was done in two stages.

1.7.3.1 Stage 1: Drafting the framework

Prior to the validation exercise, the researcher, guided by theory of change logic model, drafted the mobile health communication framework using the findings of Phases 1 and 2, together with findings from literature. The draft framework was then presented to stakeholders for verification and validation in Stage 2.

1.7.3.2 Stage 2: Validation by stakeholders

The validation exercise provided an opportunity for the stakeholders to add their expert advice to the framework. The stakeholders involved were from the Department of Health in Laikipia County, Kenya, and field experts in area of mHealth and other research disciplines. The researcher worked with the reproductive health coordinator in the county involved to access the population. From the estimated total population of 20 stakeholders, 16 participated in the exercise. The population that participated in the validation of the draft framework included all the stakeholders who were available, or their representatives. The process was facilitated by the researcher and a senior researcher.

1.7.3.3 Validation process

During the validation exercise, the participants took part in discussions. The researcher started by describing the development of the draft framework, including the prior phases that had been conducted. Then, the various components of the theory of change logic model were explained to the participants, so that they understood the logical flow of the connections. The facilitator initiated a structured process of discussion to engage the participants in the draft framework, by asking "how" and "why" questions, a technique which is sometimes called forward and backward mapping (Newcomer, Wholey and Hatry, 2004, p. 19). The checklist questions (W.K. Kellogg Foundation, 2004, p. 33), structured the discussions. The inputs by stakeholders were added to the draft framework, resulting in the validated framework that is presented in this study.

1.8 METHODOLOGICAL INTEGRITY

The researcher ensured methodological integrity in all phases of the study.

Phase 1 Systematic review: To ensure the methodological integrity, the review was carried out according to the steps described by Higgins and Green (2011:Online). Prior to conducting the review, the protocol describing every step to be followed, was developed and registered with PROSPERO (Ref. No. CRD42018102299), thus, promoting transparency in the review process (Centre for Reviews and Dissemination, 2017:Online). The review process was also monitored by two reviewers. Meticulous record-keeping was done throughout the process, to ensure that the study is repeatable, transparent and auditable. Integrity was strengthened further during the critical appraisal by including only articles that conform to items on the various Critical Appraisal Skills Programme checklists (CASP, 2017:Online).

Phase 2 Visual-based narrative inquiry: Methodological integrity was maintained by ensuring that the data that was collected was credible, transferable, dependable and confirmable (Shenton, 2004, p. 64; Morrow, 2005, p. 252). To ensure credibility, the Mmogo-method®, which is a recognised research method, was adopted. The participants who constructed visual representations of their multiple realities were the same participants who approved the findings. Questioning was conducted in dialogue format: for verification purposes, the researcher asked questions to explore the participants' explanations, thus, strengthening credibility. Triangulation was achieved by incorporating the Mmogo method®, which employs an approach called pluralistic data collection, which involves the collection of both visual data from visual representations and textual data from discussions (Roos, 2016, p. 12). To ensure transferability, the researcher provided detailed background data, to give the reader the opportunity to judge whether data can be transferred to another setting. Visual data can promote transferability of results, since it has the ability to be rich in description (Roos, 2012, p. 21). Dependability was ensured by keeping an audit trail (Morrow, 2005, p. 252), that can be used by researchers to determine whether the processes and procedures that were used are dependable. Confirmability was ensured by the researcher recognising and describing shortcomings in the study method used, and its potential effects. In-depth methodological description was done to ensure that the integrity of research results, and that it can be scrutinised.

Phase 3 Validation exercise: Four aspects of methodological integrity were incorporated, namely, credibility, validity (both internal and content), transferability and triangulation. For credibility, the framework, which is meant to facilitate mobile health communication for PNC in rural areas, was designed in accordance with the theory of change logic model, which has been tested and used in the development of other health-related frameworks. To test internal

validity, the iterative process of forward and backward mapping was used to clarify the linkages between the various components. To ensure content validity, data gathered from the systematic review and from the visual-based narrative was combined for the development of the framework. To strengthen content validity further, expert advice from stakeholders was incorporated in the framework. To improve transferability of the framework to other health settings, the researcher provided sufficient information about the research context, processes, participants, and researcher-participant relationships, to enable any reader to decide whether and how the findings may transfer to their settings. Using data from systematic review and visual-based narrative inquiry enhanced methodological triangulation, and incorporating the findings in the framework ensured data triangulation. Triangulation helped to strengthen the framework.

1.9 ETHICAL CONSIDERATIONS

A researcher is responsible for conducting research in an ethical manner, from the conceptualisation phase, through the implementation phase, to the dissemination phase (Brink, Van Der Walt and Van Rensburg, 2012, p. 32). In this study, ethical approval was obtained from both the University of the Free State Health Sciences Research Ethics Committee, Ref. No. UFS-HSD2017/1346 (Addendum B) and the Mount Kenya University Ethics and Review Committee, Ref. No. MKU/ERC/0604 (Addendum C). In addition, the researcher obtained authorisation to conduct research in Kenya from the National Commission for Science, Technology and Innovation, Ref. No. NACOSTI/P/18/1504/21787 (Addendum D) and from the Laikipia county, Department of Health (Addendum E).

In Phase 1, while conducting the systematic review, the principles maintained were honesty, accountability, and good stewardship of research (Resnik and Shamoo, 2011, pp. 73–74). Honesty was maintained by providing accurate and complete references at all times, thereby ensuring respect for intellectual property. Accountability was maintained by following a systematic review protocol that was developed and registered prior to undertaking the study. In addition, two reviewers who are experts in the research field supervised the entire review process, ensuring that the review was done according to the prescribed methods. To maintain good stewardship, all data that was retrieved was stored and backed up, to make it traceable and available when needed. All information retrieved from databases and other sources was handled responsibly and with confidentiality.

In Phase 2 of visual-based narrative inquiry, the researcher followed two foundational principles, namely, respect for participants and informed consent (Vanclay, Baines and Taylor, 2013, p. 246). To obtain informed consent, the researcher provided an information leaflet and a consent form in English and Kiswahili (Addenda F and G). These documents ensured that sufficient information and an adequate understanding of the research was provided to the participants. They were informed of their right to decline to provide specific information or to terminate participation at any stage of the study without detriment. Participants were informed that they would not benefit from the study directly, though the results of the study would be helpful for improving PNC in the future. Participants who agreed to participate in the study were requested to sign the consent form as an indication of agreement. Respect for participants was maintained during the entire process by seeking permission to have the interviews and discussions audio-recorded, as indicated in the information leaflet. In addition, the Mmogo discussion was conducted in Kiswahili, which is the local language, to ensure that every participant had an equal chance to participate. Furthermore, confidentiality of their information was maintained.

In the Phase 3, the validation exercise, the researcher, again, followed the ethical principles described for Phase 2. An information leaflet and a consent form were provided to each participating stakeholder (Addenda H and I) before the exercise commenced. As in Phase 2, informed consent and respect for participants were maintained.

1.10 SUMMARY

This chapter provided the background to the study, problem statement, aim and objectives, as well as the research question that this study sought to answer. The theoretical underpinning of the study was also described. The study design was described, including the various phases that were involved in the study. The methodological integrity of the entire study was elaborated on, as were ethical considerations taken to conduct the entire study. The next chapter will discuss the literature on mobile health communication.

CHAPTER 2: MOBILE HEALTH COMMUNICATION

2.1 INTRODUCTION

In the previous chapter, an overview of the study was provided. This chapter will provide the context needed to develop an mHealth communication framework for PNC in Kenya. Literature was gathered from various databases on the EBSCOHost, Scopus and Nexus platforms. In addition, various international and national guidelines were searched. This chapter will begin with an in-depth exploration of the concept of mHealth and the development of mHealth, specifically in the Kenyan context. Furthermore, the role of mHealth in health care delivery will be described, and the role of mHealth communication in various health domains will be discussed. Using mHealth communication to address the critical determinants of behaviour uptake, as described in the IMBP, which was the theoretical model guiding the study, will be described. PNC-related behaviour will be focussed on, since this was the focus of this study. In addition, delivery channels for mHealth communication will be described. The exploration of mHealth will be addressed in the next section.

2.2 CONCEPT OF MOBILE HEALTH (MHEALTH)

Mobile health, also known as mHealth, is a component of eHealth. According to the WHO, eHealth is defined as the use of information and communications technologies to address various health and health-related fields, such as health care services, health surveillance, health literature, health education, knowledge and research (WHO, 2019a, p. 91). In the process of reviewing eHealth, the WHO has introduced the broader term of digital health, to encompass mHealth as a subset of eHealth (WHO, 2019a, p. ix). According to the WHO, digital health is an umbrella term that encompasses both eHealth and mHealth. As such, mHealth is one of the digital health technologies, and is defined as the use of mobile wireless technologies for health (WHO, 2019a, p. ix).

Other international institutions use different phrasing to apply the definition of mHealth to their work. mHealth Alliance, an organisation hosted by the United Nations Foundation, refers to mHealth as the use of mobile communications to provide health services and information (Vital Wave Consulting, 2009, p. 8). The Alliance acknowledges that mHealth and eHealth are inseparably linked, since both are used to improve health outcomes, and their technologies work in unison (Vital Wave Consulting, 2009, p. 9). The mHealth Alliance recognises that the

most common application of mHealth is using mobile devices to educate consumers about preventive health care services. The organisation has instituted mHealth projects that focus on maternal and childhood health, and that involved sending vital health information to new and expectant mothers via mobile phones, in the Mobile Alliance for Maternal Action Innovation. The Mobile Alliance for Maternal Action Innovation has been used successfully in Bangladesh, South Africa, India, and Nigeria (Rajan *et al.*, 2017, p. ix). According to the National Institute of Health Consensus Group, a medical research agency in the United States, mHealth refers to using mobile devices to improve health research, services, and outcomes (US Department of Health and Human Services, 2013:Online). The National Institute of Health acknowledges that mobile phones are the most widely available and used new media technology for mHealth (US Department of Health and Human Services, 2013:Online). In the United States, mHealth offers an ideal solution to help mitigate the HIV epidemic, by improving HIV testing through text massaging (Arya *et al.*, 2014, p. 2254). The definitions specified by the WHO and some other international organisations display the broad use of mHealth.

Individual authors have borrowed the same concept used by the WHO to define mHealth, while using different words. For instance, it is defined as the use of mobile phones, personal digital assistants, patient monitoring devices and other information and communications technologies to support and deliver health and health care services (Feroz, Perveen and Aftab, 2017, p. 2). Nahar *et al.* (2017, p. 1) define mHealth as the delivery of health-related services via mobile communications technology. All these definitions by international institutions and individual authors describe mHealth technology as an integral part of health care delivery, thereby suggesting the vital role that mHealth technology plays in contributing to overall improvements in quality health outcomes (White *et al.*, 2016, p. 212). These improvements are due to the developments that have been reported in the field of mHealth.

2.3 DEVELOPMENT OF MHEALTH

Many stakeholders are enthusiastic about the opportunities mHealth technology is likely to offer in terms of improving access to health care and delivery, engagement of patients, and clinical outcomes (Becker *et al.*, 2014, p. 2). Enthusiasm for mHealth across the globe is attributed to the growing presence of mobile technology, increased mobile network penetration, the low cost of setting up mHealth initiatives, and its accessibility in any given setting (Zurovac *et al.*, 2012, p. 4). Almost the entire world population (96%) now lives within reach of a mobile

cellular network. Developing countries record much faster growth in mobile subscriptions than developed countries (International Telecommunication Union, 2018, p. 5). It is documented that mobile devices have reached more people in developing countries than power grids, road systems, waterworks, or fibre-optic networks have (Qiang *et al.*, 2011, p. 11). The improved penetration of mobile networks has led to an explosion of mHealth initiatives globally. By 2009, 83% of WHO regions had mHealth initiatives, and most countries had four or more initiatives (Ryu, 2011, p. 11). Among these WHO regions, African countries have taken the lead in embracing mHealth, by establishing over 1 200 mHealth initiatives by 2016; these initiatives have had a profound impact on health care (Groupe Spéciale Mobile Association, 2016, p. 52). One of the African countries that has embraced mHealth is Kenya, to which the following discussion will refer.

Kenya is one of the countries in which mHealth interventions have been implemented (Njoroge *et al.*, 2017, p. 8). In Kenya, mobile subscription had, by 2019, reached 52.2 million people, with penetration surpassing the 100% mark, because some users own two or more subscriber identification module cards (Communication Authority of Kenya, 2019, p. 7). It is now acknowledged that people and places in Kenya that were previously unreachable, are now covered by mobile networks (Kazi *et al.*, 2017, p. 1), thereby creating an opportunity to deliver health care to populations who need it most, and to address health priority needs.

In answer to the call by the WHO to address health priority needs using digital platforms, such as mHealth, in 2011, the Kenyan Ministry of Health developed an eHealth strategy that incorporates mHealth as one of the strategic areas of implementation (Ministry of Health, 2011, p. 8). In 2016, the Kenya National eHealth Policy 2016-2030 was developed, with the overarching aim of improving "the availability and quality of health care services through the use of information communication technologies" (Ministry of Health, 2016b, p. 15). With a policy in place, standards and guidelines for a mHealth system (Ministry of Health, 2017, p. 2) have been developed to provide the regulatory framework necessary for coordinating and implementing mHealth interventions (Ministry of Health, 2017, p. i). The need for standards and guidelines was created by the increasing growth of the information and communications technology (ICT) sector in Kenya, as well as the need to improve access to and quality of health care (Njoroge *et al.*, 2017, p. 8). It is also worth noting that the existence of the policy (Ministry of Health, 2016b, p. 1), strategies and guidelines for mHealth in Kenya (Ministry of Health,

2017, p. i) shows the political will to invest in mHealth, and to ensure it plays a significant role in strengthening health care delivery in the country.

2.4 ROLE OF MHEALTH IN HEALTH CARE DELIVERY

mHealth interventions are highly recommended for facilitating the delivery of health care by the health system. mHealth is recognised as a catalyst, a tool that can improve the performance of a health system. It is recommended that it is integrated into the health system, rather than being a standalone solution to known health system constraints (Labrique *et al.*, 2013, p. 160). The integration of mHealth into a health system is meant to help achieve universal health coverage as proposed in the Sustainable Development Goals (United Nations, 2019, p. 26), and to strengthen health systems (WHO, 2019a, p. 2). To strengthen the health system, the WHO recently included mHealth as one of the newly established digital health interventions that will address health priority needs, such as lack of service utilization, that may hinder universal health coverage (WHO, 2018a, p. 2). As a result, countries are urged to prioritise the development, evaluation, implementation, scaling up, and greater use of digital technologies to promote equitable, affordable, and universal access to health for all (WHO, 2019a, p. 2).

One of the critical emphases on digital technologies relates to how they can be used to stimulate demand for services and broaden access to health information, as an essential mode of strengthening the health system and ensuring universal health coverage (WHO, 2019a, p. 4). Using mHealth is highly recommended for achieving universal health coverage, to complement and enhance health system functions through mechanisms such as the accelerated exchange of information (WHO, 2019a, p. xi). Indeed, mHealth is increasingly viewed as a means to provide high quality and easily accessible health care at lower costs (Crul, 2014, p. 3). It is worth noting that mHealth can be used to address several health domains that are key to strengthening health systems, as recommended by WHO (2019a, p. 1).

2.4.1 mHealth communication in health domains

Health domains represent health system needs that have been made accessible through mobile devices. The mobile devices may be applicable in any setting, including low-resource settings, where other digital devices, such as computers, may not be feasible (WHO, 2019a, p. xii). The health domains are grouped into 10 categories: birth notification, death notification, stock notification and commodity management, patient-to-provider telemedicine, provider-to-

provider telemedicine, digital tracking of patients' health status and services, health worker decision support, provision of training and educational content to health workers, and targeted client communication.

2.4.1.1 Birth notification

Once birth has occurred, a notification can be done to capture and enable onward transmission of information on the details of birth. The notification represents the first step in the process leading to ultimate registration and certification of the birth (WHO, 2019a, p. 38). Once birth registration and certification has taken place, vital statistics, such as on birth rates, can be compiled. mHealth communication can be used to make birth event alerts and enable health workers and the community to transmit alerts or make notifications when birth occurs (WHO, 2019a, p. 38). When mHealth communication with community health workers (CHWs) was done in Lao People's Democratic Republic in Asia, birth notification was done in a timely fashion, which resulted in improved uptake of PNC (Xeuatvongsa *et al.*, 2016, p. 5782). Birth registration was also reported to have improved in Malawi when CHWs used mHealth communication to track births (Joos *et al.*, 2016, p. 12).

2.4.1.2 Death notification

mHealth communication can be used to provide notification of death, leading to the subsequent steps of death registration and certification (Jalloh-Vos *et al.*, 2014, p. 19). Death notification helps to compile vital statistics and gather information on causes of death (WHO, 2019a, p. 39). Using mHealth communication has been effective in death surveillance and notification of death events, which have enabled health workers and communities to communicate or send alerts when death has occurred (WHO, 2019a, p. 39). In Rwanda, CHWs were able to register maternal and child deaths when they received communication via mobile phone. As a result, delays in communication were reduced, and deaths were registered on time (Ngabo *et al.*, 2012, p. 6). In Malawi, community health workers used mHealth communication to track pregnancy outcomes, and as a result, there was better documentation of perinatal deaths (Joos *et al.*, 2016, p. 10).

2.4.1.3 Stock notification and commodity management

mHealth communication can be used to monitor and report stock levels, consumption, and distribution of medical commodities (Labrique *et al.*, 2013, p. 167; Iribarren *et al.*, 2017, p. 5).

This can be done via the use of communication systems such as SMS. This communication helps to manage and report supply levels of medical commodities (Bloomfield *et al.*, 2014, p. 7). For instance, SMS has been effective in Kenya to monitor antimalaria commodities. As a result, there were high reporting rates of reasonably accurate, real-time facility stock data, and the information was used by managers to undertake corrective actions and decrease stock-outs of antimalaria commodities (Githinji *et al.*, 2013, p. 8). As antimalaria commodities are needed to save mothers and their infants from the severe consequences of malaria during the postnatal period (Saito *et al.*, 2018, p. 1130), monitoring such commodities to reduce stock-outs may be significant. In Uganda, mHealth was effectively used to manage the supply of essential medicines. As a result, cases of stock-outs of drugs were reduced by rapid communication to higher-level health facilities, which could supply drugs on time (Kabakyenga *et al.*, 2016, p. 94). Such correspondence may be crucial during the postnatal period, since stock-outs of commodities, such as that needed for family planning, could hinder uptake of family planning services, which are part of PNC (Abuya *et al.*, 2012, p. 146)

2.4.1.4 Patient-to-provider telemedicine

In places where patients and health workers are separated by distance, mHealth communication can be used to facilitate the provision of health services (Labrique *et al.*, 2013, p. 166). Patient-to-provider telemedicine has the potential to increase access to health services, and also has the potential to reduce the burden of travel and reduce inequities for populations that have difficulties accessing health services (WHO, 2019a, p. 50). Patients can ask and respond to questions, send critical data, and seek guidance once they leave the clinical setting (Kahn, Yang and Kahn, 2010, p. 258). In the United States, mHealth communication was used by low-income women to seek lactation advice. As a result, there were improved rates of breastfeeding initiation and duration during the postnatal period (Martinez-Brockman, Harari and Pérez-Escamilla, 2018, p. 45). In Ghana, adolescents used mHealth communication to ask the health provider questions about reproductive health issues, which increased their knowledge, and consequently helped them to reduce unwanted pregnancies (Rana, 2017, p. 24). In India, young women used mHealth communication to seek emotional support from health care providers (Eze, Gleasure and Heavin, 2016, p. 1028).

2.4.1.5 Provider-to-provider telemedicine

Where two or more health workers are separated by distance, mHealth communication can be used for consultations and case management between health workers, including consultations with other health workers, mainly specialists, for patient case management, and for seeking second opinions (Hirsch-Moverman *et al.*, 2017, p. 40). mHealth communication was used to facilitate consultations between rural CHWs and health care providers in Guatemala, with reports indicating that it lead to a significant reduction in maternal deaths (Martínez-Fernández *et al.*, 2015, p. 287). mHealth communication between health care providers and community health volunteers in rural areas of India resulted in the provision of customised counselling messages to pregnant women (Prinja *et al.*, 2017, p. 896). In Indonesia, mHealth communication was used to facilitate communication among midwives and obstetricians. As a result, midwives showed a significant increase in confidence to deal with difficult problems that are associated with pregnancy (Colaci, Chaudhri and Vasan, 2016, p. 926).

These studies demonstrate the effectiveness of mHealth communication in facilitating provider-to-provider telemedicine, which may improve health worker performance by linking less-skilled health workers with more specialist ones (WHO, 2019a, p. 53) – an essential consideration in rural areas. In rural areas, mHealth has helped to bridge the gap caused by knowledge deficits in maternal and neonatal health amongst health care providers. For instance, in rural Bangladesh, provider-to-provider mHealth communication assisted skilled community birth attendants to become more competent at managing maternal and neonatal complications (Huq *et al.*, 2014, p. 7). A study conducted in rural areas of Rwanda, where mHealth communication was used to facilitate real-time reporting and communication between CHWs and the formal health system, lead to better uptake of hospital delivery and PNC (Ngabo *et al.*, 2012, p. 6). It is significant that most studies on mHealth interventions in developing countries that were reviewed support using mHealth communication for provider-to-provider communication (Colaci, Chaudhri and Vasan, 2016, p. 924).

2.4.1.6 Health worker decision support

The WHO recommends providing health worker decision support through mHealth (2019a, p. 65). mHealth can be used to communicate digitised job aids that combine an individual's health information with the health worker's knowledge and clinical protocols, to assist health workers to make diagnoses and treatment decisions (Leon, Schneider and Daviaud, 2012, p. 3). Job aids

have been used effectively in Colombia, where they allow CHWs to send patient information and receive instructions on how to proceed with the management of various cases (Källander *et al.*, 2013, p. 7). In India, job aids were delivered via mobile devices, to assist health workers with diagnosis and patient management. As a result, there was timely identification and management of patient complications (Modi *et al.*, 2019, p. 3). In Ghana, health workers requested emergency treatment protocols via mHealth to manage maternal and neonatal morbidities, which lead to improved maternal and neonatal care (Amoakoh *et al.*, 2019, p. 9). In Uganda, when village health team members received decision support from health care providers through mHealth, they were able to support postnatal mothers to care for their neonates (Ayiasi *et al.*, 2015, p. 6). Elsewhere in Uganda, CHWs received decision support via mobile phones to enable them to offer the right treatment to children with acute illnesses (Kabakyenga *et al.*, 2016, p. 92). Health workers using mHealth for decision support is associated with improved compliance with treatment protocols among patients, and improved health outcomes. In Kenya, using mHealth for decision support helped health workers to correctly manage children with malaria (Zurovac *et al.*, 2012, p. 4).

2.4.1.7 Digital tracking of patients

Digitised records can be used by health workers to capture and store health information on patients, and to follow up on their health status and services received (WHO, 2019a, p. 67). The digitised services may include digital service records, digital forms of paper-based registers for longitudinal health programmes, and case management logs for specific target populations (Labrique *et al.*, 2013, p. 165). Though there is not much data available, digital tracking via mHealth communication was used to follow up vaccination of children in Bangladesh; results indicate that there was improvement in vaccination coverage (Uddin *et al.*, 2017, p. 8).

2.4.1.8 Provision of training to health workers

Health workers can receive training via mobile devices to complement traditional methods of delivering continued health education and in-service training (WHO, 2019a, p. 75). Access to online educational resources using mobile phones is commonly referred to as mobile learning (WHO, 2016b, p. 29). Mobile learning using basic phones is said to be effective for training CHWs in Kenya (Levine *et al.*, 2015, p. 82). Systematic reviews done on mHealth communication in developing countries indicates that mHealth could be used effectively to

train health workers (Aranda-Jan, Mohutsiwa-Dibe and Loukanova, 2014, p. 10; Agarwal *et al.*, 2015, p. 1011). In rural areas of Ethiopia, in a low-resource setting with poor internet connectivity, mobile phones have been used to train CHWs. The training covered a variety of health topics, such as hygiene and environmental health, communicable and noncommunicable diseases, adolescent and youth reproductive health, antenatal and postnatal care, labour and delivery, nutrition, family planning, immunisation and health management. The training helped CHWs to feel confident and empowered to deliver effective services in their communities (Levine *et al.*, 2015, p. 77). In rural areas of India, where maternal and neonatal morbidity and mortality rates are reported to be high, CHWs received training via mobile phone, which enabled them to educate mothers and their families on healthy postpartum practices, as well as on identification of danger signs. As a result, the CHWs were able to assist in identifying, managing, and referring complications, thus, improving the continuum of care for mothers and neonates with complications (Levine *et al.*, 2015, p. 97).

2.4.1.9 Targeted patient communication

Transmission of customised health information for different audience segments can be achieved via mobile devices (WHO, 2019a, p. 56). The communication could involve transmission of health event alerts to a specified population group; transmission of health information based on health status or demographics; alerts and reminders to patients, and transmission of diagnostic results (WHO, 2019a, p. 56). Targeted communication has been used to offer different services, among which notifications of and reminders for appointments, medication adherence or follow-up services, health education, behaviour change communication, health promotion communication based on a known client's health status or clinical history, alerts for preventive services and wellness, and notification of health events to specific populations based on demographic characteristics (WHO, 2019a, p. 56). For instance, when mHealth communication was used by health care providers to remind mothers to attend a postnatal clinic, there was increased uptake of PNC (Shiferaw *et al.*, 2016, p. 8). Targeted communication is often used for client health education and behaviour change communication (Feroz, Perveen and Aftab, 2017, p. 1). Moreover, it is reported that mHealth communication interventions for behaviour change communication are the most common of all mHealth interventions, and also the most successful (Levine *et al.*, 2015, p. 10).

2.4.2 Targeted mHealth communication for client education and behaviour change communication

Improving people's knowledge, modifying their attitudes, and changing their behaviour require client education and behaviour change communication (Gurman, Rubin and Roess, 2012, p. 82). Providing targeted, timely health education and actionable health information, and sending behaviour change messages can be done through mobile phones, directly to patients or the general public as a means of empowering them to change or maintain positive behaviour (Thirumurthy and Lester, 2012, p. 392; Labrique *et al.*, 2013, p. 161; Iribarren *et al.*, 2017, p. 5). Positive health behaviour is among the activities achieved through mHealth communication, in addition to sending appointment reminders, supporting medication adherence, mobilising communities, raising awareness, educating people, and supporting self-management (Iribarren *et al.*, 2017, p. 5). Some of the behaviours that have been reinforced using mHealth communication and which ended up helping the population to adopt healthier practices include oral health practices (Jadhav *et al.*, 2016, p. 5), diabetes self-management, adherence to weight-loss programmes, physical activity, smoking cessation and medication adherence for antiretroviral therapy (Hall, Cole-Lewis and Bernhardt, 2015, p. 14). In the field of maternal and neonatal health, mHealth communication has largely been used as part of the prioritised area of sexual, reproductive, maternal, newborn, and child health (WHO, 2019a, p. 59). When positive behaviours that promote newborn health and wellbeing of families with newborns were practiced, it lead to a significant reduction in neonatal mortality in south Asia (UNICEF, 2016, p. 15). mHealth communication can be used with any given population that needs to adopt a specific behaviour, by addressing the critical determinants of behaviour uptake as described in the IMBP, which is the theoretical framework guiding this study.

2.4.3 mHealth communication for behaviour change: integrative model of behavioral prediction

According to the IMBP, uptake of behaviour is influenced by three primary determinants: intention, skills, and environmental facilitators/constraints (Fishbein and Yzer, 2003, p. 166). By targeting the three primary determinants, certain behaviours in specific populations can be enhanced or reduced. For instance, the model has been used successfully to improve the uptake of physical activity by addressing environmental constraints that hinder people from engaging in physical activities (Hagger and Chatzisarantis, 2014, p. 3). The model was used to improve

the uptake of condom use by young people in SSA by improving intentions through changing attitudinal beliefs about risks and benefits of condom use (Protogerou and Hagger, 2017, p. 15). In the United States, the model was used to change the intentions of mothers to adopt healthy recreational behaviours for their children (Vaala, 2014, p. 287) and, in Bangladesh, to enhance the skills required for neonatal care by mothers (Alam *et al.*, 2017, p. 5). The model proposes that the objectives of any intervention should be geared to improving any of the three primary determinants that lead to the uptake of behaviour (Yzer, 2008, p. 23). Therefore, mHealth communication, as an intervention, should address intentions, skills, and environmental facilitators that are necessary for uptake of behaviour, which, in this case, is PNC.

2.5 MHEALTH COMMUNICATION FOR POSTNATAL CARE

The greatest burden of maternal and neonatal mortalities usually is experienced during the postnatal period, when PNC is provided (WHO, 2014a, p. 1). Therefore, the use of mHealth communication in PNC should be one of the services that is prioritised, to facilitate the continuum of maternal and neonatal care. mHealth communication has been used as a complementary strategy to increase coverage of care and improve both maternal and newborn survival, by helping with communication efforts aimed at promoting PNC for mothers and newborns (Balakrishnan *et al.*, 2016, p. 5). The WHO recognises that mobile-phone-based PNC contact between mothers and the health system may be useful in the provision of PNC (WHO, 2015a, p. 1). Health systems are, therefore, expected to integrate mHealth communication and make use of this new approach to provide PNC. Uptake of PNC services has been shown to improve when mHealth communication is used, even in developing countries (Alam *et al.*, 2017, p. 10). Specifically, mHealth interventions aimed at changing the behaviour of women in the postnatal period have been proven to be effective in improving uptake of PNC services (Feroz, Perveen and Aftab, 2017, p. 1). When mHealth communication is used, women get increased exposure to and reinforcement of health messages, and the functions of mobile phones, such as images and audio clips, enhance the effectiveness of the communication (Labrique *et al.*, 2013, p. 4), which leads to behaviour change.

mHealth communication has been an effective tool for improving behaviour required during the postnatal period, such as uptake of family planning services and treatment of sexually transmitted diseases (Mechael *et al.*, 2010, p. 13). In Cambodia, mHealth intervention was

hypothesised to remind clients about contraceptive methods, for early identification of problems with side effects, to provide support and boost motivation to use post-abortion family planning, and to reduce some harmful behaviours, such as discontinuation and method switching (Smith *et al.*, 2016, p. 7). During the postnatal period, mHealth communication has helped to address some sexual and reproductive health issues that are viewed as confidential and sometimes stigmatised, such as sex, family planning, sexually transmitted infections, and HIV/AIDS (Mechael *et al.*, 2010, p. 36; Thirumurthy and Lester, 2012, p. 390).

In the Democratic Republic of Congo, where access to health services was severely compromised by violence, using mobile technologies for health education and information improved uptake of family planning and contraceptives (Mechael *et al.*, 2010, p. 39). In Uganda, mHealth communication induced attitude change in women towards adapting recommended maternal and newborn care practices (Ayiasi *et al.*, 2015, p. 6). mHealth communication, using both voice and messages for education and reminders, has been reported to increase PNC attendance (Crawford *et al.*, 2014, p. 37; Watterson, Walsh and Madeka, 2015, p. 7). In Kenya, mHealth was used by Jacaranda Health to encourage mothers in peri-urban areas to seek PNC services, and as a result, 73% of clients received PNC (Jacaranda Health, 2016, pp. 8–9). It is, therefore, essential to use mHealth communication and to develop messages that will encourage behaviour change in mothers, especially regarding PNC, which is a critical point in the continuum of care.

This section addressed the role of mHealth communication in enhancing health domains. The health domains discussed are those that are accessible via mobile devices in any setting. The health domains are achieved via various delivery channels, depending on the type of health issue to be addressed.

2.6 DELIVERY CHANNELS FOR MHEALTH COMMUNICATION

mHealth communication can be done via various delivery channels. The delivery channels commonly used with mobile devices are text messaging and voice calling (Labrique *et al.*, 2013, p. 161; WHO, 2019a, p. 21). The choice of delivery channel for mHealth communication is influenced by literacy level, mobile phone ownership, usage patterns of recipients, and cost of the channel (Rajan *et al.*, 2017, p. 10). For instance, low literacy levels of women in Nigeria influenced the choice of voice calls over text messaging; limited mobile phone use patterns were a factor that influenced the choice of voice calling in India to deliver preventive care

information to pregnant women and postnatal mothers (Rajan *et al.*, 2017, p. 5). Limited mobile phone ownership by women, who shared their phones with their husbands, and the low cost associated with text messaging were factors that influenced the choice of text messaging in Bangladesh (Rajan *et al.*, 2017, p. 10).

2.6.1 Text and voice messaging

Text messaging, commonly referred to as SMS, is an interpersonal mobile communication channel that involves the creation and real-time exchange of alphanumeric messages of 160 characters or fewer between mobile phone devices (Hall, Cole-Lewis and Bernhardt, 2015, p. 2). Voice messages are audio recordings that can be retrieved from a mobile phone at a later time by the recipient, and have the advantages of being accessible to illiterate people, holding more information per message than SMS, and the ability to be recorded in any language (Crawford *et al.*, 2014, p. 36). Both text and voice messages can be delivered instantly to individuals at any time, place or setting, even to phones that are turned off or have flat batteries (Schoenberger *et al.*, 2013, p. 2; Crawford *et al.*, 2014, p. 36). SMS is possible with an estimated 98% of mobile phones, does not necessitate technical expertise to use, and is adjustable to multiple mHealth purposes. SMS can be accessed at user convenience. In addition, the cost of SMS is generally lower than that of voice messages (Crawford *et al.*, 2014, p. 36). The term text messaging in the following discussion is used to refer to SMS.

Due to the proliferation of mobile phone technology since the year 2006, text messaging has gained widespread application as an intervention modality for health promotion, disease prevention, and chronic disease self-management. Indeed, it is the most widely used modality within the mHealth family, hence, it is used routinely as a method of communication around the world (Brinkel *et al.*, 2014, p. 11564; Poorman *et al.*, 2015, p. 969; Martinez-Brockman, Harari and Pérez-Escamilla, 2018, p. 41). In the United States, where 90% of women have mobile phones, text messaging is more prevalent than any other type of delivery channel; for instance, Text4baby, the first free national mobile health communication service in the United States, has been in use since 2010. The programme uses text messages to improve maternal and infant health outcomes. Pregnant women and new mothers receive text messages with health care reminders specific to their infants' ages. The messages include facts about prenatal vitamins, infant immunisation, safe sleep, and proper nutrition. This programme also helps to connect clients to public clinics and other services for prenatal and infant care (Whittaker *et al.*, 2012, p. 2209). Various benefits of text messaging as a delivery channel for mHealth

interventions could be the reason behind its extensive application. Text messaging is reported to be the most often used channel in mHealth interventions, and it is associated with more positive economic outcomes than voice calling (Iribarren *et al.*, 2017, p. 6).

Research indicates that text messaging has the benefit of being a high-reach, highly accessible and relatively low-cost communication strategy, making it the most commonly used type of mHealth communication (Bigna *et al.*, 2014, p. 606; Higgs *et al.*, 2014, p. 171; Nhavoto and Grönlund, 2014, p. 8; Iribarren *et al.*, 2017, p. 14; Singh *et al.*, 2017, p. 279). For instance, in the Text4baby programme, the initial launch reached more than 200 000 participants in 17 months; it provides high accessibility to medically underserved populations at no cost implication to the public (Whittaker *et al.*, 2012, p. 2211). In China, much lower cost was incurred when texting was used to remind clients of their clinic appointments, compared to voice calling (Chen *et al.*, 2008, p. 34). With the development of text messaging software that allows large batches of text messages to be delivered almost instantly, labour cost is likely to be minimised. Text messaging is said to have readership and engagement advantages over other communication modalities, making it possible to have an impact on changing behaviour (Abroms *et al.*, 2015, p. 1; Ippoliti and L'Engle, 2017, p. 6).

Health behaviours that have been changed or improved via text messaging are those in the context of HIV prevention, medication adherence, pregnancy education, substance use/smoking cessation, weight loss, diabetes management, and depression (Free *et al.*, 2013, p. 10). Most of these communications involved sending automated text messages that guided individuals in the process of behaviour change. In Kenya, text messages promoted adherence to highly active antiretroviral therapy among people with HIV (Lester *et al.*, 2009, p. 8). In South Africa, text messages reportedly had the greatest impact on promoting healthy behaviours, such as treatment adherence, eating healthier and exercising, taking folic acid and vitamins, and attending clinics regularly (Lau *et al.*, 2014, p. 6). Generally, mHealth interventions, predominantly those delivered using SMS, have been associated with increased uptake of health care, including uptake of recommended prenatal and postnatal care consultation, use of skilled birth attendants, and vaccination (Lee *et al.*, 2016, p. 13). In Bangladesh, uptake of PNC improved when postnatal mothers received text messages that encouraged them to visit postnatal clinics (Alam *et al.*, 2017, p. 3).

There is limited literature on the use of text messaging for PNC, but a systematic review that evaluated the role of mHealth applications in improving antenatal and postnatal care in

developing countries found that text messaging was used to remind postnatal mothers to attend postnatal clinics, consequently improving the uptake of PNC. In instances where text messaging is limited, such as when robust content provision is needed to engage the user in two-way communication, voice calls may be used (Ippoliti and L'Engle, 2017, p. 6).

2.6.2 Voice calling

Also known as voice communication, this is one of the simplest and most transformative technical functions of a mobile phone, and it allows interaction between mobile devices (Labrique *et al.,* 2013, p. 166). Voice calling is one of the delivery channels that is used to collect or disseminate health-related information or to direct care in health settings (Betjeman, Soghoian and Foran, 2013, p. 1). A study that explored the use of mobile technology in an HIV programme in Kenya reports that voice calling was the most commonly used delivery channel. The participants said that they used mobile phones to call health providers or CHWs when they needed to ask questions, receive assistance, or arrange appointments (Jennings *et al.*, 2013, p. 4). Certain factors lead to a preference for voice calling over text messaging, such as age, education, and socio-economic status (Wambugu and Villella, 2016, p. 12; Feinberg *et al.*, 2017, p. 185). For instance, in rural areas of India, voice calls were preferred over text messaging for delivering health information and medication reminders among individuals of older age, lower educational status, and those lacking employment (Aranda-Jan, Mohutsiwa-Dibe and Loukanova, 2014, p. 1).

Another factor common to voice calling is the inherent characteristic of interactivity, which enables clients to speak directly to a health care provider (Ayiasi *et al.*, 2016, p. 4). The absence of localisation of some languages for all mobile phones, so that messages cannot be written in all languages, may be a reason to use voice calling, as was the case in Cambodia, where many phones lacked Khmer language capability (Smith *et al.*, 2016, p. 5). Voice calling was preferred by both health workers and clients in Sierra Leone, who cited that voice calling guaranteed that the message was received, and implied 'direct' contact, which, furthermore, ensured privacy and confidentiality (Jalloh-Vos *et al.,* 2014, pp. 69, 91). Voice calling is preferred over SMS for providing a reliable shield of privacy, especially for people who share mobile phones (Gurman, Rubin and Roess, 2012, p. 100). Though not as commonly used as SMS, voice calling has been used in some isolated contexts, making it essential to achieve delivery of various health domains. In Kenya, voice calling was used to track children who had defaulted on

immunisation, and it contributed to improved retention of immunisation clients in health facilities (Levine *et al.*, 2015, p. 95).

Voice calling alone has not been reported to have significant outcomes, therefore, the combination of voice calling and text messaging is recommended (Singh *et al.*, 2017, p. 278). The study by Singh *et al.* (2017, p. 278) acknowledges that more benefits are accrued when text messaging is combined with voice calling. Voice calls combined with text messaging was the most effective intervention when they were used to remind carers of paediatric patients in low-resource settings of Cameroon of their scheduled HIV appointments (Bigna *et al.*, 2014, p. 606). In Ethiopia, both text messages and voice calls were used by health workers to remind postnatal mothers of PNC appointment dates; findings indicate that there was a significant improvement in uptake of PNC (Shiferaw *et al.*, 2016, p. 10). In Zambia, using the combination of voice calling and text messages during the postnatal period facilitated the timely delivery of laboratory results for HIV-exposed infants, thereby enhancing early diagnosis and initiation of treatment of infants (Sutcliffe *et al.*, 2017, p. 7).

In some instances, there has been no significant difference in achieving the desired effect when either type of delivery channel is used (Chen *et al.*, 2008, p. 36; Crawford *et al.*, 2014, p. 42; Higgs *et al.*, 2014, p. 174). Whether text messaging or voice calls, it is worth noting that they can be used as the primary delivery channels of mHealth communication to facilitate the main health domains, as recommended by the WHO. As the digital revolution continues to transform health care and presents opportunities for improving service delivery (Bauer *et al.*, 2015, p. 7), there is need to design an mHealth communication framework that is evidence-based and incorporates the experiences and expectations of patients, to strengthen the uptake of health services such as PNC. In addition, it is acknowledged that many mHealth interventions have failed to inspire uptake, due to poor alignment with users' needs and expectations (Mburu and Oboko, 2018, p. 15). Given that mHealth communication is proposed to strengthen health services for maternal, newborn, and child health in remote, underserved areas, where access to health services can otherwise be extremely limited (Kazi *et al.*, 2017, p. 9), a framework that embraces evidence and users' needs and expectations would be appropriate.

2.7 SUMMARY

This chapter explored the concept of mHealth, the role of mHealth in health care delivery with an emphasis on the role of mHealth communication in various health domains, mHealth

communication for behaviour change in relation to IMBP, and mHealth communication for PNC as the focus areas of this study. To conclude the chapter, delivery channels used in mHealth communication were explained. Given that the aim of this study is to develop an mHealth communication framework for PNC, the next chapter will elaborate more on PNC, a priority health care service that has experienced low uptake, particularly in developing countries, such as Kenya.

CHAPTER 3: POSTNATAL CARE

3.1 INTRODUCTION

The previous chapter provided literature on mobile health communication. This chapter will investigate the literature related to PNC. As in the previous chapter, literature was gathered from various databases that are on the EBSCOHost, Scopus and Nexus platforms. In addition, various international and national guidelines were searched. To start the chapter, the background of PNC will be described, and a description of PNC practices as guided by the WHO recommendations is provided. Uptake of PNC and determinants of PNC uptake will also be described. The chapter will end with a brief summary. The next section will address the background of PNC.

3.2 BACKGROUND

Ensuring maternal and neonatal health remains a significant challenge in LMICs, resulting in a high burden of maternal and neonatal deaths (WHO, 2016a, p. 44). The global maternal mortality rate (MMR) in 2017 was estimated to be 211 maternal deaths per 100 000 live births, while it was 342 maternal deaths per 100 000 live births in the year 2000 (WHO, 2019b, p. 2). Though MMR has declined globally, the reduction has been only 2.9% every year between 2000 and 2017 (WHO, 2019b, p. 2). In the global context, SSA had the highest MMR, estimated at 542 maternal deaths per 100 000 live births in 2017(WHO, 2019b, p. 2). The global neonatal mortality rate (NMR), in 2018, was estimated at 18 deaths per 1 000 live births (UNICEF, 2019, p. 16). Globally, between the years 1990 and 2018, the average annual rate of NMR declined by 2.6% per year (UNICEF, 2019, p. 16).As is the case with the MMR, SSA had the highest NMR in 2018, at 28 deaths per 1 000 live births (UNICEF, 2019, p. 16).

Some countries in SSA have recorded a slight reduction in maternal and neonatal mortalities. A slight decline of these rates in Kenya has been reported. Data from the 2014 Demographic and Health Survey reveals non-significant decreases in NMR from the previous 2008-09 survey (from 31/1 000 to 22/1 000) (Kenya National Bureau of Statistics, 2015, p. 114), while the Kenya National Bureau of Statistics (2015, p. 383) reports that the MMR was 362/100 000 in 2015. The 2008-09 survey reports an estimated rate of 488/100 000 (Kenya National Bureau of Statistics, 2010, p. 273). In Kenya, these rates are stagnating, even after the implementation of health care interventions, such as free maternity services policy (Gitobu, Gichangi and

Mwanda, 2018, p. 1). Given that these mortalities reflect the maternal and neonatal health services offered, efforts by health systems should focus on preventing the causes of maternal and neonatal mortality, which are mainly preventable (WHO, 2014a, p. 1).

Reducing preventable maternal and neonatal mortality is still one of the critical challenges facing many health systems, even where maternal and child health care have been prioritised (Mon *et al.*, 2018, p. 3). Sixty percent of these mortalities occur during the first six weeks after birth, the period when the provision of PNC is critical (Fort, 2012, p. 81; WHO, 2014a, p. 6; Mon *et al.*, 2018). PNC entails all the health services provided to mothers and their newborn babies in the days and weeks after birth (WHO, 2015a, p. 1). This care encompasses all preventive practices and assessments that are designed to recognise and manage or refer complications in both the mother and the newborn baby (Langlois *et al.*, 2015, p. 259). Lack of PNC may lead to complications, resulting in death or disability, as well as missed opportunities to promote healthy behaviours for women, newborns, and children (Fort, 2012, p. 81). Provision of PNC services enables HCPs to detect post-childbirth problems, including potential complications, and to offer treatments promptly (Titaley *et al.*, 2010, p. 2). PNC is one of the most critical maternal health care services and involves a continuum of care, from antenatal care to labour and delivery and after birth (Bick, 2008, p. 42; Ministry of Public Health and Sanitation, 2011, p. 58). However, PNC is reported to be the most neglected part of care, receiving less attention from skilled health care providers than care provided during the antenatal and intranatal periods (Fort, 2012, p. 82; WHO, 2014a, p. 1; Mon *et al.*, 2018, p. 3). This neglect warrants greater emphasis on the purpose of PNC.

The primary purpose of providing optimal PNC is to avert maternal and neonatal death, as well as long-term complications (Mrisho *et al.*, 2009, p. 3; Hordofa *et al.*, 2015, pp. 686–687). Providing PNC averts 60% of maternal deaths, and combats acute and chronic morbidity arising from pregnancy and childbirth-related complications (Fort, 2012, p. 81). A strong positive association between improved PNC services and reduction in maternal mortality has been established: improved PNC services protect women from life-threatening fatal pathologies, such as postpartum haemorrhage (Feroz, Perveen and Aftab, 2017, p. 9), which is the leading direct cause of maternal mortality, causing 27.1% (Say *et al.*, 2014, p. 323) of maternal deaths. Generally, PNC plays a vital role in promoting the health and wellbeing of the mother and her newborn baby (Ministry of Public Health and Sanitation, 2013, p. 240). In addition, PNC is a significant contributor to the survival of both mother and baby post-

childbirth (Better Care South Africa, 2019:Online). Considering the significance of PNC, the WHO has carried out several reviews and syntheses of evidence, in order to provide recommendations on PNC.

3.3 WORLD HEALTH ORGANIZATION RECOMMENDATIONS ON POSTNATAL CARE

The WHO recommendations on PNC address timing, number, and the place of postnatal contacts, as well as provision of PNC for all mothers and newborn babies during the first six weeks after birth (WHO, 2014a, p. 1). The first three recommendations address the provision of PNC, recommendations four to seven address newborn care, and the last five recommendations discuss maternal care.

3.3.1 Provision of postnatal care

Preparing mothers for PNC begins early in pregnancy, in order to promote continued care once the women give birth (WHO, 2016d, p. 86). However, antenatal contacts may not be sufficient to discuss the planning of PNC or to provide information about what may happen to a woman once she has given birth. In her pregnant state, a woman may not feel ready to consider life after childbirth (Bick, 2008, p. 42). These factors make it necessary to have early and immediate postnatal contact for the provision of PNC under the following 12 recommendations.

Recommendation 1: Timing of discharge from the health facility after birth

Both mothers and neonates should be provided with PNC by a skilled health care provider for at least the first 24 hours after an uncomplicated vaginal birth, whether in a health facility or at home (WHO, 2014a, 2018b, p. 167). During this time, the mother should be assessed for bleeding and signs of infection, while the baby should be thoroughly examined clinically to rule out signs of infection and to evaluate the establishment of breastfeeding before discharge (WHO, 2014a, p. 13). Despite this recommendation, the length of stay after vaginal delivery has been decreasing across the world, most notably in developed countries. Some developed countries (such as the United Kingdom) reduced the length of hospital stay after birth, which helped to decrease the beds occupied for maternal and neonatal care and, in the long run, helped to maintain the quality of care (Bowers and Cheyne, 2016, p. 2). Bowers and Cheyne (2016, p. 2) point out that more than 70% of women in England spend less than two days in hospital

following vaginal birth. In 2018, more than 77% of women who had undergone vaginal delivery were discharged within 24 hours of giving birth (Health and Social Care Information Centre, 2018, p. 1). Similar trends have been reported in Italy (Cegolon *et al.*, 2019), the United States, and other Organization for Economic Cooperation and Development member countries (Campbell *et al.*, 2016, p. 8). However, in high-income settings, virtually all deliveries occur in hospitals, thereby limiting the number of complications arising from early discharge to minimum levels. In LMICs, where a substantial proportion of mothers deliver at home, the length of hospital stays following a vaginal delivery varies significantly. The average length of stay was three days in India (2006), two days in Benin (2006) and South Korea (2013), and less than two days in Bolivia (2008), Ghana (2008), Uganda (2011) and Zambia (2007), while in Pakistan (2007) and Egypt (2008), the average length of stay was less than one day (Campbell *et al.*, 2016, pp. 7–8). In South Africa, discharge from the clinic or hospital is permissible within six hours after childbirth, provided that no abnormalities are detected before discharge (National Department of Health, 2015, p. 163).

Data from the 2014 Demographic and Health Survey in Kenya indicates that >30% of mothers are discharged in less than 24 hours following a vaginal birth (Kenya National Bureau of Statistics, 2015, p. 132). It is worth noting that Kenya's free maternity services policy enhanced utilisation of care (Gitobu, Gichangi and Mwanda, 2018, p. 9), and this potentially affects (decreases) the length of stay, due to overcrowding in public facilities. However, the NMR and MMR are still high, even after the implementation of free maternity care in Kenya's public hospitals (Gitobu, Gichangi and Mwanda, 2018, p. 9).

Recommendation 2: Number and timing of postnatal contacts

All mothers and newborns should receive three more postnatal contacts, on day 3 (48-72 hours), between days 7 and 14 after birth, and six weeks after birth (WHO, 2014a, p. 3). The schedule of postnatal contacts varies in different countries. The South African Department of Health recommends that, once a postnatal mother has been discharged from hospital, there should be two additional postnatal visits, between day 3 and 6, and six weeks after birth (National Department of Health, 2015, p. 164). The WHO recommends PNC for six weeks after birth, which is also what is recommended in South Africa; in contrast, the guidelines for quality obstetric and perinatal care in Kenya recommends a minimum of four PNC contacts, spread over the first six months after birth (Ministry of Public Health and Sanitation, 2013, p. 241). The first contact should be within 48 hours after birth, followed by contacts at 1 to 2

weeks, 4 to 6 weeks, and 4 to 6 months. The contact schedule has the intention to promote regular follow-up of both mother and neonate, thereby increasing provision of PNC (Ministry of Public Health and Sanitation, 2011, p. 29).

These additional contacts are essential to address various concerns that mothers may have, and to continue monitoring the wellbeing of both the mother and her newborn. Mothers in Singapore expressed a need for more professional support after health facility discharge, citing that they needed more guidance and support on neonatal care in the context of the home environment (Ong *et al.*, 2014, p. 776). The need for targeted postnatal contacts was also recognised in Australia, where the Newborn and Family Drop-in Service was implemented; this element of care ensures that mother-infant dyads can access primary care (Brodribb and Zadaroznyi, 2012, p. 23).

Recommendation 3: Home visits for postnatal care

The WHO recommends home visits in the first week after birth for more consideration of the mother and newborn (WHO, 2014a, p. 3). Home visits are vital during this period, as they create an opportunity for family members to be involved in PNC; family members receive appropriate information on care, which enables them to support the mother better (WHO, 2015b, p. 29). The health care provider also gets an opportunity to allay anxiety and fears relating to newborn care that are commonly expressed by mothers after discharge from the health facility, especially by first-time mothers (Ong *et al.*, 2014, p. 773). Home visits have also been claimed to lead to higher satisfaction by mothers, compared to clinic visits, primarily when the visits take place immediately after birth (Miller, Dane and Thompson, 2014, p. 10). The home visits allow for inclusivity, since problems can be attended in a relaxed home environment and, at the same time, mothers' concerns can be addressed in a detailed and individualistic manner (Nurcan and Ozcan, 2018, p. 369). A home-visiting programme in an area with health inequities in Sweden concluded that the intervention improved nurturing care, as advocated by the WHO. In addition, the study reports that the programme had the potential to achieve equitable health care (Barboza *et al.*, 2018, p. 8).

In LMICs, home visiting is rarely done during the postnatal period. A report by the Maternal and Child Health Integrated Program and Saving Newborn Lives (2012, p. 13) in Bangladesh, Malawi, Nigeria, Nepal, and Rwanda indicates that CHWs were the primary health providers involved in home visits. The fact that volunteer CHWs conducted home visits in some of these countries (Nigeria, Nepal, and Rwanda) implies that governmental support for this endeavour

is suboptimal (Maternal and Child Health Integrated Program and Saving Newborn Lives, 2012). Other countries (Ethiopia, Ghana, India, Indonesia, Uganda, Pakistan, and Sri Lanka) recently implemented postnatal home visits, though coverage of visitation is only about 10-20% within the first 48 hours after home births; furthermore, there has been no meaningful impact on mortality in most of these countries (McPherson and Hodgins, 2018, p. 9).

No data about home visits in the postnatal period were reported by the 2014 Kenya Demographic and Health Survey (Kenya National Bureau of Statistics, 2015). However, a recent randomised controlled trial in Kenya reports that home visiting enhanced mothers' knowledge and ability to recognise postnatal problems, and increased care-seeking practices (McConnell *et al.*, 2016, p. 17). These findings emphasise the need to scale up PNC coverage to reduce maternal and neonatal mortality rates, which have shown a slow decline in Kenya.

3.3.2 Postnatal care for the newborn

According to WHO, PNC should be individualised according to specific needs. It is worth noting that physiological changes that take place immediately after childbirth differ for the mother and the newborn. For the newborn, the recommendations comprise mainly assessment, exclusive breastfeeding, cord care and other routine care. Each of these aspects will be discussed further.

Recommendation 4: Assessment of the baby

Immediately after birth, full physical assessment of the baby is essential, to rule out birth injuries and congenital abnormalities, and to assess maturity (Ministry of Public Health and Sanitation, 2013, p. 178). It is this assessment that determines the next course of care. Even the physical assessment should involve immediate neonatal care, including thermal protection, delayed clamping and clean cord-cutting, and immediate breastfeeding, which should begin soon after the birth of the baby (Pattinson *et al.*, 2011, p. 3). The WHO recommends further assessment of babies during every PNC contact (WHO, 2014a, p. 20). These assessments are meant to rule out danger signs that may warrant immediate treatment or referral (WHO, 2015b, p. 153). To identify these danger signs, the HCPs should assess for history of convulsions, feeding patterns, difficulty breathing, presence of spontaneous movement, presence of high or low body temperatures, wet cord with blood or pus and swelling around cord, swollen eyes, pus draining from eye or ear and presence of yellow body, eyes or palms (Ministry of Public Health and Sanitation, 2011, p. 35; WHO, 2014a, p. 20). Though these assessments are

supposed to continue at every contact, the first physical assessment is critical, whether birth has taken place in the hospital or at home. Unfortunately, these assessments are not taking place in some African countries; for instance, in Tanzania, only around half (51.4%) of newborns were assessed during the first PNC contact in the health facility (Bishanga *et al.*, 2019, p. 8) while, in Kenya, only 48% of newborns born in health facilities were assessed (Kenya National Bureau of Statistics, 2015, p. 134). The two scenarios are an alarming indicator of suboptimal care, which requires immediate attention.

Recommendation 5: Exclusive breastfeeding

Breastfeeding is recognised as the optimal method for feeding an infant. Exclusive breastfeeding is recommended for the first six months, during which time the baby should be fed breast milk only (WHO, 2014a, p. 22). The benefit of exclusive breastfeeding cannot be overemphasised, yet, it is the most challenging area for many mothers in terms of establishing and solving problems associated with it (Guerra-Reyes *et al.*, 2016, p. 15). Evidence from high-income, low-middle-income, and low-income settings indicates that adherence to exclusive breastfeeding is still suboptimal, since mothers are not supported to breastfeed exclusively. As a result, only 41% of infants younger than six months of age are being breastfed exclusively, which is far short of the 2030 global target of 70% (WHO and UNICEF, 2018, p. 4). In high-income countries, less than 30% of infants younger than six months are breastfed exclusively: Norway (7%), United Kingdom (1%), United States (26.4%), Italy (5%), Spain (29%) (WHO, 2019a, p. 1). In industrialised countries, even the rate of partial breastfeeding at six months of age is less than 50% (Victora *et al.*, 2016:abstract).

Although the rate of breastfeeding in LMICs is generally higher than in developed countries (at all ages), exclusive breastfeeding is still at unacceptably low levels (at 50%) (Victora *et al.*, 2016:abstract). However Patel *et al.* (2015, p. 4), report that the rate of exclusive breastfeeding 42 days after birth ranged from 76% to 99.5% in LMICs. In Kenya, approximately 61% of infants below the age of six months are breastfed exclusively, and 91% of infants have been breastfed (Kenya National Bureau of Statistics, 2015, p. 165).

Recommendation 6: Cord care

Unless it is cleaned, the umbilical cord stump that remains after cord clamping serves as an entry point for infection. Daily application of chlorhexidine is recommended in areas with high neonatal mortality rates, of 30 or more neonatal deaths per 1 000 live births. This

recommendation does not, however, apply in settings that have low neonatal mortality; here the WHO recommends, instead, keeping the cord clean and dry, except where there are known cases of application of a harmful traditional substance, such as cow dung, to the cord stump (WHO, 2014a, p. 23).

Using harmful traditional substances is common in some areas of developing countries. A study conducted in Haiti reports that mothers apply potentially harmful substances to the cord stump, such as burnt nutmeg, crushed charcoal, ash, or even the mother's urine (Walsh *et al.*, 2015). In Uganda, about 49% of caregivers applied harmful (or insignificant) substances to the cord, including ash, salty water, powder, or other medical drugs, in addition to chlorohexidine (Waiswa *et al.*, 2010).

Such practices also exist in the Kenyan context, especially in rural areas. For example, a study carried out among the pastoralist communities in Kenya reports that some communities smear the cord stump with a mixture of herbs and ashes, to stop it bleeding (Byrne *et al.*, 2016, p. 5). A cross-sectional study at the Kenyatta National Hospital in Kenya revealed that only 1% of mothers knew that no substances should be applied to the cord (Amolo, Irimu and Njai, 2017, p. 6). Such practices pose a high risk of neonatal infection. Cord care is, thus, critical after birth, to reduce infections, which are rated third among the major causes of neonatal death (UNICEF, 2014, p. 15). Extensive coverage of PNC is essential to educate mothers on recommended cord care practices.

Recommendation 7: Other postnatal care for the newborn

During the postnatal period, further routine care is required to maintain the neonate's health and promote growth and development. Maintaining warmth is critical, to protect the baby against hypothermia (Ministry of Public Health and Sanitation, 2011, p. 38). The WHO recommends that bathing is delayed until 24 hours after birth; in cases where this wait is not allowed, for cultural reasons, bathing should be delayed for at least six hours (WHO, 2014a, p. 25). Other ways of ensuring that the baby remains warm include placing the baby in a warm environment, skin to skin contact, covering the baby with warm clothing and putting a hat or cap on its head (WHO, 2017b, p. 10). In addition, keeping the mother and baby in the same room promotes warmth, and helps with bonding. As part of care, communication and play with the newborn should also be encouraged (WHO, 2014a, p. 25). Immunisation, which is the main PNC component that the majority of women are aware of (Tesfahun *et al.*, 2014, p. 2350), is offered during postnatal contact to protect the baby from preventable infections. Immunisation

is a critical preventive service that can save the lives of many infants and children (Watterson, Walsh and Madeka, 2015, p. 1). The next section will address PNC for the mother.

3.3.3 Postnatal care for the mother

The health of mothers is mostly viewed as an indicator of health in any given society (Tesfahun *et al.*, 2014, p. 2342; Limenih, Endale and Dachew, 2016, p. 1). However, it has been documented that many postnatal mothers perceive PNC as being beneficial for the newborn, rather than for themselves, and this idea has contributed to a lack of PNC for the mother (Mrisho *et al.*, 2009, p. 8). Mothers can die during the postnatal period due to postpartum bleeding and infection, with bleeding contributing to 27% and infections contributing to 11% of maternal deaths (WHO, 2016d, p. 44). With provision of PNC, these deaths can be prevented (WHO, 2016d, p. 44). The WHO makes five recommendations that should be followed when providing PNC to mothers during the postnatal period. They include assessment, iron and folic supplementation, prophylactic antibiotics counselling and psychosocial support (WHO, 2014a, p. 4).

Recommendation 8: Assessment of the mother

In the first 24 hours after birth, the postpartum woman should have regular assessment of vaginal bleeding, uterine contraction, fundal height, temperature, blood pressure, and heart rate (WHO, 2017a, p. 17). Continued assessment is vital, since, during this period, many physiological changes are likely to occur in the process of recovery. During each postnatal visit, mothers should be assessed for danger signs, which include assessment of micturition and urinary incontinence, bowel function, perineal pain, and perineal hygiene, healing of any perineal wound, fatigue, back pain, headache, breast pain and uterine tenderness and lochia as well as screening for deep venous thrombosis (WHO, 2014a, p. 5).

Other aspects that require emphasis are breastfeeding progress, and psychological and general wellbeing. Continued breastfeeding is beneficial to the mother, as it promotes her health and is documented to reduce the risk of mothers developing breast and ovarian cancer, Type 2 diabetes and heart disease (WHO and UNICEF, 2018, p. 1). Providing breastfeeding support is crucial during the postnatal period, as it helps increase breastfeeding rates and improves breastfeeding self-efficacy and coping by postnatal mothers (Gallegos *et al.*, 2014, p. 8). The mother's psychological wellbeing should continue to be assessed to rule out postnatal depression. When any of the symptoms are present, further evaluation and the right referral

should be done. Mothers should be observed for any risks, signs, and symptoms of domestic abuse (WHO, 2014a, p. 4). In the case of domestic violence, which is now recognised as a global public health problem (WHO, 2016d, p. 40), they should be referred for advice and management. Resuming sexual intercourse and possible dyspareunia, as part of the assessment of general wellbeing, should be evaluated two to six weeks after birth (WHO, 2017a, p. 17). As part of providing standard care, health providers should emphasise the assessment of mothers during the postnatal period (Munabi-Babigumira *et al.*, 2019, p. 7).

Recommendation 9: Counselling

All postnatal women should be provided with information on the physiological process of recovery after birth. Some health problems are common, and result from normal physiological changes, however, postnatal mothers should be advised to report any health concerns to a health care provider (WHO, 2014a, p. 5). Postnatal mothers should be given information on all danger signs during the postnatal period (WHO, 2013, p. 126). In addition, they should be counselled on nutrition, exercise, hygiene, birth spacing and family planning, and safer sex practices (WHO, 2014a, p. 5). Other aspects that postnatal mothers should be advised on include substance abuse, and how to prepare for an emergency during the postnatal period (WHO, 2015c, p. 27). Given that many postnatal mothers are discharged from the health facility within 24 hours after giving birth, and in some countries, such as South Africa, within six hours after birth (National Department of Health, 2015, p. 163), comprehensive postnatal education may not be achieved while the mother is still in the hospital. A study carried in Zambia among postnatal mothers reports that, during the short hospital stay after birth, there was a lack of or inadequate information given to the mothers regarding the care of the newborn, and the importance of subsequent care (Muleya *et al.*, 2018, p. 368). To offer such information, continuous counselling during the entire postnatal period is required. However, not all postnatal mothers have access to such counselling services, due to social, geographical and economic barriers (Lund *et al.*, 2014, p. 1262; Duclos *et al.*, 2017, p. 42). In areas with such limitations, mobile technologies have been identified as a feasible mode of offering counselling services (Datta, Ranganathan and Sivakumar, 2014, p. 179). For instance, Mobile Midwife technology was used in Ghana to provide counselling to postnatal mothers regarding recommended neonatal care practices (Entsieh, Emmelin and Pettersson, 2015, p. 1). Though this study did not evaluate the effects of the intervention on mortality rates, the results indicate that mothers were able to move away from unhealthy traditional practices that could be detrimental to their

health. In addition, mothers were able to correctly recognise signs of ill health in their newborn babies and seek care appropriately (Entsieh, Emmelin and Pettersson, 2015, p. 1). When given counselling, postnatal mothers can easily recognise some of the danger signs in the neonate, such as excessive diarrhoea, fast breathing (tachypnoea), umbilical cord bleeding/pus, convulsions, extreme fever, unconsciousness, poor feeding, and yellowish discoloration of the body (Alex-Hart, Dotimi and Opara, 2014, p. 201; Berhane *et al.*, 2018, p. 477).

Recommendation 10: Iron and folic acid supplementation

To improve maternal and perinatal health, as well as prevent and treat iron deficiency anaemia, supplementation of iron (60 mg) and folic acid (400 µg) daily should continue for three months in the postnatal period (WHO, 2014a, p. 5). Iron and folic acid supplementation has the benefit of reducing the burden of ill health linked to postpartum anaemia (WHO, 2014a, p. 28). Postpartum anaemia is a significant public health problem that poses a considerable risk to subsequent pregnancies, leading to continued adverse maternal and infant outcomes (Singhal *et al.*, 2015, p. 616). A mother with postpartum anaemia is at risk of experiencing fatigue, altered cognition, and depression symptoms, which may have an impact on infant development (WHO, 2016c, p. 2). Postpartum anaemia can occur as a result of excessive blood loss during and after childbirth, as well as due to insufficient production of red blood cells, which is common during this period (Singhal *et al.*, 2015, p. 616). Iron and folic acid supplements after childbirth are essential to restore iron stores and to avoid the negative consequences of postpartum iron deficiency and anaemia, which may have long-term effects, such as reduced immunity, which may impact the health of the mother (WHO, 2016c, p. 2). Iron and folate supplementation during the postnatal period should be emphasised, though studies suggest that irregular PNC visits make monitoring ineffective (Singhal *et al.*, 2015, p. 616). Inadequate knowledge on the importance of supplementation was cited as the main reason for low adherence to iron and folic acid supplementation in Ethiopia (Assefa, Abebe and Sisay, 2019, p. 7). Further, this study recommends health education and creating awareness to improve uptake of these supplementations (Assefa, Abebe and Sisay, 2019, p. 7). In Kenya, iron and folic supplements should be provided to the mother within 24-48 hours after birth (Ministry of Public Health and Sanitation, 2013, p. 243).

Recommendation 11: Prophylactic antibiotics

Infections during the postnatal period are related to long term maternal disabilities and may also have a substantial influence on newborn morbidity and mortality. Infections are rated the

third-highest cause of maternal mortality, and require immediate intervention during the postnatal period (Say *et al.*, 2014, p. 325). Antibiotic prophylaxis after normal birth is likely to decrease infection risk, especially in settings where proper hygiene, infection control measures and sanitation during labour, childbirth and the postpartum period are not guaranteed, or where early recognition of puerperal infections, and laboratory investigations are inadequate (Bonet *et al.*, 2017, p. 2). Infection risk is higher in women who experience third or fourth-degree perineal tears during vaginal delivery, which warrant antibiotics for prevention of wound complications (WHO, 2014a, p. 5, 2017a, p. 436). Previously, some countries, such as India, applied widespread prescription of antibiotics for prophylactic purposes to women having both normal and operative vaginal delivery (Sharma *et al.*, 2013, p. 6). However, routine antibiotic prophylaxis is not recommended for women with uncomplicated vaginal births (WHO, 2018b, p. 165). In contrasting, a Cochrane review carried out recently suggests that routine administration of prophylactic antibiotics after normal vaginal births needs to be balanced by patient features, childbirth setting and provider experience, including considerations of raising antimicrobial resistance by using antibiotics without discrimination (Bonet *et al.*, 2017, p. 18).

Recommendation 12: Psychosocial support

The initial few weeks with a new baby are very demanding for the mother and, therefore, she needs help, both physical and emotional. Psychosocial support is an essential component of the physical and emotional wellbeing of mothers after childbirth (Rennie *et al.*, 2013, p. 7). Psychosocial support by a health care provider is crucial to provide comfort, consolation, and encouragement to mothers and address some of their psychosocial needs after childbirth (Mselle *et al.*, 2018, p. 1). The psychosocial needs that require continued psychosocial support from a health care provider include those that relate to transitioning to the new role, attachment to the infant, body self-image concerns and changes in the family relationship (Fahey and Shenassa, 2013, p. 616). In addition, psychosocial support is recommended for the prevention of postpartum depression in women at high risk of developing this condition (WHO, 2013, p. 128, 2014a, p. 5). In addition to addressing psychosocial needs, psychosocial support has also been effective in improving exclusive breastfeeding rates of postnatal mothers in the United States (Martinez-Brockman, Harari and Pérez-Escamilla, 2018, p. 45).

Having discussed at the recommended PNC for both the newborn and the mother, the next section will describe the uptake of PNC.

3.4 UPTAKE OF POSTNATAL CARE

Uptake of PNC is documented as being poor compared to other essential obstetric care, such as antenatal care and use of skilled birth attendant (Langlois *et al.*, 2015, p. 259). While the global use of skilled birth attendants is at 73% and antenatal care at 86%, the uptake of PNC still stands at 58% (WHO, 2016a, p. 46). The same findings have been reported in Swaziland, where there is a high use rate of antenatal care (97.3%) and skilled birth attendance (74.0%), and a low rate of PNC uptake (20.5%) (Tsawe *et al.*, 2015, p. 1). The 2003 Kenya Demographic Health Survey, cited by Mwangi and Warren (2008, p. 1), indicates that only 58% of women delivered in health facilities, compared to 88% who seek antenatal care; of those who give birth at home, only 10% receive any PNC. In the Democratic Republic of Congo, 93.5% of women delivered in health facilities, but only 34.6% received PNC (Ntambue *et al.*, 2012, p. 7).

Trends in the uptake of PNC in different countries show a significant variation. Uptake of and access to PNC are still limited in LMICs. According to the WHO, the current uptake of PNC by mothers in LMICs is at 58%, while that of newborns is 28% (WHO, 2016a, p. 46). In Ethiopia, studies done in two regions reveal the level of PNC service uptake to be 36.5% and 33.5% (Hordofa *et al.*, 2015, p. 691; Limenih, Endale and Dachew, 2016, p. 4). The situation is not different in other countries, such as Nepal, where PNC is utilised by 43.2% of mothers (Khanal *et al.*, 2014, p. 4). In Rwanda, it is documented that, by the year 2010, only 12.8% of women visited health facilities for PNC (Rwabufigiri *et al.*, 2016, p. 3) In Kenya, by the year 2014, only 57% of women had received PNC (Kenya National Bureau of Statistics, 2015, p. 134).

Data from demographic health surveys of various countries shows variation in uptake of PNC. For example, in Nigeria, about 40% of women received PNC within two days of delivery (Mallick, Dahiru and MacQuarrie, 2016, p. 28); the situation was similar in Rwanda, where 43% of women received PNC (Assaf, Staveteig and Birungi, 2018, p. 23). In Zambia, the uptake of PNC by women is at 16% (Bwalya, Mulenga and Mulenga, 2016, p. 1). Ethiopia recorded the lowest uptake of PNC, with a figure below 10% (Fekadu, Getahun and Kidanie, 2018, p. 14). It is important to note that Nigeria and Ethiopia are among the countries that have been reported to have the highest maternal mortalities, of 917 and 401 maternal deaths per 100 000 live births in the year 2017 respectively (WHO, 2019b, p. 2).

An increase in uptake of PNC has been documented in some countries. According to the Demographic Health Survey of Cambodia, there was an increase in uptake of PNC, from 65% to 90% from the year 2000 to 2014 (Mallick, Allen and Hong, 2018, p. 14). This increase in uptake was due to certain health care initiatives, such as community-based health insurance schemes and health equity funds instituted by the government of Cambodia that aimed to increase the use of maternal health services (Mallick, Allen and Hong, 2018, p. 33). In Sierra Leone, coverage of PNC for mothers improved significantly between the 2008 and 2013 surveys, from 56% to 72% (Assaf and Winter, 2015, p. 26). The increase was a result of several government initiatives, such as National Population Policy, the National Health Sector Strategic Plan for 2010-2015, and the Free Health Care Initiative, which were launched by the government to improve maternal health outcomes (Assaf and Winter, 2015, p. 1).

Uptake of PNC has shown regional disparities, with urban areas having higher uptake than rural areas. For instance, in Nigeria, while the uptake of PNC is 78% in some urban areas (Olaitan *et al.*, 2017, p. 5), the uptake in some rural areas is reported to be as low as 37% (Somefun and Ibisomi, 2016, p. 1). In Kenya, the uptake in urban areas is 72%, and that of rural areas, 49% (Kenya National Bureau of Statistics, 2015, pp. 132–135). The urban-rural disparity is documented in some LMICs, such as Burkina Faso, Malawi, Mozambique (Duysburgh *et al.*, 2015, p. 6) and Tanzania (Mohan *et al.*, 2015, p. 4), where innovative health care interventions in the postnatal period are recommended to improve maternal and infant outcomes. The WHO recognises that there have been gaps in the provision and uptake of PNC services that require programmes that address these gaps (WHO, 2009, p. 7). Several factors determine postnatal uptake, hence, the variation. These determinants will be discussed in the next section.

3.5 DETERMINANTS OF POSTNATAL CARE UPTAKE

Several factors determine the uptake of PNC services, including maternal characteristics, such as age, education, and employment status, antenatal visits and place of delivery, place of residence, distance from a health facility, and sociocultural beliefs (Fort, Kothari and Abderrahim, 2006, pp. 8–9; Tesfahun *et al.*, 2014, p. 2350; Hordofa *et al.*, 2015, p. 691; Rwabufigiri *et al.*, 2016, p. 3; Somefun and Ibisomi, 2016, pp. 5–8). Some of these determinants of PNC uptake are among the distal variables described in the IMBP that play an indirect role in influencing the uptake of a behaviour (Fishbein and Yzer, 2003, p. 167; Yzer,

2008, p. 24). According to the model, demographic, socioeconomic, and cultural determinants are conceptualised as possible sources of beliefs (Yzer, 2008, p. 24). The beliefs, in turn, influence the three primary determinants of intention, as described in the previous chapter.

3.5.1 Maternal characteristics

Maternal age. Several studies have linked the mother's age at the time of delivery to her probability of seeking PNC, with the majority of these studies reporting statistical significance. For example, one study reveals that the majority (51%) of women aged 20 years or older at the time of delivery were more likely to attend PNC clinics, compared to only 23% of younger mothers (Rahman, Haque and Zahan, 2010, p. 142). Two other studies in Nigeria discovered a similar effect about maternal age (Dahiru and Oche, 2015; Somefun and Ibisomi, 2016). However, one study in Nepal found that the probability of PNC uptake decreased with increasing maternal age (Khanal *et al.*, 2014, p. 610), though a confounding effect of high parity (a known determinant of PNC) may have affected the findings of this specific study. The association of young age with lower uptake of PNC may be because younger maternal age indicates lower educational attainment (Rutaremwa *et al.*, 2015, p. 3)

Education. Virtually all pertinent studies cite the woman's level of education as a definitive determinant of seeking PNC. Evidence supports the inference that higher levels of formal education influence health-seeking behaviours. Women with primary education are more likely to attend PNC clinics than women with no education (Rahman, Haque and Zahan, 2010, p. 142; Ochako *et al.*, 2011, p. 4; Akunga, Menya and Kabue, 2014, p. 1453; Khanal *et al.*, 2014, p. 610; Dahiru and Oche, 2015, p. 4; Langlois *et al.*, 2015, p. 264; Somefun and Ibisomi, 2016, p. 2; Yaya, Bishwajit and Shah, 2016, p. 6). Conversely, women with secondary and tertiary education are even more likely to seek PNC (Rutaremwa *et al.*, 2015, p. 3). In a study that supports these findings, Somefun and Ibisomi (2016, p. 7) applied multinomial logistic regression to secondary data of the Nigerian Demographic Health Survey 2013. The researchers analysed the factors related to suboptimal uptake of PNC by Nigerian mothers. They report that maternal schooling is a critical determinant of PNC, because it uplifts the socioeconomic status, empowers mothers to gain access to health services, and informs them of the importance of the available services.

In addition, the reason for this correlation could be that the knowledge gained during formal learning deconstructs unfounded beliefs that hinder access to health care (Mon *et al.*, 2018, p.

8). The learned mother has access to more accurate information about diseases and the most effective preventive strategies for diseases. Through enhanced awareness of the essence of PNC, formal education multiplies the demand for services (Dahiru and Oche, 2015). The impact of schooling on health-seeking behaviour is, furthermore, supported by the observation that virtually all studies that explored the determinants of PNC recommend targeting remote and less educated women (Neupane and Doku, 2013, p. 1922; Khanal *et al.*, 2014, p. 610; Dahiru and Oche, 2015, p. 4).

Evidence also provides insight into the influence of the woman's partner's education in seeking PNC. A study in Nepal, which examined the factors attributed to PNC uptake among Nepalese women, discovered that mothers whose partners had higher education were more likely to use PNC compared to those whose partners had a lower level of learning (Khanal *et al.*, 2014, p. 610). Moreover, other factors on the socioeconomic status continuum can explain the influence of schooling on health-seeking behaviours further; these factors include employment status and income.

Employment status and income. Another socioeconomic factor that affects the uptake of PNC and which is related to education is employment status. The assumption is that education increases the chances of securing formal employment. Women in formal employment are in a better position to afford PNC services than women who are not employed (Langlois *et al.*, 2015, p. 264). In Nepal, women working in the agricultural sector were less likely to attend PNC than women with white-collar jobs (Khanal *et al.*, 2014, p. 612). Women who occupy lucrative positions in the job market have higher income, which promotes financial access to PNC further (Rahman, Haque and Zahan, 2010, p. 145; Ochako *et al.*, 2011, p. 4). Mothers with higher income are more likely to receive PNC than their counterparts with low income (Mon *et al.*, 2018, p. 6; Wudineh *et al.*, 2018, p. 5). Low income may result in financial hardship, which is usually a barrier to accessing PNC services (Rutaremwa *et al.*, 2015, p. 7; Yaya, Bishwajit and Shah, 2016, p. 10). Furthermore, households with high income suggest that the individual is more likely to reside in an urban centre, where availability of a variety of health facilities enhances access to PNC (Ochako *et al.*, 2011, p. 5; Ruktanonchai *et al.*, 2016, p. 8).

3.5.2 Antenatal visits and place of delivery

Evidence of the influence of skilled care during pregnancy, labour, and delivery on health-seeking behaviours during the postpartum period is mixed. The majority of studies support the hypothesis that comprehensive antenatal care increases the uptake of PNC (Rahman, Haque and Zahan, 2010, p. 142; Tesfahun *et al.*, 2014, p. 2348; Somefun and Ibisomi, 2016, p. 4; Jacobs *et al.*, 2017, p. 4). In a study done in Kenya, the findings were that mothers who had attended antenatal care in hospitals and those who had received skilled antenatal care were more likely to seek postnatal health assessment (Akunga, Menya and Kabue, 2014, p. 1452). However, it is noteworthy that not all women attending antenatal care end up seeking PNC. A study in Nigeria revealed that, while 54% of participants sought antenatal care, only 29% received postnatal services (Dahiru and Oche, 2015).

The relationship between the place of delivery and the likelihood of using PNC is not yet conclusive. Studies conducted in different LMICs yielded mixed results, even though it is logical to assume that hospital delivery ensures that the mother will have the first PNC check-up before discharge. Other studies have demonstrated that hospital delivery significantly predicts the use of PNC (Rahman, Haque and Zahan, 2010, p. 144; Tesfahun *et al.*, 2014, p. 2348). In contrast, in Nigeria, women who gave birth outside hospital settings were more likely to seek PNC than those who had given birth in hospitals (Somefun and Ibisomi, 2016, p. 8). Another study in Kenya revealed that the majority of mothers who delivered at home reported having had a health check in the postnatal period (Akunga, Menya and Kabue, 2014, p. 1452).

3.5.3 Place of residence

A few studies have reported a significant association between the place of residence and PNC uptake (Tsawe *et al.*, 2015, p. 9; Somefun and Ibisomi, 2016, p. 7). Somefun and Ibisomi (2016, p. 7) indicate that the place of residence (urban vs. rural) affects women's uptake of PNC services – rural women are less likely to seek PNC. Urban areas have a greater concentration of hospitals and are also targeted by more health-promotion strategies, leading to higher uptake of PNC (Langlois *et al.*, 2015, p. 266). In addition, mothers who reside in urban areas are more likely to use PNC, since they may have higher educational status and a sound awareness of the importance of PNC services more than mothers in rural areas (Limenih, Endale and Dachew, 2016, p. 5). Mothers in rural areas often face barriers relating to accessibility, availability, and affordability of health services, which often limit them from using PNC (Lund *et al.*, 2014, p.

1262; Somefun and Ibisomi, 2016, p. 7; Duclos *et al.*, 2017, p. 42). In contrast, Tsawe et al.(2015, p. 7) report that rural women were more likely to take up PNC than mothers in urban areas; however, this finding could be due to the expansive coverage of community-based PNC.

3.5.4 Distance from health facility

Geographical accessibility is a widely recognised as predictor of health care uptake. Accordingly, the geographic distance to the nearest health facility significantly influences the mother's decision to seek PNC, and the closer the PNC is to the woman, the more likely she is to use it (Better Care South Africa, 2019: Online). A study done in Ethiopia reports that distance to the nearest health institution is a critical determinant of PNC uptake (Tesfahun *et al.*, 2014, p. 2344); similarly, a study in Nigeria concludes that distance to a health facility is a statistically significant predictor of PNC uptake (Somefun and Ibisomi, 2016, p. 3). These studies are consistent with Ruktanonchai *et al.* (2016, p. 12), who discovered that decreased access to the nearest health facility deterred uptake of all maternal and child care. It is, perhaps, essential to note that the barriers to health facilities are more pronounced in rural areas, due to inadequate infrastructure. As a result, rural areas experience low uptake of PNC services, as described in the previous section.

3.5.5 Sociocultural beliefs

A systematic review done on access barriers to obstetric care at health facilities in SSA report that people who hold traditional African beliefs and adhere to related practices, which include religion, were less likely to use PNC (Kyei-Nimakoh, Carolan-Olah and McCann, 2017, p. 7). The lack of PNC use as identified in the systematic review was ascribed to cultural restrictions on women from specific households or communities, that prevented them from leaving their homes or seeking PNC (Kyei-Nimakoh, Carolan-Olah and McCann, 2017, p. 7). Traditional beliefs prioritise the use of home-based remedies over scientific treatment. Such cultures are more likely to support using traditional birth attendants than skilled hospital personnel. Similarly, chauvinist cultures limit women's autonomy, thereby reserving the decision to seek professional care for husbands. In Ethiopia, the ability of the mother to decide on where and when to seek health care had a significant association with PNC uptake (Tesfahun *et al.*, 2014, p. 2348). Religion and ethnicity are part of sociocultural factors that influence practices and beliefs, which play a critical role in the uptake of PNC (Mon *et al.*, 2018, p. 8).

Some religious beliefs may also place barriers to health care access. For instance, Muslim women may not be permitted to attend PNC unless in the company of their spouses (Rahman, Haque and Zahan, 2010, p. 141). While this might have positive outcomes in antenatal care, mainly because of the opportunity for couple counselling about pregnancy, the negative implications are far-reaching. Specifically, such beliefs will implicitly delay health care uptake until the husband is available to accompany the wife. The findings of the same study show that Muslim women were less likely to seek PNC. Moreover, these mothers preferred interactions with female health care providers. All these issues decrease the likelihood of receiving PNC (Rahman, Haque and Zahan, 2010, p. 141). According to Warren, Muslim mothers in Ethiopia are restricted from seeking timely PNC, because of the 40-day confinement rule post-delivery. During this period, it is said the woman should protect the newborn from malevolent eyes that would otherwise harm the child (Warren, 2010, p. 112). Sociocultural beliefs are closely related to ethnicity.

The ethnicity of women has been found to be statistically significantly related to the use of PNC services (Langlois *et al.*, 2015, p. 264). A study done in the United States reports that uptake of PNC by mothers with postpartum depression was lower among black and Latina women than in whites, and this was attributed to stigma, communication problems, and logistical issues among the first two ethnic groups (Kozhimannil *et al.*, 2011, p. 7). In India, women from lower castes were found to be less likely to use PNC services than those belonging to upper castes (Langlois *et al.*, 2015, p. 266). Similar findings are reported for Nepal, where specific ethnic groups were considered disadvantaged and more likely to discontinue PNC (Chalise *et al.*, 2019, p. 9). Community-based programmes were recommended to reach to such ethnic groups.

3.6 SUMMARY

This chapter described PNC. Several recommendations provided by the WHO for the provision of PNC and the practices of each recommendation were explained, as were uptake and determinants of PNC. Some of the determinants that were explained are among the distal variables highlighted in the IMBP. The in-depth description of PNC in this chapter referred to the low uptake of PNC, and the proposed potential of mHealth communication to strengthen PNC described in the previous chapter, form the basis for the development of an mHealth communication framework to address the crucial gap in uptake of PNC in rural areas. The next

chapters will describe the phases carried out to develop an mHealth communication framework for PNC in rural areas, in the form of publishable articles.

CHAPTER 4: MHEALTH COMMUNICATION TO STRENGTHEN POSTNATAL CARE IN RURAL AREAS: A SYSTEMATIC REVIEW

4.1 INTRODUCTION

Uptake of postnatal care in rural areas remains weak, and contributes to increasing rates of maternal and neonatal mortality. mHealth communication, as an emerging technology, has the potential to improve coverage of health services, though there is limited evidence to demonstrate how this technology can strengthen PNC in rural areas. This chapter will present a published article that describes a systematic review on the best available evidence regarding mHealth communication to strengthen PNC in rural areas.

4.2 ARTICLE DETAILS

Title	mHealth communication to strengthen postnatal care in rural areas: A systematic review
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RESEARCH ARTICLE Open Access

mHealth communication to strengthen postnatal care in rural areas: a systematic review

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Abstract

Background: Postnatal care (PNC) in rural areas is characterised by low uptake, with possible effect on maternal and neonatal mortality rates. Mobile health (mHealth) communication has been proposed to promote the uptake of health services; however, there is limited information on how mHealth can strengthen PNC in rural areas. The objective of this review was to gather the best available evidence regarding mHealth communication to strengthen PNC in rural areas.

Methods: Studies published between 1 January 2008 and 31 August 2018 were searched in electronic databases hosted by EBSCO Host. Reference list checking and contact with authors were also done. Critical appraisal of the eligible studies was also done.

Results: The results of 11 articles were synthesised to report the determinants of PNC uptake. Determinants were aligned to the Integrative Model of Behavioural Prediction (IMBP). One-way mobile phone messaging was the most common type of mHealth communication used. mHealth communication influenced mothers' intentions, skills, and environmental constraints associated with uptake of PNC. Intentions were influenced by attitudes, perceived norms and self-efficacy. Positive attitudes, as well as changed attitudes toward PNC practices were observed. Perceived norms that were enhanced were delivery at a health facility with immediate PNC, seeking of reinforcement and professional health support of newborn care practices, and male partner support. Improved self-efficacy was demonstrated by mothers who attended scheduled appointments and they were confident with regard to newborn care practices. Skills for PNC that were improved included cord care, thermal care, appropriate breastfeeding and problem-solving. The environmental constraints faced and which were addressed in the studies included inaccessibility, unavailability and unaffordability of PNC services in rural areas.

Conclusions: Results from the literature included in this study show that one-way mobile phone messaging is the common type of mHealth communication used to strengthen PNC in rural areas. mHealth communication can influence intentions, skills and environmental constraints as determinants of PNC uptake. mHealth communication is recommended to strengthen PNC in rural areas. To widen the evidence, more studies in the field of mHealth communication that report a variety of both maternal and neonatal outcomes are needed.

Keywords: Postnatal care, Mobile health, Communication, Rural, Systematic review

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Background

Postnatal care (PNC) is the care provided to the mother and the neonate from birth up to 6 weeks [1]. This study focused on the PNC care provided by health professionals. PNC improves the chances of survival of both the mother and the neonate, by helping prevent and treat complications arising from childbirth, and by providing the mother with valuable information on how to care for herself and her neonate [2]. PNC care is recommended to improve maternal and neonatal health, which has received relatively little attention in many low- and middle-income countries (LMICs) [3].

Globally, the uptake of PNC shows a substantial gap between LMICs and high-income countries, with high-income countries reaching 90% of mothers and neonates, compared to only 30% being reached in LMICs [4]. PNC that is provided in LMICs tends to be lower and weaker in rural areas than in urban areas; this phenomenon creates regional inequalities, and holds disadvantages for the population living in such areas [5]. Rural areas refers to areas of open country and small settlements [6]. Rural areas are characterised by poor access and uptake of health services, in addition to other issues, such as low literacy levels, large geographical areas, social marginalisation, unskilled human resources and inadequate financial resources among the population [7, 8]; all these factors can influence uptake of PNC services. For the purposes of this study, all areas outside an urban area were considered to be rural. Among the LMICs that report suboptimal uptake of PNC in rural areas are Kenya and Nigeria. These two countries have substantial urban-rural disparities: the uptake in rural Kenya is 49%, compared with 72% in urban areas [9], while Nigeria reports a PNC uptake of 27% in rural areas, compared to 73% in urban areas. Tanzania also experiences this disparity, with less than 25% of the population in rural areas utilising PNC [10]. To address this inequality, and to strengthen PNC in rural areas, practical solutions have to be devised.

Technological approaches to solving this problem, such as mobile Health (mHealth), have the the potential to reduce inequalities in PNC uptake by improving communication between healthcare providers and clients [11]. Studies generally propose mHealth communication interventions as effective solutions for problems relating to maternal and neonatal health [12, 13]. These interventions are recommended to enhance preventive maternal and healthcare services by improving client education and behaviour change communication, tracking of registries/vital events, data collection and reporting, provider-to-provider communication, and electronic health records [14, 15]. All these aspects are essential for strengthening uptake of PNC, particularly in rural areas where accessibility of maternal and neonatal health often has numerous obstacles, such as social, geographical and economic barriers, shortages of skilled health staff, lack of information on sexual and reproductive health, the cost of medical treatment, sociocultural factors and negative perceptions of quality of care [16, 17].

The increasing use of mobile phones by diverse populations holds promise that implementing mHealth interventions could expand healthcare coverage and strengthen the uptake of health services, such as PNC [18]. The availability and, thus, utilisation of mobile phones is growing rapidly, almost the entire world population, or 96%, is now living within reach of a mobile cellular network, with developing countries registering much faster growth in mobile broadband subscriptions than developed countries [19]. Though rural areas are said to be limited regarding mobile penetration compared to urban areas [20], the increasing trend in penetration has great potential for the application of mHealth interventions in rural areas.

Though these interventions have been proposed to address a variety of health challenges, there is limited literature and evidence to demonstrate how mHealth interventions can be used to strengthen PNC in rural areas. The World Health Organization has identified knowledge gaps in the area of mHealth, and recommends more research to be undertaken to evaluate the role of mHealth interventions in the delivery of PNC, and to determine how the interventions could contribute to improving maternal and perinatal health [1]. The objective of this study was to perform a systematic review of the best available evidence about mHealth communication, in order to strengthen PNC in rural areas. The Integrative Model of Behavioral Prediction (IMBP) [21] was used in this review to highlight various determinants that may strengthen PNC uptake.

Theoretical framework

The IMBP (Fig. 1) guided this review by identifying the determinants of behaviour change that might affect PNC uptake. The IMBP accounts for uptake of any behaviour in any given population [22]. It is a powerful model for predicting behaviour across a variety of fields, and has been used to boost or reduce certain behaviours with public health implications [23–26]. According to the IMBP, only a small number of determinants need to be considered to predict, change, or reinforce a particular behaviour in any given population [22]. The model proposes that any given behaviour is most likely to occur if a person has a strong intention to perform the behaviour, if a person has the necessary skills and abilities required to perform the behaviour, and if no environmental constraints prevent behavioural performance [21]. Intentions are influenced by the attitude toward performing the behaviour, perceived norms

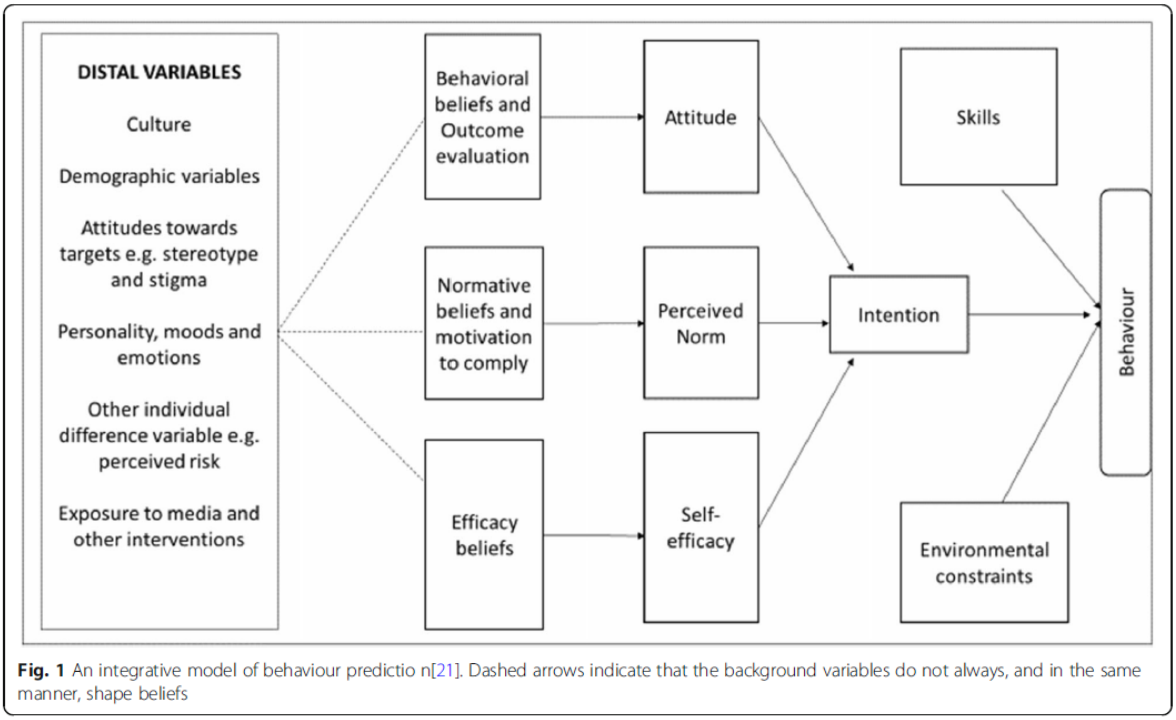

Fig. 1 An integrative model of behaviour predictio n[21]. Dashed arrows indicate that the background variables do not always, and in the same manner, shape beliefs

concerning performing the behaviour, and the person's self-efficacy with respect to performing the behaviour [21, 22]. Attitudes, perceived norms, and self-efficacy are global perceptions that represent a variety of specific beliefs about the particular behaviour [22]. They are all functions of specific beliefs that influence intentions in the model. In this review, the uptake of PNC was determined by highlighting the various outcomes aligned with the primary determinants of the behaviour in the model, i.e., intention, skills, and environmental constraints.

Methods

Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines were followed in this systematic review [27]. The PICO (population, intervention, comparison, outcome) format [28] was used to develop a research question that guided the search strategies and review, namely, how can mHealth strengthen PNC in a rural area? The protocol was registered in the International Prospective Register for Systematic Reviews (PROSPERO) CRD42018102299 [29].

Search strategies

After a rapid appraisal, search words were generated from three major PICO elements (population, intervention, outcome) and a group of synonyms and related concepts was created and combined using OR and AND operators, to ensure comprehensive search (Table 1). The following databases were used on the EBSCOHost interface: Academic Search Complete, Africa-Wide Information (containing data from the National Research Foundation database of current and completed research projects), CAB Abstracts, CINAHL with Full Text, Communication & Mass Media Complete, ERIC, Health Source: Consumer Edition, Health Source: Nursing/Academic Edition, MasterFILE Premier, MEDLINE with Full Text (containing the same data as PubMed), PsycINFO, SocINDEX with Full Text and SPORTDiscus with Full Text. In addition, checking the reference lists of the studies that were included added three further studies. The authors were contacted in the case of two studies, to confirm the settings of the studies. Before the final analysis, the search was rerun, but no other studies were retrieved for inclusion.

Study selection

The inclusion criteria that were applied included that the literature had to be written in English, or that studies written in other languages had to have abstracts written in English, mHealth communication had to be between healthcare personnel and mothers, or involved community members, mHealth communication was aimed at improving health outcomes of either a mother or child, mHealth communication was with mothers or community members from semi-urban and rural areas, and that

Table 1 Search words aligned to PICO

Variable	Search Words
Population: Postnatal mothers or involved community members (any person that could support the mother/baby to ensure better PNC outcome, e.g., father; grandmother; village elder; community health worker)	(family* or families* or mother* or father* or parent* or (communit* n3 (carer* or caregiver* or care-giver* or "care giver*" or "lay worker*" or "health worker*" or volunteer*) (child* or pediatr* or paediatr* or postnatal* or post-natal* or neonat* or newborn* or "after birth*" or "MATERNAL health service*")
Intervention: Mhealth intervention	AND (mHealth or "mobile health" or sms or "mobile phone*" or "mobile telephone*" or cellphone* or "cell phone*" or "text* messag*" or "short message service*"or mHealth or m-health or "mobile health" or ehealth or e-health or sms* or "instant messag*" or "mobile phone*" or "mobile telephone*" or cellphone* or "cellular phone*" or "cellular telephone*" or smartphone* or "smart phone*" or "mobile device*" or "electronic device*" or "portable device*" or "phone intervention*" or "telephon* interventio-n*"or online or app or apps or "WIRELESS communication systems in medical care" or "ONLINE information services")
Outcome: beliefs, attitude; norms; self-efficiency; skills; intention; environmental constraints	(belief* or conviction* or faith or trust* or norm or norms or custom* or attitude* or outlook* or approach* or Self-efficac* or ability* or Skill or skills or expertis* or ability* or talent* or proficien* or knowhow or capability* or knack or competent* or Intent* or determination* or planning or resolve or decide* or decision* or choose or select* or choice*)

literature had to have been published between 1 January 2008 and 31 August 2018. Exclusion criteria were that mHealth communication focused on peer support amongst mothers, mHealth communication was with mothers or community members whilst mothers were still hospitalised, literature involved evaluation of mHealth programmes and health systems, and literature represented research briefs, research news, commentaries, editorials or proposals. Three reviewers (FM, MR and AF) independently screened titles, abstracts, and full-text articles to decide whether an article was relevant. Any discrepancies among reviewers were resolved by obtaining consensus. Only studies published in peer-reviewed journals were included. The results of study screening and selection are illustrated in Fig. 2.

Data extraction

A standardised, pre-piloted form was used to extract data from the studies included, to assess study quality and to synthesise evidence. Extracted information included bibliographical details, methodology, outcomes and intervention, critical appraisal rating and study findings (see Additional file 1.).

Quality assessment of studies included

Three reviewers conducted the critical appraisal of the study independently, to ensure the validity and to increase the reliability of the process. A critical appraisal checklist that was suitable for each research design of studies that were appraised was selected. For randomised, controlled trials and qualitative and cross-sectional studies, checklists developed by the Critical Appraisal Skills Programme (CASP) [30] were used to assess the quality of each study. The quality of non-randomised studies was examined using the checklist for quasi-experimental studies (non-randomised experimental studies) of the Joanna Briggs Institute [31]. Although the scores differed according to the research design used, all these checklist tools focused on the following aspects: appropriateness of methods used, clarity of focus, the recruitment process, the accuracy of measures used, data collection, presentation and analysis, clarity in the statement of the findings, and appropriateness of context. Higher scores indicated higher quality. A data extract sheet provides the quality assessment of all studies included. Grades were assigned to show the level of the evidence according to guidelines of the American Dietetic Association [28] (Additional file 1).

Results

A narrative synthesis of the results of the studies, structured around IMBP, was done to highlight the best evidence of mHealth communication for strengthening PNC in rural areas. Results were gathered from the 11 articles that met the eligibility criteria. The results summarise the type of mHealth communication used and determinants that strengthen PNC, namely, intentions, skills and environmental constraints. Intentions were influenced by attitudes, perceived norms, and a person's self-efficacy with respect to PNC uptake (Additional file 2).

Types of mHealth communication used to strengthen PNC in rural areas

Seven types of mHealth communication were used to strengthen PNC in rural areas; these were phone calls, one-way messaging, interactive messaging, audiovisual material and videos, voice messages, and combined messaging and phone calls. Mobile phone calls were used by

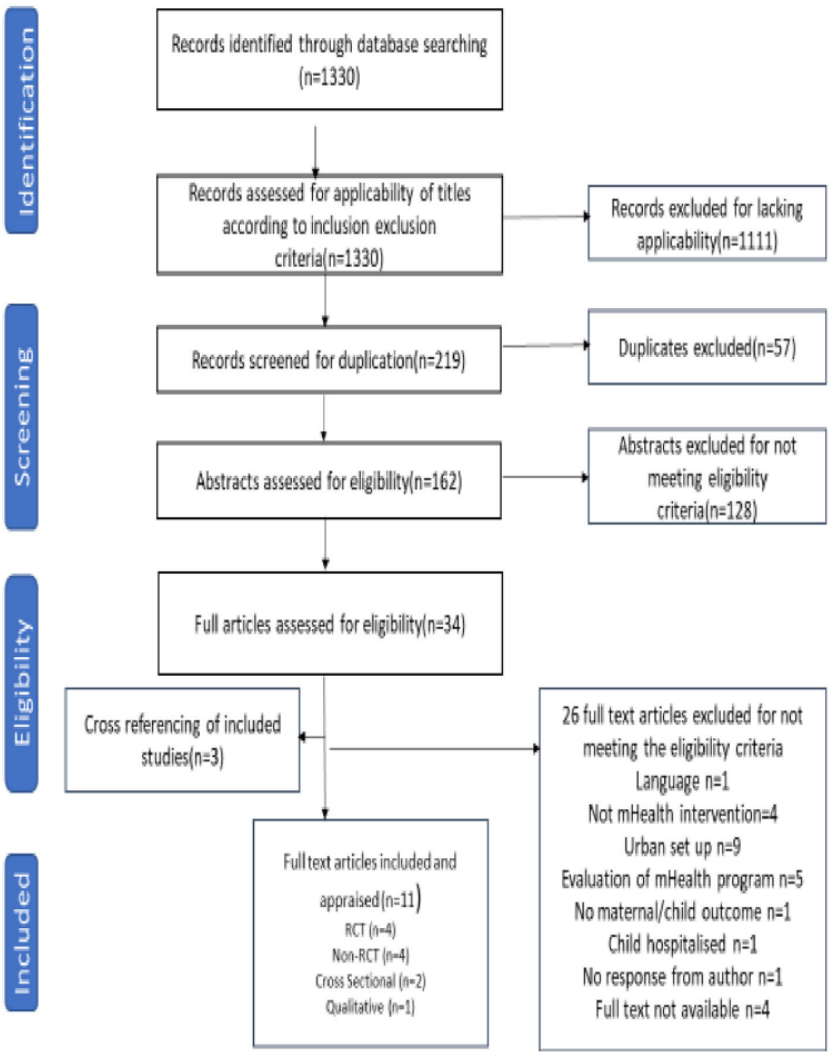

Fig. 2 PRISMA flow diagram for database search of studies. The diagram show the studies included and reasons for excluding some of the studies

village health team members to consult healthcare professionals on matters regarding PNC [32, 33]. These calls were also used by healthcare practitioners (HCPs) to remind mothers to attend PNC clinics and to inform them of their laboratory results [7, 13, 34, 35]. One-way mobile phone messaging was used by HCPs to remind mothers of clinic appointments, communicate test results from the clinic and to give them information on PNC [7, 13, 34–39]. Interactive mobile phone messaging between HCPs and mothers was used to discuss breastfeeding practices and remind mothers to attend PNC clinics [40]. Mobile phone audio visual application and educational videos was sent to mothers by HCPs to illustrate various PNC practices [37]. A combination of one-way mobile phone messaging and phone calls was used by HCPs to remind mothers about their clinic appointment dates [13, 35]. Voice messages were delivered to mothers by HCPs to inform them of neonatal care [7]. Among all these types of mHealth communication, one-way mobile phone messaging was commonly used to influence the three primary determinants of PNC uptake, i.e., intention, skills and environmental constraints.

Intentions

Intentions, as described in the IMBP, are influenced by attitudes, perceived norms and self-efficacy, all of which are functions of specific beliefs described in the model. Though not all articles addressed the three determinants

of intention, the themes emerging from the results that were found to change or maintain PNC outcomes targeting attitude, perceived norms, and self-efficacy, were as follows.

Attitudes

Although not all the articles addressed attitude change, some studies indicated that positive attitudes were observed, while other studies specified changes in attitudes of mothers when mHealth communication was used. In Kenya, some mothers changed attitudes towards attending postnatal clinics for HIV testing of their infants and, as a result, their infants were tested [40]. In rural areas of Guatemala, some mothers changed their attitudes to exclusive breastfeeding after health professionals wrote text messages to them on newborn nutrition and, consequently, they started breastfeeding exclusively [38]. In rural areas of Ethiopia, there were postive attitudes observed about delivering in the hospital and seeking PNC services in health centres. In rural areas of Bangladesh, some mothers changed their beliefs about PNC and consequently attended PNC clinics to have their children vaccinated in a timely manner [39], they changed attitudes to recommended PNC practices, such as delaying the first bath and breastfeeding babies immediately after birth [7]. In rural areas of Uganda, providing additional information through mHealth communication lead to attitudinal change on newborn care practices among some mothers, i.e., breastfeeding immediately after birth, cord care and thermal care by mothers [32].

Perceived norms

The results report enhanced perceived norms about the uptake of PNC services when mHealth interventions were used. For example, in rural areas of Uganda, Ethiopia and India, HCPs used mHealth communication to influence mothers to deliver in hospitals and seek care for newborns' illnesses. Previously, the norm in these countries had been to deliver at home, and mothers delayed seeking care for newborns' illnesses [33, 36, 37]. In Ethiopia, mHealth interventions influenced mothers to deliver in the presence of trained health extension workers and to use PNC immediately; this represented an improvement in the use of PNC compared to their intial preference for delivering at home and not using PNC soon after delivery [36]. In rural areas of Uganda, use of mHealth communication with health professionals during home visits elicited male partner participation in PNC issues; these men were not previously involved, and their participation enhanced uptake of PNC [32].

Self-efficacy

Although not all articles addressed self-efficacy, the results show improved self-efficacy with the use of mHealth communication among some mothers. Postnatal women in particular, demonstrated a capacity to adhere to recommended PNC practices. In Cameroon, some mothers gained the confidence to attend scheduled PNC appointments for HIV care [34]. In India, mothers demonstrated the ability to recognise and report complications during the postnatal period [37]. In Guatemala, the use of mHealth communication enhanced mothers' capacity to breastfeed their newborns exclusively [38]. In Ethiopia, mHealth communication assisted mothers to become receptive to following PNC advice [13]. In Uganda, use of mHealth communication helped mothers to have confidence that, by observing recommended newborn practices, their babies would achieve favourable outcomes, such as proper cord healing [32].

Skills

Though it was not reported by all studies that were reviewed, several skills for PNC were strengthened. mHealth interventions such as reminders to mothers on skills previously taught were used. In Uganda, mothers gained skills in cord care, thermal care and breastfeeding immediately after birth when health professionals explained the skills through mobile phone consultations [32, 33]. When text messages were sent to mothers in Guatemala, providing information regarding breastfeeding practices, mothers reported that they practiced exclusive breastfeeding successfully [38]. In Bangladesh, when text messages were used to give information on neonatal care, mothers demonstrated skills related to breastfeeding immediately after birth and bathed newborns after 3 days [7].

Environmental constraints

mHealth communication addressed possible environmental constraints, such as inaccessibility, unavailability and affordability, which act as barriers to the uptake of PNC services in rural areas, although not all the articles explored this aspect. For instance, mHealth communication addressed the inaccessibility of PNC in rural areas of Uganda, and helped mothers to access information in a timely fashion, and prompted maternal and newborn care [32, 33]. In rural areas of Ethiopia, mHealth communication was used to track mothers by notifying them of PNC services; this provided information on the availability of PNC services [13, 36]. In Kenya, mothers reported that receiving mHealth communication facilitated PNC services [40]. In India, text messages to mothers facilitated more significant contacts without requiring mothers to travel to a health facility, and this enhanced the availability of PNC services [37]. With the use of mobile phone messaging to track newborns due for vaccination, there was timely vaccination of children in rural areas of Bangladesh – the messaging facilitated PNC [39]. In Zambia, text messaging was used to

encourage mothers to return to the clinic and to give test results, leading to early diagnosis and enrolment for care [35].

Discussion

Results from the data synthesis give evidence that a variety of mHealth communication can be used to strengthen PNC in rural areas. One-way mobile phone messaging is the most common type of mHealth communication that is used to strengthen PNC uptake in various rural areas. This is a clear indication that mobile messaging may be the communication of choice for most users instead of other means of mHealth communication. This inference is in line with findings of studies done by Feroz et al. and Watterson et al. [14, 41], who found improved uptake of health services when mobile messaging was used, compared to other types of mHealth communication. Mobile messaging has been cited to be cost effective to implement, and is rated highest for achieving favourable outcomes in health programmes [42–44].

To help with interpretation of the results, the IMBP was used to describe determinants of PNC uptake in rural areas. The evidence from the results indicate that the intention to use PNC services was influenced by positive or changed attitudes, enhanced perceived norms, and improved self-efficacy. Mothers acquired various skills that are required during the postnatal period, and which facilitated use of PNC. Also, the application of mHealth communication reduced environmental constraints that usually hinder the uptake of PNC. All these changes lead to uptake of PNC in rural areas.

Attitudes of mothers to PNC uptake changed in some studies, while others reported positive attitudes with the use of mHealth communication; this attitude was towards PNC practices, such as breastfeeding, cord care, thermal care and care-seeking on newborns' illnesses. A study in Sierra Leone reports that mHealth communication helped mothers to change their attitudes to family planning and, as a result, there was increased uptake of contraceptive services [45]. A study in Malawi reported a change in attitude about immunisation among mothers who received mHealth communication via SMS [43]. Though the two studies in Sierra Leone and Malawi reported on PNC services, these studies were excluded from the systematic review of the current study, since health system programmes were evauated, rather than mHealth interventions. Furthermore, a positive attitude to PNC services has been recognised as a key factor in the uptake of services [46–48].

From the results it is clear that mHealth communication also enhanced perceived norms. Accordingly, mothers utilised immediate PNC, and received support and reinforcement from HCPs and mothers' male partners. Adopting norms, such as hospital delivery, leads to uptake of PNC services. One study demonstrated that women who deliver in a hospital are more likely to use PNC than those who deliver at home [49]. mHealth communication has been identified as a catalyst for involving male partners and gaining their support for uptake of maternal and neonatal health services [50]. These norms are among those recommended by the World Health Organization for uptake of PNC services [1].

The results highlight improved self-efficacy of mothers, who became confident with PNC services and were able to use them when mHealth communication was used. Mothers expressed confidence about following advice, and reported active coping when caring for their newborns. When HCPs used mHealth communication, clients in Cambodia reported improved self-efficacy in using contraception [51]. Other studies have reported improved self-efficacy, although this self-efficacy was for health workers who used mHealth communication [52–54].

This review shows that exclusive breastfeeding, thermal care, cord care and problem-solving skills were strengthened by mHealth communication. Other studies report similar findings, though in different contexts. For example, exclusive breastfeeding and problem-solving skills were strengthened when mHealth communication was used by HCPs in one of the most urban areas of the United States [55]. There are not many studies that report on skills improvement among clients who use mHealth communication, but Labrique et al. [56] suggest that mHealth communication can reinforce and monitor skills among HCPs. In Uganda, mHealth communication improved the skills of community health workers involved in the programme implementation and who were required to manage newborns' illnesses [54].

Environmental constraints, which are commonly cited as a hindrance for the uptake of any health services, were also addressed, and evidence suggests that mHealth communication assists to improve accessibility and availability and promote affordability of PNC services in rural areas. These findings are in line with other studies that demonstrate that mHealth communication reduces physical barriers to accessibility [14, 49, 54] and avails health services at reduced costs [57]. Furthermore, uptake of maternal care is hindered mainly by poor geographical access [16].

This systematic review had its strengths and weaknesses. To strengthen the review, the IMBP was used to help synthesise evidence on specific determinants that lead to PNC uptake. The reviewer also used thorough and clear inclusion and exclusion criteria. The study critically appraised papers published in peer-reviewed journals. The inclusion of five randomised controlled

trials strengthened the evidence presented herein further. The quality of studies was rigorously determined and most of them scored highly. Although the articles that were included were few in number and heterogeneous, there is evidence that mHealth communication can be used to strengthen PNC in rural areas and should, therefore, be utilised, especially considering the advances of mHealth technology.

Nevertheless, the study had limitations. Only papers written in English were eligible for the review and the studies included had limited PNC outcomes that were related to mothers. The term "postnatal" as recommended by WHO was used, rather than "postpartum", which possibly explains the the limited outcomes related to mothers. Not all studies reported on every IMBP determinate or only reported positive outcomes. The authors acknowledge that not all rural areas reported on in this study are similar.

Conclusion

This systematic review concludes that, although a variety of mHealth communication types can be used to strengthen PNC in rural areas, the commonly used type was one-way mobile messaging. mHealth interventions can improve uptake of PNC by influencing intentions and skills and reducing environmental constraints. By changing beliefs related to attitudes, perceived norms and self-efficacy, intentions to use PNC are enhanced. Skills for PNC that can be strengthened by use of mHealth communication are breastfeeding, cord care, thermal care, delayed bathing of babies, safer sleep practices, care-seeking and problem-solving. mHealth communication can reduce environmental constraints, such as inaccessibility, unavailability and unaffordability of PNC services in rural areas, thus, facilitating uptake of these services. Use of mHealth communication is, therefore, recommended to strengthen PNC in rural areas. To strengthen the evidence, there is a need for more studies in the field of mHealth communication that report a variety of both maternal and neonatal outcomes.

Supplementary information

Supplementary information accompanies this paper at https://doi.org/10.1186/s12884-019-2531-0.

Additional file 1. Data extraction and critical appraisal of studies included. This file provides bibliographic details, and information on the aims, design, setting, sample, inclusion-exclusion criteria, primary and secondary outcomes, data collection, intervention, control group, data analysis, critical appraisal, study findings, limitations and recommendations of each article.

Additional file 2. Data synthesis on how mHealth strengthens PNC in a rural areas. This file highlights the types of mHealth communication and the determinants of PNC uptake.

Abbreviations

CASP: Critical appraisal skill programme; HCP: Health care provider; IMBP: Integrative model of behavior prediction; JBI: Joanna Briggs Institute; LMICs: Low and middle-income countries; mHealth: Mobile health; PICO: Population, intervention, comparison, outcome; PNC: Postnatal care; PRISMA: Preferred reporting items for systematic review and meta-analysis; PROSPERO: Prospective register for systematic reviews; RCT: Randomised controlled trial; WHO: World Health Organization

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Authors' contributions

FM designed the protocol, performed the selection, reviewed all selected articles, performed data extractions, and wrote the manuscript. MR and AF validated and reviewed the selection and data extractions, and critically reviewed and approved the final manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

Mt. Kenya University Ethical Review Committee (MKUERC) in Kenya, and Health Sciences Review Ethics Committee (HSREC), University of the Free State, South Africa. Ref No: MKU/ERC/0604 and UFS-HSD2017/1346.

Competing interests

The authors declare that they have no competing interests.

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4.4 ASSOCIATED ADDENDA

Addendum J: Author guidelines (*BMC Pregnancy and Childbirth*)

Addendum K: Additional file 1 (Data extraction)

Addendum L: Additional file 2 (Data synthesis)

CHAPTER 5: EXPERIENCES OF POSTNATAL MOTHERS WITH HEALTH CARE PROVIDERS AND THEIR VIEWS ON MHEALTH COMMUNICATION IN RURAL KENYA: MMOGO METHOD®

5.1 INTRODUCTION

This chapter will present an article that describes the experiences of postnatal mothers with health care providers, and their views on mHealth communication in rural Kenya.

5.2 ARTICLE DETAILS

Title	Experiences of postnatal mothers with health care providers and their views on mHealth communication in rural Kenya: Mmogo method®
Authors	Florence Mbuthia, Marianne Reid, Annali Fichardt
Journal	*PLoS One*
Journal details	Open access, Peer-reviewed journal Listed as an accredited journal by the DoHET [South Africa] Impact factor 2.766 (2018 Journal metrics)
Status	Under review

5.3 ARTICLE 2

Abstract

Introduction

The uptake of postnatal care (PNC) remains low in rural areas of Kenya, and this contributes to high rates of maternal and neonatal mortality. Mobile health (mHealth) communication has been proposed to improve uptake of health services. The purpose of this study was to explore experiences of postnatal mothers with health care providers and their views on mHealth communication in rural Kenya.

Methods

The authors applied the Mmogo method®, a visual-based narrative inquiry. Laikipia county, a rural area in Kenya, was purposively sampled. Women with at least one living child, access to a mobile phone, who had resided in the county for at least six months and who were willing to participate in the research were purposively sampled. Participants expressed their experiences in relation to health care providers (HCPs) in the postnatal period by producing visual presentations with culturally acceptable material provided to them. As they explained the meaning of their visual representations, the experiences with HCPs and their views on mHealth communication were explored. The visual images were photographed and their discussions were audio recorded. The recorded data formed the textual data, which was transcribed and analysed using thematic analysis. Visual and textual data were then triangulated to formulate the themes.

Results

Five themes emerged from the discussions: expectations of mothers regarding HCPs, with reports of not all expectations being met; positive experiences with HCPs, which were expressed as physical and emotional support that mothers had received; outcomes of positive experiences with HCPs that were specific to the mother and child; expectations of mHealth communication, which focused on health education and psychological support; and positive attitudes towards mHealth communication, which focused on HCPs' accessibility and health facility availability and accessibility.

Conclusion

Postnatal mothers in the study had positive experiences with HCPs and views on mHealth communication. Therefore, mHealth communication can be adopted in health systems to improve uptake of PNC services in rural areas.

INTRODUCTION

The period soon after childbirth poses substantial health risks for both the mother and her neonate (1). Postnatal mothers face the risk of bleeding and infection, while the neonate may develop birth asphyxia, severe infections, and conditions related to prematurity (2), which could result in significant ill health, and even death. Indeed, the majority of maternal and neonatal deaths, as well as long-term complications, occur during this period (1). In addition,

it is acknowledged that postnatal mothers usually face increased health needs during the postnatal period, compared to the antenatal period (3). To address these needs, and to assure the best possible outcomes for both mother and neonate, postnatal care (PNC) is required.

PNC is an intervention recommended worldwide for both the mother and the neonate in the first six weeks after birth, to prevent and treat complications stemming from childbirth, and to provide the mother with important information on how to care for herself and her neonate (a child under the age of 28 days) (1,4). PNC is provided by health care providers (HCPs), who are supposed to have at least four contacts with postnatal mothers during the postnatal period (1,5). During these contacts, HCPs play an important role in meeting the vast needs of postnatal mothers and their neonates (6). Good supportive relationships between HCPs and mothers is essential to ensure that mothers seek and take up PNC services (3). This requirement, therefore, underpins the need to explore postnatal mothers' experiences with HCPs.

Patient experience encompasses the range of interactions that patients have with the health care system, which includes care received from HCPs (7). Research indicates that many patients perceive a positive relationship between HCP and patient as the most important aspect of the provision of health care (8). Moreover, patient experiences with HCPs are positively associated with uptake of preventive care, as well as adherence to recommended clinical practice and medication (9). During the postnatal period, a positive experience with HCPs has been indicated to help alleviate fears and anxiety, help mothers gain confidence in caring for their neonates, and learning mothering skills (5,10,11). Good or positive experiences with HCPs remain an important precursor to encouraging mothers to utilise maternal health services (6,12). Inversely, negative experiences with HCPs may result in reduced uptake of services, which is likely to increase the risk of poor health outcomes (3,13,14). Negative experiences reported by postnatal mothers are largely determined by poor communication received from HCPs (10). Therefore, to reduce negative experiences and increase uptake of PNC services, and to improve health outcomes, there is a need to enhance effective communication of HCPs with mothers – a major aspect of patients' experiences.

Effective communication between HCPs and mothers is a prerequisite for building a therapeutic relationship (12). Therefore, HCPs ought to communicate effectively with postnatal mothers and, thereby, assist them in care, clarify doubts, and offer guidelines, all of which can strengthen the adaptive process of a mother after childbirth (15,16). Effective communication is necessary for patient education and information sharing, both of which are critical during the

postnatal period (17). Postnatal mothers should be educated about baby care, nutrition and vaccination, lochia flow, hygiene implementation, sleeping problems, fatigue, and puerperal exercises; in addition, their psychological and emotional state should be assessed (18). Indeed, it is recommended that HCPs should place greater emphasis on postnatal education, so as to empower mothers to acquire the right skills for the postnatal period (6). To facilitate postnatal education, mHealth communication has been recommended. Results indicate positive behaviours and improved uptake of PNC services among postnatal mothers (19), which, therefore, imply that mHealth communication can be an effective source of information during the postnatal period.

mHealth communication has been identified as a feasible mode of health education, with the potential to increase knowledge about maternal and child health care (20). In addition, research indicates that postnatal mothers are more likely to use mHealth communication to reach their HCPs in efforts to seek knowledge on modifiable health risks during the postnatal period (21). It is also recognised that mHealth communication can be used to increase coverage of care and improve both maternal and neonatal outcomes by helping with communication efforts aimed at promoting PNC for mothers and their neonates (22). By improving communication between HCPs and mothers, mHealth communication has the ability to reduce inequalities relating to PNC uptake in many settings (23) – this achievement would be particularly important in rural settings.

Rural areas are characterised by lower uptake of PNC services than urban areas. For instance, in Kenya, only 49% of mothers in rural areas receive PNC, compared with 72% of urban mothers (24). In addition, there is unequitable distribution of health facilities in Kenya, as well as disparity in uptake of health services between rural and urban areas, with rural areas being disadvantaged (25). Mothers in rural areas face low availability and inaccessibility of health care services, which contributes further to lower uptake (26). As a result, postnatal mothers in rural areas have unmet information needs on matters regarding their care and that of their neonates (27). Therefore, mHealth communication has been proposed to give people living in rural areas the ability to connect with HCPs, thus, improving accessibility to information, as well as all other health services (28). In fact, mHealth interventions that are aimed at changing the behaviour of women in the postnatal period have proven to be effective for improving the uptake of PNC services (29). In light of the applicability and significance of mHealth

communication in rural areas, it is critical to examine postnatal mothers' experiences with HCPs, and their views of mHealth communication in rural Kenya.

Research on postnatal mothers' experiences with HCPs is scarce, and studies that have explored patient experiences with health care have concentrated more on the antenatal and intrapartum periods (30,31). This paucity of research is particularly acute in rural settings. The fact that there is limited evidence on experiences and views relating to mHealth communication among postnatal mothers in rural settings made it imperative to conduct this research. Therefore, the purpose of this study was to explore postnatal mothers' experiences with HCPs and their views on mHealth communication in rural Kenya, so as to inform mHealth communication.

MATERIALS AND METHODS

Study design

This was a visual-based narrative inquiry study that used the Mmogo method® (32), which is a visual projective data-collection method, to explore postnatal mothers' experiences with HCPs as well as their views on mHealth communication in rural Kenya.

The Mmogo method®

"Mmogo" is a South African Setswana word that refers to relatedness, co-ownership, togetherness, co-construction and interpersonal threads (32). As such, the method was used in this study to enable co-construction of a narrative that facilitated exploration of experiences at both individual and group levels. The Mmogo method® acknowledges that people are relational beings, and that their visual presentations project something about themselves and the socially constructed contexts in which they function (33). In this study, the Mmogo method® assisted in providing insight into the social meaning of experiences of postnatal mothers with their HCPs, as well as their views on mHealth communication in a rural context. The Mmogo method® is carried out in four phases. In the first phase, introduction is done, group norms are set, the study objectives, requirements, possible risks and benefits, and participants' rights are explained, and informed consent obtained. In Phase 2, participants express their experiences with HCPs in the postnatal period by producing a visual representation. Participants are given the opportunity to use the culturally acceptable materials provided (in this study, malleable clay, beads of different colours, and dried wooden stalks) and to create a picture to express themselves in response to an open-ended prompt posed by the facilitator. In Phase 3,

participants are questioned individually about the meanings of their visual representations, and their views obtained. Group discussions for each individual visual representation are also done and participants' views obtained. In Phase 4, participants and researchers undergo debriefing.

The method was chosen as the most appropriate to enable postnatal mothers to express themselves visually and verbally through the representations they formed within their cultural contexts. By using visual representations, participants are able to access feelings, perceptions and attitudes that are difficult to report on, as would have been the case when using direct interviews and other survey techniques (32). The method also helped the authors to create an optimal context for participation of postnatal mothers in the research process, where interpersonal interactions also took place. The subjective meanings of visual representations, as given by postnatal mothers, assisted the authors to gather data about their experiences with HCPs during mothers' postnatal period, as well as their views on postnatal mHealth communication. The method gathered two types of data: visual data, derived from the photographs of visual representations, and textual data, which consisted of the verbatim transcriptions of both individual and group discussions.

Setting and Participants

The Laikipia county, a rural area in Kenya, was purposively sampled. This county was selected due to its low uptake of PNC which was at 31% compared to national uptake level of 51% (24). It has a high poverty rate of 28.5%, which represents the proportion of the population who live on less than US$1 per day (34). From the listed rural health care facilities (n=8), the four largest facilities in terms of patient population were purposively selected. The inclusion criteria comprised of women in their postnatal period, with at least one living child, access to a mobile phone, residing in the county for at least six months and willing to participate in the research. The authors were assisted by the reproductive health nurse of the facility who provided health care to the women; the nurse identified women who complied with the inclusion criteria. After explaining the purpose of the study, the women were invited to attend a group session on a scheduled date. The recruitment continued until saturation of data was reached across the four sampled health facilities. A total of 26 participants in total were recruited from the mother and child health clinics in the four health facilities which were coded as M, J, G, N respectively. Each facility represented one group that comprised of five to eight women. The majority of participants were aged between 21 and 35 years (n=21, 80.8%), married (n=24, 92.3%), and had attained seven years of schooling (n=19, 73.1%). The main source of income was

subsistence farming. The monthly expenditure on cell phones ranged between US$0.5 and US$15, with the majority (n=19, 73.1%) spending less than US$5 per month.

Data Collection

The authors personally used the Mmogo method® in each of the four health facilities. The following open-ended prompt was used to stimulate discussions: Would you please use the material supplied to create a picture that would explain your experience with the HCPs at the postnatal clinic? The first author conducted the group sessions with the aid of two assistants. One assistant photographed the visual representations and recorded the discussions, which were conducted in the Kiswahili language, while the other assistant took the field notes. One of the authors supervised the data collection. The initial hesitancy of participants to construct visual representations soon evolved into excitement. This is a typical reaction of participants in the Mmogo method®.

Data Analysis

All the audio-recorded discussions were transcribed verbatim and were translated from Kiswahili into English. The translated transcripts were reviewed and edited to ensure correct interpretation of the mothers' experiences. The facilitator of Mmogo sessions transcribed the data, while two other co-coders verified the accuracy of the text against the audio recording. Data analysis was structured according to the six steps prescribed by Clarke and Braun (35). During analysis, the authors constantly moved back and forward between the entire data set, highlighting codes of short segments of data with similar meanings, using different highlight colours. All the relevant coded data were then collated into potential themes and subthemes. Both visual and textual data were triangulated during the development of themes and sub-themes.

Methodological Considerations

To ensure trustworthiness of the data collected during the entire research process, the authors ensured the four aspects of trustworthiness, namely, credibility, transferability, dependability and conformability, as described by Guba (36), at all phases. Credibility was enhanced by triangulating visual and textual data. In addition, transcriptions were checked against audio recordings to ensure an accurate reflection of the participants' experiences, and this enhanced the credibility of the findings. The authors described the phenomenon under study in detail, and described the methods used for both data collection and analysis, thereby ensuring

transferability of results. To ensure dependability and conformability, an audit trail was ensured. Moreover, three authors were continuously involved through consensus discussions.

Ethical Considerations

This study was approved by Mt. Kenya University Ethical Review Committee, Ref. No. MKU/ERC/0604, in Kenya, and the Health Sciences Research and Ethics Committee of the University of the Free State, South Africa, Ref. No. UFS-HSD2017/1346. Permission to carry out the study was obtained from relevant authorities. The author obtained written informed consent and permission to have the visual representations photographed and discussions audio recorded from all study participants.

RESULTS

Postnatal mothers were asked to explain the meaning of their visual representations in relation to their experiences with the HCPs at the postnatal clinic. Through reflective questioning, the researcher probed mothers' views about mHealth communication further. Five themes emerged from the discussions, as shown in Fig 1: expectations of mothers regarding HCPs, positive experiences with HCPs, outcomes of positive experiences with HCPs, expectations of mHealth communication, and positive attitude towards mHealth communication.

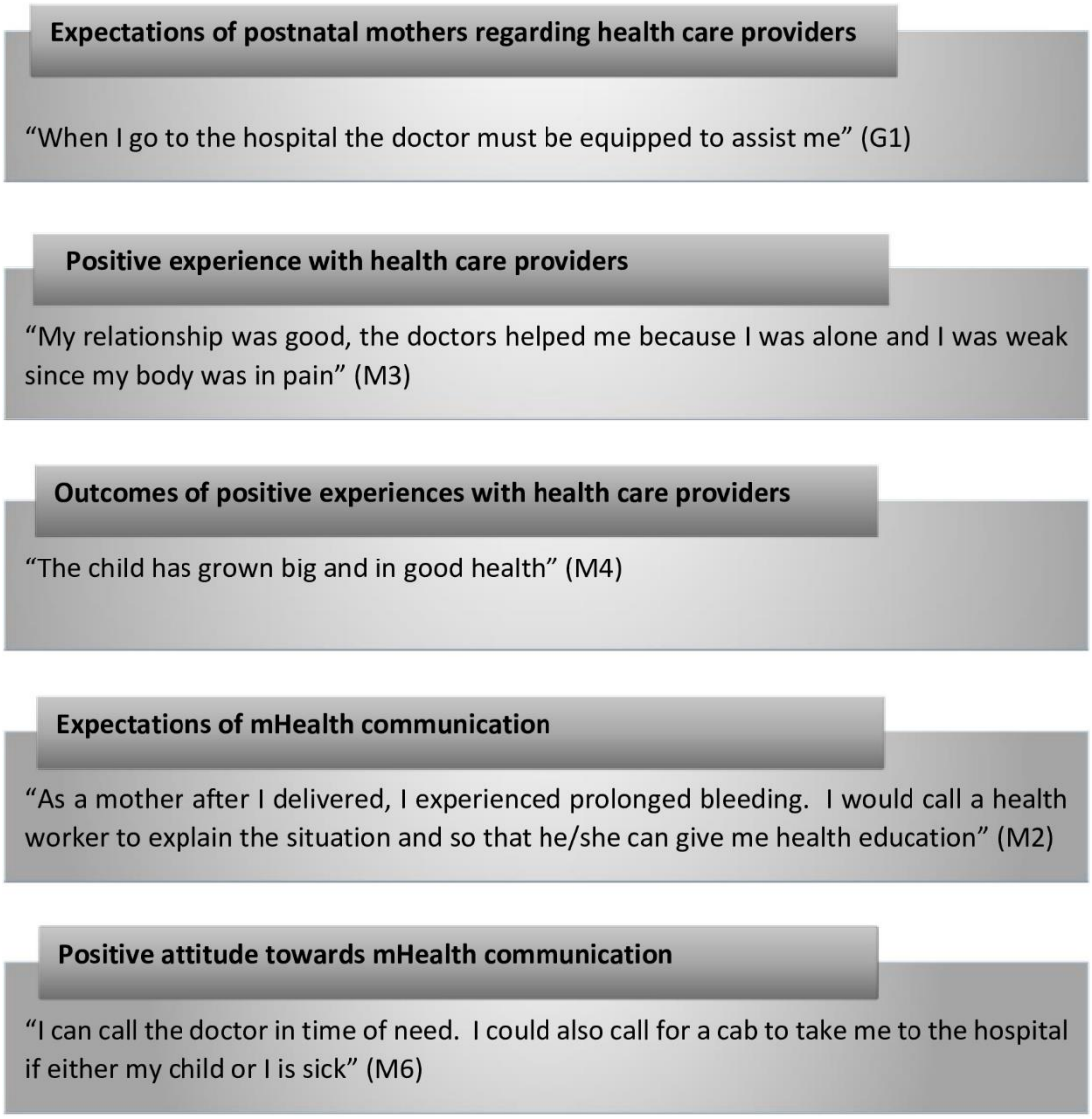

Fig 1 Five themes with quotes that emerged on experiences with HCPs and views about mHealth communication

Theme 1: Expectations of postnatal mothers regarding HCPs

It was evident from the results that mothers seeking health services during the postnatal period had different expectations regarding HCPs. Some had their expectations met, while others did not.

Expectations met

Some of the postnatal mothers reported that HCPs were available to serve them, others mentioned that HCPs had adequate resources required to serve them, while still others reported that they were given health education that met their expectations. Mothers had this to say:

When I go to the hospital the doctor must be equipped to assist me (G1)

I expect to get everything I need at the clinic. Sometimes you are told medicine is not available and you must go somewhere else far to get it. At the doctors it is available and you do not have to go far to get it (N4)

To express her experience, one of the participants made a picture of a boat and a rower on the water, as shown in Figure 2. Though her explanation did not initially clearly explain her expectations, her description expressed that her expectation had been met; this is what she said:

When a boat gets inside water it does not know what to find or what danger lies ahead, I did not know what I was to be told at the clinic or what services would be offered. I did not know but the doctors taught me and showed me love. I did not know what was going on after my delivery. During the time for the child's clinic visit, I was taught everything I am supposed to do at vaccination time (G7)

Fig 2: A boat on the water, with a rower rowing

Expectations not met

Some mothers reported unmet expectations, and expressed frustration about expecting to be served within a reasonable time, but having to queue for a long time.

You have to line up and wait for the doctor to come and serve you and when you are done you go home (G1)

One mother described ineffective communication, stating that she communicated with HCPs only when her child's weight reduced. Another mother constructed a visual image of a small bed in the hospital, as shown in Figure 3. In her explanation, she stated that the hospital bed was too small, thus, not meeting her expectation of adequate accommodation. The mother's predicament was observed by group members, and they commented on the inappropriate position the mother and baby took up in the bed. One of the group members said:

The child is supposed to sleep in front of the mother and not behind the mother (J4)

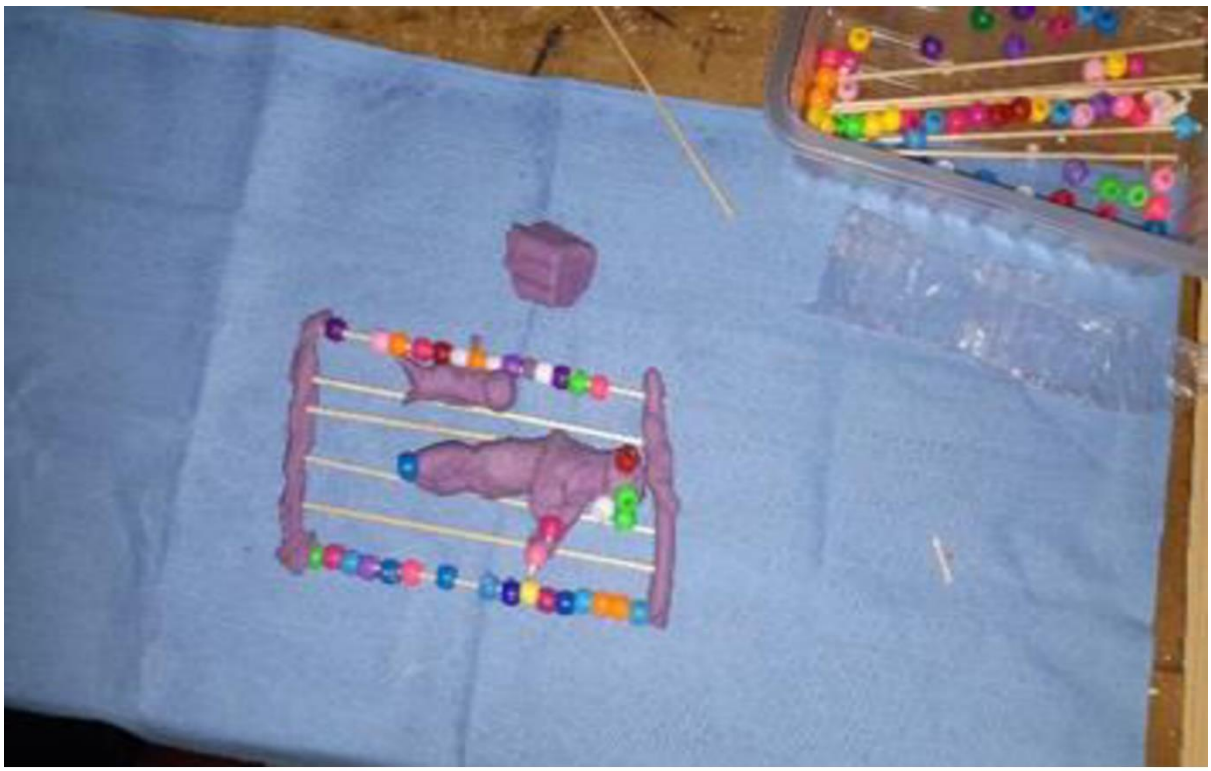

Fig 3: Mother and child sleeping in a small hospital bed

The possibility of initial bonding between this mother and her baby was not explored further by the group.

Theme 2: Positive experiences with HCPs

Positive experiences with HCPs were prevalent among mothers. Quite a number of mothers expressed happiness and love through their visual representation and verbalisation. Most of the

images that the mothers constructed depicted love, with some constructing flowers to express happiness, some made hearts to represent the love they were shown, and still others made a symbol of "LOVE" to express the happiness they felt as a result of good relationships with HCPs. Positive experiences were reported to take the forms of physical and emotional support given by HCPs.

Physical support

Many postnatal mothers reported that they were offered physical support by HCPs, in various ways. Some reported they were served well, and others stated that they were well taken care of and helped by the HCPs. Physical support also took the form of the service that the mothers needed at the moment, for instance, some were provided with medicine while others were supported in handling their child. One mother was offered a room for her child to sleep and where she could change her child's clothes. Participants made the following statements:

> *My relationship was good, the doctors helped me because I was alone and I was weak since my body was in pain (M3)*

> *In the hospital they offered a room where children are attended to and I was able to change my child's clothes and she would sleep there as well when there are no people in the hospital (M6)*

Emotional support

The majority of postnatal mothers described how they were shown love and encouraged by HCPs. Some reported that they received warmth and comfort from HCPs. HCPs were available during difficult times to offer emotional support, as one mother reported:

> *When I took my child to the clinic, the doctors served me well. It was a difficult time since it was during the post-election violence (M6)*

One mother, through her visual representation of a doll and a hospital, described that the HCPs pampered her like a doll.

> *When I came, I found it like home because I had some people to cater for me. The doll shows how the doctors took care of me as a doll. The hospital is where I felt warm so I felt comfortable as a doll in a home (N1)*

Emotional support was also expressed through good rapport and reassurance. HCPs were seen as offering emotional support when they praised mothers, were closer to the mothers and waited for the mothers at the clinic. This made mothers feel valued by HCPs.

> *The relationship was not bad, whenever I or the child has a problem, I would tell the doctors and they would solve it. Like during the first time the child was not breastfeeding and I told the doctor. The doctor reassured me that it was normal since the child breastfeeds gradually. The conversation was good (G3)*

Theme 3: Outcomes of positive experiences with HCPs

Postnatal mothers experienced various outcomes as a result of positive experiences with HCPs. Some of these outcomes affected the mothers, whilst others affected the child.

Effects on the mother

Mothers' positive experiences with HCPs had positive outcomes. For some mothers, their anxiety about breastfeeding and newborn care was alleviated. For others, breastfeeding skills were provided by HCPs. As a result, mothers felt confident of their ability to take care of their children. Mothers were also provided with guidance on how to support their children through various developmental stages. One mother said:

> *The relationship was good; the health workers showed me how to bring up my child, how to feed when weaning time comes that is after six months. And also, how to breastfeed the child (J1)*

Effects on the child

There were positive outcomes on the children as a result of mothers' positive experiences with HCPs. Some mothers reported that they had healthy children who were free of illness, with good weight gain, and effective bonding. A positive relationship with HCPs resulted in exclusively breastfed children. The effects were reported by some mothers as follows:

> *The child had grown big and in good health (M4)*

> *The child just wants to play and sleep, and hasn't fallen ill (M1)*

Another mother constructed an image with symbols of love, describing that her positive experience with HCPs resulted in the child being vaccinated. This is what she said:

This is a sign of a hospital and those inside the hospital are symbols of love. I was served well, the child got vaccinated and my relationship with the doctors was good (M4)

Theme 4: Expectation of mHealth communication

As postnatal mothers explained the meaning of their visual representations in relation to their experiences with HCPs, their discussion led the researcher to probe further through the use of reflective questioning, which explored mothers' views on mHealth communication. As they discussed the topic, it was clear that postnatal mothers had significant expectations of mHealth communication. Their expectations focused mainly on health education and psychological support.

Health education

The mothers expected that mHealth communication would help them receive health education from HCPs. They expected to be educated on how to raise their children, and how to handle danger signs and complications during the postnatal period. Some mothers expected to be given health education on family planning and nutrition, while others expected to be given health education on how to take care of themselves, and how to use mobile phones appropriately during the postnatal period. The following are some statements by postnatal mothers that indicate their expectations of mHealth communication regarding health education:

As a mother after I delivered, I experienced prolonged bleeding. I would call a health worker to explain the situation and so that he/she can give me health education (M2)

When you get the doctor's number you can find out why your child's weight remains the same and the doctor would educate you on which food to give the child (N6)

Psychological support

It was notable that mothers expected mHealth communication to be used by HCPs to offer psychological support during the postnatal period. Some of the main aspects of psychological support mothers mentioned were checking on their personal progress, as well as progress of their children. Still others expected to receive psychological support on breastfeeding.

You [HCPs] would call me and ask about my health progress and that of my child (J2)

You [HCPs] ask me if the child is breastfeeding well (N5)

Psychological support in form of follow-up was mentioned by one mother, who indicated that HCPs can use mHealth communication to follow up on her home care and clinic visits to vaccinate her child. She said the following:

> *When I was leaving the hospital there was advice that you gave for example my hygiene and the child's and you would call me and ask if I still maintain it. There are symptoms I may see on the child I would tell you about and how I personally feel in my body and ask your advice. You [HCPs] can communicate with me and remind me to bring the child for vaccination (N1)*

Theme 5: Positive attitude towards mHealth communication

It was clear that postnatal mothers had positive attitudes towards mHealth communication. They regarded it as useful for accessing a health facility and HCP services.

Improve HCP accessibility

Mothers were positive about mHealth communication and viewed it as a means to improve HCP accessibility, which enabled them to receive services during critical times, such as during emergencies, when complications from childbirth arose, and at night, when accessibility and availability of HCPs may be limited. As a result, mothers received advice and consulted HCPs on matters regarding their health, and that of their children. Some had this to say:

> *The child would get sick at night or during the day and you would call the doctor for information, the doctor would ask questions and you give answers and the doctor would guide you on the first aid before you go to the hospital (N6)*

> *I would call the doctor for advice and I would record it. Also take pictures of the child. And I would also call the doctor when the child is sick (G7)*

Improve availability and accessibility of health facility services

mHealth communication was also believed to help improve availability and accessibility of health facility services. Some mothers said they used mHealth communication to call the health facility before they left home, to ensure the services would be available when they arrive. Others mentioned that mHealth communication assisted them seek means of transport, so as to access the health facility services.

The phone would be helpful if the child fell sick at night, I could call the doctor and ask them to come to the hospital and attend to the child (J2)

I can call the doctor in time of need. I could also call for a cab to take me to the hospital if either my child or I am sick (M6)

DISCUSSION

In this study, the researcher explored the experiences of postnatal mothers with HCPs and their views on mHealth communication in a rural area of Kenya. The results indicate that mothers had various expectations of their HCPs, with some being met and others not. The unmet needs related to inadequate accommodation, ineffective communication and long queuing, as reported by some mothers. Among the expectations that were met were those relating to health education, availability of HCPs and adequacy of resources. Such expectations were also met in studies that were done in Zambia and England (5,27). Awareness of patients' expectations is recommended, as it could assist HCPs to understand patients' perspectives, and improve communication (17,37,38). A study in Ethiopia that assessed adult patients' expectations of HCPs in an outpatient clinic found that meeting patients' expectations regarding their health is one way of improving health care services, hence, facilitating uptake (39). A study in Australia reports that postnatal mothers had negative views of PNC, due to expectations that were not met regarding availability of HCPs' time, continuity of care, consistency of care, and communication (10). A study done among Canadian postnatal mothers reports unmet expectations, as mothers indicated that they felt a strong sense of abandonment by HCPs, with the majority stating that they were not followed up by HCPs during the postnatal period, compared to what they had experienced during the antenatal period (40). In Singapore, postnatal mothers were not given health education by HCPs and, as a result, they stated that they lacked infant care skills, such as bathing, swaddling, and burping, as well as factual information on common normal and abnormal symptoms (41). It is, thus, clear that having met and unmet expectations among mothers may have either a positive or negative impact on uptake of health services.

In this study, further referred to as the Laikipia study, postnatal mothers experienced physical and emotional support from HCPs, with most mothers reporting positive experiences. Elsewhere, this kind of support has been shown to contribute to a positive effect on the physical health and psychological wellbeing of postnatal mothers (17,27,42). The findings of the Laikipia study are in line with findings of a study that was carried out in Iraq, where mothers

reported that they were satisfied with PNC services, because they were given enough support and help on feeding and caring for their babies (43). Another study, in Australia, reports that mothers expressed happiness with practical advice and assistance they received from HCPs in relation to baby care and their immediate physical recovery (44). Swedish postnatal mothers reported negative experiences with HCPs, stating that they were dissatisfied with the insufficient support they received (14); mothers referred to the insufficient time that HCPs spent with postnatal mothers. Negative experiences were also reported in Uganda, where mothers indicated that they lacked emotional support from HCPs during childbirth and this resulted in an increase in home deliveries (45).

Both positive and negative experiences can have effects on mother or child health. Postnatal mothers from the Laikipia study experienced various effects because of positive experiences with HCPs. The effects included weight gain and good health for the child, and acquisition of breastfeeding skills and relief from anxiety for the mother. Similar effects resulting from positive experiences with HCPs were reported in Malawi and by two systematic reviews that assessed outcomes of patient-HCP relationships (8,9,46). In England, postnatal mothers reported improved breastfeeding, and stated that they received excellent support from their HCPs (27).

In addition to reporting their experiences with HCPs and its effects, the postnatal mothers in the Laikipia study also gave their views on mHealth communication. In their discussion, it was clear that postnatal mothers in the Laikipia study had various expectations of mHealth communication. They expected mHealth communication to be used by HCPs to provide health education and offer psychological support. Such expectations have been met elsewhere, for instance, women in the Democratic Republic of Congo used mHealth communication to seek health education on family planning, resulting in improved uptake of PNC services (47). In Malawi, mHealth communication was used by HCPs to educate pregnant women on various aspects related to pregnancy (48). The Laikipia study's postnatal mothers had a positive view of mHealth communication; they regarded it as useful for improving HCP and health facility accessibility during the postnatal period. In Burkina Faso, mHealth communication was perceived by women as saving time, by making it possible to access HCPs services when it is hard to travel, and for calling the HCP to enquire about their availability before travel (49). In Malawi, mHealth communication was used by clients in rural areas to improve access to health

facility services, such as counselling and follow-up, which helped clients to save on the time and expense of travel (50).

The strength of the Laikipia study lies in its use of a culturally sensitive data collection method. It enabled postnatal mothers to express multiple experiences within their social context as it related to HCPs, and their views on mHealth communication. Mothers from rural areas were given the opportunity to express their health needs, whilst being given a platform to positively influence health communication with HCPs via mHealth.

The study was limited to a single rural area. It may be possible to transfer findings to similar settings. Since the group discussions were held in Kiswahili and translated to English, richness of data could have been lost. This possibility was limited by involving a researcher in the research team who was able to facilitate the groups in Kiswahili and contribute to translating the text to English.

Various WHO PNC recommendations (1) may be addressed within a rural setting should the needs identified by this study be implemented through mHealth in a way that aligns with the current Kenyan mHealth policy and guideline (51, 52).

CONCLUSION

Postnatal mothers in a rural area of Kenya had various experiences with HCPs during their postnatal periods. Their overwhelmingly constructive experiences with HCPs related to emotional and psychological support the mothers received. These positive experiences of HCPs had fruitful effects on both the mother and the child. Mothers viewed mHealth communication as a means to provide them with PNC health education and psychological support. The opinion was shared that accessibility, availability and affordability of PNC health services would improve if mHealth was used. Due to the positive views postnatal mothers expressed about mHealth communication, in conjunction with their positive experiences with HCPs, mHealth communication can be adopted by both the HCP and postnatal mothers, with the likelihood of improving uptake of PNC services in rural areas.

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5.4 ASSOCIATED ADDENDUM

Addendum M: Author guidelines (*PLoS One*)

CHAPTER 6: DEVELOPMENT AND VALIDATION OF A MOBILE HEALTH COMMUNICATION FRAMEWORK FOR POSTNATAL CARE IN RURAL KENYA

6.1 INTRODUCTION

Theory-based mobile health communication is needed to strengthen uptake of PNC in rural Kenya. This chapter will present an article that describes the development and validation of an mHealth communication framework for PNC in rural Kenya.

6.2 ARTICLE DETAILS

Title	Development and validation of a mobile health communication framework for postnatal care in rural Kenya.
Authors	Florence Mbuthia, Marianne Reid, Annali Fichardt
Journal	*African Journal of Reproductive Health*
Journal details	Open access, Peer-reviewed journal Listed as an accredited journal by the DoHET [South Africa]
Status	Under review

6.3 ARTICLE 3

ABSTRACT

Health care challenges that are informed by frameworks strengthen health systems. A need exists for a theory-based framework that may be useful to strengthen postnatal care. This paper describes the development and validation of an mHealth communication framework for postnatal care in rural Kenya. The framework was developed through a multi-method research design, underpinned by the theory of change logic model. Prior to the development of the framework, two separate studies, were carried out, in addition to a literature review. Thereafter the framework was developed, and forms a third study, which was done in two stages. In the

first stage, the authors used the theory of change logic model to integrate the results of the first two studies and the literature review, to develop a draft framework. In the second stage, stakeholders' input was integrated into the draft framework, thereby validating the final mHealth communication framework. An mHealth communication framework was developed which articulated the elements needed for planning and designing an mHealth communication initiative in rural areas, to strengthen postnatal care. In conclusion, a theory-based mHealth communication framework was developed using the theory of change logic model. The framework incorporated the best available evidence, the community's needs, and stakeholders' input; therefore, the authors recommend implementing the framework to support the desired outcomes and contribute to lowering maternal and neonatal mortalities, especially in rural areas.

Keywords

Mobile health, communication, postnatal care, rural, framework

BACKGROUND

Several frameworks have been developed in the health system to date. These frameworks range from those strengthening the health systems to those assessing the performance of health systems[1,2]. Regardless of the type of framework, the World Health Organization recommends that frameworks should be designed to respond to emerging evidence and challenges facing health systems[3]. Among a variety of challenges, inaccessibility to health services is a global concern that has led to slow progress in achieving health goals[4]. As a result, emphasis on universal health coverage is prominent in the newly formulated Sustainable Development Goals, to ensure that everyone can access health services[4]. One of the critical health services required immediately after birth is postnatal care (PNC).

PNC services are essential for reducing maternal and neonatal deaths. This is particularly important in sub-Saharan Africa, where the rates of maternal and neonatal death are particularly high[5,6]. Unfortunately, the uptake of PNC has been low, particularly in rural areas[7]. In addition, mothers in rural areas are less likely to use PNC services, given the difficulties they face in accessing these services[8]. The accessibility of PNC in rural areas is often limited by geographic inaccessibility, unavailability of health services, unaffordability, and unacceptability, all of which contribute to reduced uptake of health services such as PNC. To improve uptake of PNC services, mHealth, an emerging technology, has been recommended.

Indeed, mHealth communication is one of the digital technologies that the World Health Organization has recognised as helping to improve coverage of PNC[9]. By ensuring universal health coverage for PNC services, mHealth can help to stimulate demand and broaden access to health information, thus, creating awareness of PNC services[9]. One example of mHealth is that postnatal mothers in need of PNC can be contacted via mobile phone, thereby improving the uptake of PNC services further[10]. Evidence suggests that mHealth communication has led to improved uptake of PNC services when it is used in low and middle-income countries[(11-13)]. In rural areas, where uptake of PNC is poor, mHealth communication is suggested as an effective way to improve coverage of PNC services[14,15].

In Kenya's rural areas, mHealth communication is highly recommended, given the high penetration and acceptance of mobile phones among the population living in these regions[16]. In addition, the Kenyan Ministry of Health has designed policies and guidelines to direct the use of mHealth technologies[17,18]. Like in many other countries, these policies and guidelines provide a regulatory framework for mHealth programmes by creating optimal conditions for mHealth implementation[19].However, even with regulatory frameworks in place, many mHealth projects in high and low-income countries are reported to have stagnated at pilot level, compromising their sustainability[20]. The reason given for lack of scale-up of mHealth interventions is that most of them are poorly specified, vaguely described, and under-theorised[21,22]. Many of these interventions are reported to describe unrealistic needs and expectations of target users. In Kenya, the failure of mHealth initiatives is attributed to a lack of involvement of users and stakeholders during the design stage[23].

These findings warrant using a theory-driven approach when developing a framework. Detailed, evidence-based planning would involve stakeholders in the design stage, and will describe, in detail, how and why mHealth interventions will work, long before they are implemented. Such an approach may be more useful to policymakers, and may help them to plan better, and direct resources to where they might be most impactful[24]. Heeding to this advice, the authors will describe the development and validation of a mobile health communication framework for PNC in rural Kenya that is guided by the theory of change logic model.

THEORETICAL UNDERPINNING

The theory of change logic model is often used for developing effective initiatives in organizations[25], where the model can be used to either design, implement, or evaluate

initiatives[26,27]. The theory of change logic model is described as a tool that defines events that are expected to produce a particular, desired outcome[27]. The model visually describes how resources and activities translate into impacts, and it also makes explicit the assumptions underlying implementation plans and strategies[28]. It is useful, in that it informs policymakers of critical aspects that make a programme work in a compelling way[29]. In this study, elements of the model were linked visually, thereby demonstrating how and why mHealth communication interventions could strengthen PNC in rural areas.

METHODS

The framework was developed through a multi-method research approach that was underpinned by the theory of change logic model. Prior to developing the framework, two separate studies, namely, a systematic review and a visual-based narrative inquiry, were carried out, as was a literature review. The first study, the systematic review, helped to synthesise the best available evidence on mHealth communication's ability to strengthen PNC in rural areas. To achieve this goal, the authors carried out a thorough search of articles published in electronic databases on the EBSCOhost platform from January 2008 to August 2018. Articles that met eligibility criteria were critically appraised and relevant data extracted. The findings were reported[13] and used to outline the key strategies in the framework. The second study explored the experiences of postnatal mothers with health care providers and mothers' views on mHealth communication during the postnatal period. Data was collected through a visual-based narrative inquiry that adapted a visual-projection method of data collection, referred to as the Mmogo-method®[30]. Data was obtained from postnatal mothers attending health facilities, during four group discussions in a purposively selected rural area in Kenya. Findings of this study formed some of community needs and influential factors in the framework. In addition to the two studies, a review of the literature was done to determine the desired results in the framework. The summary of the two studies and conclusions are summarised in Table 1.

Table 1: Summary of the studies undertaken		
Date of study	**Method**	**Conclusion of the study**
2018	Systematic review	One-way mobile messaging is commonly used to influence intentions and skills needed for PNC uptake and to reduce environmental constraints related to uptake of PNC
2019	Visual-based narrative inquiry	Postnatal mothers in rural areas have • Positive experiences with health care providers • Positive attitudes towards mHealth communication • A variety of expectations regarding mHealth communication

Developing the framework, which formed the third study, was done in two sequential stages. In the first stage, the authors, guided by the theory of change logic model, developed a draft framework to integrate the results of the two previous studies and the literature review. In the second stage of the third study, a validation exercise took place with expert stakeholders (n=16). The stakeholders involved were the policymakers at the Department of Health in the same rural area where the second study was done. These stakeholders were field experts from different research disciplines. All the stakeholders were invited to a one-day validation session that was facilitated by the authors. Prior to the discussion of the draft framework, a summary of previous studies and application of the theory of change logic model to the framework development was presented to stakeholders. Stakeholders' engagement followed a forward and backward mapping[31] process, which allowed the logic and linkage of components to be clarified. During the discussions, additional comments were made if found necessary. The rigor of the process was assessed according to a checklist proposed by the WK Kellogg Foundation[32]. The final framework was verified by all stakeholders.

Rigor

Rigor refers to the principle of the research outcome[33], and was maintained throughout the process of developing and validating the framework. Rigor was achieved by incorporating the four aspects of methodological integrity, namely, credibility, validity, transferability, and triangulation[33]. For credibility, the authors designed the framework using the theory of change logic model, which has been tested and used in the development of other health-related frameworks[(34-36)]. Forward and backward mapping, an iterative process, was used to clarify the linkages between the various components of the model; this helped to verify internal validity.

Data gathered from the systematic review and the visual-based narrative inquiry were combined in the development of the framework, and this helped to ensure content validity. Furthermore, expert advice from stakeholders was incorporated in the framework. Though the transferability of the framework to other health settings cannot be guaranteed, the authors provide sufficient information about the research context, processes, participants, and author-participant relationships to enable a reader to decide whether and how the findings could transfer to their settings. In addition, an audit trail on the development of the framework is available. It is expected that the stakeholders involved will be positive about piloting such a framework in their setting. Using different methods to collect data helped to enhance methodological triangulation, and incorporating the findings in the framework ensured data triangulation. Triangulation helped to strengthen the framework.

Ethical considerations

Ethical clearance for this study was granted by both the Health Sciences Research and Ethics Committee of the University of the Free State, South Africa, Ref. No. UFS-HSD2017/1346, and the Mt. Kenya University Ethical Review Committee in Kenya, Ref. No. MKU/ERC/0604. Permission to carry out this study was obtained from relevant Kenyan authorities. The authors obtained informed consent and permission from all study participants. Throughout the process, the principles of beneficence – doing good and no harm to the participants – were maintained. The participants were informed of their right to not give specific information, and their right to terminate participation at any stage of the study without detriment.

RESULTS

An mHealth communication framework for PNC in rural Kenya, which represents the results of this study, is illustrated in Figure 1. The framework represents the theory of change logic model, which consists of elements necessary for planning and designing mHealth communication initiatives to strengthen PNC in rural areas. The first text box refers to the problem that the framework attempted to solve. The second text box represents community needs, which specify the priority needs of postnatal mothers in rural areas. The third text box, labelled desired results, represents the vision of the future, and describes what mHealth communication for postnatal care in rural areas would achieve in the short and long term. The fourth text box lists the influential factors that relate to support for, or potential barriers that might influence the change hoped for or expected from the mHealth communication framework for PNC in rural areas. Strategies are listed in the fifth text box, which lists examples of best

practices proposed and evidence-based mHealth communication interventions that have been used in other rural areas to achieve the kind of results suggested by this study's framework. The sixth text box states the assumptions of the framework. These are the presuppositions behind how and why the change strategies would be successful among postnatal mothers in rural Kenya. These assumptions reflect beliefs, norms, and ideological perspectives that needed to be taken into consideration.

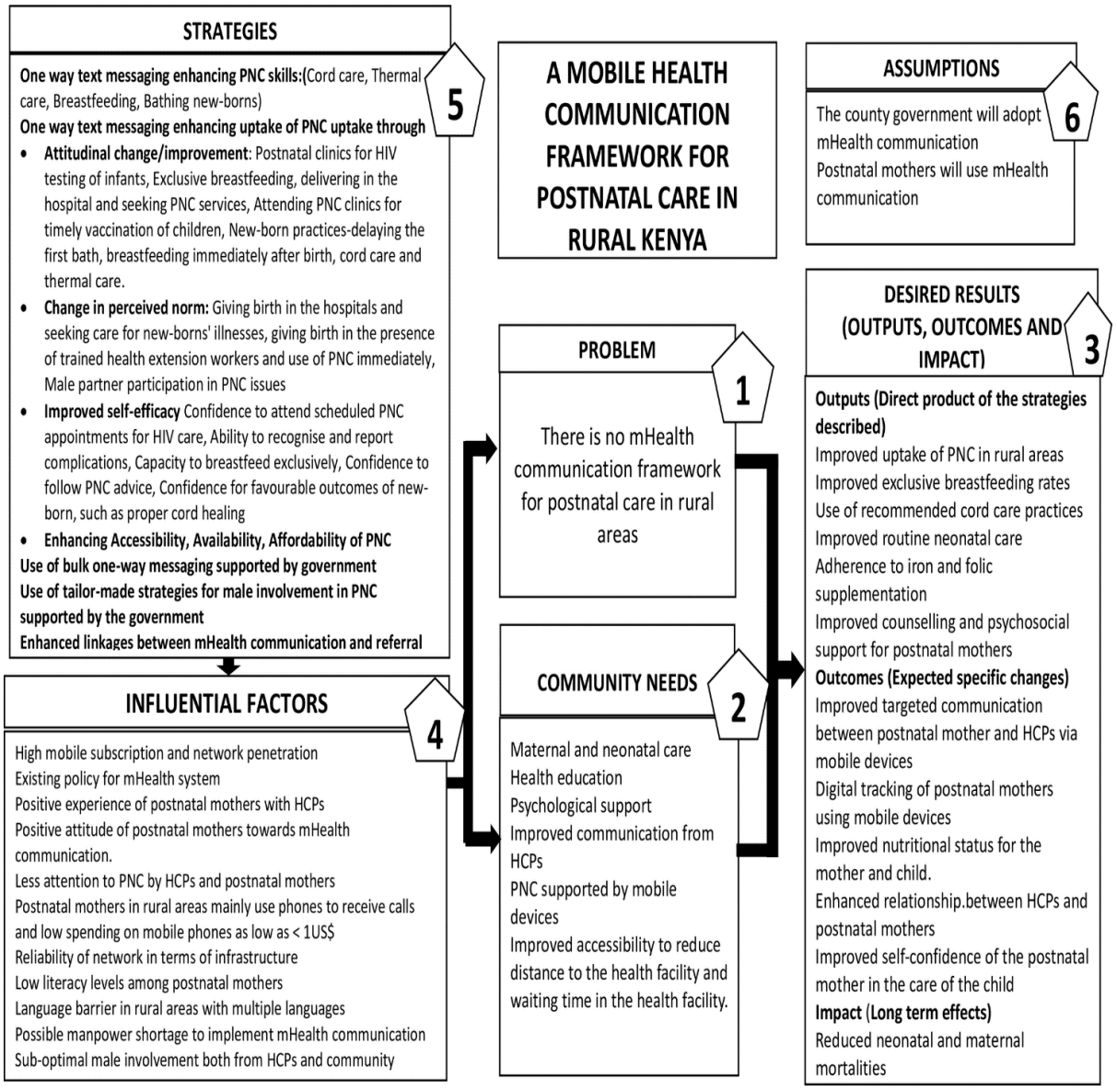

Figure 1: A mobile health communication framework for postnatal care in rural Kenya

DISCUSSION

This paper provides clear, concise, and systematic information on the processes involved in the development and validation of an mHealth communication framework for postnatal care in

rural areas. The draft framework, which was developed and guided by the theory of change logic model, was validated by stakeholders who could influence policy for a rural area in Kenya. Various components of the completed framework, as illustrated in Figure 1, will be discussed.

Problem

The problem that the authors attempted to solve related to the lack of an mHealth communication framework for postnatal care in rural areas. This problem was revealed by evidence gathered by the authors during the systematic review[13]. The stakeholders validated the problem during the validation exercise. Lack of mHealth communication for PNC in rural areas is an issue referred to by many authors[37-39].

Community needs

Acknowledging users' needs and expectations determines the uptake and success of any mHealth intervention[23]. As illustrated in Figure 1, postnatal mothers had several needs. The documented disparities in the uptake of PNC in Kenya[40] creates a need for maternal and neonatal care in rural areas. In study two, postnatal mothers emphasised that they expected health education, psychological support, and improved communication from health care providers via mHealth communication. The World Health Organization also recognises the need to support postnatal mothers via mobile devices, and that it could be one way of curbing high maternal and neonatal mortalities[10]. While validating the framework, the stakeholders identified the need for mHealth communication to improve the accessibility of health services by reducing the distance to and waiting time in rural health facilities. Inaccessibility of health services is common in most rural areas of sub-Saharan Africa, which creates the need to have mHealth communication in these regions[38,41,42].

Desired results

In Figure 1, the desired results were presented as outputs, outcomes, and impact. The outputs gathered from the literature review include improved uptake of PNC[43,44], improved exclusive breastfeeding rates[45,46], use of recommended cord care practices, which resulted in reducing neonatal infections[43], improved routine neonatal care, such as immunisation and maintaining warmth[43], adherence to iron and folic supplementation, leading to a reduction of postpartum anaemia and greater infection prevention[43,47-49], as well as counselling and psychosocial support of mothers[43,44,50,51].

Outcomes to be achieved, as highlighted in the framework, include improving targeted communication between postnatal mothers and health care providers via mobile devices[9,12,52-55] and digital tracking of postnatal mothers health status and services using mobile devices[9,56,57]. The stakeholders added to the outcomes by indicating that mHealth communication could result in improved nutritional status for the mother and child, and could enhance the relationship between the health care provider and postnatal mothers. An enhanced relationship helps to increase trust and respect, a finding that was reported by a study done in rural areas in Ethiopia, where health care providers used mHealth communication to offer health services to their clients[58]. In addition, the stakeholders suggested that postnatal mothers could be more confident in caring for their children – about which a study in rural areas of Uganda reported when postnatal mothers received mHealth communication from their health care providers regarding proper neonatal practices[59]. The desired impact, that is, the long-term effect of using mHealth communication and which was validated by the stakeholders, was reduced maternal and neonatal mortalities. This impact was found in rural areas of Ghana, where mHealth communication has been used effectively[60].

Influential factors

The factors likely to support the utility of the framework are the high mobile subscription and network penetration in Kenya[61], and existing policy relating to mHealth[17,18]. These factors are likely to have led to the establishment of various mHealth projects in Kenya[62], as well as recommendations to have mHealth communication prioritised in rural areas[16]. Positive experiences of postnatal mothers with health care providers and positive attitudes towards mHealth communication were also considered to be factors that may influence the use of mHealth communication.

On the other hand, various factors are likely to hinder the achievement of the desired results in the framework. In the past, little attention was given to PNC by health care providers[43,63,64] and, according to the stakeholders, postnatal mothers in rural areas had demonstrated little concern about PNC. In addition, the findings indicate low spending on mobile phones by mothers in rural areas, with the majority of them using their phones mainly to receive calls. This tendency may be attributed to the low socioeconomic status of most mothers in rural areas – a factor that has been documented to hinder the success of mHealth initiatives, particularly those targeting women[65]. Another factor that might hinder the achievement of the outcomes, as reported by the stakeholders, is the reliability of the mobile network in terms of infrastructure. This finding

confirms other studies done in rural areas, which indicate that the availability of, for instance, electricity may affect the reliability of the network[66,67]. Furthermore, network coverage is seldom evenly distributed in rural areas, due to a weak signal[37]. Other limiting factors suggested by the stakeholders are low literacy levels, the language barrier in places with multiple languages, possible shortages of human resources to implement mHealth communication, and suboptimal involvement in PNC by men. These factors are also reported to influence the uptake of mHealth communication in rural areas of India and other developing countries[68,69].

Strategies

The systematic review in study one[13], proposed strategies to achieve the desired results in the framework. It included one-way text messaging enhancing uptake of PNC services, the skills that postnatal mothers in rural areas require to use PNC, and environmental facilitators for PNC uptake[13]. Other strategies that were added by the stakeholders are using bulk one-way messaging that is supported by government, using tailor-made strategies supported by government to involve men in PNC, and enhancing linkages between mHealth communication and existing referral strategies. Bulk messaging has the advantage of high penetration of the general public, in addition to being cost-effective[70]. Encouraging men to be involved in women-related programmes is highly recommended. As a result, there are calls for programmatic and policy initiatives that accommodate men in service delivery[71]. As stated by the stakeholders, involving government is emphasised as a critical precursor to the success of any mHealth intervention[19,67,72].

Assumptions

Through logic and critical thinking, the authors presupposed that the county government would adopt mHealth communication and that postnatal mothers would use mHealth communication. These assumptions were fundamental, given that they are likely to influence the choices made regarding any mHealth initiative. The stakeholders validated these assumptions.

This paper had a number of strengths. Firstly, two stringent requirements in the development of the framework using the theory of change logic model were met: simplicity and sufficient details[27]. Simplicity helped to ensure usability and readability, while providing sufficient details ensured that the context of the real world was included, which is essential for the evaluability of the framework. Secondly, the framework incorporated the best available

evidence on mHealth communication, combined with contextual realities specified for mHealth communication by postnatal mothers in rural areas. In addition, the stakeholders, who are policymakers and play a significant role in the implementation of the framework, were engaged during the validation of the framework. Thirdly, this mHealth framework was developed before any mHealth communication for postnatal care had been initiated and implemented in the county, thus, adhering to the ideal and recommended practice. Following such practice ensured that the authors were able to suggest realistic goals, activities, and outcomes. Fourthly, having this framework before implementation created greater awareness in the stakeholders who were involved, and this increases the likelihood of adoption. The authors acknowledge that not all stakeholders were, initially, familiar with the theory of change logic model, however, skilful facilitation of the workshop, following a systematic validation process, mitigated possible negative effects.

CONCLUSION

A theory-based mHealth communication framework is needed to strengthen PNC in rural Kenya. By using the theory of change logic model, various elements were linked to demonstrate how an mHealth communication framework can strengthen PNC in rural Kenya. The model helped the authors to identify the best practices or strategies to help solve the problem, including a statement of assumptions regarding why the selected strategies could work. In addition, the model helped to describe the needs and assets of the community who are the recipient of PNC and to recognise the factors that may influence the implementation of the proposed framework. The theory of change logic model also allowed the research to describe the desired results of mHealth communication in rural Kenya. The framework incorporated the best available evidence, the community's needs, and stakeholders' inputs. The authors recommend the implementation of the theory-based framework, as it may be useful to strengthen PNC in rural Kenya. It might contribute to reducing maternal and neonatal mortalities, especially in rural areas. However, the authors acknowledge that the decision to implement the framework lies with the stakeholders involved.

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Contributions of Authors

FM, MR, and AF conceived and designed the study. FM and MR were involved in the data collection. All authors participated in the development of the framework. All the authors were involved in the writing and review of the manuscript. All authors approved the final version of this manuscript.

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6.4 ASSOCIATED ADDENDUM

Addendum N: Author guidelines for *African Journal of Reproductive Health*

CHAPTER 7: CONCLUSION, RECOMMENDATIONS, AND CONTRIBUTIONS OF THE STUDY

7.1 INTRODUCTION

This last chapter will outline the conclusions drawn from the entire study, of which the aim was to answer the research question: What should an mHealth communication framework for PNC in rural Kenya constitute? The chapter will start with a brief overview of the study, to remind the reader about the background of the study, its aim and objectives, as well as the methods used to achieve the objectives. This will be followed by a description of factual conclusions and an interpretation of the conceptual conclusions. The final part of this chapter will explain the limitations and provide recommendations from the study. Lastly, the contributions of the study will be highlighted.

7.2 OVERVIEW OF THE STUDY

Uptake of PNC, a critical health service that is recommended by the WHO to promote maternal and neonatal health, has been poor, and failure to take up PNC contributes to high rates of maternal and neonatal death, especially in LMICs (WHO, 2014a, p. 1). In addition, the uptake of PNC has displayed disparity between urban and rural areas. Specifically, in Kenya, uptake of PNC in rural areas is far lower than in the counterpart urban areas. To improve uptake of health services such as PNC, integration of mobile technology as an emerging strategy has been proposed. The high penetration of mobile technology, including in rural areas (International Telecommunication Union, 2018, p. 5), creates a great opportunity to use mHealth communication to improve uptake of PNC services. Despite the availability of mobile technology, lack of appropriate mHealth communication frameworks has meant that this potential has not been tapped. This study was designed to propose a suitable mHealth communication framework that can be used to improve uptake of PNC in rural Kenya. To achieve this aim, the study had three specific objectives. Namely. to

i. Gather the best available evidence regarding mHealth communication to strengthen PNC in rural areas [systematic review];
ii. Explore experiences of postnatal mothers with health care providers and their views on mHealth communication in rural Kenya [Mmogo-method®]; and

iii. Validate a draft mHealth communication framework for PNC in rural Kenya [validation exercise].

To achieve these objectives, the IMBP and theory of change logic model guided the study theoretically. The IMBP provided a structure that helped to identify the critical determinants that influence the uptake of PNC – behaviour that is recognised as vital for mothers and neonates. After identification of the determinants, the theory of change logic model was used to develop an mHealth communication framework for PNC in rural Kenya. A multi-method research design was used to help collect different types of data, which were used to develop an mHealth communication framework for PNC in rural Kenya. Systematic review and visual-based narrative inquiry were used independently to collect data in different phases. The systematic review, which was used in the first phase, assisted to identify, appraise, synthesise, and interpret research-based evidence that existed in the field of mHealth communication for PNC in rural areas at the time of the study. The evidence provided some of the strategies incorporated in the mHealth communication framework that was developed.

A visual-based narrative inquiry was used in the second phase of the study to explore the experiences of postnatal mothers with health care providers, as well as views on mHealth communication in rural Kenya. Data was collected by means of the Mmogo-method®. Thematic analysis was done, which elicited key themes that represent experiences of postnatal mothers with health care providers and their views on mHealth communication. The data from this phase formed part of community needs and influential factors in the developed framework.

The data gathered from the two phases were used to develop an mHealth communication framework in the third phase of the study. This was done in two stages. In the first stage, the theory of change logic model was used to draft an mHealth communication framework for PNC in rural Kenya. Data gathered from the systematic review and visual-based narrative inquiry were combined with additional literature and used to develop a draft mHealth communication framework. In the second stage, policy-informing stakeholders from the same rural area where data was gathered, added their inputs and validated the framework.

From the phases of the study, various conclusions can be drawn, beginning with factual conclusions, as described in the next section.

7.3 FACTUAL CONCLUSIONS

A number of factual conclusions can be highlighted from the data gathered from the systematic review and visual narrative inquiry.

7.3.1 Best available evidence about mHealth communication to strengthen PNC in rural areas

The findings from the systematic review revealed that several types of mHealth communication was used to strengthen PNC in rural areas. They included phone calls, one-way messaging, interactive messaging, audio-visual material and videos, voice messages, and a combination of messaging and phone calls. Among all these types, one-way messaging is the most commonly used. Evidence also revealed that mHealth communication can be used to improve uptake of PNC by influencing the determinants that predict behaviour uptake according to the IMBP. This can be achieved by influencing skills, intentions and environmental factors, which are considered as the critical determinants of uptake of any behaviour in the IMBP. The PNC skills of the mother that mHealth communication can strengthen are breastfeeding, cord care, thermal care, delayed bathing of babies, safer sleep practices, care-seeking and problem-solving. The evidence reveals that the intention to use PNC can be enhanced by changing beliefs related to attitudes, perceived norms and self-efficacy related to PNC. Furthermore, the evidence also reveals that inaccessibility, unavailability and unaffordability of PNC are the environmental factors that can be reduced with use of mHealth communication in rural areas.

7.3.2 Experiences of postnatal mothers with health care providers and expectations on mHealth communication in rural Kenya

The visual narrative inquiry reveals that postnatal mothers had expectations regarding health care providers, with some being met and others not. The postnatal mothers also had positive experiences with health care providers which related to the physical and emotional support they had received from their health care providers. The positive experiences had various positive outcomes, for both mothers and their infants. The findings also revealed that postnatal mothers had expectations related to mHealth communication; they viewed it as a means to offer PNC health education and psychological support. In addition, they expressed a positive attitude towards mHealth communication, since it was perceived as improving health care providers' accessibility and health facility availability and accessibility. With positive attitudes and

various optimistic expectations regarding mHealth communication, it can be concluded that if both health care providers and postnatal mothers use mHealth communication, it may improve uptake of PNC in rural Kenya.

7.4 INTERPRETATION OF CONCEPTUAL CONCLUSIONS

Having described the factual conclusions, the researcher, furthermore, analysed the evidence to answer the research question relating to what an mHealth communication framework should constitute. This analysis was achieved by integrating factual conclusions and combining it with input from policymakers and users, as well as additional literature to develop the framework (Figure 7.1).

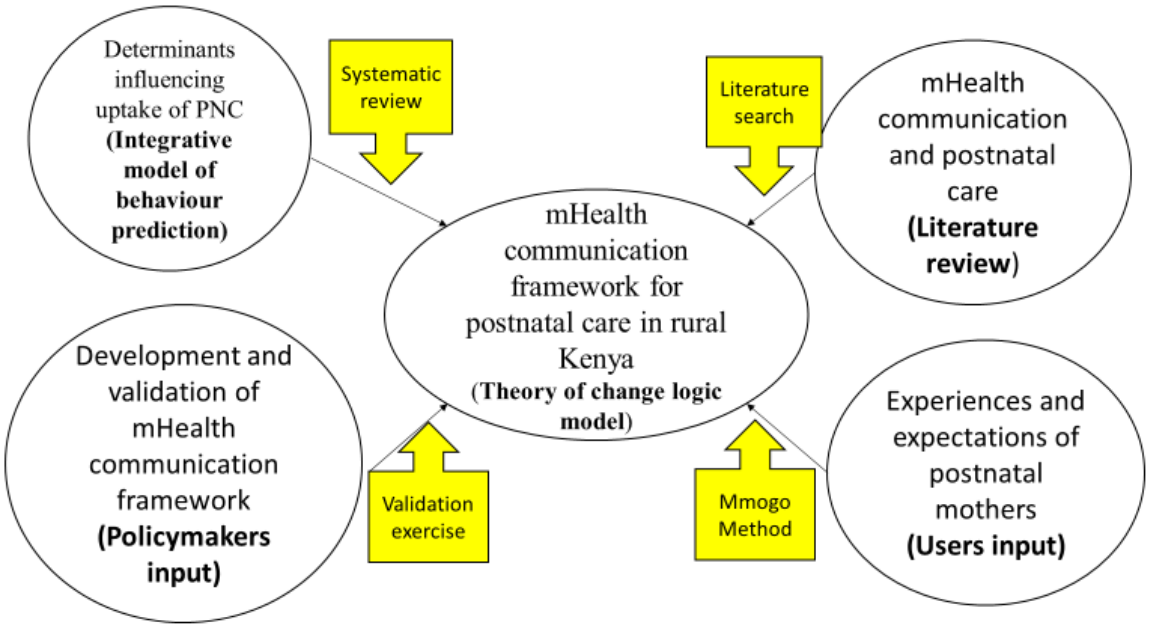

Figure 7.1 Conceptual framework

The evidence from this study was interpreted within the theory of change logic model, which is based on a solid knowledge of what works. By using the model, the mHealth communication framework was developed, from which the conceptual conclusions were interpreted. The content of the framework consisted of evidence that was gathered from the systematic review, which provided the determinants that influence the uptake of PNC, the data obtained from the visual-based narrative inquiry, and the Mmogo-method®, which provided information on the experiences and expectations of postnatal mothers, stakeholders' inputs in the validation exercise, and additional literature on mHealth communication and PNC. This content was interpreted and packaged within the various elements of the theory of change logic model.

The elements included the problem to be addressed by the framework, community needs, desired results, influential factors, strategies, and assumptions. These elements were considered necessary for developing an mHealth communication framework, as they would inform the policymakers of how mHealth interventions can work in rural Kenya.

The first element is the problem to be addressed, which was identified as the lack of an mHealth communication framework for PNC in rural areas. This problem is even more significant, given that evidence clearly shows that mHealth communication can actually strengthen PNC in rural areas.

The second element represents the community needs that led to the development of the mHealth communication framework. There is disproportionately low uptake of PNC in rural areas compared to urban settings, despite the fact that mothers and their babies in rural areas need PNC as much as their urban counterparts do. From the findings, it is clear that these mothers require health education, psychological support and improved communication from their health care providers via mHealth communication. They also need PNC that is supported via mobile devices, which is critical for answering the global call to achieve universal health coverage. In addition, using mHealth communication will improve the accessibility of health services by negating the necessity to travel long distances to health facilities and to wait for hours at the health facilities – situations that postnatal mothers in rural areas usually endure. These needs represent the contextual realities of what postnatal mothers in rural Kenya want in relation to mHealth communication.

The third element comprises the desired results, both short- and long-term, distinguished as output, outcomes and impact that can be achieved when mHealth communication is used. The use of mHealth communication will result directly in improved exclusive breastfeeding rates, use of recommended cord care practices, improved routine neonatal care, adherence to iron and folic supplementation and improved counselling and psychosocial support for postnatal mothers. Given that these are the recommended, evidenced-based PNC practices, the uptake of these practices will help improve maternal and perinatal health. Furthermore, mHealth communication could have specific and measurable outcomes, by improving targeted communication between postnatal mothers and health care providers, facilitating digital tracking of postnatal mothers' health status and services, improving the nutritional status of the mother and child, enhancing the relationship between health care providers and postnatal mothers, and improving the self-confidence of the postnatal mother caring for the child. These

outcomes suggest positive effects that could be achieved to the benefit of both the mother and the child, and clearly indicates improved maternal and perinatal health. The overall impact to be attained in the long run is a reduction in maternal and neonatal mortalities, which has been a global public health concern that demands attention, particularly in rural areas.

The fourth element describes the influential factors that could support or hinder the use of mHealth communication strategies and, consequently, affect the achievement of desired results. The factors that should be considered supportive to the use of mHealth strategies are the high rate of mobile subscription and high network penetration in rural areas, coupled with the already existing national mHealth policy, which offers a regulatory framework in the country. In addition, the positive experiences of postnatal mothers of health care providers, in conjunction with the positive attitudes of postnatal mothers towards mHealth communication, can facilitate the use of mHealth communication in rural Kenya.

However, there are factors that can hamper the use of mHealth strategies in rural Kenya. These factors include the lack of attention currently being given to PNC by both mothers and health care providers in rural settings, the fact that mothers in rural areas are using mobile phones mainly for receiving calls, and low spending on mobile communication. Other factors that may hinder use of mHealth strategies are the poor reliability of the network in terms of infrastructure, low literacy levels among postnatal mothers, the language barrier in rural areas, where multiple languages are used, possible manpower shortages to implement mHealth communication, and suboptimal involvement of men, both from health care providers and the community. Given that all these factors represent the reality of rural settings, they were made explicit by calling for stakeholders' attention during planning and piloting of mHealth communication, to ensure that the desired results would be achieved.

The fifth element constitutes the mHealth strategies that are proposed to help meet the needs of postnatal mothers in rural Kenya, in order to achieve the proposed desired results. These strategies include the use of one-way messaging to address skills, intentions and environmental factors that influence uptake of PNC, use of bulk one-way messaging supported by the government, use of tailor-made strategies for involvement of men in PNC supported by the government, and enhanced linkages between mHealth communication and referral strategy. As highlighted, these strategies signify the need for collaborative efforts between the users and implementers of mHealth communication.

The sixth element constitutes the assumptions behind the way the described mHealth strategies would work to achieve the desired results. It is assumed that the county and postnatal mothers will adopt the use mHealth communication strategies, and desired results will be realised. The mHealth communication framework that was developed addresses the realistic needs and expectations of postnatal mothers in rural settings who are recipients of PNC.

Having set out the conclusions above, the next section will explain the limitations of the study.

7.5 LIMITATIONS OF THE STUDY

The study was limited to a single rural area in Kenya, which may limit the transferability of the findings to other settings. However, to mitigate the effects of such a limitation, the researcher has provided an extensive audit trail that enhances the transferability of the framework design and development process to similar settings, particularly in low- and middle-income countries.

7.6 RECOMMENDATIONS FOR POLICY, PRACTICE, EDUCATION AND RESEARCH

Based on conclusions of the study, the researcher makes the following recommendations.

1. Health care providers can strengthen uptake of PNC in rural areas by using mHealth communication to support the skills postnatal mothers need to use PNC, and by improving accessibility, availability and affordability of PNC services during the postnatal period.
2. Health care providers can enhance the health education and psychological support needed by postnatal mothers, and strengthen targeted communication, as well as do digital tracking of postnatal mothers' health status and services by using mHealth communication during the postnatal period.
3. Health care providers can use mobile phone devices to call postnatal mothers and offer both physical and emotional support, as well as strengthen communication, which can assist to sustain a positive relationship with postnatal mothers during the postnatal period.
4. To reap the benefits of the developed framework, policymakers can pilot the theory-driven mHealth communication framework that was developed, which describes why and how mHealth communication can work to strengthen PNC in rural Kenya by involving both users and stakeholders as collaborators.

5. During piloting of the developed mHealth communication framework, policymakers can enhance the utility of the framework by addressing the factors described to influence achievement of the desired results.
6. Policymakers can pilot use of one-way messaging to address skills, intentions and environmental factors that influence uptake of PNC by using government-supported strategies, such as bulk messaging.

7.7 CONTRIBUTIONS OF THE STUDY

The value of this study relates to both knowledge contribution and the practical significance of the developed framework. In contributing to knowledge, this study filled a gap that existed, by demonstrating the role played by mHealth communication in improving uptake of PNC, and the contribution that mHealth communication can make to improve maternal and perinatal health. As such, this study has provided evidence on the use of mHealth communication for PNC in rural areas by carrying out a systematic review, a method that is recognised as providing medical research findings that can be used to make decisions about health policy (Wieseler and McGauran, 2010, p. 1240).

Furthermore, the evidence was gathered through application of the theoretical perspectives, thereby adding to existing knowledge. By using the IMBP to study uptake of PNC, this study has added to knowledge by revealing that mHealth communication can be used to enhance skills required to use PNC, facilitate the environmental factors that can support uptake of PNC and enhance intentions that lead to PNC uptake. Furthermore, the evidence shows that the intention to use PNC can be enhanced by focusing on beliefs related to attitudes, perceived norms and self-efficacy in relation to PNC. Using the theory of change logic model to develop the framework filled the gap that existed in relation to a theory-based mHealth communication framework for PNC in rural Kenya. In addition, the published article from this study already provides a proof that knowledge has been contributed in the scholarly arena and dissemination of that knowledge has taken place.

The practical significance of the developed framework can be derived from the fact that the framework has incorporated the best available evidence and the contextual realities of rural settings from the users' and policymakers' perspectives. The framework describes the use of mHealth communication framework for PNC in rural Kenya by linking evidenced-based strategies with the desired results. In addition, the framework addresses the contextual needs

of the postnatal mothers in rural areas by highlighting some of the influencing factors and assumptions to be considered to achieve the desired results. Therefore, the implementation of the developed framework is projected to improve both maternal and neonatal outcomes and address the high rate of maternal and neonatal mortalities, especially in LMICs.

In addition to contributing knowledge, this study broadened the researcher's understanding of research, and demonstrates the ability to conceptualise a framework, choose the appropriate methods and integrate the findings into the framework. The various phases involved in this study provide a better understanding of the appropriate use of different research methods in developing an mHealth communication framework. The involvement of the stakeholders, who added their inputs and validated the framework, is considered to be of great significance, given that they are also experts in their specific areas of practice. In addition, the mHealth communication framework that was developed informs policymakers on the important issues that require their attention if the desired results are to be achieved. Their involvement also increases the likelihood of the framework being piloted. To demonstrate the utility of the framework for improving the uptake of PNC in rural areas further, the researcher hopes to collaborate with both the users and implementers in the rural area for possible piloting of the framework.

7.8 CONCLUDING REMARKS

Mobile health technology is emerging as a new approach that can be used to accelerate universal health coverage and, thus, assist to reduce the high rates of maternal and neonatal mortalities all over the world. Using mHealth communication for critical health services, such as PNC, has not been generally considered, particularly not in rural areas, where uptake remains low. Furthermore, there is a need for a theory-based mHealth communication framework for PNC in rural Kenya. This study, therefore, sought to develop such a framework by gathering the best evidence available on mHealth communication, exploring users' perspectives and incorporating stakeholders' inputs. The developed framework, which is evidence-based, highlights the existing needs of postnatal mothers in a rural setting, and suggests practical strategies that can be used to meet these needs and achieve the desired results. Factors that can support or hinder the strategies were also described. The assumptions behind the way the framework will work were also given. The researcher looks forward to piloting the framework by involving stakeholders from rural Kenya, thereby informing policies on matters regarding

health further. Policymakers can use the framework to support the universal coverage of PNC services in an attempt to enhance the uptake of PNC services and possibly lower maternal and neonatal mortalities.

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ADDENDA

ADDENDUM A: POSTGRADUATE SUPERVISION AGREEMENT

POSTGRADUATE SUPERVISION AGREEMENT:
Master's & Doctoral Candidates

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
POSTGRADUATE SCHOOL
NAGRAADSE SKOOL

The following agreement is entered into between the student and the supervisor, in line with principles of academic freedom and integrity, and keeping in mind individual responsibility and reasonable autonomy. Both student and supervisor are expected to take ownership of this agreement in a spirit of mutual accountability.

The Supervisor

1. Undertakes to provide academic guidance and support to the best of their ability in relation to the scope and design of the research project, as detailed in a formal research proposal accepted by the department/school.
2. Will make time available for regular contact with the student (at least once a month). This contact may include emails or phone calls, as well as face-to-face contact sessions, as agreed in advance with the student.
3. Will provide written feedback and constructive criticism within a reasonable timeframe of receiving written submissions from the student. This timeframe for feedback is to be agreed upon in advance but should not exceed 4 weeks.
4. Will provide a 6-monthly progress report on the student's work to the HOD, which will be entered onto the student's academic record and may be accessed by the Dean's Office or Institutional Higher Degrees Committee.
5. Will be prepared for any pre-arranged meeting with the student.
6. Will consider the student's academic, technical and writing skills and refer them to an appropriate postgraduate workshop/support activity if deemed necessary to supplement any gaps in knowledge or expertise.
7. Will support and advise the student in preparation for all required steps on the postgraduate journey, including title registration, ethical clearance, legal or policy issues relating to the conduct of the research and the submission and assessment processes.
8. Undertakes to familiarise themselves with all policies and rules governing postgraduate programmes and to advise the student on such issues should the student request clarity on any particular issue.
9. Will help to ensure, to the best of their ability, that student's final submission is of sufficient quality for examination, including complying with all submission requirements and policies.
10. To liaise with the Examination Control Office or other relevant body to ensure the examination process and feedback/corrections are managed according to standards set by the university.

The Student

1. Undertakes to work independently and conscientiously under the guidance of the supervisor, including reading widely on the topic to ensure a thorough knowledge of the pertinent literature, and familiarising themselves adequately with the agreed-upon methodology.
2. Takes responsibility to make appointments with the supervisor well in advance, to confirm such appointments closer to the time and to ensure appointments are kept.
3. Will carefully plan and prepare for contact sessions with the supervisor for maximum benefit of the time allotted. This could include doing required reading or preparing written input for the meeting.
4. Should submit written work for discussion at the meeting well in advance, as agreed upon with the supervisor.
5. Will ensure written work is relatively free of grammar and spelling errors. Responsibility for writing quality should rest with the student.
6. Undertakes to consider all advice and feedback provided by the supervisor and will demonstrate how they have done so in the following draft of their work.
7. Should keep a record of all points discussed in each meeting, in writing, and ensure appropriate steps are taken to apply such feedback and advice. These discussion reports/minutes should be kept on record and presented at meetings if requested by the supervisor for further discussion.
8. Should plan their time to ensure they keep to an agreed-upon schedule with their supervisor.
9. Will ensure that all steps are taken to uphold university policies, ethical principles and rules in all their applied research and written work. Where unsure, they should contact their supervisor for clarity.
10. Will not apply undue pressure or unrealistic expectations on a supervisor by missing deadlines, expecting feedback within unreasonable timeframes or submitting substandard or rushed work. This includes trying to submit the final research product before the supervisor is satisfied that it meets all examination criteria and is of sufficient standard.

Contact Us

T: +27 (0)51 401 7161
E: postgrad@ufs.ac.za
Johannes Bril Building, Ground Floor, Bloemfontein Campus

Both Supervisor & Student

1. Agree on all expected roles and processes, including the specific roles of co-supervisors where appropriate.
2. Will meet regularly and as frequently as is reasonably expected, to ensure steady progress and will keep appointments, be punctual and respond appropriately and timeously to messages.
3. Will ensure they are contactable by the other party and will respond to queries or requests within a reasonable, agreed-upon timeframe.
4. Will keep each other informed of any unforeseen absences or changes in personal circumstances, which could impact on the work schedule. Alternate plans must be discussed and agreed-upon in such cases.
5. Will undertake to ensure all written work or practical research is done according to expected university standards and abide by all university policies and rules. Where it is felt this is not the case, breaches of quality or ethical standards should be discussed and attempts made to improve this situation before any grievance proceedings are engaged.

We confirm that we have read and understood the statement on the previous page and that we will agree to uphold this agreement. In addition, we agree to the following:

- The student will submit work according to an agreed-upon schedule and will receive written feedback within ___2 weeks weeks of submission.
- We, the student and supervisor, agree to meet at least once every _____4_____ weeks.
- If for some reason one party is unable to meet at the agreed-upon date, we will reschedule the meeting to suit both parties well in advance. We, the student and supervisor, have agreed on a format in which records of all meetings will be kept, and how all feedback will be engaged with and reported back on.
- We, the student and supervisor, will both keep a copy of this signed agreement.

Student Name: _ Florence Wangari Mbuthia Student Nr: _2016446920 Student email address: flowmbuthia@gmail.com Phone number: +254720304568 Signature:	Supervisor Name: Dr Marianne Reid Staff nr: 0854214 Supervisor email : reidm@ufs.ac.za Supervisor Phone number: :+27 844614634 Signature:
Co-supervisor Name: Dr. Annali Fichardt Staff Nr: 041467 Co-supervisor email: fichardtae@ufs.ac.za Co-supervisor Phone nr: _051 401 9169 Signature:	Co-supervisor Name: _____ Staff Nr: _____ Co-supervisor email: _____ Co-supervisor Phone nr: _____ Signature: _____

Faculty: Health Sciences

Department/School: Nursing

Degree: PhD Nursing

Date: 4th April 2019

ADDENDUM B: CERTIFICATE OF ETHICAL CLEARANCE (HEALTH SCIENCES RESEARCH ETHICS COMMITTEE)

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

Health Sciences Research Ethics Committee

10-Apr-2018

Dear Mrs Florence Mbuthia

Ethics Clearance: **A mobile health communication framework for postnatal care in rural Kenya**
Principal Investigator: **Mrs Florence Mbuthia**
Department: **School of Nursing (Bloemfontein Campus)**

APPLICATION APPROVED

Please ensure that you read the whole document

With reference to your application for ethical clearance with the Faculty of Health Sciences, I am pleased to inform you on behalf of the Health Sciences Research Ethics Committee that you have been granted ethical clearance for your project.

Your ethical clearance number, to be used in all correspondence is: **UFS-HSD2017/1346**

The ethical clearance number is valid for research conducted for one year from issuance. Should you require more time to complete this research, please apply for an extension.

We request that any changes that may take place during the course of your research project be submitted to the HSREC for approval to ensure we are kept up to date with your progress and any ethical implications that may arise. This includes any serious adverse events and/or termination of the study.

A progress report should be submitted within one year of approval, and annually for long term studies. A final report should be submitted at the completion of the study.

The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

For any questions or concerns, please feel free to contact HSREC Administration: 051-4017794/5 or email EthicsFHS@ufs.ac.za

Thank you for submitting this proposal for ethical clearance and we wish you every success with your research.

Yours Sincerely

Dr. SM Le Grange
Chair : Health Sciences Research Ethics Committee

Health Sciences Research Ethics Committee
Office of the Dean: Health Sciences
T: +27 (0)51 401 7795/7794 | E: ethicsfhs@ufs.ac.za
IRB 00006240; REC 230408-011; IORG0005187; FWA00012784
Block D, Dean's Division, Room D104 | P.O. Box/Posbus 339 (Internal Post Box G40) | Bloemfontein 9300 | South Africa
www.ufs.ac.za

ADDENDUM C: CERTIFICATE OF ETHICAL CLEARANCE (MOUNT KENYA UNIVERSITY ETHICS AND REVIEW COMMITTEE)

Mount Kenya University

FEBRUARY 20, 2018

Ref. No. MKU/ERC/0604

CERTIFICATE OF ETHICAL CLEARANCE

This is to certify that the proposal titled **"A MOBILE HEALTH COMMUNICATION FRAMEWORK FOR POSTNATAL CARE IN RURAL KENYA",** whose Principal Investigator is Ms Florence Wangari Mbuthia has been reviewed by Mount Kenya University Ethics Review Committee (ERC), and found to adequately address all ethical concerns.

Mr Francis W. Makokha
Secretary, Mount Kenya University ERC

Sign: _____ **Date:** 21.02.2018

Prof. Francis W. Muregi
Chairman, Mount Kenya University ERC

Sign: _____ **Date:** 21.02.2018

The Chairman
Mount Kenya University
Ethics Review Committee
P. O. Box 342 - 0100, Thika

ADDENDUM D: RESEARCH AUTHORISATION (NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION)

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone:+254-20-2213471,
2241349,3310571,2219420
Fax:+254-20-318245,318249
Email: dg@nacosti.go.ke
Website : www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/18/1504/21787**

Date: **5th April, 2018**

Florence Wangari Mbuthia
University of the Free State
SOUTH AFRICA.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Mobile health communication framework for postnatal care in rural Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Laikipia County** for the period ending **20th March, 2019.**

You are advised to report to **the County Commissioner, the County Director of Education and the County Director of Health Services, Laikipia County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

BONIFACE WANYAMA
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Laikipia County.

The County Director of Education
Laikipia County.

ADDENDUM E: RESEARCH AUTHORISATION (LAIKIPIA COUNTY, DEPARTMENT OF HEALTH)

REPUBLIC OF KENYA
COUNTY GOVERNMENT OF LAIKIPIA
DEPARTMENT OF MEDICAL SERVICES AND PUBLIC HEALTH

OFFICE OF THE CHIEF OFFICER
P.O. Box 1271-10400,
Nanyuki, Kenya

Ref: CGL/HEALTH/RESEARCH/VOL.1/20 **Date**: 12th September 2018

FLORENCE WANGARI MBUTHIA
UNIVERSITY OF THE FREE STATE
SOUTH AFRICA

RE: RESEARCH AUTHORIZATION

You application for authority to carry out research on "Mobile Health Communication Frame Work for Post natal care in rural Kenya" in Laikipia County is granted.

Note that you shall deposit a copy of the final research report with the department upon completion.

Yours faithfully,

DEPARTMENT OF MEDICAL SERVICES AND PUBLIC HEALTH
CHIEF OFFICER
12 SEP 2018
SIGN.....
COUNTY GOVERNMENT OF LAIKIPIA

DR. DONALD MOGOI
Ag. CHIEF OFFICER
COUNTY DEPARTMENT OF HEALTH

Cc. County Director Medical Services

ADDENDUM F: INFORMATION LEAFLET FOR PARTICIPATION IN THE GROUP (MMOGO-METHOD®)

Study title: A mobile health communication framework for postnatal care in Rural Kenya.

Researcher: Ms Florence Mbuthia *Mobile number: +254720304568.*

Dear participant

I am a student at the School of Nursing of the University of the Free State. If you are pregnant and use cell phone, I invite you to join a group where we will talk about how communication helped you during your postnatal period. If you join the group, I will ask you a question about your relationship with personnel at the postnatal clinic. You will "answer" me by making something with your hands. I will give you the material that you can use to make something. Afterwards, every group member will take a turn to show the group what they had made. Then, you will have the opportunity to talk about all the things that everybody made. I will take a photo of the thing you made. I will tape the group's discussion with a recorder.

The group meeting will last about 2 to 3 hours. You will only do one group. You must tell me if you want to participate in this group discussion. I won't be angry if you don't want to take part in this group. You don't have to pay any money to participate in this group. You will not get hurt if you join this group. You will not receive any money if you join the group, though I will provide a meal and pay for your transport on the day of the group meeting. I will not use your name when I talk about the groups' discussion. I can go to other cities and tell them what happened in the groups, or publish the story in academic magazines. Your name will not be mentioned. I can show them the photos of the things you made, but I will not tell them who you are.

If you have any questions or problems about the groups, please phone me at +254720304568. If you don't like something I do or say, you can phone the following number and tell them what is bothering you: +27 51 401 7795 in South Africa or +254 (020)870901/2 in Kenya.

Yours truly

_____

Ms. Florence Mbuthia, Cell: +254720304568, florence.wangari@dkut.ac.ke

ADDENDUM G: INFORMED CONSENT: PARTICIPATING IN THE GROUP (MMOGO-METHOD®)

You have been asked to do a group in _____(town) You have been told by ***Ms Florence Mbuthia*** what the group is about. She told you that she will help with transport and provide a meal if you do the group. If you feel hurt by the group discussion, she will arrange somebody to help you with it.

You may phone ***Ms Florence Mbuthia*** at +**254*720304568*** any time if you have questions or problems about the group, or if you are hurt by the group's discussion. You can phone the number, +27 51 401 7795, at the University of the Free State or +254 (020)870901/2, at Kenyatta University, if you have any questions about something that ***Ms Florence*** said or did in the groups that you didn't like.

You are free to join the group or not. You can stop at any time if you don't want to continue. You will not be harmed or punished if you don't want to participate in the group.

If you agree to join the group, you will be given a signed copy of this document as well as the information leaflet.

Ms Florence Mbuthia told me everything about the group process. I understand what to do in the group and I give my permission to participate in the group.

_____ _____

Signature of Participant Date

_____ _____

Signature of Witness Date
(Where applicable)

_____ _____

Signature of Interpreter Date
(Where applicable)

ADDENDUM H: INFORMATION LEAFLET FOR PARTICIPATING IN THE VALIDATION WORKSHOP

Study title: A mobile health communication framework for postnatal care in Rural Kenya

Researcher: Ms Florence Mbuthia, Mobile number: +254720304568.

I, Florence Mbuthia, am doing research towards a PhD degree on the development of a mobile health communication framework for postnatal care (PNC) in Rural Kenya. A mixed methods study design will be implemented and a three-phased approach will be followed.

Phase 1 will involve a systematic review. During this phase the researcher will examine relevant literature for the best available evidence on mobile health communication to strengthen PNC.

Phase 2 will involve a narrative inquiry that will be conducted in rural health facilities in Laikipia County. The researcher will purposively identify pregnant women attending antenatal care services to include as participants. This research will seek to understand the postnatal experiences of women in rural areas and how the experiences can inform communication to strengthen PNC. The researcher will use the data of Phases 1 and 2 to develop a draft mobile health communication framework.

In Phase 3 the researcher will arrange a research workshop in which stakeholders from different research disciplines, Department of Health and field experts, will participate as team members to validate the draft framework. This workshop will form part of the process to enhance the integrity of the development of a mobile health communication framework. A senior researcher will be asked to assist the researcher to facilitate this workshop.

You are invited to form part of this workshop as a valuable member with certain expertise. There are no foreseeable risks to being involved in the study. There are no direct benefits from your participation in the study. Your participation is voluntary and you may discontinue participation at any time without penalty or loss of benefits. There are no costs involved in participation in this study. All efforts will be made to keep personal information confidential, though absolute confidentiality cannot be guaranteed because of the group discussions. Results of the research will be published but no personal information will appear in any document. Organisations that may inspect and/or copy your research records for quality assurance and

data analysis include the Health Sciences Research Ethics Committee and Kenyatta University Ethic and Review Committee. I will be happy to answer any queries regarding this study and look forward to your positive response.

Yours truly

_____

Ms. Florence Mbuthia, Cell: +254720304568, florence.wangari@dkut.ac.ke

ADDENDUM I: INFORMED CONSENT: PARTICIPATING IN THE VALIDATION EXERCISE

You have been asked to participate in a research study. You have been informed about the study by ***Ms Florence Mbuthia.*** You have been informed about any available compensation or counselling if emotional harm occurs as a result of study-related procedures. You may contact ***Ms Florence Mbuthia*** at ***+254720304568*** any time if you have questions about the research or if you are injured as a result of the research.

You may contact the Secretariat of the Health Sciences Research Ethics Committee, University of the Free State at telephone number, +27 51 401 7795 or Kenyatta University Ethic and Review Committee on +254 (020)870901/2, if you have questions about your rights as a research participant. Your participation in this research is voluntary, and you will not be penalised or lose benefits if you refuse to participate or decide to terminate participation.

If you agree to participate, you will be given a signed copy of this document as well as the participant information sheet, which is a written summary of the research.

The research study, including the above information, has been described to me verbally. I understand what my involvement in the study means and I voluntarily agree to participate.

_____ _____

Signature of Participant Date

_____ _____

Signature of Witness Date
(Where applicable)

_____ _____

Signature of Interpreter Date

(Where applicable)

ADDENDUM J: AUTHOR GUIDELINES (*BMC: PREGNANCY AND CHILDBIRTH*)

Retrieved from: https://bmcpregnancychildbirth.biomedcentral.com/submission-guidelines

ADDENDUM K: ADDITIONAL FILE 1: DATA EXTRACTION AND CRITICAL APPRAISAL OF STUDIES INCLUDED

No.	Bibliographic details	Methodology	Outcome and intervention	Critical appraisal/ level of evidence	Study findings
Randomised controlled trials(n=4)					
1.	Ayiasi RM, Kolsteren P, Batwala V, Criel B: **Effect of village health team home visits and mobile phone consultations on maternal and newborn care practices in Masindi and Kiryandongo, Uganda : A community-intervention trial**. *PLoS Med* 2016 **11**(4):e0153051. doi: 10.1371/journal.pone.0153051	**Aim:** To measure the effect of home visits combined with mobile phone consultations on maternal and newborn care practices. **Design:** Randomised controlled trial **Setting:** 16 health centres in Masindi and Kiryandongo districts, Uganda.	**Primary outcomes:** To increase health facility delivery. **Secondary outcomes:** To improve maternal outcomes related to • antenatal clinic attendance; and • birth preparedness. To improve newborn outcomes related to • cord care; • thermal care; • breastfeeding practices; and • care-seeking for newborn illness.	**Critical appraisal tool used:** Critical Appraisal Skills Program (CASP) tool for randomised controlled trial. Randomisation rigorous. Participants managed rigorously. Attrition low. Data analysed according to groups. Groups and interventions comparable. Context appropriate. **Score on appraisal:** 10/11	**Primary outcomes:** Health facility delivery 90% in intervention compared to 28% in control arm. This was statistically significant [17.94 (6.26–51.37); p<0.001]. **Secondary outcomes:** Antenatal visits by women were 85% in the intervention compared to 71% in control – not statistically significant. Birth preparation was adequate in 51.8% of women in intervention group compared to 20.8% among the control. This was statistically significant [2.58 (1.00–6.65); p=0.05] Neonatal outcomes showed significant associations with

		Sample: 1 388 participants from 16 clusters **Inclusion criteria:** First antenatal visit. Cut-off of 28 weeks of gestation. **Exclusion criteria:** Women above 28 weeks of gestation.	**Data collection:** During recruitment, biodata information was recorded. After the intervention, 10 research assistants and three supervisors collected data using structured questionnaires. Data was collected on maternal practices: • Antenatal attendance • Birth preparation • Place of delivery; And newborn care practices: • Tying and cutting of the cord; • Wrapping and bathing of the newborn; • Initiation of exclusive breastfeeding; and • Care-seeking in case of newborn falling ill.	Included Level of evidence: II	the intervention, except for breastfeeding practices. Cord care [3.05 (1.81–5.12); p<0.001] Thermal care [7.58(2.52–22.82); p<0.001] Breastfeeding practices [71.26 (0.70–2.29); p=0.44] Timely care-seeking care for newborns' illnesses [4.93 (1.59–15.31); p=0.006] **Limitations:** Health worker attrition delayed the recruitment of study participants. Midwives had to attend workshops frequently, causing further delays in the recruitment process. **Recommendations:** Further investigations on community problems, such as offering pre-lacteal feeds and early bathing of newborns, to identify appropriate solutions.

			Intervention group: Village health teams (VHTs) were given mobile phone handsets capable of making unlimited phone calls for consultation with professional health workers. The VHTs made two prenatal and one postnatal home visit to households to provide educational messages for maternal and newborn care. **Control group:** No mobile phones. No follow-up visits by VHTs. Routine education in the health centres. **Data analysis:** Chi-square test statistic to compare individual characteristics.		

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			Multi-variable analysis for covariates that showed significant differences. Cluster-level analysis to cater for intra-cluster correlation. Odds ratios using random effects.		
2.	Atnafu A, Otto K, Herbst CH: **The role of mHealth intervention on maternal and child health service delivery: findings from a randomized controlled field trial in rural Ethiopia**. *mHealth* 2017, **3**:39–39. doi: 10.21037/mhealth.2017.08.04	**Aim:** To determine whether a locally developed mobile phone SMS-based data exchange application influencing health extension workers can improve maternal health services, contraceptive utilisation rates, and immunisation coverage compared	**Primary outcomes:** To find out: • % change in ANC attendance: timing and number of visits; • % change in clean and safe deliveries; • % change in deliveries attended by skilled provider; • % change in stock-out of contraceptives at the health post level; • % change in immunisation coverage (TT2, Penta1, Penta3, measles); and	**Critical appraisal tool used:** CASP tool for randomised controlled trial. Randomisation rigorous. Blinding not done. Participants managed rigorously. Attrition low. Data analysed according to groups. Groups and interventions comparable. Context appropriate.	**Primary outcomes:** In Treatment 1, ANC attendance increased from 15.8% to 31.5% and in Treatment 2, from 45.32% to 59.84%. In control area there was a decrease, from 24.48% to 23.27%. Home delivery in Treatments 1 and 2 reduced from 61.57% and 50.70%, to 33.73% and 35.82% respectively after the intervention. Deliveries conducted in the presence of an HEW in

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		to a traditional approach. **Design:** Randomised controlled trial **Setting:** Three districts in rural Ethiopia. **Sample:** 1 080 mothers/district **Inclusion criteria:** ***For baseline survey:*** Women 15–49 years. Women with child younger than than 5 years. ***Post intervention survey:*** Women 15–49 years.	• % of women visited by a health education worker during pregnancy. **Secondary outcomes:** Not stated **Data collection:** Data was collected on: • ANC service utilisation; • Delivery services; • Family planning utilisation; • Child immunisation; and • PNC visit by community health worker. The survey was conducted twice, once at baseline and at the end of the intervention. Pre-tested, structured questionnaire was used by	**Scores on appraisal tool:** 9/11 Included Level of evidence: II	Treatment 1 increased significantly, with a p value less than 0.050, whereas, in the control area there was a statistically significant reduction in deliveries attended by an HEW, at a p value less than 0.001. Health institution delivery increased, from 23.44% to 55.07% in Treatment 1 compared to the control. This is a statistically significant difference, with p value <0.001. Health-professional-assisted deliveries in the three groups increased, from 26.79%, 41.96% and 21.79% to 55.23%, 63.54% and 52.05% respectively. No percentage change in stock-out of contraceptives at the health post level. Full vaccination coverage decreased in all three groups,

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		Woman with child younger than one year old. **Exclusion criteria:** Not stated	a team of data collectors that included a district field supervisor, local supervisor and data collectors at each district **Intervention group:** There were two intervention groups. • Treatment 1 partial intervention: all HEWs received a mobile phone with a customised software application • Treatment 2, full intervention: all HEWs received a phone loaded with Frontline SMS application and two CHWs in village received mobile phones without the customised software application		from 88.63%, 76.19% and 81.82%, to 58.31%, 58.72% and 62.98% respectively. Timing of mother's first PNC visit by CHW increased in the two intervention groups, from 80% and 68.30%, to 95% and 88.46% respectively. **Secondary outcomes:** Not stated or reported **Limitations:** Major change in the vaccination and contraceptive delivery processes across all health centers in the middle of the intervention. Problems with the mobile phones and mobile network. Logistical problems in availing timely project phones to the newly assigned health center heads and HEWs.

No.	Bibliographic details	Methodology	Outcome and intervention	Critical appraisal/ level of evidence	Study findings
			Control group: No mobile phones were distributed **Data analysis:** Descriptive analyses		**Recommendations:** Initiate systematic awareness programme on the potential of mHealth on health for the concerned stakeholders. Scaling up mHealth use to other geographical areas and different health care applications.
3.	Odeny TA, Bukusi EA, Cohen CR, Yuhas K, Camlin CS, McClelland, RS: **Texting improves testing: A randomized trial of two-way SMS to increase postpartum prevention of mother-to-child transmission retention and infant HIV testing**. *AIDS* 2014, **28**(15):	**Aim:** To determine whether interactive text messages improved rates of clinic attendance and early infant HIV testing. **Design:** **Randomised controlled trial** **Setting:** Mix of rural and urban settings in	**Primary outcomes:** To improve maternal postpartum clinic attendance. To improve virological infant HIV testing by 8 weeks postpartum. **Secondary outcomes:** Not stated **Data collection:** Biodata was collected during recruitment.	**Critical appraisal tool used:** CASP tool for randomised controlled trial. Randomisation rigorous. Participants managed rigorously. Attrition low. Data analysed according to groups. Groups and interventions comparable.	**Primary outcomes:** Postpartum clinic visit: In SMS group, 38 of 194 (19.6%) women attended PNC, compared to 22 of 187 (11.8%) of the control group [relative risk (RR) 1.66, 95% confidence interval (CI) 1.02–2.70, p=0.04]. Women in the SMS arm had a significantly higher probability of attending clinics within 8 weeks, compared to those in the

No.	Bibliographic details	Methodology	Outcome and intervention	Critical appraisal/ level of evidence	Study findings
	2307–2312. doi: 10.1097/QAD.0000000000000409	Nyanza region, Kenya. **Sample:** Intervention group (n=195) and control group (n=93), total 388 **Inclusion criteria:** 18 years old. Between 28 weeks gestation and delivery. Enrolled in PMTCT. Planning to remain in the study area. Had access to a mobile phone. Reported ability to read or had someone who could read SMS on their behalf and to whom they had	Women's return visits and infant HIV testing data were extracted from clinic records after the intervention. **Intervention group:** Up to 8 SMS were sent to women during pregnancy, from 28 weeks to delivery, and 6 SMS after delivery up to 6 weeks, by study staff who also collected data from records. **Control group:** No SMS, standard of care **Data analysis:** Unadjusted relative risk regression to compare the proportions of women retained and infants tested. Kaplan-Meier methods and log-rank tests to compare time to clinic	Context appropriate. **Scores on appraisal tool:** 10/11 Included Level of evidence: II	control arm [RR 1.83, 95% CI 1.11–3.01]. **Infants DBS testing:** In the SMS group, 172 of 187 (92.0%) were tested, compared to 154 of 181 (85.1%) in the control group [RR 1.08, 95% CI 1.00–1.16, p=0.04]. The probability of infant HIV testing within 8 weeks was significantly higher in the SMS than in the control group [RR 1.09, 95% CI 1.01–1.17]. **Secondary outcomes:** Not stated or reported **Limitations:** Exclusion of women who lacked access to phones, or who shared phones but had not disclosed their HIV status.

No.	Bibliographic details	Methodology	Outcome and intervention	Critical appraisal/ level of evidence	Study findings
		disclosed their status. **Exclusion criteria:** Not stated	visit and time to infant HIV testing. Unadjusted Cox regression to estimate a hazard ratio comparing intervention to control arms outcomes.		**Recommendations:** Future qualitative "exit" interviews to provide insight into perceptions of the messages, potentially illuminating their mechanism of action. Expansion of such affordable and easily accessible mHealth intervention.
4.	Bigna JJR, Noubiap JJN, Kouanfack C, Plottel CS, Koulla-shiro S: **Effect of mobile phone reminders on follow-up medical care of children exposed to or infected with HIV in Cameroon (MORE CARE): A multicentre, single-blind, factorial,**	**Aim:** To assess whether reminders sent to carers by text message, mobile phone call, or concomitant text message and mobile phone call, increased attendance at medical appointments for HIV care. To ascertain the most efficient (i.e.,	**Primary outcomes:** To improve attendance to the previously scheduled appointment for HIV care. To improve primary efficacy outcome relative to the staff working time used and the direct financial costs of the intervention. **Secondary outcomes:** To report success or failure of each reminder.	**Critical appraisal tool used:** CASP tool for randomised controlled trial. Randomisation rigorous. Group not similar at start of trial. Participants managed rigorously. Attrition low. Data analysed according to groups.	**Primary outcomes:** All interventions improved attendance compared to control: For text message plus call the OR was 8.5 (2.8–25.2; p<0.0001). For call 5.7 (2.2–14.5; p<0.001). For text message 3.0 (1.3–6.8; p=0·01).

No.	Bibliographic details	Methodology	Outcome and intervention	Critical appraisal/ level of evidence	Study findings
	randomised controlled trial. *Lancet Infect Dis* 2014, **14**(7):600–6008. doi: 10.1016/S1473-3099(14)70741-8.	cost-effective) method of mobile-phone-based reminder. **Design:** Randomised controlled trial **Setting:** Three regions in Cameroon representing urban (Essos), semi-urban (Kousséri), and rural (Goulfey) settings. **Sample:** 224 participants per group **Inclusion criteria:** Aged 18 years or older. Accompanying a child younger than 15 years who was	**Data collection:** At recruitment, study nurse collected: • Participant identification code; • The date of the next scheduled follow-up appointment; • The treating physician's name; • The participant's phone number; and • The preferred language of communication (French or English). During intervention the contents of the text messages, phone calls and procedures were documented. **Intervention group:** Study medical administrative assistant implemented three interventions to mothers to	Groups and interventions comparable. Context appropriate. **Scores on appraisal tool:** 9/11 Included Level of evidence: II	The Hosmer and Lemeshow goodness-of fit test generated a χ^2 of 8.7 (df=8; p=0.37). Text messaging was the most efficient intervention when both the direct costs of the intervention and staff working time were taken into account. When only the direct costs of the intervention were taken into account, the phone call was the most efficient intervention. When all text messages and calls (i.e., across all relevant groups) were taken together, the staff working time did not differ significantly between the text message and call interventions. **Secondary outcomes:** Not reported.

No.	Bibliographic details	Methodology	Outcome and intervention	Critical appraisal/ level of evidence	Study findings
		infected with or had been exposed to HIV for HIV care. Owned a mobile phone. Able to communicate verbally, read or write in English or French. **Exclusion criteria:** Did not have a mobile phone. Had an appointment scheduled in less than 3 days. Could not communicate verbally. Could not use written communication.	provide an appointment reminder by • Text message; • mobile phone call; or • Text messages and phone calls. The content of the text messages, phone calls and procedures were documented for analysis after intervention. **Control group:** No reminder (usual practice) **Data analysis:** Descriptive statistics. Odds ratios (ORs) with 95% CIs to compare the efficacy of the different interventions with respect to the primary efficacy outcome.		**Limitations:** No guarantee that the message was actually read by the participant. Sample size had a low statistical power for detecting differences between the intervention groups. Measure of staff working time did not take into consideration factors that could indirectly affect the time taken to implement each intervention, such as documentation. **Recommendations:** Assess the acceptability of these reminder methods for carers and patients before widespread implementation.

No.	Bibliographic details	Methodology	Outcome and intervention	Critical appraisal/ level of evidence	Study findings
		Did not want to receive a text message. Did not want to receive a phone call.	t test to compare continuous variables. χ^2 test to compare binary variables. Multivariate regression analyses. Hosmer and Lemeshow test of goodness of fit.		
Quasi-experimental studies (n=4)					
5.	Prinja S, Nimesh R, Gupta A, Bahuguna P, Gupta M, Thakur JS: **Impact of m-health application used by community health volunteers on improving utilisation of maternal, new-born and child health care services in a rural area of Uttar**	**Aim:** To assess the impact of an mHealth intervention used by community health volunteers on uptake of maternal, neonatal and child health (MNCH) services. **Design:** Quasi-experimental study	**Primary outcome:** To improve coverage of key MNCH services such as • ANC visits; • Consumption of iron-folic acid (IFA) supplementation; • Tetanus toxoid vaccine; and • Full antenatal care. **Secondary outcomes:**	**Critical appraisal tool used:** Joanna Briggs Institute (JBI) Critical Appraisal Checklist for quasi experimental studies. Clear cause and effect described. Participants, groups and intervention comparable.	**Primary outcomes:** Coverage of ≥3 ANC visits increased by 10.3%. IFA supplementation coverage increased by 12.58%. Coverage of ≥2 tetanus toxoid increased by 4.28% Full ANC increased by 1.1%. **Secondary outcomes:**

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	Pradesh, India. *Trop Med Int Heal* 2017, **22** (7):895-907. doi: 10.1111/tmi.12895	**Setting:** Community development blocks of Kaushambi district of rural area of Uttar Pradesh, India. **Sample:** **Pre-intervention:** 450 mothers with children aged 29 days to 6 months, and 310 women with children aged 12–23 months. **Post-intervention:** 534 women with children aged 29 days to 6 months. 1 019 women with children between 12 and 23 months of age.	To improve quality of antenatal care using the following indicators: • Measurement of height; • Measurement of weight; • Measurement of blood pressure; and • A blood and urine test. To improve identification and reporting of complications during pregnancy and after childbirth. To improve coverage of • Institutional deliveries • Ambulance usage for delivery; and • Full immunisation. **Data collection:** Annual Health Survey individual-level data was accessed from Ministry of Health and Family Welfare	Follow-up complete and data analysed according to the groups. Multiple measurements of outcome present. Measurement of outcome reliable with appropriate statistics. **Score on appraisal:** 9/9 Included Level of evidence: I	There was decrease in weight taking (10.7%) and blood testing (5.7%). There was increase in blood pressure by 0.7 %, and urine testing by 2.4%. Self-reporting of illnesses/complication during pregnancy increased by 13.11%, and by 19.6 after delivery. Institutional delivery increased by 4.02%. Ambulance usage increased by 2.06%. Full immunisation decreased by 6.4%. **Limitations:** Allocation of interventions was not randomised. Limited number of variables used for matching.

No.	Bibliographic details	Methodology	Outcome and intervention	Critical appraisal/ level of evidence	Study findings
		Inclusion criteria: Women with children aged 29 days to 6 months. Women with children aged 12–23 months. **Exclusion criteria** Not indicated	in 2011 before the intervention. Household survey was done in 2015 by a team of 35 graduate-level field investigators who collected data from mothers on: • Utilisation of antenatal care services; • Institutional delivery; • Postnatal care; and • Immunisation status of infants. **Intervention group:** Community health volunteers (ASHAs) used mHealth application as job aids to support, • Client assessment; • Counselling; • Early identification; and • Treatment and/or rapid referral of pregnancy,		Sample of women dropped after matching in pre-study. Different reference period used for pre-and post-study. **Recommendations:** An assessment of the costs to understand whether the improvements in service utilisation justifies the increase in investments on account of mHealth. Replication of such an intervention in the entire state or country.

No.	Bibliographic details	Methodology	Outcome and intervention	Critical appraisal/ level of evidence	Study findings
			postpartum and newborn complications. **Control group:** No mHealth intervention **Data analysis:** Matched analysis using Nearest neighbour method with 1:1 algorithm and calliper width of 0.025 to detect differences in the two groups. Difference-in-difference analysis (DID) to compare changes in coverage of services in intervention area relative to the control area was used.		
6.	Prieto JT, Zuleta C, Rodríguez JT: **Modeling and testing maternal and newborn care mHealth interventions: A**	**Aim:** To develop a descriptive model of structural characteristics of mHealth in the context of newborn	**Primary outcomes:** To compare the effects of simultaneous interventions on knowledge and self-reported health behaviour regarding newborn	**Critical appraisal tool used:** JBI Critical Appraisal Checklist for quasi-experimental studies.	**Primary outcomes:** There was increase in knowledge, from 58% before intervention, to 93% after intervention. This was a significant change (p<.001)

No.	Bibliographic details	Methodology	Outcome and intervention	Critical appraisal/ level of evidence	Study findings
	pilot impact evaluation and follow-up qualitative study in Guatemala. *J Am Med Informatics Assoc* 2017, **24**:352-60. doi: 10.1093/jamia/ocw102	nutrition, and to assess the effects of illustrative interventions. **Design:** Experimental design **Setting:** Rural clinics in Guatemala **Sample:** 100 women **Inclusion criteria:** Mothers more than 8 months pregnant or who had babies not older than 4 months. Understand written Spanish. Willing to participate in a mobile technology programme.	nutrition among new mothers. **Secondary outcomes:** Not stated **Data collection:** Face-to-face interviews were conducted Women were interviewed and asked about their knowledge and practices of breastfeeding at recruitment and at the end of the study, by two investigators. **Intervention group:** There were three groups with different interventions: • Group 1 received text messages twice a week. • Group 2 were assigned to 1 of 3 peer-to-peer groups of 10 individuals each.	Clear cause and effect described. Groups and intervention comparable. Data analysed according to the groups. Multiple measurements of outcome present. Appropriate statistics. **Scores on appraisal tool:** 7/9 Included Level of evidence: II	The most effective intervention in terms of increase in knowledge was Group 1 that received text messages only. Most participants in Group 1 (60%, n=12/20) experienced a knowledge increase. All individuals in Group 1 (100%, n=20/20) were, at the end of intervention, aware of the exclusive breastfeeding message, compared to 67% (n=8/12) in the control group. No significant difference in self-reported behaviour, but a significant relation (p=0.010) between changes in knowledge and changes in self-reported behaviour was found. 89% (n=54/61) of those participants who were aware of the exclusive breastfeeding message at the end of the experiment reported to have

No.	Bibliographic details	Methodology	Outcome and intervention	Critical appraisal/ level of evidence	Study findings
		Exclusion criteria: Not stated	• Group 3 were assigned to 1 of 3 peer-to-peer groups (as for Group 2), received information regarding breastfeeding practices (as for Group 1) and could communicate with a health professional. Mothers received text messages twice a week for 23 weeks, related to newborn nutrition, on mobile phones they had been given when they enrolled in the project**.** **Control group:** Mothers simply given a mobile phone and were instructed to use it for matters related to their babies. **Data analysis:** Descriptive statistics		exclusively breastfed their babies. **Secondary outcomes:** Not indicated **Limitations:** Not stated **Recommendations:** New mHealth studies should explore the potential of mixed methodologies for the analysis of low-resource health environments. They should also exploit the possibilities of innovative data collection mechanisms. Future projects could consider finding financial equilibrium by asking for a subscription fee to cover the cost of text message transmission.

No.	Bibliographic details	Methodology	Outcome and intervention	Critical appraisal/ level of evidence	Study findings
7.	Shiferaw S, Spigt M, Tekie M, Abdullah M, Fantahun M, Dinant GJ: **The effects of a locally developed mHealth intervention on delivery and postnatal care utilization; A prospective controlled evaluation among health centres in Ethiopia.** *PLoS One* 2016, **11**:1–15. doi: 10.1371/journal.pone.0158600	**Aim:** To determine whether an mHealth intervention and training of health providers on client-centred care can improve maternity service utilisation, specifically repeat ANC attendance, institutional delivery, and PNC service utilisation, compared to the conventional approach. **Design:** Quasi-experimental study **Setting:** Semen Shewa Zone, Amhara region, central Ethiopia.	**Primary outcomes:** To improve percentage of women who had • At least 4 ANC visits; • Institutional delivery; and • PNC visits at the health centre. **Secondary outcomes:** Not stated **Data collection:** Exit interviews were conducted by health workers (nurses/health officers) with consecutive ANC attendants before and after intervention. Data collected before was biodata. After the intervention, data was collected through	**Critical appraisal tool used:** JBI Critical Appraisal Checklist for quasi-experimental studies. Clear cause and effect described. Participants, groups and intervention comparable. Data analysed according to the groups. Multiple measurements of outcome present. Measurement of outcome reliable with appropriate statistics. **Scores on appraisal tool:** 8/9 Included Level of evidence: II	**Primary outcomes:** At least 4 antenatal visits (27.0% in intervention versus 23.4% in control); AOR: 1.31(95% CI 1.00–1.72) but not statistically significant. Institutional delivery (43.1% in intervention versus 28.4% in control); AOR: 1.98 (95% CI 1.53–2.55). PNC in the health centres (41.2% in the intervention versus 21.1% in control); AOR: 2.77 (95% CI 2.12–3.61). **Secondary outcomes:** Not stated **Limitations:** Limited background information about women in the medical records.

No.	Bibliographic details	Methodology	Outcome and intervention	Critical appraisal/ level of evidence	Study findings
		Sample: 10 health facilities (5 intervention, 5 control). A sample size of 500 in each group. **Inclusion criteria:** Not stated **Exclusion criteria:** Not stated	facility record review and exit interviews, on • Attendance of at least 4 ANC visits; • Institutional delivery; and • PNC visit within 6 hours of delivery. **Intervention group:** Health workers received an Android phone (3 phones per facility) loaded with an application that sends reminders for scheduled visits during ANC, delivery and PNC, and educational messages on danger signs and common complaints during pregnancy. **Control group:** No mobile phone and no reminders (usual care).		**Recommendations:** Explore the possible mechanisms of action of various components of existing mobile health solutions and evaluate their effectiveness in other priority health programmes, such as malnutrition, family planning and immunisation of children on a bigger scale. Provide more applications that offer practical solutions to health challenges that are likely to benefit from technology-based innovations.

No.	Bibliographic details	Methodology	Outcome and intervention	Critical appraisal/ level of evidence	Study findings
			Data analysis: Chi-square tests to compare the baseline and follow-up characteristics of clients. Logistic regression models. 95% CI for the difference of proportions. Significance set at α=0.05.		
8.	Uddin MJ, Shamsuzzaman, M, Horng, L, Labrique, A, Vasudevan L, Zeller K, Chowdhury M, Larson CP, Bishai D, Alam N: **Use of mobile phones for improving vaccination coverage among children living in rural hard-to-**	**Aim:** To develop and test a mechanism to use mobile phones to improve child vaccination coverage. To assess feasibility and effectiveness of mobile phone system of vaccination registry, newborn	**Primary outcomes:** To compare vaccination coverage among 0–11-month-old children in rural hard-to-reach and urban street-dweller areas before and after mobile intervention. **Secondary outcomes:** Not indicated **Data collection:**	**Critical appraisal tool used:** JBI Critical Appraisal Checklist for quasi-experimental studies. Clear cause and effect described. Participants, groups and intervention comparable. Follow-up complete and data analysed according to the groups.	**Primary outcomes:** Full vaccination in the rural intervention area increased, from 58.9% to 76.8%, while decreasing in the rural control area, from 65.9% to 55.2%, resulting in a DID of +29.5% ($p<0.001$). Full vaccination rates in the urban intervention area increased from 40.7% to 57.1%, while decreasing in

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	reach areas and urban streets of Bangladesh. *Vaccine* 2016, **34**, 276-283. doi: 10.1016/j.vaccine.2015.11.024	tracking, and parental reminders. **Design:** Quasi experiment **Setting:** Rural hard-to-reach and urban street-dweller populations of Bangladesh. **Sample:** 520 per group **Inclusion criteria:** Over 18 years old. Had given birth within one year prior to data collection. Able to give written informed consent in Bengali. Children age 0–11 months.	EPI cards, when available, maternal recall with structured questionnaires where cards were not available **Intervention group:** Mothers were sent automatic SMS reminders about upcoming EPI sessions. **Control group:** No intervention, usual care **Data analysis:** Chi-square tests to compare sociodemographic characteristics. Z-tests to compare vaccination coverage between baseline and end line surveys. Difference-in-difference (DID) estimation was used to track longitudinal	Multiple measurements of outcome present. Measurement of outcome not similar. Appropriate statistics used. **Score on appraisal:** 8/9 Included Level of evidence: II	the urban control area from 44.5% to 33.9%, resulting in a DID of +27.1% ($p<0·05$). Intervention effect on age-appropriate vaccination was positive for all age groups, with DIDs ranging from +13.1% to +30.5% and ORs ranging from 2.5 to 4.6 ($p<0.001$ across all rural versus urban comparisons per age group). The largest intervention effect was on age-appropriate vaccination for children over 70 days, OR 4.6 in the urban intervention area ($p<0.001$, 95% CI 2.1–7.8). **Limitations:** Time and funding constraints. Using maternal recall for vaccination history was not as accurate as EPI cards, but

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		Exclusion criteria: Not stated	differences in coverage from baseline to end line between control versus intervention areas. Logistic regression model to test DID for statistical significance and a 95% confidence interval around the odds ratio (OR).		mothers could not produce the cards. **Recommendations:** Research in mechanisms to increase the mHealth intervention's health impacts, scalability, sustainability, and cost-effectiveness**.** Use of the mHealth in low-income countries with high mobile phone use and robust EPI programmes.
Cross-sectional surveys(n=2)					
9.	Alam M, D'Este C, Banwell C, Lokuge K: **The impact of mobile phone-based messages on maternal and child healthcare behaviour: A retrospective cross-sectional survey in**	**Aim:** To evaluate the effectiveness of a mobile-phone-based intervention in Bangladesh, designed to improve compliance with WHO guidelines	**Primary outcomes:** To improve assistance during delivery. **Secondary outcomes:** To improve breastfeeding immediately post birth. To improve delayed bath of newborn up to 3 days.	**Critical appraisal tool used:** CASP tool for cross-sectional studies. Focus clear. Methods appropriate. Recruitment not described. Accurate measures used.	**Primary outcomes:** 307 (65%) women assisted by trained personnel during delivery at health facility. 111 (23%) women had a skilled birth attendant present at birth. 58 (12%) were assisted by untrained relatives or local

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	Bangladesh. *BMC Health Serv Res* 2017, **17**:1-13. doi: 10.1186/s12913-017-2361-6.	related to delivery and neonatal care. **Design:** Cross-sectional survey **Setting:** Five districts in Bangladesh. **Sample:** 476 mothers **Inclusion criteria:** Exposed to the service for at least 3 months during pregnancy or after childbirth. Live birth in the last delivery. Last born child's age between 3 and 18 months.	To improve attendance of four PNC visits. **Data collection:** Involved face-to-face interviews in participants' homes by two researchers. Data was collected on: • Where the baby was born; • Who assisted at delivery; • What was baby fed right after birth; • When was baby given first bath after birth; and • Frequency of PNC visits. **Data analysis:** Bivariate analysis to compare characteristics between exposure groups. Chi-square tests to examine associations	Data collection, presentation and analysis acceptable. Clear statement of the findings. Context appropriate. **Scores on appraisal tool:** 9/11 Included Level of evidence: II	traditional birth attendants at home deliveries. These findings were not statistically significant. **Secondary outcomes:** 443 (93%) fed their babies colostrum immediately after birth. 33 (7%) fed sweetened water, honey or mustard oil. This had no significant association. 294 (62%) women bathed their babies 72 h or more after delivery, 80 (17%) bathed babies in the first 48 h. 100 (21%) bathed babies between 48 and 72 h. Findings about first bath were significant (RRR 1.7; 95% CI 0.93–3.0; p=0.083)

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		Exclusion criteria: Could not be contacted by phone for an appointment. Not at home during the interview. Unwillingness to participate. Outside the survey areas for an indefinite time.	between explanatory and outcome variables. Multiple regression analyses to investigate the relationship between exposure to early warning messages and the outcomes of interest. Multinomial regression analysis for assistance during delivery and timing of first bath. Logistic regression analysis for breastfeeding immediately post birth. Negative binomial regression for frequency of PNC visits.		273 (57%) did not have PNC visits within 42 days after childbirth. The rest reported having 1 (n=79, 17%), 2 (n=54, 11%), 3 (n=34, 7%) or 4 visits (n=36, 8%). This is not statistically significant (IRR: 1.2; 95%CI 0.94–1.6; p=0.117). **Limitations:** Limited generalisability. Association between early messages and outcomes limited. Power of study is based on a moderate to large association. Reliance on self-report of practices, which can introduce bias and problems of recall. Many contextual factors, which contribute to delivery practices, not captured.

No.	Bibliographic details	Methodology	Outcome and intervention	Critical appraisal/ level of evidence	Study findings
					Recommendations: Need for larger studies and randomised designs to overcome the limitations encountered in this study.
10.	Sutcliffe CG, Thuma PE, van Dijk JH, Sinywimaanzi K, Mweetwa S, Hamahuwa M, et al.: **Use of mobile phones and text messaging to decrease the turnaround time for early infant HIV diagnosis and notification in rural Zambia: An observational study.** *BMC Pediatr* 2017, **17**(66):1–10. doi: 10.1186/s12887-017-0822-z	**Aim:** To evaluate the feasibility of using: • Mobile phones to contact mothers in rural Zambia; and • SMS reporting system to deliver test results. **Design:** Cross-sectional survey **Setting:** Macha Hospital in a rural area of Choma	**Primary outcome:** To improve the process of early infant diagnosis using text or phone calls. **Secondary outcome:** To evaluate the performance of a national SMS reporting system to deliver test results from the central laboratory to the clinic. **Data collection:** Clinic and medical records were retrieved by study nurse. Data was collected on time when the mother returned	**Critical appraisal tool used:** CASP tool for cross-sectional studies. Focus clear. Methods appropriate. Recruitment not clear. Accurate measures used. Data collection not clear. Data presentation and analysis acceptable. Clear statement of the findings. Context appropriate. **Scores on appraisal tool:**	**Primary outcomes:** 87% mothers preferred a phone call above text messages. Contact made with mother in 96% of tests. Median of 6 days after receiving test results before mother was called. Mother visited clinic after having been asked to attend clinic: median 18 days, IQR 5,40. Shorter duration of returning to clinic lead to early diagnosis into care. **Secondary outcomes:**

No.	Bibliographic details	Methodology	Outcome and intervention	Critical appraisal/ level of evidence	Study findings
		District, Southern Province, Zambia. **Sample:** 419 mother-infant pairs **Inclusion criteria:** Bringing infants to either the HIV clinic or a primary health centre associated with the hospital. Access to a mobile phone. Willingness to participate **Exclusion criteria:** Not stated	to receive her child's test results. **Data analysis:** Descriptive statistics. Chi-square tests to compare categorical variables. Wilcoxon rank sum tests to compare continuous variables.	7/11 Included Level of evidence: IV	Rural health centres were first called median 7 days (IQR 3, 20). Median time from sample collection to ART initiation 103 days (IQR 71,144). Median time from delivery of test results to clinic to disclosure to mother 37 days (IQR 17,57). Mothers with infants with positive results returned to the clinic sooner (median 15 days; IQR 7,27) than those with negative results (median 39 days IQR 18,61; $p<0.0001$). SMS reporting improved from 38% (2013) to 91% (2014). **Limitations:** Not possible to determine the impact of the intervention on retention.

No.	Bibliographic details	Methodology	Outcome and intervention	Critical appraisal/ level of evidence	Study findings
					Evaluation of the national SMS system did not involve the central laboratory or the individuals involved in sending the text messages. Not able to determine the full benefit of mobile technology in reducing the turnaround time from the lab to the clinic. **Recommendations:** Additional resources necessary for ongoing monitoring to ensure quality. Programmes and clinics need to weigh the costs of text message systems against the benefits of earlier diagnosis and treatment for HIV-infected infants.
Qualitative studies (n=1)					
11.	Ayiasi RM, Atuyambe LM, Kiguli J, Orach	**Aim:**	**Outcomes:** To determine:	**Critical appraisal tool used:**	**Outcomes:**

No.	Bibliographic details	Methodology	Outcome and intervention	Critical appraisal/ level of evidence	Study findings
	CG, Kolsteren P, Criel B: **Use of mobile phone consultations during home visits by community health workers for maternal and newborn care: Community experiences from Masindi and Kiryandongo districts, Uganda.** *BMC Public Health* 2015, **15**:560.	To explore perceived maternal and newborn benefits of VHTs making home visits to prenatal and postnatal women and using mobile phone consultations to link VHTs to professional health care workers for further advice. **Design:** Qualitative design **Setting:** Two districts in Uganda **Sample:** 67 interviews (with women, VHTS, professional health workers)	• The perceived benefits of home visits and phone consultations; • Perceptions regarding recommended newborn care practices; • Perceptions regarding delegation of promotional maternal and newborn messages to VHTs. In depth interview: Conducted with prenatal, postnatal women, VHT members and professional health workers. **Data collection:** Through in-depth interviews, key informant interviews and group discussions. **Data analysis:**	CASP tool for qualitative research. Clear statement of aims. Methodology appropriate. Design, recruitment and data collection appropriate to aims. Researcher-participant relationship adequately addressed. Ethical issues not adequately addressed. Data analysis rigorous. Clear statements of findings. Context appropriate. **Scores on appraisal tool:** 9/10 Included Level of evidence: II	Perceived benefits of home visits and phone consultations, • Improved access to maternal and newborn care; • Provided additional information leading to attitudinal change; • Contributed to emotional satisfaction among VHTs, prenatal and postnatal women; and • Elevated social status for VHTs, women felt well cared for and enlisted male partner support. Perception regarding recommended newborn care practices was as follows: • Cord care: Nearly all women accepted and practised non-application of substances on the umbilical stump. Women reported they relied on

No.	Bibliographic details	Methodology	Outcome and intervention	Critical appraisal/ level of evidence	Study findings
		In total 87 participants	Interviews were audiotaped and transcribed directly into English. Typed texts were read several times and exported to NVivo Version 10. Latent content analysis was done (subjective interpretation of text data through systematic classification process of coding and identifying themes or patterns).		advice offered by their VHTs; • Thermal care: About 3 in 4 women admitted to practising delayed bathing; following the VHT's teachings; and • Breastfeeding and pre-lacteal feeds: Nearly all women agreed to initiate breastfeeding within one hour after delivery. They learnt from VHTs that newborns were too young to take in anything other than breastmilk. Perceptions regarding delegation of promotional maternal and newborn messages to VHTs were that promotional maternal and newborn interventions to VHTs were mostly accepted. Working with VHTs was found acceptable. **Limitations:**

No.	Bibliographic details	Methodology	Outcome and intervention	Critical appraisal/ level of evidence	Study findings
					Related to qualitative technique. Limited number of women. **Recommendations:** Not stated

ADDENDUM L: ADDITIONAL FILE 2: DATA SYNTHESIS ON HOW MHEALTH STRENGTHEN PNC IN A RURAL AREA

Article	Type of mHealth	Strengthening of PNC				
		Intention	Skills		Environment constraints/facilitators	
		Attitudes	Norms	Self-efficacy		
Ayiasi RM, Kolsteren P, Batwala V, Criel B: **Effect of village health team home visits and mobile phone consultations on maternal and newborn care practices in Masindi and Kiryandongo, Uganda : A community-intervention trial**. *PLoS Med* 2016 **11**(4):e0153051. doi: 10.1371/journal.pone.0153051 **LEVEL OF EVIDENCE: II**	Mobile phone call consultations by village health teams with healthcare professionals.	Not addressed	Village health team members used mobile phone calls to positively influence mothers to deliver in hospitals and seek care for the newborns' illnesses.	Not addressed	Use of mobile phone consultation with healthcare professionals positively influenced mothers to improve cord and thermal care of their newborns.	Healthcare professionals in consultation with village health team members facilitated timely and prompt seeking of maternal and newborn care.

Atnafu A, Otto K, Herbst CH. **The role of mHealth intervention on maternal and child health service delivery: findings from a randomized controlled field trial in rural Ethiopia**. *mHealth* 2017, 3:39-39. doi: 10.21037/mhealth.2017.08.04 **LEVEL OF EVIDENCE: II**	One-way mobile phone messaging to health extension workers and voluntary community health workers.	Not addressed	Health extension workers and voluntary community health workers used one way mobile phone messaging to positively influence mothers to deliver in hospitals. Health extension workers used one-way mobile phone messaging to positively influence mothers to deliver in their presence.	Not addressed	Not addressed	Use of mobile phone messaging by community health workers facilitated mothers to receive PNC services soon after birth.
Odeny TA, Bukusi EA, Cohen CR, Yuhas K, Camlin CS, McClelland RS: **Texting improves testing: A randomized trial of two-way SMS to increase postpartum prevention of mother-to-child transmission**	Interactive mobile phone messaging between postnatal mothers and study nurse.	Use of text messages positively influenced mothers to attend postnatal clinics. Use of text messages positively	Not addressed	Not addressed	Not addressed	Use of interactive mobile phone messages facilitated postnatal mothers to receive postnatal care services that were personal.

retention and infant HIV testing. *AIDS* 2014, **28**(15):2307–2312. doi: 10.1097/QAD.0000000000000409 **LEVEL OF EVIDENCE: I**		influenced mothers to take their infants to the clinic for HIV testing.				
Bigna JJR, Noubiap JJN, Kouanfack C, Plottel CS, Koulla-shiro S: **Effect of mobile phone reminders on follow-up medical care of children exposed to or infected with HIV in Cameroon (MORE CARE): A multicentre , single-blind , factorial , randomised controlled trial.** *Lancet Infect Dis* 2014, **14**(7):600–6008. doi: 10.1016/S1473-3099(14)70741-8. **LEVEL OF EVIDENCE:II**	One-way mobile phone messaging appointment reminders by study nurse to mothers. Mobile phone call appointment reminders by study nurse to mothers. Combined mobile phone messaging and mobile phone calls for appointment reminders by	Not addressed	Not addressed	One-way mobile phone messaging and mobile phone calls positively influenced attendance of scheduled appointments for HIV care by mothers.	Not addressed	Not addressed

	study nurse to mothers.					
Prinja S, Nimesh R, Gupta A, Bahuguna P, Gupta M, Thakur JS. **Impact of m-health application used by community health volunteers on improving utilisation of maternal, new-born and child health care services in a rural area of Uttar Pradesh, India.** *Trop Med Int Heal* 2017, **22** (7):895-907. doi: 10.1111/tmi.12895 **LEVEL OF EVIDENCE: I**	One-way mobile phone messaging to community health volunteers. Mobile phone audio-visual application used by community health volunteers as job aids.	Not addressed	Community health volunteers used mobile phone audio-visual to positively influence mothers to deliver in the hospital.	Mobile phone audio-visual application by community health volunteers positively influenced mothers to recognise and report compli-cations after pregnancy.	Not addressed	Timely one-way mobile phone messaging reminders to community health volunteers facilitated mothers to receive PNC services and facilitated greater contact with public sector.
Prieto JT, Zuleta C, Rodríguez JT: **Modeling and testing maternal and newborn care mHealth interventions: A pilot impact evaluation and follow-up qualitative**	One-way mobile phone messaging to mothers on newborn nutrition by health professionals.	Use of mobile phone messaging on nutrition positively influenced mothers to believe in the value of	Not addressed	Use of mobile phone messaging on nutrition positively influenced mothers to exclusively	Use of mobile phone messaging on nutrition positively influenced mothers to practice exclusive breastfeeding.	Not addressed

study in Guatemala. *J Am Med Informatics Assoc* 2017, **24**:352-360. doi: 10.1093/jamia/ocw102 **LEVEL OF EVIDENCE: II**		exclusive breast-feeding.		breastfeed their newborns.		
Shiferaw S, Spigt M, Tekie M, Abdullah M, Fantahun M, Dinant GJ: **The effects of a locally developed mHealth intervention on delivery and postnatal care utilization; A prospective controlled evaluation among health centres in Ethiopia.** *PLoS One* 2016, **11**:1–15. doi: 10.1371/journal.pone.0158600 **LEVEL OF EVIDENCE: II**	One-way mobile phone messaging reminder to the health worker and phone call reminder to the mother.	One-way mobile phone messaging reminder to the health worker and phone call reminder to the mother positively influenced mother to deliver in the hospital and seek PNC services in the health centres.	Not addressed	One-way mobile phone messaging reminder to the health worker and phone call reminder to the mother positively influenced mothers to feel valued and responsive to following advice.	Not addressed	One-way mobile phone messaging reminder to the health worker facilitated tracking of the mothers, reminding them to attend to PNC services.
Uddin MJ, Shamsuzzaman M, Horng L, Labrique A,	One-way mobile phone messaging to	One-way mobile phone messaging to	Not addressed	Not addressed	Not addressed	One-way mobile phone messaging to both the mothers

Vasudevan L, Zeller K, et al.: **Use of mobile phones for improving vaccination coverage among children living in rural hard-to-reach areas and urban streets of Bangladesh.** *PMC* 2017, **34**:276-83. doi: 10.1016/j.vaccine.2015.11.024 **LEVEL OF EVIDENCE: II**	both the mothers and health workers.	both the mothers and health workers positively influenced mothers to vaccinate their children in a timely manner.				and health workers facilitated timely vaccination of children.
Alam M, D'Este C, Banwell C, Lokuge K: **The impact of mobile phone based messages on maternal and child healthcare behaviour: A retrospective cross-sectional survey in Bangladesh**. *BMC Health Serv Res* 2017, **17**:1-13. doi: 10.1186/s12913-017-2361-6. **LEVEL OF EVIDENCE: II**	One-way mobile phone text or voice messages to mothers on delivery and neonatal care.	One-way mobile phone text or voice messages positively influenced mothers to change their beliefs on delaying first bath, and breastfeeding their babies with colostrum immediately after birth.	Not addressed	Not addressed	One-way mobile phone text or voice messages positively influenced mothers to breastfeed their babies immediately after birth and bath their newborn only after three days.	Not addressed

Sutcliffe CG, Thuma PE, van Dijk JH, Sinywimaanzi K, Mweetwa S, Hamahuwa M, et al.: **Use of mobile phones and text messaging to decrease the turnaround time for early infant HIV diagnosis and notification in rural Zambia: An observational study.** *BMC Pediatr* 2017, **17**(66):1-10. doi: 10.1186/s12887-017-0822-z **LEVEL OF EVIDENCE: IV**	One-way mobile phone messaging or phone calls to mothers to inform of them of test results.	Not addressed	Not addressed	Not addressed	Not addressed	One-way mobile phone messaging or phone calls facilitated mothers to return to the clinic, leading to early diagnosis and enrolment for care.
Ayiasi RM, Atuyambe LM, Kiguli J, Orach CG, Kolsteren P, Criel B: **Use of mobile phone consultations during home visits by community health workers for maternal and newborn care:**	Mobile phone call consultations by village health teams with health care professionals.	Mobile phone call consultation by village health teams with health care professionals positively influenced mothers to	Mobile phone call consultation by village health teams with health care professionals positively influenced male partner participation in	Mobile phone call consultation by village health teams with health care professionals positively influenced mothers'	Mobile phone call consultation by village health teams with health care professionals positively influenced mothers to achieve desired	Mobile phone call consultation by village health teams with health care professionals facilitated mothers' access to maternal and newborn care services.

Community experiences from Masindi and Kiryandongo districts, Uganda. *BMC Public Health* 2015, **15**:560. **LEVEL OF EVIDENCE: II**		change beliefs in newborn care practices, i.e., breastfeeding immediately after birth, cord care and thermal care. The intervention also lead to attitudinal change by providing additional information.	maternal and newborn care issues.	confidence to arrive at more favourable outcomes for their babies.	newborn care practices, i.e., breastfeeding immediately after birth, cord care and thermal care.	

Notes:

- ✓ **Type of mHealth**: Device + manner of message conveyed.
- ✓ **Norms**: Who is "social network'? + What is outcome of their influence?
- ✓ **Attitude**: Change in behaviour. (Behavioural attitude. The synonyms are beliefs, views, act, approach, perspective, position, stand, expression, mindset, inclination.)
- ✓ **Efficacy**: The ability to produce a desired or intended result. (Synonyms are effectiveness, effectualness, efficaciousness, efficacity, efficiency, productiveness, ability, capability, capacity. potency, puissance, strength.)

- ✓ **Skill**: A particular ability. (Synonyms are expertise, skilfulness, expertness, adeptness, adroitness, deftness, dexterity, ability, prowess, mastery, competence, competency, capability, efficiency, aptitude, artistry, art, finesse, flair, virtuosity, experience, professionalism, talent, cleverness, smartness, ingenuity, versatility, knack, readiness, handiness.)
- ✓ **Environmental constraints/facilitators**: Physical hindrances/enablers.

ADDENDUM M: AUTHOR GUIDELINES (*PLoS ONE*)

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ADDENDUM N: AUTHOR GUIDELINES (*AFRICAN JOURNAL OF REPRODUCTIVE HEALTH*)

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