THE USE OF MEDIC MOBILE APPLICATION BY COMMUNITY- BASED HEALTH VOLUNTEERS TO MONITOR PRE- AND POST PREGNANCY STATUS IN NORTHERN GHANA: A CASE STUDY OF SELECTED DISTRICTS

BY

ANDREWS O. ASAMOAH

(10442067)

A DISSERTATION SUBMITTED TO THE SCHOOL OF PUBLIC HEALTH, UNIVERSITY OF GHANA IN PARTIAL FULFILMENT FOR THE AWARD OF THE MASTER OF PUBLIC HEALTH (MPH) DEGREE

JULY 2018
DECLARATION

I, Asamoah, Andrews Obed hereby declare that except for references to other people’s work which have been duly acknowledged, this thesis is the result of my own research carried out at the School of Public Health, College of Health Sciences, University of Ghana under the supervision of Prof. Moses Aikins (HPMM-SPH).

This thesis has neither in whole nor in part been presented for another degree.

Andrews O. Asamoah
(Student)

Prof. Moses Aikins
(Supervisor)
DEDICATION

This work is dedicated to the Almighty God for making it possible for me to successfully complete this study and then to my dedicated and committed supervisor, Prof. Moses Aikins, and my family Mrs. Rita Asamoah, Papa Kwabena Danso Asamoah, Nana Akwaboah Nyansah Asamoah and Owura Kwadwo Yeboah Asamoah for their support and encouragement throughout this period.
ACKNOWLEDGEMENTS

First, I am highly thankful to God for giving me knowledge, good health, favour and guidance to develop and complete this dissertation. I wish to take this opportunity to express my sincere appreciation to my supervisor, Prof. Moses Aikins for his encouragement, concrete suggestions, critical guidance, corrections, show of concern and above all his in-depth knowledge and commitment provided me for this work. I also appreciate his valuable hours spent on me because of this work. May God bless him and replenish in hundred-fold whatever he’s lost on me.

I am also grateful to my wife and children for their support at all times. To my mother and siblings, I say God bless you for your prayers. To Catholic Relief Services, I am highly indebted to you, both management and staff for your support to make this a reality especially Mohammed Ali for the support. I further acknowledge the advice of other lecturers at Department of Health Policy, Planning and Management at School of Public Health, University of Ghana Legon and the supporting staff for typing various introductory letters needed for data collection.

Special thanks to all District Health Directors of East and West Mamprusi, Mamprugu Moaduri and Kumbungu districts for facilitating the data collection process. I am also grateful to District Health Information Officers who supported me in the data collection as well as all research assistance. To you all I say thank you and may God bless you all.
ABSTRACT

Background:

Skilled assistance to child birth in Northern Region is noted as the lowest (36.4 percent) as compared with national rate of 74 percent, yet over 80 percent of all maternal deaths occur around the period of delivery. Fortunately, various research on mHealth solutions have shown to contribute to an improved maternal health outcome. However, these mHealth applications have not been fully utilized for improved maternal health outcome.

Objective:

This study assessed the use of medic mobile application by community-based health volunteers (CHVs) in monitoring pre and post pregnancy status in Northern Ghana.

Methods:

A descriptive cross-sectional research design was used targeting 123 CHVs who use the MMA application. Data on pregnancy status were analysed from the medic-mobile web-based platform. The complete census was conducted on all available CHVs who were engaged in MMA. The study reviewed on-going intervention by Catholic Relief Service.

Results:

The study observed that correct use of MMA by CHVs was relatively low in the first quarter of the programme but however, increased by 33 percent in the second quarter after some refresher trainings and supportive supervision. The use of MMA captured averagely 38 percent of all pregnancy status data in the four districts, exceeding the project target of 30 percent. Again, a quarterly analysis of the use of MMA showed that access to 4+ ANC services, skilled delivery and
48-hour PNC services in all the four districts increased over time. Similarly, pregnancy status indicators were relatively better in MMA facilities than non-MMA facilities.

**Conclusion and Recommendation:**

Some challenges observed include discontinuity of some CHVs and the delay in replacing them. Largely, the use of MMA helps to monitor pregnancy status adequately. Community-based health volunteers who are no more using the application should be replaced while at the same ensuring that trainings for such interventions are not limited to the start of the project.
TABLE OF CONTENT

DECLARATION ..................................................................................................................... i
DEDICATION ...................................................................................................................... ii
ACKNOWLEDGEMENTS ........................................................................................................ iii
ABSTRACT ........................................................................................................................ iv
LIST OF TABLES ...................................................................................................................... ix
TABLE OF FIGURES ............................................................................................................. x
LIST OF ABBREVIATIONS ...................................................................................................... xi
CHAPTER ONE ...................................................................................................................... 1
INTRODUCTION .................................................................................................................... 1
  1.0 Background .................................................................................................................. 1
  1.1 Problem Statement ...................................................................................................... 4
  1.2 Justification of the study ............................................................................................. 6
  1.3 General Objective ....................................................................................................... 7
    1.3.1 Specific Objective ................................................................................................. 7
  1.4 Research Questions ..................................................................................................... 7
  1.5 Organisation of the Study .......................................................................................... 8
  1.6 Conceptual Framework .............................................................................................. 8
CHAPTER TWO ..................................................................................................................... 10
LITERATURE REVIEW ......................................................................................................... 10
  2.0 Introduction ................................................................................................................ 10
  2.1 General Background and Concept of mHealth ........................................................... 10
  2.2 Medic Mobile in mHealth Context ............................................................................. 12
  2.3 mHealth as a Health System Strengthening Tool ....................................................... 16
  2.4 mHealth in Maternal Healthcare Services ................................................................ 20
  2.5 Use of mHealth for medication adherence ............................................................... 23
  2.6 Use of mHealth as a Behaviour Change Communication (BCC) tool ....................... 27
  2.7 Use of mHealth for data collection, surveillance and monitoring ............................. 28
  2.8 Use of mHealth for treatment and management of diseases ..................................... 30
  2.9 mHealth for Supply Chain Management .................................................................. 33
  2.10 mHealth for Human Resource Management ............................................................ 36
  2.11 Benefits in the use of mHealth ................................................................................. 37
  2.12 Challenges hindering the rollout of mHealth in developing countries ........................ 39
2.13 The role of community-based health volunteers in mHealth intervention.......................... 41
2.14 Summary of the Chapter................................................................................................. 43

CHAPTER THREE .............................................................................................................. 44

METHODS ......................................................................................................................... 44
3.0 Introduction.................................................................................................................... 44
3.1 Study Design................................................................................................................... 44
3.2 Study Location................................................................................................................ 45
  3.2.1 West Mamprusi ....................................................................................................... 45
  3.2.2 Kumbungu District ................................................................................................. 46
  3.2.3 East Mamprusi ....................................................................................................... 47
  3.2.4 Mamprugu Moaduri .............................................................................................. 47
3.3 Study Variables.............................................................................................................. 48
3.4 Sampling......................................................................................................................... 48
3.5 Sample Size.................................................................................................................... 49
3.6 Data Collection............................................................................................................... 49
3.7 Quality Assurance.......................................................................................................... 49
3.8 Data Analysis.................................................................................................................. 50
  3.8.1 Determination of correct use of MMA ................................................................. 50
  3.8.2 Estimation of proportion of ANC attendance captured by MMA......................... 51
  3.8.3 Estimation of skilled delivery captured by MMA ................................................... 51
  3.8.4 Estimation of PNC attendance captured by MMA ................................................ 52
  3.8.5 Presentation of results ............................................................................................ 52
3.9 Ethical Considerations.................................................................................................... 52
3.10 Summary of the chapter .............................................................................................. 54

CHAPTER FOUR .............................................................................................................. 55

RESULTS .......................................................................................................................... 55
4.0 Introduction.................................................................................................................... 55
4.1 Description of CRS’ Tech4PROMISE Project Districts ............................................... 55
4.2 Demographic Characteristics of CHVs ........................................................................ 56
4.3 Correct Use of MMA by CHVs per District ................................................................. 58
4.4 Health facilities per District against facilities MMA operates .................................... 60
4.5 Antenatal Care attendance captured by MMA............................................................ 61
  4.5.1 Average 4+ ANC Attendance per quarter in MMA facilities only ......................... 62
LIST OF TABLES

Table 4.1: Description of CRS’ Tech4PROMISE Project Districts ...........................................57

Table 4.2: Demographic Characteristics of CHVs.................................................................58

Table 4.3: Correct Use of MMA by CHVs per District.........................................................59

Table 4.4: Health Facilities per District against facilities MMA operates ..........................60

Table 4.5: Antenatal Care Attendance captured by MMA..................................................62

Table 4.6: Skilled deliveries captured by MMA per District ...............................................65

Table 4.7: Skilled deliveries in MMA facilities against facilities without MMA ..............67

Table 4.8: Postnatal Care Attendance captured by MMA against district target..............68

Table 4.9: PNC attendance within 48-hours in MMA facilities against non-MMA facilities.....70
# TABLE OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1.1</td>
<td>Conceptual Framework for the use of MMA by CHV</td>
<td>9</td>
</tr>
<tr>
<td>Figure 2.1</td>
<td>Medic Mobile Application processes</td>
<td>14</td>
</tr>
<tr>
<td>Figure 2.2</td>
<td>Medic Mobile Application Detailed Work Flow</td>
<td>15</td>
</tr>
<tr>
<td>Figure 4.1</td>
<td>Correct Use of MMA by CHVs per Quarter</td>
<td>60</td>
</tr>
<tr>
<td>Figure 4.2</td>
<td>Submission of Valid Data as captured by MMA per district</td>
<td>61</td>
</tr>
<tr>
<td>Figure 4.3</td>
<td>Average 4+ ANC Attendance per quarter in MMA facilities only</td>
<td>63</td>
</tr>
<tr>
<td>Figure 4.4</td>
<td>Facilities with MMA and without MMA on 4+ ANC attendance</td>
<td>64</td>
</tr>
<tr>
<td>Figure 4.5</td>
<td>Skilled deliveries captured by MMA per quarter in MMA facilities only</td>
<td>66</td>
</tr>
<tr>
<td>Figure 4.6</td>
<td>Quarterly 48-hour PNC attendance rate in MMA facilities only</td>
<td>69</td>
</tr>
</tbody>
</table>
# LIST OF ABBREVIATIONS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACT</td>
<td>Artemisinin-based Combination Therapy</td>
</tr>
<tr>
<td>AL</td>
<td>Artemether Lumefantrine</td>
</tr>
<tr>
<td>ANC</td>
<td>Antenatal Care</td>
</tr>
<tr>
<td>ARV</td>
<td>Antiretroviral</td>
</tr>
<tr>
<td>BCC</td>
<td>Behavioural Change Communication</td>
</tr>
<tr>
<td>CF</td>
<td>Community Facility</td>
</tr>
<tr>
<td>CHPS</td>
<td>Community-based Health Planning and Services</td>
</tr>
<tr>
<td>CHVs</td>
<td>Community Health Volunteers</td>
</tr>
<tr>
<td>CHN/Os</td>
<td>Community Health Nurses/Officers</td>
</tr>
<tr>
<td>CHW</td>
<td>Community Health Worker</td>
</tr>
<tr>
<td>CRS</td>
<td>Catholic Relief Service</td>
</tr>
<tr>
<td>DHIO</td>
<td>District Health Information Officer</td>
</tr>
<tr>
<td>GHS</td>
<td>Ghana Health Service</td>
</tr>
<tr>
<td>GoG</td>
<td>Government of Ghana</td>
</tr>
<tr>
<td>GOe</td>
<td>Global Observatory for eHealth</td>
</tr>
<tr>
<td>HIV</td>
<td>Human Immuno-Deficiency Syndrome</td>
</tr>
<tr>
<td>HAS</td>
<td>Health Surveillance Assistance</td>
</tr>
<tr>
<td>HW</td>
<td>Health Worker</td>
</tr>
<tr>
<td>ICT</td>
<td>Information, Communication and Technology</td>
</tr>
<tr>
<td>IMPACT</td>
<td>Improving Prescription Adherence through Computerized Text Messaging</td>
</tr>
<tr>
<td>IVR</td>
<td>Automated Interactive Voice Response</td>
</tr>
<tr>
<td>LMIC</td>
<td>Low and Middle-Income Countries</td>
</tr>
<tr>
<td>Acronym</td>
<td>Full Form</td>
</tr>
<tr>
<td>---------</td>
<td>-----------</td>
</tr>
<tr>
<td>MCH</td>
<td>Maternal and Child Health</td>
</tr>
<tr>
<td>MDG</td>
<td>Millennium Development Goals</td>
</tr>
<tr>
<td>mHealth</td>
<td>Mobile Health</td>
</tr>
<tr>
<td>MMA</td>
<td>Medic Mobile Application</td>
</tr>
<tr>
<td>MMR</td>
<td>Maternal Mortality Ratio</td>
</tr>
<tr>
<td>MoH</td>
<td>Ministry of Health</td>
</tr>
<tr>
<td>PNC</td>
<td>Postnatal Care</td>
</tr>
<tr>
<td>RDT</td>
<td>Rapid Diagnostic Test</td>
</tr>
<tr>
<td>RTMM</td>
<td>Real-Time Medication Monitoring</td>
</tr>
<tr>
<td>SDGs</td>
<td>Sustainable Development Goals</td>
</tr>
<tr>
<td>SMS</td>
<td>Short Message Services</td>
</tr>
<tr>
<td>TBAs</td>
<td>Traditional Birth Attendants</td>
</tr>
<tr>
<td>TRCL</td>
<td>Telemedicine Reference Centre</td>
</tr>
<tr>
<td>UNF</td>
<td>United Nations Foundation</td>
</tr>
<tr>
<td>USAID</td>
<td>U.S. Agency for International Development</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
</tbody>
</table>
CHAPTER ONE

INTRODUCTION

1.0 Background

In reviewing the Government of Ghana Sustainable Development Goal (SDG) 2015 report, it was clear that socio-economic status of the country within the last twenty years have shown an improvement in most sectors of the economy (Gogh, 2015). This, according to the report, is as a result of innovative ideas and interventions within the framework of Millennium Development Goals (MDGs), which had eventually culminated into Sustainable Development Goals (SDGs). Achievement of key indicators in the SDGs does not only change policy direction of the country but also determine the direction of growth, development and investment even among key development partners. As sectors like education (especially among girl child), access to safe drinking water and parity among school girls continue to enjoy phenomenon growth, key health indicators including maternal mortality and infant mortality continues to lag behind the key targeted indicators in the MDGs/SDGs (UNDP, 2013).

Investing in the health sector has been identified as one of the key promoters in ensuring the growth of an economy (Gunn, 2015). There are a number of significant benefits in investing in health and not only do the benefits limited to improving the health of a given population, but also gives significant economic returns (Nicholson, 2015). Nicholson (2015) in a recent 2015 Lancet report on Commission on Investing in Health discusses the effects of health investment on the GDP of a country through productivity, education, access to resources and other sectors of the economy. Countries all over the world are now actively working towards the fulfilment of universal health
coverage. There is therefore the global quest for universal health coverage through efficient and
effective methods (Liu et al., 2012). However, the global demand for health coverage is not just
for providing health service at cheaper rate, but also to ensure that quality services are provided
with an improved and innovative ideas to increase accessibility at all levels (Liu et al., 2012). Delivering health care service at the door step of the individual requires effective strategies and
approaches that are cost effective.

Information, Communication and Technology (ICT) based solutions have been identified in recent
times as one of the most cost effective and efficient service delivery methods (UNF, 2010). ICT
based solutions serve as a medium in improving public health challenges facing millions of people,
especially within the developing world (UNF, 2010). Wireless communications within the ICT
portfolio are noted as one of the most universally used and widely accepted technology in Africa
(UNF, 2010). Health care service provision through mobile communications - known in ICT field
as mHealth – has come up strongly in the last decade as an innovative solution for a wide array of
pressing health care and health care system needs (United Nations Foundation, 2010). Mobile
technology has become one of the most cost-efficient methods for increasing accessibility to health
care and ensuring that health service is affordable (UNF, 2010)). Development partners as well as
policy makers continue to invest in this sector as it provides the platform for improving the concept
of universal health coverage across board. Through mobile technology, accessibility to
communications is improved while helping to transfer voice and data to healthcare providers on
time (UNF, 2010). Deloitte Centre for Health Solutions in 2014 conducted an analysis on four
dimensions of effective mHealth and concluded that the use of mobile and wireless devices to
support medical and public health practice and research was gaining increased attention, however, the full importance had yet to be realized (Greenspun et al, 2014).

Mobile use is fast growing in developing countries where it is estimated that about 64 percent of all mobile users are in developing countries (UNF, 2010). Wang and Liu (2009) indicated that mobile phone usage is a rapidly growing area in altering the manner in which healthcare is delivered. They further discussed that through mobile wireless technology patients experience as well as the cost of healthcare are easily determined. West (2015) also argued that through mobile devices and mobile health (mHealth) services, management of chronic disease, maternal care and disease epidemics are improved. Not only does mHealth improve service delivery, but also helps to track status of patients and to report on their conditions as well for effective follow up. It also provides an avenue for providing critically needed health services to underserved areas (West, 2015). Vulnerable communities through mHealth are brought closer to health information which provides an opportunity to connect to people and eventually reducing the delay in seeking health care services. It is therefore clear that mHealth plays an important role in improving maternal, neonatal and child health indicators.

One of the recent mHealth solutions is the Medic Mobile Application. Medic mobile uses communication technologies to improve the health of underserved and disconnected communities. As a mHealth provider, medic mobile build mobile and web tools for health workers (both professional and community health volunteers), helping them to provide better care that reaches everyone, especially the vulnerable communities (Medic Mobile, 2014). Medic mobile again
develops free and open-source tools that can be adapted for specific health service delivery. This study therefore sought to assess how medic mobile application as a mHealth solution improves maternal health outcomes of underserved communities in the Northern Region of Ghana.

1.1 Problem Statement

Sengupta (2011), mentioned that maternal mortality remains the highest cause of death among women within the reproductive age (15-49 years). It is also reported that more than 1500 women within the same age die per day through pregnancy related causes (UN, 2009). The 2015 Millennium Development Goal Accelerated Framework report on Ghana shows that maternal mortality ratio (MMR) for the country remained 380 per 100,000 live births, far worse than two-thirds of the ratios in other developing countries (UN, 2015). The Northern Region in 2016 recorded 420 maternal death per 100,000 live births (GHS, 2017) far higher than the national rate of 380 deaths per 100,000 live births (GHS, 2016). Majority of these deaths were as a result of avoidable causes.

Northern Region (NR) records the lowest rate of patronage of skilled assistance at childbirth (GSS, 2015). The region’s record shows that only 36.4 percent of mothers seek skilled assisted deliveries as against the national rate of 74 percent (GSS, 2015), largely due to traditional beliefs that prevents women from accessing health care as well as challenges with geographical access to healthcare, yet over 80 percent of all maternal deaths occurred around the period of delivery (GHS, 2015). For instance, the Institutional MMR in the Northern Region remains one of the lowest – 107 against 143 of national (GHS, 2015). If all deliveries are to receive skilled assistance, MMR in the region would be improved to higher extent. Communities in the NR have unequal access to
health facilities and skilled professionals. Postnatal check-ups also remain a major challenge in the Northern Region. Maternal death definition takes into consideration the importance of postnatal check-ups at least within the first 42 days of termination of pregnancy for the health of the mother as well as two years continuous visits for the health of the baby. However, NR records the least postnatal check-ups within 48 days (59.3 percent) compared with national rate of 81 percent (GSS, 2015).

In an assessment conducted by Catholic Relief Service (CRS) in East Mamprusi District in 2014, women cited limited access to health facilities and the absence of referral systems (CRS, 2015). A Ghana Health Service 2016 Annual report showed an improvement in antenatal care (ANC) services for at least one visit (GHS, 2017). However, four times visits, which is a good measure for seeking ANC services remains a challenge in the Northern Region. The challenge has however been that some are unable to visit the facilities again when they are due for next visits. This, according to the Northern Region 2016 Annual Performance report, indicated that over 45 percent of all women tend to forget the date of their next visit due to illiteracy while others have difficulty in reaching the health personnel (GHS, 2016). With a strong community referral and follow up systems, there is the possibility of improving attendance of required four ANC visits. Even when pregnant women are informed of danger signs, there are no tracking system to know when such a woman is due for ANC visits. More dangerous is when they are due for delivery with some signs of complications but no support systems to ensure the woman in question receive skilled assisted delivery (Bliss & Streifel, 2015).

Fortunately, various research on mHealth solutions have shown to contribute to an improved maternal health outcome. The question remains whether these applications have been used fully
within the northern sector to improve maternal health outcomes. Where mHealth solutions have been applied, they only target health professionals who only work at the facility level to the neglect of the support systems that function at the community level. Awoonor et al. (2013), mention that mHealth solutions have mostly concentrated on community nurses who often base their work in the Community-based Health Planning and Services (CHPS) compound and are unable to follow up at the community level on essential services. There is therefore a gap in referral system for continuum of care from the point of household through to the health provider. The role of community health volunteers (CHVs) in using mHealth intervention to strengthen referral systems is mostly neglected mainly because CHVs are seen as a support system for health workers only during community health service and not as referral points for improved health outcome (Awoonor et al., 2013).

1.2 Justification of the study

Monitoring of pre- and post-pregnancy status within the Northern Region have been limited to only routine maternal and child health interventions including awareness creation, safe motherhood programs and the popular free maternal health care services. However, Northern Region records one of the highest maternal mortalities and low ANC attendance in the country (GHS, 2016). Through this study, maternal health outcome of pregnant women would be improved through the recording and tracking of pregnant women. On the provider side, the study would help in the monitoring of pregnant women for the provision of continuum of care of health services.
1.3 General Objective

The general objective of the study was to assess the use of medic mobile application (MMA) by community-based health volunteers (CHVs) in monitoring pre- and post-pregnancy status in Northern Ghana.

1.3.1 Specific Objective

The specific objectives are:

1) To determine the correct use of MMA by CHVs to transmit and report pregnancy related cases
2) To determine the proportion of ANC attendance captured by MMA
3) To determine the proportion of skilled deliveries captured by MMA
4) To determine the proportion of PNC attendance captured by MMA

1.4 Research Questions

The main research questions that were addressed in order to answer the research problems are:

- Are the CHVs using the MMA correctly to register and transmit information into the MMA dashboard?
- What proportion of ANC attendance have been captured by MMA within the project cycle?
- What proportion of skilled delivery have been captured by MMA?
- What proportion of PNC attendance have been captured by MMA?
1.5 **Organisation of the Study**

The study is organized into six chapters. The first chapter discusses the general background to the research and highlights key sections like statement of problem, objectives and research questions and justification to the research. Chapter two of the research reviews various literature around the subject and its relevance to the topic. Chapter three presents the methodology adopted in carrying out this research and explains the unit of enquiry for the research. In addition, the chapter briefly discusses the profile of the study area. In chapter four, results and findings of the research are discussed and analysed thoroughly. Analytical tools are employed in the analysis to highlight the key issues emanated from the study.

Chapter five discusses the key findings of the research and their relationship with existing literature. Conclusions and recommendations are deduced from the discussions and presented in chapter six.

1.6 **Conceptual Framework**

The application of mHealth within the continuum of care approach for maternal and child health is a typical model best fit for the use of medic mobile system for improved maternal and child health. For this study, the proposed concept the systematic approach of using MMA to improve ANC attendance, skilled delivery and PNC attendance. Figure 1.1 explains how the study analysed the use MMA and its relationship with the three key indicators mentioned above.
The framework in figure 1.1 explains that the MMA usage goes through a process, which eventually results in an outcome. The usage of MMA will depend on the number of CHVs trained to use the application. In all, 160 CHVs received training on the use of MMA. These trained CHVs were expected to correctly use MMA through registrations, validation and submission. The assessment of how MMA system improves ANC attendance, skilled deliveries and PNC attendance, the proposed framework tries to understand the feedback mechanism that exist within the correct use of MMA. Again, the underlying assumption as per the framework was that through the frequent follow ups as a result of the MMA use, pregnant women would consistently visit healthcare facility for ANC services and at the same time deliver in the facility with the support of skilled personnel. Additionally, the mother would access PNC services especially within the first 24 days of delivery. The framework discusses this flow using the MMA usage, process and outcome approach.
CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

The chapter discussed the various concepts of mHealth and how it has emerged over the years. It also presents the core concept of Medic Mobile Application and the channels of operation. The chapter discussed the various topics on mHealth and how it has been used in advancing health care services. The review of literature looked at publications and journals and summarised the key outcomes of various researchers that have been done in the field of mHealth. Key areas reviewed include mHealth as a health system tool, mHealth and maternal health, mHealth for monitoring health status and indicators, etc. The chapter concludes with a summary of the outcome of the various literature reviewed. The following discussions therefore reviews various articles and publications related to mHealth and the work of community-based health volunteers.

2.1 General Background and Concept of mHealth

Since the introduction of Millennium Development Goals, great strides have been made in reaching key targets by some developing countries while others move at a very slow rate. One area of key challenge has always been the Goal 5 (maternal health) as countries continue to struggle to reach the target (UNDP, 2015). A 2010 World Bank report (collaborated by WHO, UNICEF and UNFPA) on maternal mortality ratios across the globe narrowing down to regional and country levels showed that sub-Saharan Africa countries have made insufficient progress and some to extent none (World Bank, 2010). Several strategies by all stakeholders including governments, development partners, Civil Society Organizations, among others have been developed to curb or
reduce the burden of mortality among pregnant women when trying to give life. The use of information and communication technology has been widely accepted as one of the best strategies to reducing high rates of maternal mortality in sub-Saharan Africa (ICT4Health, 2012). Through ICT, health care solutions, also known as eHealth are developed to provide alternative solution for health outcomes (UNF, 2010).

Different tools and services are provided through eHealth solutions, which provides more appropriate solutions to quality health care provision. Ghana Health Service through its Enterprise Architecture document defines e-Health as “the use of modern information and communication technologies to meet needs of citizens, patients, healthcare professionals, healthcare providers, as well as policy makers” (GHS, 2009). With advent of technologies, different models and devices for eHealth have emerged (WHO, 2011). One of these medium through which eHealth operates is the use of mobile and wireless technologies, also known as mHealth. “The unprecedented spread of mobile technologies as well as advancements in their innovative application to address health priorities has evolved into a new field of eHealth, known as mHealth” (WHO, 2011). There is no clear-cut definition for mHealth.

Several schools of thought have defined mHealth in a different way. However, all thoughts and arguments have concluded on one key point, the use of mobile phones. For instance, Global Observatory for eHealth (GOe) defines mHealth as a public and medical health practice through the use of mobile devices (e.g. mobile phones) and other wireless devices (WHO, 2013). Globally, mHealth has been identified as having the potential to change the content of health service delivery
through the use of mobile and wireless technologies to accomplish the goal of health outcome (WHO, 2011). Reaching vulnerable population through mobile and wireless devices have become very necessary with the rising demand and use of these devices in developing countries. The International Telecommunication Union in its recent report showed that almost 5 billion mobile phones have been subscribed in the world (WHO, 2013). The Global Observatory for eHealth Series by WHO (2011), shows that the rate of growth in terms of adoption and usage of mobile phone networks in developing countries far exceeds the rate of growth of other infrastructure such as road network, electricity and water.

In 2011, over 500 million users in Africa were identified as mobile phone users (Mobile Africa Report, 2016), and at least half of people in remote areas have access to or use mobile phones (UNF, 2009). The wide spread of mobile usage even across rural communities where access to health care delivery is limited has resulted in the emergence of the use of mHealth for effective and efficient health care delivery.

2.2 Medic Mobile in mHealth Context

Medic Mobile is a non-governmental organization operating under the mHealth context to provide technical support in health system strengthening framework. Medic mobile uses technologies that are communication-based to provide technical guidelines on health for underserved and disconnected communities. The MMA uses three-case programme in addressing health care challenges. In Use Case I, MMA works to improve maternal and neonatal mortality. Under this system, the application provides services on antenatal care, postnatal care and family planning. In
Use Case II, MMA works to improve child health outcomes through provision of system-based solutions for nutrition, immunization and integrated case management systems. Finally, under Case III, MMA aims at strengthening community health systems by introducing applications for health worker performance management, health system performance management, outbreak surveillance and communication systems (Medic Mobile, 2017).

The MMA works on building the capacity of community health workers (including community health nurses and community-based health volunteers) by strengthening the community health system to improve health outcomes. It is widely known that health workers are the key providers of health care services (Medic Mobile, 2017) and therefore integrating the three areas of focus as discussed above results in a comprehensive approach to community healthcare. With health workers at the centre of care, the tool/software allows individual members who are responsible for healthcare to be engaged in improving health care. Health workers uses the tools which have been developed on a feature mobile phone to register every pregnancy, track infant immunization, nutrition and other essential child health services. The health workers again track disease outbreaks faster and communicate about emergencies. Figures 2.1 and 2.2 shows the various stages in which the system operates and how feedback systems are sent for action.
Health workers at the community level are expected to register new pregnancies with the tools developed on the mobile phones and transmit the registry into the web-based platform. The platform sent automated reminders and advices to both the local health facility and the community core coordinator. The details of the process is further described in Figure 3 with the various stages and the workflow.
Figure 2.2: Medic Mobile Application Detailed Work Flow

Source: Medic Mobile, 2015

Figure 2.2 shows that Community-based Health Volunteer (CHV) identifies pregnant women and children whose age is below 2 years in the community. At stage 1, the CHV registers the pregnant woman as well as the child under 2 years and send an SMS to the medic system. The system then sends the CHV a notification short message services (SMS) to the CHV on registration status. The system then generates a schedule for the clients. When the client’s appointment is due, an SMS is sent to the CHV at Stage 2, prompting him/her to remind the client to go for the appointment which is done at Stage 3. At Stage 4, the client attends the clinic as per the appointment. A confirmation is sent to the platform on client’s visit to the facility.
Another message is sent to the CHV with missed opportunities. A follow up is done at Stage 5. The CHV then confirms the clinic visit and sends a clinic confirmation SMS to the system at Stage 6. Alerts on danger signs are also sent to the CHW and the nurse/midwife when a client misses an appointment and the same process in Stages 5 and 6 are followed through.

2.3 mHealth as a Health System Strengthening Tool

WHO defines health system strengthening as the process of identifying and implementing the challenges in policy and practice in a country’s health system in order to allow the country respond better to the identified health challenges (WHO, 2011). This definition is further explained by WHO to include initiatives and strategies that improve the functions of health system for improved coverage, access, quality and efficiency of health (Islam, 2007). The U.S. Agency for International Development (USAID) in its 2015-2019 HSS Vision document defines HSS as comprising of strategies, activities and responses proposed to improve the health performance of a country (USAID, 2015). A review of these two definitions shows that a well-functioning health system should include all other sectors to work to achieve health sector goals and performance. Both WHO and USAID through the analysis identify six building blocks, which work toward a strong HSS. These building blocks among others, include health information under which the concept of mHealth functions. The 2015-2019 HSS Vision of USAID further explains that to effectively understand the performance of each HSS block, strong evidence should back the work to prove that strengthening a particular block will improve health outcomes (USAID, 2015). It is no doubt that several research in the area of health information have shown that consistent strengthening of health information component of HSS will increase access, improve quality and ensure sustainability of health programmes.
The increasing number of mHealth projects, some of which are piloted in several areas has increased the level of interest and commitment by policy makers and developing partners to invest in mHealth intervention (Labrique, 2013). Fortunately, most of these pilots have proven to be effective by showing how mHealth conceptually reduces specific health challenges that hitherto affected coverage key health interventions like maternal and child and reproductive health in general (Labrique, 2013). However, successes of these interventions have not been documented enough or have phased the challenge of scale up by some development partners (WHO, 2011), mainly as a result of inadequate empirical evidence supporting the value of cost, performance and health outcomes (Free et al., 2013; mHealth Alliance, 2013). However, in recent times, a number of documentations have been done to show how mHealth works as health system strengthening tool for improving some indicators in the MDGs/SDGs that developing countries have lagged behind (Global Health, 2013). One of such is the recent mHealth reviews which proposed that innovations and strategies should rather focus on the public health principles which underlies the initiative instead of the technology been used (Global Health, 2013).

Additionally, research organizations as well international agencies, including USAID and WHO have worked to frame mHealth interventions to operate within the framework of health system goals and outcomes (WHO, 2013). These discussions and framework consolidation have influenced the decision by all parties in agreeing on common mHealth functions and applications for improved health outcome.
Twelve key mHealth functions and applications have been identified as health system strengthening tool.

1. Client Education and Behaviour Change Communication: This type of mHealth application creates a channel for delivering behavioural-based contents purposely for improving knowledge, modify attitudes and promoting best health practices (Global Health, 2013) by engaging 1 or more actors mostly pregnant women by influencing their health behaviours on use and adherence to medications (Lester et al., 2010). The assumption is that all pregnant women or nursing mothers have access to mobile phones.

2. Sensors and Point-of-Care Diagnosis: This system developed novel sensors and technologies to conduct diagnosis test, store and communicate the results through mobile phones and evaluates the results. This works best when clients have limited access to the health facilities but have access to mobile phones. The patients’ health status is monitored remotely through a sensor (Global Health, 2013).

3. Registries and Vital Events Tracking: Mobile phones are used to track events and register health outcomes. It is very effective and commonly used because the mobile phone based registrations help to easily identify and count eligible beneficiaries of an intervention (Labrique, 2013) and increases accountability of interventions and provides adequate and prompt care to clients (Chang, et al., 2013).

4. Data Collection and Reporting: The data collection and reporting system under mHealth is focused on improving data collection by frontline health workers who hitherto had challenges reporting on data from their respective facilities. The system helps health workers to shift from a paper-based data collection and submission to an improved electronic based system through the use of mobile phones (Modi Research Group, 2013).
5. Electronic Health Records (EHRs): EHRs as mHealth system allows health workers to electronically register clients on the service they are served with and submit the results where it becomes easy to update patient’s histories even while on the field (Global Health, 2013), and this has improved the continuum of care at any point of service delivery (John Hopkins School of Public Health, 2013).

6. Electronic Decision Making: The electronic decision-making tool application provides opportunity to healthcare providers to access available protocols through automated algorithm or rule-based instructions which guides the provider in the provision of quality care, especially on task shifting issues (Global Health, 2013) and provides phone-based step-by-step guide for diagnosis and treatment (Derenzi et al., 2011).

7. Provider-to-Provider Communication: The provider-to-provider communication uses caller groups to discuss common health issues among practitioners. It is noted as one of the simplest and most improved mHealth application in terms of health service provision, which improves communication vertically and horizontally and commonly used for telemedicine (Global Health, 2013).

8. Provider Work Planning and Scheduling: The provider and scheduling tool remind health workers on events and activities for effective follow ups on clients per appointment schedules. The reminder is automated such that the rate of reminders keeps increasing as the time for the event/appointment draws closer. The MoTech “Mobile Midwife Service” provides this type of service (Grameen Foundation, 2013).

9. Providing Training and Education: Existing mHealth application tools continue to strengthen health workforce and creates an avenue for improving health staff capacity to provide quality
healthcare. The provision of continuing medical education using videos and messages is very useful in areas with high mobile phones usage (Chang et al., 2013).

10. Human Resource Management (HRM): The HRM mHealth tool is useful for health workers and their supervisors who are distance away from each other. In this application, supervisors through a web-based platform monitor the work of their supervisees in their facilities to assess whether health workers provide real time services or otherwise as was done in Uganda (UNICEF, 2013).

11. Supply Chain Management: Most mHealth used supply chain management tool to track and manage stocks and supplies, especially for essential commodities like family planning (Global Health, 2013). In Ghana, the introduction and piloting of the e-tracker to track the processes of medical supplies to the last-mile has taken some time to be rolled-out but is gradually gaining some grounds (GHS, 2015).

12. Financial Transaction and Incentives: The use of mHealth in financial transaction is not common in the global health discourse. It is however, noted to be one of the emerging areas. The main reason for introducing this tool is to focus on decreasing financial challenges that clients face in the quest for adherence to medical requirements (Global Health, 2013).

2.4 mHealth in Maternal Healthcare Services

In Zanzibar, it was estimated that about 50 percent of all deliveries in the country were conducted by unskilled attendant (Ministry of Health and Social Welfare, Tanzania, 2008). Meanwhile, maternal mortality in the country was mostly through preventable causes when in effect it takes less than a day on the average for a woman to deliver at the health facility (Lund et al., 2008). It was noted that antenatal attendance was high, however, skilled delivery was continuously low. Based on this, a number of mHealth interventions were introduced by different actors and agencies
(Lund et al., 2008). One of search intervention as discussed by Lund et al. (2012), is the “wired mothers” mobile phones intervention. One group of primary healthcare facilities and women attending those facilities was randomised to receive a mobile phone intervention, whereas the control group received no intervention. The study showed that the wired mothers’ mobile phone intervention increased significantly skilled delivery attendance amongst women of urban residence (95 percent), but, in its current form, did not reach rural women and therefore, the results could not be generalised to include rural communities. Skilled delivery increased among intervention as compared with control group.

In the Department of Alta Verapaz (an administrative district of the country), it was observed that 74 maternal deaths were recorded vis-a-vis 27,052 live births making MMR of 273 deaths per 100,000 live births. Largely, the main causes of the maternal deaths were hypertensive disease (25 percent), pneumonia (19 percent), diarrhoea (18 percent) and malaria (8 percent). Based on the above challenges, a Non-Governmental Organization TulaSalud introduced telemedicine concept of mHealth by providing remote support to community health workers known as community facilitators (CFs). According to Martinez-Fernandez et al. (2015), the intervention by TulaSalud enrolled 125 CFs within the Alta Verapaz and each of them was provided with a mobile phone. The researchers in this study adopted observational methodology and worked through control (no telemedicine) and intervention (tele-CFs) groups and were both rural based.

The study showed that the m-health system introduced by TulaSalud significantly reduced maternal mortality and child mortality in the Department of Alta Verapaz. A detailed analysis of
the information shows that impact becomes noticeable two years after the start of the intervention, making it difficult for obtaining significant short-term impact results in telemedicine projects.

In Kenya, it was observed that up to 70 percent of new-borns did not have exact weights measured and recorded by the end of the first week of life. Gisore et al., (2012) in a study describes a comparison of the new-born- weight and pregnancy case finding data obtained before and after provision of weighing scales and mobile phones to village elders in proportionate terms. The study observed that the recorded birth weight increased from 43 ± 5.7 percent (before) to 97 ± 1.1 (after). Moreover, the study showed that when community systems are strengthened, all health outcomes could be improved. However, the study failed to discuss the other factors including the behavioural change strategies adopted to influence community members on the importance of weighing. Availability of mobile phones and weighing scales alone cannot influence the outcome.

Noordam et al. (2011), conducted a similar study to assess how the use of mobile phones could improve maternal health services in Low and Middle-Income Countries (LMIC). The assessment was based on available scientific and grey literature, which centred on mHealth and maternal health with emphasis on less developed countries. The study observed that most projects, which use mobile phones to promote maternal health services mainly centred on improving health service delivery by addressing the delay in receiving care as well as the delay in seeking care. From all the literature reviewed, the general conclusion was that access to mHealth intervention has the potential of improving maternal health care. One limitation of the study was that it only focused on literature, which addresses health worker knowledge and service provision with limited review on pregnancy related danger signs and health care seeking which are mostly the main cause of
maternal mortality.

World Vision (2014), also analysed the importance of mHealth in improving maternal care delivery. World Vision mHealth intervention in Afghanistan over a period of time showed that antenatal attendance in some selected provinces increased by 20 percent while at the same time the number of pregnant women receiving skilled delivery in a recognized health facility increased by 22.3 percent. The report showed that access to skilled delivery was somehow limited in most of the provinces and therefore the mHealth intervention increased access to maternal health care with the resultant effect being the increase in ANC attendance and skilled delivery.

2.5 Use of mHealth for medication adherence

Suffoletto et al., (2012) in a paper published by Society for Academic Emergency Medicine analysed the effects of mobile phone text messages programme on oral antibiotic use and its related feedback on adherence to patients who are discharged from emergency department. Foster et al., (2007), indicated that one way of influencing patient’s health-related behaviour was through the transitioning of care from the health-facility to the home. Unfortunately, patients most often fail to adhere to the prescriptions by a physician after they leave the facility (Thomas, et al., 1996). The Suffoletto et al., (2012) through a randomised control clinical trial (control and intervention groups) used a system called Improving Prescription Adherence through Computerized Text-messaging (IMPACT). The assessment showed that adherence among patients receiving text messages did not differ from those who did not receive any text messages. This was largely because the design of the tool did not include follow mechanism. Text messages alone could not influence the uptake of medications. Follow-up mechanism needs to be strengthened to ensure that
clients are adhering to prescriptions. Additionally, the class of the beneficiaries should be considered in the design in-terms of educational status.

Park, Howie-Esquível and Chung, (2014) also reviewed the use of text messaging to patients with coronary heart disease on adherence to their medication. Similarly as in the study by Suffoletto et al., (2012), the team in this study compared three groups of patients – 1) those receiving text messages for medication reminders and education; 2) those receiving only text messages for education; and 3) those with no messages. The results of the study showed that clients who received both text messages and reminders had a higher percentage of correct doses and adherence with those receiving no text messages with less percentage of adherence and correct doses. The findings again depicted that any text messaging should be comprehensive to address some bottlenecks in adherence. This is because even though those receiving only text messages for education had an increased percentage of adherence than those with no text messages, the absence of the reminder messages decreases the rate between them and the first group. mHealth interventions is a very promising way of improving adherence, however, any intervention on that should be comprehensively thought through to address any challenge that might affect results.

Quilici et al. (2013), also assessed the effect of motivational short message service through mobile phones on aspiring adherence for patients with acute coronary syndrome after discharge from hospital. Sneop et al. (2007), maintained that aspirin resistance and to some effect non-adherence remain a major risk factor for frequent ischemic conditions. Quilici et al., (2013) in the study analysed two group of patients – 1) patients who receive text messages; and 2) patients without text messages. Patients within the intervention group received text messages for continuous 30
days as a reminder for adhering to daily aspirin intake of 75 mg. The results showed that 92 percent of those receiving SMS adhered to aspirin intake and were very satisfied with the service while 41 percent of control group adhered. The main findings from the study showed that daily motivational messages through mobile phones to client with coronary syndrome had the potential of improving aspirin adherence at one month, which is a critical timeline after the discharge from the hospital. The study analysed other determining factors that contributes to both adherence and non-adherence to aspirin intake and did not limit analysis to only the mHealth tool since not one approach is capable to improve adherence.

The use of mHealth to improve medication adherence has also been tested. In Bangalore, India, Rodrigues et al., (2012) assessed how mobile reminders support the adherence to antiretroviral (ARVs) therapy among HIV patients. In the region of Bangalore, it was observed that some patients had difficulty in adhering to ARVs even though adherence was somehow encouraging. The study, which was mainly a quasi-experimental cohort study, recruited 150 HIV patients and followed them through for a period of 6 months. Study participants received two forms of messages – 1) an automated interactive voice response (IVR); and 2) non-interactive neutral picture SMS. All messages were sent once a week. The main findings of the study include a proportionate increase in optimal adherence from 85 – 91 percent among study participants within the 6 months period. One notable finding of the study was that messages sent to HIV patients were noted as non-intrusive and not a threat to privacy. Significantly, a larger proportion of the study participants saw the IVR as very useful mHealth tool for improving adherence to ARVs. The results showed that with SMS reminders, ARV adherence could be improved in all settings knowing that one major challenge of adherence even in Ghana was forgetfulness (GHS, 2009).
In Cameroon, Mbuagbaw et al., (2012) did a similar study to test the effectiveness of mobile text messages to HIV patients on weekly basis to improve adherence. The researchers in this study used similar motivational messages as was in the case of the India study. The difference in the two research was the introduction of a control group in the Cameroon study. Eligible participants were randomized to intervention and control groups from the Yaoundé Central Hospital. Participants aged over 21 years and had access to mobile phones were recruited for the study and excluded those who had been on ARV for less than one month. Motivational text messages were sent to participants in the intervention group which included a reminder once a week for a period of 6 months (same as was done in India). The results showed that participants in the intervention group had had 90 percent rate of adherence as compared with the control group of 66 percent. However, the study had some limitations. The study observed that the number of adherence during the last week of the study was relatively higher which does not necessarily measure the true adherence over time thereby not reflecting the expected behaviours for a long time.

Hettinga, Gussinklo and Gutter, (2013), also tried to assess how medication adherence levels improved when epilepsy patients continuously receive customised SMS reminders. The study was to first assess adherence using the Real-Time Medication Monitoring (RTMM) system through an automated SMS reminder. Participants for the study were selected from an outpatient clinic providing tertiary-level of epilepsy services to patients in Zwolle, north-eastern Netherland. Study participants received SMS messages on when to take their medication with most often a question as “Have you taken your medication yet”? In order to provide adequate and comprehensive assessment of the RTMM system, the study team selected another group of epilepsy patients without SMS reminders. The results showed that patients with SMS had 82.2 percent correct
medication intake as against those without SMS of 68.5 percent. Again, only 7.1 percent of intervention group had missed doses against 17.9 percent of control group. By inference, the study showed that patients who were monitored through the RTMM system had increased adherence for epilepsy medication. However, the study was done in small clinic with only 28 participants, which made it a bit difficult in generalising the findings.

A similar study using the RTMM system was conducted by Vervloet et al. (2012), on patients with type 2 diabetes. In this study, Vervloet et al., (2012) selected 104 patients with the condition with poor adherence to oral antidiabetics. Among the 104 patients, 56 were selected randomly as the intervention group to receive the reminders periodically while 48 as control group. The study participants were followed through over six months period as has been the case in most of the mHealth adherence interventions. The findings of the study showed that patients who continuously received SMS through the RTMM system had an improved uptake of doses (50 percent) within a given timeframe (i.e 1-hour window) as compared to those within the control group (39 percent). Similar to the study by Hettinga et al. (2013), the RTMM system with reminders to patients with type 2 diabetes increased adherence to oral medication. The sample size of 56 intervention group participants was also small to have a generalized analysis as well as grouping specification. Again, the study did not provide any clear explanation as to whether the study population took their medication after receiving the SMS or took their medication prior to receiving the reminders.

2.6 Use of mHealth as a Behaviour Change Communication (BCC) tool

Another area of focus in the use of mHealth in recent times has been in behaviour change communication, which mostly influences decisions on key health seeking behaviours. This
approach, as discussed earlier, adopts different strategies in reaching clients for education and awareness creation. In some cases, BCC materials using mHealth are done in videos and/or audios. In some cases, the use of text messages becomes the BCC tools for changing attitudes towards the adoption of positive health practices.

Cole-Lewis and Kershaw (2010), reviewed how text messages were used as a tool for changing health behaviours for disease prevention and management. The primary objective of the review was to assess the effectiveness of behaviour change communication approaches and interventions in the management of diseases as well as addressing the basic health challenge in terms of prevention. As such, the study team compiled a number of clinical results from a quasi-experimental studies and randomized control trials, which had text messages as mHealth intervention for changing health behaviours. Four key diseases were considered for the study and these included HIV, diabetes and hypertension and asthma. The main finding of the study was the increased utilization of health services as a result of BCC text messages (Hanauer, et al, 2005). Studies from Atun et al, (2009) and Krishna, et al., (2009) in different studies found that the use of mobile phones remained a useful tool in communicating behaviour change messages and consequently, improving uptake of key health services. Franklin et al (2006) indicated that the most effective tool on using mHealth for BCC was when text messages are sent as reminders to clients with periodic prompt notifications.

2.7 Use of mHealth for data collection, surveillance and monitoring

Another useful function of mHealth is data collection, surveillance and monitoring. In discussing mHealth as HSS tool, it was clearly noted that among the 12 key components was the fourth point
of data collection and reporting (WHO, 2013).

In South Africa for instance, Tomlinson et al. (2009), looked at the use of mobile phones as a data collection tool for a household survey. The idea was to see how, with CHVs with some experience in data collection, could be used as data collectors using mobile phones with little capacity building exercise. Community Health Volunteers were therefore trained in the use of mobile phones for conducting the survey in Umlazi which had both urban and rural characteristics and had a high infant mortality rate of 60 per 1,000 live births (Ijumba & Barron, 2005). The results within a four-month period was that, through the support of the mobile phones, with over 39,665 households surveyed, not a single data was lost by the team. This is because the data collection system was connected to a web-based interface where the data collected were transmitted and stored in a cloud system. Additionally, through the web-based platform, team supervisors and managers were able to monitor the rate of work as well as commencement and cessation of work. This clearly shows that for data collection, mobile phones with web-based interface system provides quality and reliable data based for timely decision making.

In the area of surveillance, Brinkel et al., (2014) conducted a systematic review to understand how the use of mobile phones had supported health surveillance in Sub-Saharan Africa. Nine different studies were reviewed which met the inclusion criteria of the study. Almost all the reviews (80 percent) used low cost basic phones (popularly known as feature phones) for data collection and surveillance. And at the same time applied SMS system. This is very similar to the MMA system discussed earlier where feature phones are used to collect real time data and data transmitted through a web-based platform using SMS system. The surveillance system in most of the studies
were on infectious diseases, which required a real-time update and reporting for prompt response. One major finding of the study was that about 87 percent of the studies reviewed were able to provide quick and prompt update on infectious diseases and other health issues appropriately confirming the importance and usefulness of mHealth in surveillance. However, the study failed to analyse the difference in surveillance system using feature phones and android platforms and the cost effectiveness.

2.8 Use of mHealth for treatment and management of diseases

The use of mHealth has also been tried in the management and treatment of diseases mostly chronic illness like diabetes, HIV, hypertension, etc. The concept of mHealth for chronic disease management has arisen largely due to the limited nature of heath workforce and the constraints in reaching patients at a remote area (WHO, 2006). Moreover, the proliferation of mobile phones has made it easy for the adoption of the mHealth for key health interventions.

Schnall et al., (1997) using a qualitative research method, looked at how mHealth technology could be used as a persuasive tool for HIV treatment, care and management among Persons Living with HIV. To this extent, mobile apps and features, which had the possibility of meeting the needs of the people were identified. As a way of improving the functionality of the app and the tool for management of HIV, a number of focus group discussions were conducted by the team to solicit views and ideas on strategies that best fit the purpose. By way of strengthening the analysis of the study, Fogg’s functionality role triad for computing technology model was used to help determine the theory illustration of mHealth concept. Participants observed the approach as very effective means of managing HIV conditions and therefore made a number of suggestions to improve the
design of the tool. Games/virtual rewards, simulations as well as coding of health tasks were considered. The findings from the assessment were then used to develop a mobile app to provide basic education on management of HIV conditions.

Cafazzo et al., (2012) also conducted a pilot study on the design of an mHealth app for self-management of adolescent type 1 diabetes. One of the chronic conditions that were mostly diagnosed in children is type 1 diabetes which requires continuous attention of management both in the house and at the community level (Pediatr, 1994). The study selected 20 adolescent patients who attended diabetes clinic for more than 6 months using qualitative approach. These participants were introduced to an app that discussed the management of type 1 diabetes. The result after the 6 months showed that the intervention showed an increase in the daily average frequency of blood glucose measurement by 50 percent. Additionally, the other indicators that were self-reported showed a significant increase. The study however, was carried out in single site with a very small convenient sample size and no control group to compare results. The results could be corroborated with a similar study by Logan et al. (2007) on the use of mobile phones for the management of hypertension in diabetes. The promising results from all these studies provide the platform for further studies on how the studies could be replicated in Sub-Saharan Africa as all studies focused on developed world.

The use of mHealth as a means of linking village doctors with clinical physicians was also tested by Khan et al., (2015). In this study, Khan et al., (2015) analysed how formal doctors in medical hospitals can provide capacity assistance to village doctors in Chakaria through call centres. It was
noted that the village doctors in the province of Chakaria served providers practicing some amount of modern medicine even though they had no or little formal training but were prescribing medicines to clients who visited them (Ahmed et al., 2009). With the proliferation of ICT (mobile phones), a Telemedicine Reference Centre (TRCL), an mHealth system was established in the Chakaria province to provide technical coaching to village doctors through free phone calls and video conference even consultation with a client. For the study, 55 village doctors were selected purposely based on their use and non-use and were interviewed using qualitative methods. The results showed that the village doctors, being linked to formal doctors, were happy with the mHealth system which improved their delivery of service. It provided opportunity for new learning and helped to provide quality service. One limitation of the study was that it failed to assess the view of the professional doctors on the system and their perception for using the approach to provide remote service to clients through the village doctors.

Goyal et al., (2013) did a similar study on the use of mobile app for self-management of type 1 diabetes among adolescents. However, in this study, the team used a randomized control trial where two groups (intervention and control) were used for the study. In addition, this study had more participants than the one conducted by Cafazzo et al (2012). The study aimed at assessing the effects of bant on haemoglobin. Another difference was that the study used 12 months and recruited 92 participants (46 receiving usual care and another 46 receiving usual care and bant). The study by Cafazzo et al. (2012) assessed the app satisfaction for 6 and 12 months. The study results showed that patients in the intervention group had an improved HbA10 and increased SMBG. The findings between the intervention and control group was that while the bant users taking SMBG ≥ 5 daily had a significant improvement in HbA10 of 58 percent, the patients without
any bant had no significant change. The result confirms the importance of mHealth in treatment and management of chronic disease if well managed.

2.9 mHealth for Supply Chain Management

One of the emerging areas of mHealth is supply chain management. In supply chain management, mHealth helps in monitoring or tracking the distribution of medical supplies and commodities from the national medical stores through to the last mile.

Shieshia et al., (2014) assessed how community health supply chain performance could be improved and strengthened using mHealth technology in Malawi. A report by the Ministry of Health, Malawi (2010), showed that one of the major challenges of health care delivery included supply chain, especially at the community level. For this reason, an mHealth tool called cStock was introduced to be used by health surveillance assistants (HSAs) for reporting community stock data. Shieshia et al. (2014), in assessing the effectiveness and reliability of cStock observed that the tool was acceptable to all users and that over 70 percent of community and facility providers were able to send and receive messages without any challenge. The study observed that when the HSAs were trained in the use of cStock, they were able to use cStock system to routinely order for medical products when they observe shortages without waiting for institutional routine system, which sometimes takes longer time because of bureaucracy. Additionally, cStock also reduced the unnecessary distribution of medicines and other supplies through an automated system, which estimates the quantity of drugs a facility required and this helped to improve transparency and accountability in the management of stocks.
The challenge of medical supply to health facilities, especially in Africa has been a major concern for all development partners. USAID in 2010 through its Deliver Project introduced an mHealth intervention in some selected countries, including Ghana, Tanzania, Guinea, Zambia, Nigeria among others (USAID, 2010). It was observed that in Africa health facilities were not getting the needed drugs and medical supplies for their patients. The Deliver Project was therefore an mHealth intervention that looked at the use of mobile phones to improve access to drugs and medical supplies. In Ghana, the project evaluation report for 2016 showed that the introduction of mobile phone to create access to medical supplies and drugs had results. Facilities, which hitherto had reported shortages of essential medical supplies like family planning commodities had constant supply of commodities through the mobile alert and signal system (USAID, 2016). Through that, about 4 million unintended pregnancies were prevented while at the same time preventing over 52,000 and 13,000 child deaths and maternal deaths respectively within a period of 6 years (USAID, 2016).

In Guinea, the focus of the Deliver Project with the mHealth intervention was on strengthening the country’s supply system and the capacity of health workers to be able to manage contraceptives and malaria commodities. Within the 33 districts that the project was implemented, it was noted that the rate of contraceptive use had increased by 40 percent while at the same time malaria in pregnancy reduced by 35 percent (USAID, 2016).

Githinji et al. (2013), discussed the role of SMS using mobile phones in reducing the stock-out of life saving malaria commodities in Kenya. It was observed that stock-out of essential malaria
commodities mainly artemether lumefantrine (AL) and rapid diagnostic tests (RDT) was increasingly high in rural health facilities. In view of that, an SMS based reporting system on these two essential malaria commodities were introduced in 187 public health facilities in five districts in Kenya. The review of the SMS based reporting system by Githinji et al. (2013), revealed that about 97 percent of the facilities used the SMS reporting of stock-out, which resulted in 93 percent accurate stock-out reports. By the end of the pilot phase, stock-outs of one or more AL had reduced by 38 percent while stock-out of RDT commodities reduced by 24 percent. One other observation by the study was that nearly 44 percent of the AL and 73 percent of RDT stock-outs were responded by managers of the various commodities. Again, stock-outs decline in these districts were noted to be far greater than the stock out decline at the national level.

Similarly in Tanzania, Barrington et al. (2010), assessed the role of an mHealth intervention “SMS for Life” to improve the management and supply of anti-malaria drugs in rural communities. In 2009, prior to the intervention, Tanzania was noted as the third largest population with high malaria cases with over 11 million cases recorded every year (WHO, 2009). Barrington et al., (2010), indicated that with the high incidence of malaria in the country, a number of health institutions through Roll Back Malaria Partnership undertook a 21-week pilot roll-out using SMS for Life with the aim of improving supply and access to artemisinin-based combination therapy (ACT). As was in the Kenyan study, the SMS for Life concept in Tanzania focused mainly on AL and RDT supplies to rural facilities. The study recorded over 93 percent response rate on using SMS for Life in reporting of stock-outs. It was observed that the proportion of health facilities which reported no stock-out of the essential malaria commodities reduced from the initial 78 percent at baseline
to 26 percent at endline (Barrington et al., 2010). The study further observed that the overall AL stocks increased by 64 percent across the implementing districts.

2.10 mHealth for Human Resource Management

The use of mHealth for managing human resource is gradually receiving maximum attention due to the limited nature of health staff, especially in rural communities. Target groups have always been community based workers often located in isolated areas with no direct contact to technical support (Labrique et al., 2013). In Rwanda, the Ministry of Health introduced the mUbuzima intervention, an mHealth package which provides a direct linkage between higher level staff (national and regional) and the local level staff (mainly community health workers) though a mobile system (MoH, Rwanda, 2013). It was observed in the country that there were shortages of health workers (HWs) at all levels especially at the local.

As in most African countries, specialized physicians were concentrated at the national capital with low level staff who have little or no knowledge of some key health management conditions working at the community level (MoH, Rwanda, 2013). The Ubuzima system ensured that supervisors (specialized doctors) provide the needed training and support to health staff at the local level to improve health delivery. The tool improved the capacity of HWs treatment and management of some key diseases at the community level.
2.11 Benefits in the use of mHealth

The benefits of mHealth have been discussed in a number of peer reviews and publications in a different journals. West (2015), in a study discussed a number of benefits of mHealth to maternal health care in developing countries. The study reviewed 25 mHealth interventions which used voice and text messages in maternal healthcare management across Africa, Asia and Latin America. It was noted in the research that reminders to either clients or community health workers increased compliance to medicine uptake on timely basis (Krishna, et al., 2009). Entner (2012), also discussed some benefits of mHealth to include reduction in unproductive man hours through the reduction in travel time for information, enabling faster decision making by health professionals and enabling health professionals to track clients who are missing out on appointments.

In another study by Prgomet et al. (2009), an evaluation of the use mobile devices by health professionals in practices found to have three key benefits: 1) quick response by healthcare providers especially on test results and diagnosis; 2) reduction in the number of errors in medication prescription; and 3) improved data management and record-keeping practices.

James et al. (2010), revealed that mobile text messages and telephone reminders used as mHealth intervention increased adherence and appointment to attendance by 7 percent. The same research showed that in Malaysia, for instance, non-attendance to maternal care appointments (ANC and PNC) reduced by 40 percent for new mothers who received text reminders. This perhaps is one of the most important role mHealth is proposed to work on. The key benefit here is that through mHealth, pregnant women as well as lactating mothers are reminded of their appointment dates and by that increases access to maternal healthcare.
The WHO reiterated the importance of mHealth to maternal health (WHO, 2013). In the report, it is mentioned that about 800 women die from preventable causes associated with pregnancy and childbirth of which 40 percent are issues related to complications related to the placenta. Unfortunately, these complications are not identified on time since most of these women do not visit health facilities. However, with mobile communication, these complications could be detected using ultrasound and majority of these could be addressed (WHO, 2013).

In a study conducted in Dangme West District of Ghana on the use of mobile phones for maternal and child health services, it was concluded that the use of mobile phones by health professionals and community health volunteers improved emergency obstetric referrals and promoted prenatal behaviour changes among expecting mothers (Tigest et al., 2012). Again, Musoko (2002) cited in a World Bank Report (2003), indicated that a mHealth intervention in Iganda District of Uganda with a catchment population of 6 health units and one referral health unit increased pregnancy related referrals by 40 percent and reduced maternal mortality ratio by 50 percent in 3 years.

In Afghanistan, available data shows that the introduction of m-health has increased antenatal attendance by 20 percent and a subsequently increasing the number of women receiving skilled deliveries in a health facility by 22.3 percent (World Vision, 2016). It is clear that the use of mHealth interventions improves the uptake of maternal health care services specifically on antenatal care, skilled deliveries and postnatal care services.

Similarly, Abroms, et al. (2011), discussed the benefits of mHealth in the context of smoking cessation program. The study looked at how the use of mobile devices could provide guidelines in
addressing smoking challenges. The study team assessed 47 different mobile applications that had the potency of stopping smoking. The apps, according to the study, monitored the number of cigarettes smoked as well as designs that provide guidelines on how to quit smoking. Included in the system was continuous text messaging. It was observed that different apps provided different spectrum of opportunities to individuals who smoked to guide their behaviour in smoking for possible cessation.

Despite the numerous benefits of mHealth to healthcare provision in developing countries, there are a number of challenges that have hindered the scale up of mHealth interventions in developing countries. These challenges have been discussed below.

2.12 Challenges hindering the rollout of mHealth in developing countries

Within the wide range of benefits for mHealth programmes, there is the existence of challenges on mHealth tools implementation. Effective use of mobile devices therefore, requires extensive analysis of the challenges to understand how these challenges could be addressed for improved health systems (Mohammadzadeh & Safdari, 2014).

The application of technology in developing countries is not very easy and simple (West, 2015). There is the issue of organizational and technological barriers (Cripps & Standing, 2011) and user attitudes and technology acceptance (Venkatesh et al, 2012). Moreover, according to Cripps and Standing (2011), even though there has been a dramatic increase in the use of mobile phones in developing countries, knowledge of and use of the technology to address health issues remain a challenge. Technically, there is the challenge of system compatibility with personal task which
mostly affects how data and information are communicated unto the system or cloud. This sometimes affects the system to function effectively leading to basic errors and wrong data generation (Viitanen et al, 2011). Other technical factors like network reliability, sustainability of connections, frequent interruption of the system especially when data is being collected etc. affects mHealth implementation (Aggarwal, 2012).

There is also the challenge of cooperation and collaboration between parties. In almost all cases, mHealth interventions require the support of government agencies, telecommunication industries, NGOs and healthcare providers. The challenge has always been getting all these people to work together in rolling out a specific mHealth intervention (Mohammadzadeh & Safdari, 2014). Among these players, there is the challenge of seeing themselves as competitors rather than partners. The same system is mostly duplicated by parties for the same group of people.

The other challenge that has been identified in mHealth roll-out in developing countries is associated with beneficiaries. Mohammadzadeh and Safdari (2014), explains that most beneficiaries of mHealth interventions have low level of literacy. However, most of the applications that are been used for these mHealth interventions are a bit complex to the user. The high level of illiteracy in most of rural communities in developing countries affects the quality of data collected. Mistakes are mostly generated from the community through data collection and this can be in the form of data manipulation, re-writing, misrepresentation, etc. all due to illiteracy (Lawler et al, 2011). Again, on the part of the beneficiary, one other challenge that threatens the scale up of mHealth intervention is the threat to confidentiality and privacy of an intervention (Mohammadzadeh & Safdari, 2013).
The cost of any intervention is very critical in the rollout of the intervention. The cost of system implementation and sometimes the maintenance of the system is relatively high especially in developing countries (Mohammadzadeh & Safdari, 2013). Leon, Schneider and Daviaud (2012), explain that one of the major challenges with mHealth scale-up in Africa is the problem of securing a sustainable resource. Most often, mHealth interventions have been on pilot base, which never ends up being scaled-up even when the results from the pilot show promising results.

2.13 The role of community-based health volunteers in mHealth intervention

The shortage of health personnel in developing countries has called for an urgent need for the concept of volunteerism in rural communities. In 2006, it was estimated that about 4.3 million doctors, midwives and nurses were in shortfall (WHO, 2006). Sadly, most of these shortfalls were linked to less developed countries who had challenges with the achievement of MDGs. For instance, Africa is estimated to account for 25 percent of all global burden of disease but only contribute 1.3 percent of all workforce globally (Nullis-Kapp, 2005). Scheffler et al (2008) also estimated that countries in sub-Saharan Africa where there are high health needs are the ones mostly affected with the shortage of health workforce.

With these above challenges, countries and organizations have adopted the concept of community health volunteer concept as a measure for addressing some of the gaps created. The principle of task shifting to lower-level health volunteers is applied in most developing countries. Here, the task shifting is to health volunteers who are often volunteers working already at the community level and have received some amount of training from either the local Health directorate or an NGO operating in the district and are effective in delivering health programmes (Dovlo, 2004;
Jokhio et al, 2005). In most of rural communities, CHVs are often the first and only point of contact for individuals who need clarification on some healthcare or are seeking healthcare services (Walker, 2013). They provide health services which is needed by the community members and are sometimes seen as health professionals providing basic health services. Breu (2014) argues that CHVs provides basic life-saving interventions within the needs of the community and strengthen the linkages that exist between health facilities and communities.

In Ghana, CHVs worked closely with nurses and midwives to provide basic primary healthcare education and conduct health promotion campaigns. They are also used for community mobilization for services, including child welfare clinics and health durbars. Additionally, other literature from over the world have shown that CHVs are used for four main issues in health outcome – health promotion, data collection, monitoring (follow ups) and basic management of minor infections (Hongoro & McPake, 2004).

There are however some challenges in conducting community health volunteer work. The level of skills and knowledge among health volunteers in the health sector is very limited, especially to the number of tasks that CHVs perform at the community level (Agarwal, 2015). Again, the absence of motivation and stipends often affect the level of commitment by CHVs. The type of motivation differs with organizations and the particular project been implemented. Some volunteers who are given mobile phones for community work often see the phones as motivation for the work they do. To some, the availability of identifications as CHVs motivates them to work (CRS, 2015). Some organizations provide tee-shirts to volunteers as a way of motivating them. But the best motivation CHVs see is the provision of stipend for the service they provide even though the concept of volunteerism does not include money.
All these types of motivations support the work they do at the community level. With the work load on volunteers, new inventions and innovations have come through especially the use of mobile phones to improve health. Shankar et al (2016), explain that when CHVs have access to mobile phones for their work, health outcomes are better realised while seeing the mobile phones as an incentive. Shankar et al (2016), again indicated that through mobile phones messages could be recorded and could be used by CHVs as an aid for education at the household level. This was very evident in India where the use of mobile phones for health education among pregnant women and lactating mothers was led by CHVs (Gupta, 2016). The role of CHVs cannot be over emphasised in the discussion of mHealth in a developing country.

2.14 Summary of the Chapter

The application of mobile technology for improved health outcome has widely been discussed through a number of publications. The literature so far has discussed the twelve (12) key areas of mHealth application in general. However, emphasis in the review was placed on how mHealth improves maternal and child health outcome. Literature further discussed the main benefits of mHealth interventions and the challenges of mHealth, especially with its roll-out in Sub Sahara Africa including Ghana. It was evident in the review that none of the mHealth interventions had been scaled up to a larger scope making it difficult to generalize across regions. Additionally, literature on mHealth application for improved maternal outcome is limited in Ghana. Studies that have been conducted on mHealth application in Ghana had largely focused on frontline health workers mostly midwives. None of the literature reviewed showed a study on how community-based health volunteers were used as referral points to link community women to health facilities.
Similarly, gaps existed on the literature review on whether or not CHVs have the capacity to correctly use mobile technology for any health intervention. Studies on mHealth have mainly focused on the outcome of the intervention, neglecting the processes that ensured the success of the intervention or system. Further review of literature showed that no studies had been conducted on the use of mHealth tools for monitoring pre- and post-pregnancy status in northern Ghana.

CHAPTER THREE

METHODS

3.0 Introduction

This section presents the methods that were employed in the study, which include the design of the study, study variables and the sampling approach for the study. The processes for data collection as well as the source of data have been discussed. The various units of analysis in the study have been clearly explained in this chapter. Finally, the chapter discusses the characteristics of the study locations and situate the analysis into the key conditions of each district in relation to maternal and child health.

3.1 Study Design

The research was descriptive cross-sectional study (a cross-sectional study is a type of observational study that analyses data from a population, or a representative subset, at a specific point in time) focusing on beneficiaries (pregnant women and lactating mothers) and users of a
mHealth intervention (community-based health volunteers) being implemented by Catholic Relief Service, an international non-governmental organization. The study adopted retrospective study which reviewed data from the start of the project – May 2017 through to May 2018. Quantitative approach to research was adopted in this study where data from a web-based platform is analysed. The study subjects included community-based health volunteers in the 160 operational communities as well as pregnant women who were reached by the CHVs in the four districts. The study also reviewed ANC, delivery (skilled and home deliveries) and PNC records from the start of MMA and compared with records at the time of the study.

3.2 Study Location

The study locations were the CRS and Ghana Health Service partnership Tech4PROMISE intervention medic mobile application intervention districts in the Northern Region – Kumbungu, West Mamprusi, East Mamprusi and Mamprugu Moaduri Districts. These have been explained below.

3.2.1 West Mamprusi

According to the 2010 Population and Housing Census, the district had a population of 121,117 and accounts for about 4.9 percent of the region’s total population (GSS, 2014). The district covers a size of 4,892 km² with Walewale as its capital. Males constitute 49.2 percent and females represent 50.8 percent. More than six in every ten (63.2 percent) of the population of the district lives in rural areas, while the remaining 36.8 percent lives in the urban areas. The Total Fertility Rate for the district was 3.8 children per woman. The General Fertility Rate is 111.9 births per 1000 women aged 15-49 years which is among the least in the region. The proportion of females who have never attended school (53.6 percent) is higher than their male counterparts (43.6
percent). Of those who are currently attending school, 50.6 percent are in primary and 17.2 percent are in JHS. Nearly half (48.3 percent) of the unemployed population are seeking work for the first time. Of the population 12 years and older, 20.5 percent own mobile phones. Higher proportion of males (27.5 percent) than females (14.0 percent) own mobile phones (GSS, 2014).

### 3.2.2 Kumbungu District

The population of Kumbungu, according to the 2010 Population and Housing Census, was 39,341. Males constituted 50.0 percent and females represented 50.0 percent (GSS, 2014). The district is a rural district with all the population living in rural communities. The Total Fertility Rate (TFR) for the District was 3.6, which is slightly lower than the Regional average of (3.54). The District has a household population of 39,033 with a total number of 4,133 households. By age 25-29 years, more than half of females (89.4 percent) are married compared to a little above half of males (57.7 percent). Among the married, 86.0 percent have no education while about 50.2 percent of the never married have never been to school. Of the population 11 years and above, 26.0 percent are literate and 74.0 percent are non-literate. The proportion of literate males is higher (32.9 percent) than that of females (19.3 percent). About 81.3 percent of the population aged 15 years and older are economically active while 18.7 per cent are economically not active. Among the population 12 years and above, 16.9 percent have mobile phones. Men who own mobile phones constitute 26.9 percent as compared to 7.1 percent of females (GSS, 2014).
3.2.3 East Mamprusi

The population of East Mamprusi District, according to the 2010 Population and Housing Census, was 121,009 representing 4.9 percent of the region’s total population. Males constituted 49 percent and females represented 51 percent. The district has a rural population of 81,850, representing 67.6 percent. The population of the district is youthful (0-14 years) representing 47.6 percent and depicting a broad base population. The district has a Total Fertility Rate of 3.6, which is slightly higher than the regional average of 3.5. The district has a household population of 119,596 with a total number of 13,895 households. The average household size in the district is 8.6 persons per household. By age 25-29 years, four out of five of the females (84.8 percent) are married compared to a little above half of males (59.1 percent). Of the population 11 years and above, 33.0 percent are literate and 67.0 percent are non-literate. Of the population 12 years and above, 14 percent have mobile phones. Among the men, those who own mobile phones constitute 18.3 percent as compared to 9.8 percent of females.

3.2.4 Mamprugu Moaduri

The population of Mamprugu Moagduri District, according to the 2010 Population and Housing Census, was 46,894 representing 1.9 percent of the region’s total population. Males constituted nearly 50 percent and females represented just a little above 50 percent. In terms of rural-urban distribution, the district has all of its inhabitants living in rural localities. This implies that the district is completely a rural one. The district has a sex ratio of 99.9. The Total Fertility Rate for the district was 3.4. The district has a household population of 45,160 with a total number of 5,214 households. The average household size in the district is 9.0 persons per household. About six in ten (59.9 percent) of the population aged 12 years and older are married. Of the population 12
years and above, 7.8 percent have mobile phones. Men who own mobile phones constitute 11.6 percent as compared to 4.3 percent of females. Under one percent of the population 12 years and older use internet facilities in the district. Only 4 households representing 0.1 percent of the total households in the district have desktop/laptop computers.

3.3 Study Variables
The dependent variable for this study was the outcome variable determined through the use of MMA. The main dependent variable for the study was the pre- and post-pregnancy status of women in Northern Region. The dependent variables were ANC attendance, skilled delivery and PNC attendance as captured by MMA.

The independent variable for this study is the use of MMA by community-based health volunteers: in terms of registration, validation and submission and socio-demographic characteristics of CHVs.

3.4 Sampling
Kumar (1999), explains that a sample is a sub-group of the population which is an ideal representative of the entire population. Researchers usually cannot make direct observations of every individual in the population they are studying. Instead, they collect data from a subset of individuals (a sample) and use those observations to make inferences about the entire population (Muzinda, 2007). For this study, a complete census (a total count of all available CHVs) was conducted on the electronic web-base of all CHVs in the four study districts who have received training from Catholic Relief Service and are collecting data on pregnancy status within the
assigned communities. Data for this study was gathered from secondary source. Purposive sampling method was also employed where targeted CHVs were sampled for the study.

### 3.5 Sample Size
A total of 160 CHVs were trained and provided with mobile phones for the medic mobile application roll-out by CRS through GHS. All the CHVs were sampled for interview for the study. However, only 123 were available for the survey. All data submitted by the CHVs were used for analysis. Data were sorted to include correct use and incorrect use.

### 3.6 Data Collection
Data collection was done at two levels. Primary data from CHVs were collected using semi-structured questionnaire through face-to-face interviews. Notes were taken during the interview to capture other relevant information that were not captured in the questionnaire. Secondary data was downloaded from the web-based platform of Catholic Relief Service where the medic mobile application open source data was stored. Access to the web-based platform was sought from the Program Manager who supported in downloading all relevant data from the site. Other forms of secondary data collected include District Annual reports and data from district health information systems provided by District Health Information Officers.

### 3.7 Quality Assurance
In statistical analysis, data quality is critical, not only about the type of data produced but also the source of the data type, which influences the analysis (Nederpelt & Daas, 2012). For this study,
data obtained from the MMA web-based were solely used for the analysis. Incomplete data that were found in the database were not used for the analysis. In instances where data gaps were identified, follow up enquiries were made to the Project Manager of the project and GHS staff, who manage the data flow from the field. Similarly, where there were data discrepancies, follow up enquiries to the facilities involved as well as the CHVs responsible for MMA data collection were done to ensure that data obtained was of high quality. Demographic data collected from all CHVs were led by the investigator with the aim of ensuring the correct information was collected. District Health Information Officers (DHIO) were involved in each district during the CHV data collection as a way of ensuring consistency and accuracy in data. The DHIOs were trained in the use of the questionnaire to collect demographic data. The DHIOs were the main research assistance used in data collection.

3.8 Data Analysis

Data analysis for the study is discussed in this section. The analysis is done based on the four key objectives of the study.

3.8.1 Determination of correct use of MMA

The correct use of MMA was analysed based on data from the web-based platform. Two key data were used in the analysis – valid and invalid data. In analysing the validity of data, data from the start of the project were reviewed to determine the rate of validity over the period. The valid data through the web based included all data (ANC, delivery and PNC) that appeared on the platform as valid and were sorted out and analysed. Similarly, all data (ANC, skilled delivery and PNC) that appeared on the web base as invalid were sorted out and analysed. The correct use and
incorrect use of MMA were measured using the number of valid data as against the number of invalid data that were sent to the web-based platform (dashboard).

3.8.2 Estimation of proportion of ANC attendance captured by MMA

Data on ANC attendance from the MMA web-based platform was collated and analysed. This was used to estimate the proportion of women who made one or more ANC visits to a health facility as a result of follow ups by CHVs. The proportion of ANC attendance through MMA was estimated based on the data available at the web-based and compared with available results at the district level on ANC attendance. Similarly, data on women who were registered by MMA and made four ANC visits were retrieved from the medic mobile data base and compared with all ANC attendance captured by MMA. The two data were used to estimate the proportion of women who made the required number of ANC visits.

3.8.3 Estimation of skilled delivery captured by MMA

Data on skilled delivery captured by the MMA web-based platform was collated and analysed. The total number of deliveries registered by MMA was also collated and analysed. The total delivery data included both skilled and home deliveries. By this, the proportion of skilled delivery captured by MMA was determined using the overall delivery (both skilled and home deliveries). Similarly, facility and district level data on skilled and home deliveries were used to estimate the proportion of overall skilled delivery captured by MMA.
3.8.4 **Estimation of PNC attendance captured by MMA**

Data on PNC attendance from the MMA web-based platform was collated and analysed to estimate the proportion of women who visited the health facility after delivery for early postnatal care services. The proportion of PNC attendance through MMA was estimated based on the data available on the web-based platform as compared with the overall PNC attendance data at the district levels. Monthly PNC attendance as captured by MMA was retrieved from the web-based platform to estimate the proportion of PNC from the start of the intervention as compared to the time of survey.

3.8.5 **Presentation of results**

The results of the study have been presented based on the four main objectives of the study. In each objective, results of the study as per the objectives discussed were outlined and discussed.Demographic characteristics of the study participants (community-based health volunteers) were also presented per the results from the primary data collection source. Where necessary, results of each objective were presented in graphs and tables. Proportions that were estimated as part of the analysis were also presented.

3.9 **Ethical Considerations**

The study made use of both primary and secondary data and for that reason, the study addressed all the ethical issues related to both primary and secondary data.

**Ethical Clearance:** Ethical clearance was granted by the Ghana Health Service Ethics Review Committee as requirement for the conduct of this study.
Study Approval: A letter of introduction from the School of Public Health (SPH) was sent to the Catholic Relief Service to seek permission to retrieve data from the Medic Mobile platform for the study. A similar letter was sent to the District Directors of Health Services, Ghana Health Services in the four districts (Kumbungu, West Mamprusi, East Mamprusi and Mamprugu Moaduri) and to interact with the Community Health Volunteers who work with health facilities at the community level.

Study Subjects: Consent was sought from the Community-based volunteers who were the main study subjects for the primary data collection.

Potential Risk/Benefits: The researcher anticipated minimal risk in the study. This was largely so because most of the data were retrieve from online. There was no direct link to any pregnant woman or lactating mothers whose status were measured in this study. Again, with CHVs, the demographic data that were required did not bother on sensitivity which would have posed higher risk.

Privacy and Confidentiality: Participants (CHVs) were assured of confidentiality and privacy of the information provided. To assure privacy and confidentiality, study codes were used on all data forms (completed questionnaires). Participants did not provide names so as to prevent easy identification of individuals on a particular questionnaire. This was discussed prior to the conduct of an interview. Data gathered were encrypt whereas sheets that contain fact sheets were removed. Similar codes will be used for communities as well as districts to avoid easy tracing of data source by a third party.

Data security, storage and usage: Data from medic mobile data base was uploaded and stored on both hard drive of a computer and external drive. Demographic data from the CHVs were
collected with questionnaire and entered into table format and stored on hard drive of a computer. Data files on computers and external hard drives are been protected with security codes (password) to prevent easy access by another person.

**Description of consenting process:** For primary data, CHVs were briefed about the purpose of the study. Participants were also informed of the potential risk and benefits of the study related to them while participating in the study. Participants were assured that the information provided would be used purely for the study and nothing further. Again, data storage as well as data security and usage were discussed with the participants. Participants were informed that they could choose to participate in the study or withdraw, if they felt otherwise. All CHVs who were available agreed to participate in the study without withdrawing. For this reason, all the participants were made to sign the consent form (refer to appendix for the consent).

**Compensation:** Respondents were not given any reward/compensation for participation or responding to the questionnaires.

**Declaration of Conflict of Interest:** There was no conflict of interest in this study.

**Protocol Funding:** The funding of this study was the sole responsibility of the principal investigator.

### 3.10 Summary of the chapter

The chapter discussed the method adopted for the study, which is cross-sectional design with quantitative analysis. The study collected data from both primary and secondary sources with
primary data on CHVs demographic characteristics while secondary data downloaded from a web-based platform. A complete census was conducted for all CHVs who were available for the study. Similarly, all pre and post pregnancy status data were downloaded from the web-base for analysis. Detailed discussions were also done with regards to data collection and analysis, quality assurance, presentation of results and ethical review considerations.

CHAPTER FOUR

RESULTS

4.0 Introduction

The introduction of MMA by CRS in partnership with GHS is one of a number of mHealth tools and applications discussed under literature. This section therefore analyses and presents the results of the study on the use of MMA to monitor pre and post pregnancy status in four districts of Northern Region of Ghana. In cases where MMA findings were compared to the district-wide figures, figures were picked from Ghana Health Services Districts Annual Reports for 2017. The district reports include East Mamprusi, West Mamprusi, Kumbungu and Mamprugu Moaduri.

4.1 Description of CRS’ Tech4PROMISE Project Districts

The mHealth concept as applied by CRS using the MMA was introduced into a project called Technology for Promoting Replication of Maternal and Infant Survival Excellence (Tech4PROMISE). The project’s aim is to ensure that pregnant women and mothers as well as their new-born babies have access to and use skilled assistants at child birth and during postnatal period (CRS, 2016). The Tech4PROMISE project which used the MMA tool was integrated into two main CRS’ projects; Promoting Maternal and Infant Survival (PROMISE) and Rural
Emergency Health Services and Transport (REST). Prior to the start of the project, CRS in partnership with the Regional Health Directorate and the four District Health Directorates agreed on the facilities that were to be used for the piloting of the Tech4PROMISE project. In each district, the number of facilities selected for the intervention are detailed out in Table 4.1 with associated number of communities. In all, the project worked in 32 facilities. However, for each facility selected, five communities under the catchment area of the facility were selected for the intervention. These communities were therefore, beneficiaries of MMA using mobile phones.

Table 4.1: Description of CRS’Tech4PROMISE Project Districts

<table>
<thead>
<tr>
<th>District</th>
<th>Number of facilities</th>
<th>Number of Communities</th>
<th>Integrated Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kumbungu</td>
<td>9</td>
<td>45</td>
<td>PROMISE</td>
</tr>
<tr>
<td>West Mamprusi</td>
<td>8</td>
<td>40</td>
<td>REST</td>
</tr>
<tr>
<td>East Mamprusi</td>
<td>6</td>
<td>30</td>
<td>REST</td>
</tr>
<tr>
<td>Mamprugu Moaduri</td>
<td>9</td>
<td>45</td>
<td>REST</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>32</strong></td>
<td><strong>160</strong></td>
<td>43.2</td>
</tr>
</tbody>
</table>

Source: CRS’ Tech4PROMISE project report, 2017

4.2 Demographic Characteristics of CHVs

In each of the 160 communities for the Tech4PROMISE project, one (1) CHV was selected as the point person for the MMA pilot implementation. The survey observed that of the 160 CHVs identified at the beginning of the programme, 146 (91.2 percent) were still interacting with the MMA platform. However, 123 were available for the interview given a response rate of 76.9 percent. The 14 CHVs who were no more registering women through the MMA system were
observed to have gone to school or had travelled out of the community to seek other opportunities elsewhere.

Table 4.2 shows that only 15 (12 percent) of the CHVs interviewed were females. All the females had had education with 6 (5 percent) of male with no education. More than half (i.e. n=74; percent=60) of the CHVs had education up to JSS or Middle School. However, none of the CHVs had had tertiary education.

Table 4.2: Demographic Characteristics of CHVs

<table>
<thead>
<tr>
<th>Items</th>
<th>Male (%)</th>
<th>Female (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational Level:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Education</td>
<td>6 (5%)</td>
<td>0 (0%)</td>
<td>6 (5%)</td>
</tr>
<tr>
<td>Primary</td>
<td>31 (25%)</td>
<td>7 (6%)</td>
<td>38 (31%)</td>
</tr>
<tr>
<td>JSS/Middle</td>
<td>67 (54%)</td>
<td>7 (6%)</td>
<td>74 (60%)</td>
</tr>
<tr>
<td>Secondary/Vocational</td>
<td>4 (3%)</td>
<td>1 (1%)</td>
<td>5 (4%)</td>
</tr>
<tr>
<td>Employment Status:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed</td>
<td>82 (67%)</td>
<td>12 (10%)</td>
<td>94 (76%)</td>
</tr>
<tr>
<td>Unemployed</td>
<td>26 (21%)</td>
<td>3 (2%)</td>
<td>29 (24%)</td>
</tr>
<tr>
<td>Residence:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>105 (85%)</td>
<td>14 (11%)</td>
<td>119 (97%)</td>
</tr>
<tr>
<td>Peri-Urban</td>
<td>3 (2%)</td>
<td>1 (1%)</td>
<td>4 (3%)</td>
</tr>
<tr>
<td>District:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kumbungu</td>
<td>32 (26%)</td>
<td>6 (5%)</td>
<td>38 (31%)</td>
</tr>
<tr>
<td>West Mamprusi</td>
<td>28 (23%)</td>
<td>5 (4%)</td>
<td>33 (27%)</td>
</tr>
<tr>
<td>East Mamprusi</td>
<td>20 (16%)</td>
<td>0 (0%)</td>
<td>20 (16%)</td>
</tr>
<tr>
<td>Mamprugu Moaduri</td>
<td>28 (23%)</td>
<td>4 (3%)</td>
<td>32 (26%)</td>
</tr>
</tbody>
</table>
On employment status, it was observed that only 26 (21 percent) of the males and 3 (2 percent) of females were unemployed as at the time of the study. Additionally, 119 (97 percent) of the communities within which the CHVs operate were rural in nature with the exception of three communities in West Mamprusi District, which was described as peri-urban. The study observed that the mean age of all CHVs was 32 years.

### 4.3 Correct Use of MMA by CHVs per District

The overall correct use rate of MMA was 82.8 percent as shown in Table 4.3, which is a little bit lower than the ideal 100 percent correct use rate. Again, from Table 4.3, averagely, West Mamprusi maintained a higher MMA correct use rate of 87 percent with Kumbungu having the least correct use rate of 76.7 percent.

Table 4.3: Correct Use of MMA by CHVs per District

<table>
<thead>
<tr>
<th>District</th>
<th>Valid Data</th>
<th>Total Data</th>
<th>Correct Use Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kumbungu</td>
<td>1,211</td>
<td>1,579</td>
<td>76.7</td>
</tr>
<tr>
<td>West Mamprusi</td>
<td>1,161</td>
<td>1,332</td>
<td>87.1</td>
</tr>
<tr>
<td>East Mamprusi</td>
<td>2,229</td>
<td>2,767</td>
<td>80.6</td>
</tr>
<tr>
<td>Mamprugu Moaduri</td>
<td>2,296</td>
<td>2,655</td>
<td>86.5</td>
</tr>
<tr>
<td><strong>Total/Average</strong></td>
<td><strong>6,897</strong></td>
<td><strong>8,333</strong></td>
<td><strong>82.8</strong></td>
</tr>
</tbody>
</table>

Average quarterly MMA correct use rate differs per quarter as shown in Figure 4.1. In quarter one, MMA correct use rate by CHVs was relatively low (53 percent) but increased to 86 percent in the
second quarter and eventually to 97 percent in the fourth quarter. Plausible reasons associated with the increase were the refresher trainings and supportive supervision from GHS and CRS teams.

Within the 12-month period of data collection and submission through MMA, a total of 6,897 valid data on pregnancy status were captured by MMA. At the district level, Mamprugu Moaduri recorded the highest valid data with 2,296 (33 percent) as shown in Figure 4.2. West Mamprusi recorded the least data of 1,161 (17 percent) of total valid data captured by MMA.

Figure 4.1: Correct Use of MMA by CHVs per Quarter
4.4 Health facilities per District against facilities MMA operates

The MMA intervention did not reach all facilities within the districts. It was observed that about 32 (43 percent) of all facilities were covered by the MMA intervention. All the facilities where MMA was deployed were mainly CHPS Compounds within a zone. With district breakdown, Mamprugu Moaduri had the highest coverage of MMA deployment (n=9 of 32; 56.3 percent) with East Mamprusi having a low coverage of 6 of 32 (28.5 percent) (see Table 4.4). There were no targets set by the facilities or districts in terms of MMA capture. However, the project implementers, Catholic Relief Service, targeted to capture at least 30 percent of all data for ANC,
deliveries and PNC. This target was set primarily because of the large number of data capture by hospitals.

Table 4.4: Health Facilities per District against facilities MMA operates

<table>
<thead>
<tr>
<th>District</th>
<th>Facilities with MMA support</th>
<th>Total District Facilities</th>
<th>% Facilities with MMA Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kumbungu</td>
<td>9</td>
<td>17</td>
<td>53.0</td>
</tr>
<tr>
<td>West Mamprusi</td>
<td>8</td>
<td>20</td>
<td>40.0</td>
</tr>
<tr>
<td>East Mamprusi</td>
<td>6</td>
<td>21</td>
<td>28.5</td>
</tr>
<tr>
<td>Mamprugu Moaduri</td>
<td>9</td>
<td>16</td>
<td>56.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>32</strong></td>
<td><strong>74</strong></td>
<td><strong>43.2</strong></td>
</tr>
</tbody>
</table>

4.5 Antenatal Care attendance captured by MMA

The estimation of ANC attendance as captured by MMA was analysed and compared with district data. Table 4.5 shows that a total 4,607 ANC attendances by pregnant women were recorded through the MMA use. Within the same period, a total of 11,035 ANC attendances were recorded by all the 74 facilities in the four districts. By reference, MMA was estimated to have captured 41.7 percent of all ANC attendance, exceeding the project’s ANC data capture target of 30 percent.

Table 4.5: Antenatal Care Attendance captured by MMA

<table>
<thead>
<tr>
<th>District</th>
<th>Target</th>
<th>MMA Capture</th>
<th>Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Mamprusi</td>
<td>2,164</td>
<td>986</td>
<td>45.6</td>
</tr>
<tr>
<td>West Mamprusi</td>
<td>3,542</td>
<td>1,428</td>
<td>40.3</td>
</tr>
</tbody>
</table>
Kumbungu 2,343 990 42.3
Mamprugu Moaduri 2,986 1,193 40.0
Total 11,035 4,607 41.7

4.5.1 Average 4+ ANC Attendance per quarter in MMA facilities only

Some of the ANC records were repeated attendances. For this reason, the study also analysed 4+ ANC attendance by pregnant women. The average 4+ ANC attendance in MMA facilities increased with the use of MMA tool over the period as shown in Figure 4.3. In the first quarter, the 4+ ANC attendance recorded in MMA facilities only was 1,468 (50 percent) but later increased to 2,319 (79 percent) and 2,672 (91 percent) in quarters two and three respectively. The results in Figure 4.3 show that the use of MMA increased 4+ ANC attendance by 45 percent from quarter one to quarter four.

Figure 4.3: Average 4+ ANC Attendance per quarter in MMA facilities only
4.5.2 Facilities with MMA and without MMA on 4+ ANC attendance

The average 4+ ANC visits within MMA facilities was also compared with the 4+ ANC visits of non-MMA facilities as shown in Figure 4.4. For the MMA facilities only, an average rate of 79 percent 4+ ANC was recorded while facilities without MMA recorded an average 4+ ANC rate of 58 percent. Again, Figure 4.4 shows that the proportion of pregnant women who made at least 4+ ANC visits differs from each district. In East Mamprusi, 74 percent of all pregnant women who were captured by MMA and had delivered made at least 4+ visits; 69 percent in Kumbungu, 79 percent in West Mamprusi and 85 percent in Mamprugu Moaduri. However, in facilities without MMA use, the 4+ ANC visits obtained was relatively low ranging from 51 percent in Mamprugu Moaduri to 69 percent in Kumbungu as shown in Figure 4.4.

Figure 4.4: Facilities with MMA and without MMA on 4+ ANC attendance
4.6 Skilled delivery captured by MMA per District

According to the study, a total of 1,286 skilled deliveries were captured by MMA in all the 32 facilities while the overall skilled deliveries recorded by all the 74 facilities within the four districts, including non-MMA deployed facilities were 3,487 as shown in table 4.6. By this estimation, the MMA was able to capture approximately 37 percent of all skilled deliveries in the district. On district perspective, Kumbungu had the highest record of MMA capture of skilled deliveries (342 of 743; 46 percent) followed by East Mamprusi (389 of 896; 43.4 percent) and Mamprugu Moaduri (306 of 845; 36.2 percent). West Mamprusi recorded the least skilled deliveries (249 of 1,003; 24.8 percent).

Figure 4.6: Skilled delivery captured by MMA per District
<table>
<thead>
<tr>
<th>District</th>
<th>District Target</th>
<th>MMA Capture</th>
<th>MMA Capture (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Mamprusi</td>
<td>896</td>
<td>389</td>
<td>43.4</td>
</tr>
<tr>
<td>West Mamprusi</td>
<td>1,003</td>
<td>249</td>
<td>24.8</td>
</tr>
<tr>
<td>Kumbungu</td>
<td>743</td>
<td>342</td>
<td>46.0</td>
</tr>
<tr>
<td>Mamprugu Moaduri</td>
<td>845</td>
<td>306</td>
<td>36.2</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>3,487</strong></td>
<td><strong>1,286</strong></td>
<td><strong>36.9</strong></td>
</tr>
</tbody>
</table>

4.6.1 Skilled deliveries captured by MMA per quarter in MMA facilities only

Skilled delivery in all the MMA deployed facilities increased over time as shown in figure 4.5. Skilled deliveries in MMA facilities were relatively low (59 percent) in the first quarter as shown in figure 4.5 but increased to 78 percent in quarter two. By the end of the year, the rate of skilled delivery in MMA facilities increased by 39 percent from quarter one to quarter four. Averagely, the skilled delivery for MMA facilities was 83 percent.

4.6.2 Skilled deliveries in MMA facilities against facilities without MMA

Similarly, skilled delivery records captured by MMA only in the 32 facilities were compared to facilities without MMA use as shown Table 4.7. The average skilled delivery records in MMA facilities only was higher (83.1 percent) than facilities without MMA (64.8 percent). Table 4.7 further shows that skilled delivery in MMA facilities in each district was relatively higher than non-MMA facilities. East Mamprusi had the highest record of skilled delivery of 91.5 percent with West Mamprusi recording the least of 75.4 percent. However, in comparing the record to non-MMA facilities, skilled delivery in MMA facilities in West Mamprusi was higher (75.4 percent)
than skilled non-MMA facilities (50.2 percent). Skilled delivery in MMA facilities in Mamprugu Moaduri exceeded skilled delivery in non-MMA facilities by 35.6 percent (table 4.7).

Figure 4.5: Skilled deliveries captured by MMA per quarter in MMA facilities only

Table 4.7: Skilled deliveries in MMA facilities against facilities without MMA

<table>
<thead>
<tr>
<th>District</th>
<th>Facilities with MMA (%)</th>
<th>Facilities without MMA (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Mamprusi</td>
<td>91.5</td>
<td>87.0</td>
</tr>
<tr>
<td>West Mamprusi</td>
<td>75.4</td>
<td>50.2</td>
</tr>
<tr>
<td>Kumbungu</td>
<td>87</td>
<td>79.1</td>
</tr>
<tr>
<td>Mamprugu Moaduri</td>
<td>78.4</td>
<td>42.8</td>
</tr>
<tr>
<td>Average</td>
<td>83.1</td>
<td>64.8</td>
</tr>
</tbody>
</table>
4.7 Postnatal Care attendance captured by MMA against district target

The analysis in this study was done using the 48-hour postnatal care service provision for postpartum women. The MMA captured a total of 1,863 48-hour postnatal care services (see table 4.8) out of the district 48-hour PNC services record of 5,322. Mamprugu Moaduri MMA captured more 48-hour PNC attendance (45.2 percent) as compared with other districts. Again, Kumbungu had the lowest data capture of 17.9 percent. Averagely, the MMA captured 35.3 percent of all 48-hour PNC attendance as shown in table 4.8.

Table 4.8: Postnatal Care attendance captured by MMA against district target

<table>
<thead>
<tr>
<th>District</th>
<th>Target</th>
<th>MMA Capture</th>
<th>Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Mamprusi</td>
<td>1,543</td>
<td>616</td>
<td>39.9</td>
</tr>
<tr>
<td>West Mamprusi</td>
<td>1,003</td>
<td>384</td>
<td>38.3</td>
</tr>
<tr>
<td>Kumbungu</td>
<td>1,432</td>
<td>256</td>
<td>17.9</td>
</tr>
<tr>
<td>Mamprugu Moaduri</td>
<td>1,344</td>
<td>607</td>
<td>45.2</td>
</tr>
<tr>
<td>Total</td>
<td>5,322</td>
<td>1,863</td>
<td>35.3</td>
</tr>
</tbody>
</table>
4.7.1 Quarterly 48-hour PNC attendance rate in MMA facilities only

An analysis of 48-hour PNC attendance within MMA deployed facilities alone as shown in figure 4.6 shows that attendance increased from 68 percent in the first quarter to 89 percent in the third quarter and eventually to 93 percent in the fourth quarter. Figure 4.6 further shows that within the period, 48-hour PNC attendance in MMA facilities only increased by 25 percent from quarter one to quarter four.

Figure 4.6: Quarterly 48-hour PNC attendance rate in MMA facilities only
4.7.2 PNC attendance within 48-hours in MMA facilities and non-MMA facilities

Again, the average 48-hour PNC attendance rate within the facilities where MMA was deployed alone was approximately 81 percent, which is relatively higher than the facilities without MMA use (62.5 percent) as shown in table 4.9. District level comparison also shows that in each of the districts, 48-hour PNC attendance was equally higher than facilities without MMA. In East Mamprusi, MMA facilities recorded 84.7 percent 48-hour PNC attendance while non-MMA facilities recorded 74.3 percent (a difference of about 10 percent). The difference between MMA and non-MMA facilities in terms of 48-hour PNC attendance was high in West Mamprusi district (32 percent) as compared with other districts as shown in table 4.8.

<table>
<thead>
<tr>
<th>District</th>
<th>MMA facilities (%)</th>
<th>Non-MMA facilities (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Mamprusi</td>
<td>84.7</td>
<td>74.3</td>
</tr>
<tr>
<td>West Mamprusi</td>
<td>78.0</td>
<td>46.5</td>
</tr>
<tr>
<td>Kumbungu</td>
<td>83.2</td>
<td>64.1</td>
</tr>
<tr>
<td>Mamprugu Moaduri</td>
<td>78.4</td>
<td>65.0</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>81.1</strong></td>
<td><strong>62.5</strong></td>
</tr>
</tbody>
</table>
4.8 Summary of the chapter

The results from the study showed that only 12 percent of all CHVs were women while 24 percent of all CHVs were unemployed. Again, the study observed a mean age of 32 years with over 97 percent of the study population being rural. The use of MMA tool was deployed in 32 facilities out of 74 facilities in the four districts. The average correct use rate of MMA by CHVs was 83 percent but differed from quarter to quarter. The results for the use of MMA to monitor pregnancy status differed in terms of average capture. The use of MMA captured averagely 43 percent of all data available in the four districts. The results also showed that the use of MMA increased pregnancy status in terms of 4+ ANC, skilled delivery and 48-hour PNC over the four quarters. The next chapter presents the discussions of the findings as they relate to current literature.

CHAPTER FIVE

DISCUSSIONS

5.0 Introduction

The main findings of the study was discussed in this chapter. The discussions focused on the four main objectives of the study and how they relate to literature. A summary of the findings were provided in the first paragraph and further discussions with reference to literature followed the discussion.
5.1 Correct Use of MMA by CHVs

The study observed that the correct use rate of MMA increased from 53 percent in quarter one to 97 percent in the last quarter. It was observed that the initial training was not enough for CHVs to use the MMA correctly as more invalid data (75 percent) were submitted in the first quarter. However, with the introduction of refresher trainings and supportive supervision after the first quarter by project teams (both CRS and GHS), invalid data submission by CHVs reduced in the second quarter which eventually increased the correct use rate by 33 percent. This clearly shows that for any mHealth intervention to be used correctly by any team, it is important that periodic trainings are provided.

The training of CHVs prior to the start of the project roll-out ensured that CHVs had the needed capacity to monitor pregnancy status using MMA. Gupta, (2016) also indicates that when capacity of CHVs are built, they are in a better position to use mHealth tools effectively. Similarly in South Africa, a study by Tomlinson et al. (2009), looked at how the use of mobile phones by CHVs, with some capacity building, helped to improve household data for national purposes. The CHVs were therefore, trained in the use of mobile phones for conducting a pilot survey in Umlazi which has both urban and rural characteristics (Ijumba & Barron, 2005). The results within a four-month period was that, through the support of the mobile phones, with over 39,665 households surveyed, not a single data was lost by the team. This is because CHVs were monitored consistently and had frequent update of training during the period.

Capacity building in any intervention is very critical if desired objectives are to be achieved. It
must be noted that even without educational qualification, periodic use of any mHealth tool together with constant coaching and guidance could help achieve results. Shankar et al (2016) explain that when CHVs have access to mobile phones for their work, health outcomes would be better realised while seeing the mobile phones as an incentive. This was very true in the case of MMA usage by CHVs in the 32 communities. Shankar et al (2016), again indicated that through mobile phones, messages could be recorded and used by CHVs as an aid for education at the household level. Gupta (2016) confirmed this assertion in a study conducted in India where the use of mobile phones for health education among pregnant women and lactating mothers was led by CHVs.

5.2 Monitoring of pre and post pregnancy status

The proportion of ANC, skilled delivery and PNC attendance captured by the use of MMA was relatively higher than the projected target by the project team within the period. Comparatively, both 4+ ANC attendance, skilled delivery and 48-hour PNC attendance was relatively higher in all MMA deployed facilities than non-MMA facilities. Moreover, the MMA tool was able to capture, in all the three indicators, rates above the set target by the project implementers (30 percent).

On ANC attendance, it was observed that the rate of 4+ ANC attendance increased over time in the MMA deployed facilities from 50 percent in quarter one to 95 percent in quarter four. The average 4+ ANC attendance in MMA deployed facilities was 79 percent while non-MMA facilities recorded 58 percent within the same period. For instance, the MMA captured 42 percent of the total 4+ ANC data in the four districts. World Vision, (2014) also analysed one of their mHealth
interventions in Afghanistan and observed that antenatal attendance in some selected provinces increased by 20 percent while at the same time the number of pregnant women receiving skilled delivery in a recognized health facility increased by 22.3 percent.

Skilled delivery increased from 53 percent in quarter one to 98 percent in quarter four. Average skilled delivery recorded in MMA facilities was 83. However, for non-MMA facilities average skilled delivery was 65 percent. The average 48-hour PNC attendance was recorded at 81 percent. However, for non-MMA facilities, the average 48-hour PNC attendance was 62 percent. The 48-hour PNC attendance increased by 25 percent from quarter one to quarter four. In Zanzibar, a study by Lund et al (2008) on the use of mobile phones to monitor pregnancy status showed similar results. It was observed that through the mobile phone use, access to skilled delivery (which hitherto was a major challenge for the district) increased by 52 percent within a period of two year (Lund et al., 2008). The difference in the Zanzibar study as compared with the MMA use is the point person using the mobile device. While the MMA use was directly by CHVs, the mobile phone usage in the Zanzibar study was by beneficiaries (pregnant women). Again, Noordam et al., (2011) also argued that the use of mobile devices improves skilled delivery which is a key determinant of maternal mortality. Again, the increases observed in 48-PNC attendance were also largely attributed to the increase in skilled delivery. Lund et al (2008) argue that when pregnant women had access to skilled delivery, it consequentially affected the outcome of 48-hour PNC services. It is therefore appropriate to ensure that women have access to skilled delivery if neonatal mortalities are to be reduced.
Further studies conducted on mobile phone usage for health (mHealth) in Dangme West District of Ghana on maternal and child health services showed that the use of mobile phones by health professionals and community health volunteers improved emergency obstetric referrals and promoted prenatal behaviour changes among expecting mothers (Tigest et al., 2012). The use of mHealth to improve health outcomes as in the case of the use of MMA for monitoring pregnancy status is very critical. Quilici et al., (2013) assessed the effect of motivational short message service through mobile phones on aspirin adherence for patients with acute coronary syndrome after discharge from hospital. Sneop et al., (2007) had indicated that aspiring resistance and to some effect non-adherence remain a major risk factor for frequent ischemic conditions. The results by Quilici et al., (2013) showed that 92 percent of those receiving SMS adhered to aspirin intake and were very satisfied with the service.

Again, the use of MMA to monitor pregnancy status helped pregnant women to change some behaviour in the uptake of maternal health care services. Through the MMA use, access to ANC and skilled delivery increased. Studies by Cole-Lewis and Kershaw (2010), reviewed how text messages are used as a tool for changing health behaviours for disease prevention and management. The main finding of the study was the increased utilization of health services as a result of BCC text messages (Hanauer, et al, 2005). Studies from Atun et al, (2009) and Krishna, et al., (2009) in different studies found that the use of mobile phones remained a useful tool in communicating behaviour change messages and consequently, improving uptake of key health services. Franklin et al (2006) indicated that the most effective tool on using mHealth for BCC was when text messages were sent as reminders to clients and community-based agents with periodic prompt notifications especially on danger signs and missed opportunities as well as
appointments.

The results from the study (the use of MMA to monitor pre and post pregnancy status) was largely as a result of an improvement in the data capture by CHVs after the first quarter. A review of the various literature on the use of mobile devices (mHealth) for maternal health interventions shows that the uptake of or monitoring pregnancy status was mainly through the following functions it performs:

1. Beneficiaries and users of mHealth tools receive constant reminders and notifications which ensure that pregnant women are frequently accessing maternal health services

2. Danger signs are identified periodically which helps providers to respond quickly to such emergencies. The MMA tool adequately provides a platform for flagging pregnancy-related danger signs thereby reducing the risk for maternal mortality.

3. Instance where CHVs are used, they provides them the opportunity to do periodic follow-ups which hitherto were not mostly done within community health systems.

Other unexpected findings were observed as part of the study. It was noted that where there were system challenges, CRS communicated periodically with Medic Mobile system administrators to ensure that the challenges were addressed. Again, the introduction of the MMA roll-out used existing community systems and structures (using existing GHS trained CHVs) in monitoring pregnancy status. These approaches and methods ensure that programs and interventions are sustained even after the exit of programme initiators and relatively provides least cost. The MMA intervention was also nested into an existing program which ensured continuity and appropriate linkages to the various community health systems. Gisore et al., (2012) also assessed whether the
use of mobile phones could help record appropriate weight of pregnant mothers and children. The study observed that the recorded birth weight increased from 43 ± 5.7 percent (before) to 97 ± 1.1 (after). Moreover, the study showed that when community systems were strengthened, all health outcomes improved.

Some challenges were observed which if not critically addressed, might have negative impact on the overall programme outcome in future. Mohammadzadeh and Safdari (2014) indicated that effective use of mobile devices requires extensive analysis of the challenges to understand how these challenges could be addressed for improved health systems. The level of supervision on CHVs had reduced over time from both CRS and GHS side. The assumption was that the CHVs were equipped to use the MMA to monitor pregnancy status. However, some invalid data were still recorded (even though on a minimal level) on the dashboard. Additionally, communities whose CHVs had stopped working over the past 6-months had not had any replacement. It was expected that the replacement should go with a training for these CHVs. Again, one of the main challenges identified and confirmed by literature was the limited network for the use of mobile devices in some remote communities. Over 90 percent of the communities had easy access to mobile network connectivity, however, there were instances where some areas had challenges submitting data after registering someone. Sometimes it takes more than two days to have some data transmitted. West (2015) stated that the application of technology in developing countries was not very easy and simple. Aggarwal (2012), analysed other factors that affect mHealth interventions in developing countries. Some of these factors were technical factors like network reliability, sustainability of connections, frequent interruption of the system especially when data was being collected etc. affected mHealth implementation.
5.3 Summary of the chapter

Correct use of MMA by CHVs has been shown to depend largely on the type, level and period of trainings provided to CHVs. Similar studies reviewed had shown that when users of mHealth intervention received adequate and constant training, expected outcome would be realised. When mHealth interventions are used correctly and systems adhered to, expected outcome would be achieved. The use of MMA had shown that ANC, skilled delivery and PNC can be improved through the use of mHealth. The chapter has discussed relevant results with reference to literature. Based on the discussions of the key findings, the next chapter inferred conclusion and made some recommendations.

CHAPTER SIX

CONCLUSIONS AND RECOMMENDATIONS

6.0 Introduction

From the discussions in the previous chapter, this chapter concluded the study with some recommendations and contributions to knowledge as well as the limitations to the study. This section presents the conclusions based on the specific objectives of the study.
6.1 Conclusion

The study on the use of MMA to monitor pre and post pregnancy status has so far shown that with continuous supportive supervision, mobile devices could be used appropriately to collect accurate data for any decision making. Again, the results from the study showed that correct use of mobile devices (MMA) by community-based health volunteers improved pregnancy status (ANC attendance, skilled delivery and PNC attendance) of 123 communities in the four districts. Therefore, mHealth is a key tool that could improve pregnancy status in districts where uptake of ANC, skilled delivery and PNC services are low. Again, the application of mHealth intervention for monitoring pregnancy status and improving referral systems is largely effective in rural and peri-urban communities where tracking and follow-up is easy to be conducted than in urban communities. It is equally important to acknowledge the role of CHVs as the link providers of healthcare services between pregnant women and health workers. This role especially in mHealth interventions on maternal and child health has been demonstrated to work in the MMA roll-out. When CHVs’ capacity is built, they could be used to further collect other additional data through the use of mobile phones for improved health outcome.

6.2 Contributions to knowledge

Key findings through literature showed that mHealth interventions using CHVs were limited. The use of mHealth for maternal and child health cases have centred on the beneficiaries of the intervention. This study has demonstrated how CHVs can contribute to the improving of health outcomes using mobile phones. One of the key challenges in monitoring pre and post pregnancy status in Ghana has to do with strong linkages and referral systems. This study provided some guidelines in improving policy direction on improving referral systems through mobile phones and
CHVs. The use of mobile phones to monitor pre and post pregnancy status, in practice, does not require extensive budgeting and therefore could be adopted by GHS through the monitoring and evaluation unit for tracking and recording pregnancy outcomes.

6.3 Recommendations

The study proposes the following recommendations to improve similar future interventions:

1. Catholic Relief Service in collaboration with Ghana Health Service should work together to ensure that communities whose CHVs have left or those who are no more using the MMA tool are replaced. This will enhance continuous monitoring of pregnancy status among pregnant women.

2. Selection and training of mHealth intervention participants should not be limited to only the start-up. Follow-up trainings including refresher and on-the-job trainings should be done periodically to ensure that users of mHealth tools are well equipped to use the tool.

3. Maternal health education at ANC should stress on the importance of continuum of care (ANC–Skilled Delivery – PNC) for the early development of the child and the well-being of the mother. At each stage of the continuum, healthcare providers should emphasis all the three stages irrespective of the client they meet.

6.3 Limitations to the study

The study, as in other studies, had some limitations. Data collection period was limited and therefore did not allow for further data collection and analysis on other factors including program implementation activities that might contribute to the changes in correct use of MMA as well as
pregnancy status indicators. Again, the MMA was deployed in only 32 out of 74 health facilities in the four districts. It would have been appropriate to understand how the MMA use helps in monitoring pregnancy status in the entire district to be able to make conclusive statement for the districts. Notwithstanding the above limitation, the study results have not been affected and thus are credible, reliable and useful for any policy evaluation and decision making.

6.3 Future Research

Based on the limitations observed as part of the study, the following possible areas are recommended for further research in the nearest future.

a. Studies on other programmatic factors that enhances the use of MMA application

b. Pregnant women who are registered by MMA within the first trimester can be studied through the continuum of care process to assess how MMA can influence maternal health over a period of time
REFERENCES


journal of environmental research and public health, 11(11), pp. 11559–11582.


Dovlo D. (2004); Using mid-level cadres as substitutes for internationally mobile health professionals in Africa. A desk review. Human Resour Health, 2(7)


text-messaging system to support young people with diabetes. *Diabet Med.* 23(12):


Ghana Health Service (2009) 'Enterprise Architecture (The eHealth Architecture); Ghana Health Service


Ghana Health Service (2016) 'Ghana Health Service 2015 Annual Report'. Ghana Health Service


Grameen Foundation: connecting the world’s poor to their potential [Internet]. Washington, DC: Grameen Foundation; [cited 2013 Mar 13]. Mobile Technology for Community Health (MOTECH); [about 2 screens]. Available from: http://www.grameenfoundation.org/what-we-do/technology/mobile-health


Hanauer David A., Katherine Wentzell, Nikki Laffel and Lori M. Laffel (2009). Computerized automated reminder diabetes system (CARDS): e-mail and SMS cell phone text messaging reminders to support diabetes; *Diabetics Technology and Therapeutics*; 11(2)

Hao Wang and Jing Liu (2009), “Mobile Phone Based Health Care Technology”, Recent Patents in Biomedical Engineering, Volume 2, pp. 15-21


James G. Kahn, Joshua Yang, & James S. Kahn (2010), 'Mobile Health Needs and Opportunities in Developing Countries', Health Affairs, p. 258.

John Koku Awoonor; James Philip; Allison Stone; Stephane Helleringer; Bruce MacLeod; Jemima Frimpong; Maggie Schmit (2013) ‘The Mobile Technology for Community Health (MoTeCH) Initiative: AN mHealth System Pilot in a Rural District on Northern Ghana’. Value in Health; Volume 16, Issue 3, Pages A270–A271


mHealth Alliance (2013); Vital Wave Consulting. Sustainable financing for mobile health (mHealth): options and opportunities for mHealth financial models in low and middle income countries. *mHealth Alliance.*

Mobile Africa (2016) 'The Mobile Economy Africa 2016' facilitated by Global System Mobile Association, GSMA


Muzinda M. (2007); 'Monitoring and Evaluation practices and challenges of Gaborone Based Local NGOs Implementing HIV/AIDS project in Bostwana; University of Bostwana;

Nederpelt, P. Van & Daas, P. (2012) ‘49 Factors that Influence the Quality of Secondary Data Sources’. Statistical Netherlands; ISSN: 1572-0314


Nullis-Kapp C. (2005); 'Health Workers Shortage could deraul development goals. Bull World Health Organ, pp. 5-6


USAID (2010) ‘Innovative Mobile Phone Use Improves Access to Drugs and Medical Supplies in Africa’. *United States Agency for International Development*


adherence to oral medication in type 2 diabetes patients who are real time electronically monitored’, *International Journal of Medical Informatics*, 81(9), pp. 594–604.


APPENDICES

Appendix A: Participant’s Information Sheet

| Title of study | The Use of Medic Mobile Application by Community-based Health Volunteers to Monitor Pre- and Post-Pregnancy Status in Northern Ghana: A Case study of selected districts |

My name is Andrews Obed Asamoah of Catholic Relief Services pursuing Master of Public Health weekend program at the Department of Health Policy, Planning and Management, School of Public Health, College of Health Sciences, University of Ghana. My contact detail is P.O. Box AN 6333, Accra North. My cell phone contact is 0244966972 and email contact is kbasamoah83@gmail.com

Nature of the Study

Access to maternal and child health services remain one of the greatest challenges in health system in Northern Ghana. Pregnant women sometimes find it difficult to visit a facility for four-time required ANC visits prior to delivery. However, some referral and support systems can help facilitate the process. The introduction of MMA by CRS assumes that role. The study will therefore be conducted largely using secondary data with some amount of primary data from community-based health volunteers who are the frontline MMA tool users for analysis. Primary information will only bother on the how the MMA phones have been used.

Purpose of the study
I am undertaking a study on the Use of medic mobile application by community-based volunteers to monitor pre- and post-pregnancy status. The study hopes to assess how MMAs helps to capture ANC, skilled delivery and PNC status.

**Potential risks/benefits**
The researcher anticipates minimal risk in the study. This is largely so because most of the data will be retrieve from online. There is no direct link to any pregnant woman or lactating mothers whose status will be measured in this study. Again, with CHVs, the demographic data that will be required will not bother on sensitivity which would have posed higher risk.

**Privacy/Confidentiality**
I would like to assure you that whatever information provided will be handled with strict confidentiality and will be used purely for the research purposes. Your data will not be shared with anybody who is not part of the research team. Data analysis will be done at the aggregate level to ensure anonymity. Your identity will not be disclosed in the material that will be published.

**Data storage and usage**
Data from the CHVs will be collected with questionnaire and entered into table format and stored on hard drive of a computer and the same time keep the questionnaire in safe for two years before disposing them off.

**Voluntary withdrawal and compensation**
Participation in this study is voluntary and participants can choose not to answer any particular question or all questions. You are at liberty to withdraw from the study at any time
without prejudice from the study team. However, it is encouraged that you participate since your opinion is important in determining the outcome of the study. Respondents will not be provided any reward/compensation to respond to the questionnaire.

Contacts for Further Clarifications:

Further clarifications on this study could be communicated on a request to either the investigator, Andrews Obed Asamoah on a phone contact 0244966972 or Madam Hannah Frimpong, the administrator, Ghana Health Service – Ethics Review Committee of the Research and Development Division on a phone contact 0507041223.

Appendix A: Questionnaire

School of Public Health
Dear Respondent,

This is a research carried out on the use MMA in your community. I will therefore like to take a few minutes of your precious time to answer these questions. You are assured that the answers you give will be strictly confidential and your name will not be mentioned in my research reports.

Thank you.

<table>
<thead>
<tr>
<th>Qns. No.</th>
<th>Questions</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Respondents ID/Code</td>
<td></td>
</tr>
<tr>
<td><strong>Section 1</strong></td>
<td><strong>Demographic Information</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 Male</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 Female</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Age in years</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>What is your current level of education?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. No education</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Primary</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Middle/JSS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Secondary/Vocational</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Tertiary</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Employment Status</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Employed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Unemployed</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Residence</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Peri-urban</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Rural</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Name of community</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Trained before MMA use</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. No</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>How long have you use MMA? Record the responds in Months</td>
<td></td>
</tr>
</tbody>
</table>
### Secondary Source of Data

Correct Use of MMA

<table>
<thead>
<tr>
<th>A. Registration</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. ANC</td>
</tr>
<tr>
<td>ii. SD</td>
</tr>
<tr>
<td>iii. PNC</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. Validity of MMA usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. ANC</td>
</tr>
<tr>
<td>ii. SD</td>
</tr>
<tr>
<td>iii. PNC</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C. Submission:</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. ANC</td>
</tr>
<tr>
<td>ii. SD</td>
</tr>
<tr>
<td>iii. PNC</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Number Submitted</th>
</tr>
</thead>
</table>

---

**Appendix C: Participant's Consent Form**

95
I have read or have had someone read all the above, asked questions, received answers regarding participation in this study, and I am willing to give my consent to participate in this study. I will not have waived any of my rights by signing this consent form. Upon signing this consent form, I have agreed to be a participant.

_______________________________
Name of Volunteer

_____________________________   _______________________
Signature or mark of volunteer    Date

If volunteers cannot read the form themselves, a witness must sign here:

I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered and the volunteer has agreed to take part in the research.

_______________________________
Name of witness

_____________________________   _______________________
Signature of witness    Date
I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual.

_____________________________________________________
Name of Person Who Obtained Consent

_____________________________________________________
Signature of Person Who Obtained Consent Date

Date…………………… Address……………………………………
Address: Andrews O. Asamoah
School of Public Health
College of Health Sciences
University of Ghana
P. O. Box LG13
Legon - Accra