UNIVERSITY OF GHANA
COLLEGE OF HEALTH SCIENCES

FEASIBILITY OF MOBILE HEALTH FOR TREATMENT COVERAGE REPORTING: LYMPHATIC FILARIASIS CONTROL PROGRAMME IN GHANA

BY
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THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON, IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF PHD PUBLIC HEALTH DEGREE

MARCH 2017
DECLARATION

I, Frances Baaba da-Costa Vroom declare that this thesis is my own work produced from research undertaken under supervision. It has not been presented in whole or part for any academic award in this or any other university. All references used in this work have been duly cited.

Signature: …………………………… Date: …………………………..

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SIGNATURE PAGE

I hereby certify that this thesis was supervised in accordance with procedures laid down by the University.

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(Co-Supervisor)
ABSTRACT

Background
Health information plays a pivotal role in ensuring the success of health systems. It ensures the health system blocks receive the needed information for effective decision-making. Improving data reporting systems can, therefore, strengthen the delivery of health programmes and health systems. Information Communication Technology (ICT), particularly mobile phone applications (mHealth) have become pivotal in the delivery of quality health data. The Neglected Tropical Diseases (NTD) Control programme in Ghana engages community health volunteers (CHV) to conduct house-to-house mass drug administration (MDA) of albendazole and ivermectin for the treatment and management of lymphatic filariasis. Community health volunteers register community members during the MDA and collect information on dosage of drugs administered. They are expected to summarise the data collected in the registers and submit the reports to the sub-district supervisors and eventually to the NTD national office via regional supervisors. Unfortunately, this process delays and hampers mop-up drug distribution, reporting to donors and planning and decision making for the subsequent years’ MDA. The NTD programme intends to address reporting challenges using mHealth applications. However, little is known about the acceptability and feasibility of data reporting using mobile phones, particularly among community health volunteers (CHVs). This study assessed the feasibility of CHVs using mobile phones for reporting MDA data for the programme. In particular, the study assessed bottlenecks in data reporting for the MDA, CHVs mobile phone use, mHealth technology acceptance among the CHVs and the quality of data reported.

Methods
The study employed a mixed methods research design using multiple cross-sectional studies. This was an implementation research involving qualitative interviews, CHV training, mHealth
intervention, data collection and data quality assessment. The study was conducted in two episodes (T1 and T2) over a two year period in Ahanta West district and Nzema East Municipality, both in the Western Region of Ghana. Due to the small number of CHVs in the two study sites, all CHVs who consented to participate were enrolled without sampling. Supervisors at the sub-district, district, regional and national levels were interviewed to understand the context of programme implementation. Qualitative data were collected using in-depth interviews and focus group discussions. A structured questionnaire was administered to CHVs on mobile phone use patterns and challenges and to determine CHVs acceptance to use mobile phones to report MDA data. Quantitative data were analysed using Stata 13® (StataCorp LP) and MS Excel 2013®. Frequencies and proportions were used to describe the quantitative data. Generalised structural equation modelling was used to assess CHVs acceptance to use mobile phones for MDA reporting. Differences in proportions between programme data and data submitted by SMS and USSD were calculated to determine completeness and accuracy of MDA data reported. Qualitative data was translated, transcribed and coded. Data was uploaded into Nvivo® Pro by QSR International to store and organise the data. The data were analysed using thematic content analysis perspective.

**Results**

Mobile phone ownership and access were almost universal (99%) with voice calls being the most used function (73%) followed by text messages at 33%. Mobile phone use among CHVs was almost universal. Poor network connectivity and lack of electricity were significantly associated with challenges of using mobile phones. Behavioural intention was a strong determinant of actual use of the technology in T1 but was not significant in T2. The CHVs use of mobile phone technology for reporting MDA data was dependent on other factors such as volunteerism, incentives and submission to authority. Data completeness from both study sites
in both episodes ranged from 0 – 100% with about half of messages received (n=56) reporting 100% of indicators expected. Data accuracy, on the other hand, was generally poor across study sites. Reasons for delays in reporting were attributed to poor numeracy skills among CHVs, difficult physical access to communities, high supervisor workload, poor adherence to reporting deadlines, difficulty in reaching communities within the allocated time and untimely release of programme funds. Poor accuracy of data was mainly attributed to the inadequate motivation for CHVs and difficulty in calculating summaries.

Conclusions
The results of this study have shown that the data reporting bottlenecks occur upstream (sub-district and district levels). Community health volunteers are willing to accept mobile phones for reporting MDA data. However, health system and programmatic issues have an influence on their decisions to use mobile phones for reporting. Accuracy and completeness of MDA data were generally poor. Using mobile phones to report MDA data is feasible due to CHV high mobile phone use and CHV acceptance to use mobile phone for data reporting. Accuracy and completeness will have to be improved and network connectivity in various communities will also have to be improved. Choosing the right technology for data reporting can ensure data completeness. To improve data accuracy, measures will have to be applied to the current paper-based system to ensure it will be adequately translated in terms of technology. The immediate supervisors of CHVs; community health officers (CHOs) at the sub-district level, could be provided with the mobile technology tools to submit the summarised data from the sub-district level to ensure timely reporting.
DEDICATION

This thesis is dedicated to my family. My husband Kwesi da-Costa Vroom, my parents Edward and Teresa Prah and my siblings, Irene, Anita, Louisa, Edward and Edwina.
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I wish to thank the Almighty God for His mercies and grace over the period of this study.

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<td>ART</td>
<td>Anti-Retroviral Therapy</td>
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<td>BI</td>
<td>Behavioural Intention</td>
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<td>CDD</td>
<td>Community-directed Distributors</td>
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<td>CHPS</td>
<td>Community-Based Health Planning and Services</td>
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<td>CHV</td>
<td>Community Health Volunteer</td>
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<td>CHW</td>
<td>Community Health Workers</td>
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<td>ComDT</td>
<td>Community Directed Treatment</td>
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<td>DHIMS2</td>
<td>District Health Information Management System version 2</td>
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<td>DQA</td>
<td>Data Quality Assessment</td>
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<td>EE</td>
<td>Effort Expectancy</td>
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<td>eHealth</td>
<td>Electronic Health</td>
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<td>EHR</td>
<td>Electronic Health Record</td>
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<td>FC</td>
<td>Facilitating Conditions</td>
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<td>FGD</td>
<td>Focus Group Discussion</td>
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<td>GHS</td>
<td>Ghana Health Service</td>
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<td>GIS</td>
<td>Geographical Information System</td>
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<td>GSMA</td>
<td>Groupe Speciale Mobile Association</td>
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<td>HIS</td>
<td>Health Information Systems</td>
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<td>HIV</td>
<td>Human Immunodeficiency Virus</td>
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<td>HSA</td>
<td>Health Surveillance Assistant</td>
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<td>ICT</td>
<td>Information Communication Technology</td>
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<td>IDI</td>
<td>In-depth Interview</td>
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<td>IR</td>
<td>Implementation Research</td>
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<td>ITU</td>
<td>International Telecommunication Union</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>IVR</td>
<td>Interactive Voice Response</td>
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<td>LF</td>
<td>Lymphatic Filariasis</td>
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<td>MDA</td>
<td>Mass Drug Administration</td>
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<td>mHealth</td>
<td>Mobile Health</td>
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<td>MIS</td>
<td>Management Information Systems</td>
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<td>MNCH</td>
<td>Maternal, Newborn and Child Health</td>
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<td>MOTECH</td>
<td>Mobile Technology for Community Health</td>
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<td>MVP</td>
<td>Millennium Villages Project</td>
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<td>NCA</td>
<td>National Communication Authority</td>
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<td>NGOs</td>
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<td>NTDP</td>
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<td>PDA</td>
<td>Personal Digital Assistant</td>
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<td>PE</td>
<td>Performance Expectancy</td>
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<td>PEOU</td>
<td>Perceived Ease of Use</td>
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<td>PMTCT</td>
<td>Prevention of mother-to-child transmission</td>
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<td>PU</td>
<td>Perceived Usefulness</td>
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<tr>
<td>SI</td>
<td>Social Influence</td>
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<td>SMS</td>
<td>Short Message Service</td>
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<td>TAM</td>
<td>Technology Acceptance Model</td>
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<tr>
<td>TBA</td>
<td>Traditional Birth Attendant</td>
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<tr>
<td>USAID</td>
<td>United States Agency for International Development</td>
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<td>USSD</td>
<td>Unstructured Supplementary Service Data</td>
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<tr>
<td>UTAUT</td>
<td>Unified Theory of Acceptance and Use of Technology</td>
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<td>VHW</td>
<td>Village Health Workers</td>
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CHAPTER 1
INTRODUCTION

1.1 BACKGROUND
Health information plays a pivotal role in ensuring the success of health systems (World Health Organisation, 2010a). It provides a basis for monitoring and evaluating other building blocks of the health system, namely, leadership/governance; medical products, vaccines and technology; health workforce; service delivery and health financing. The health system building blocks require efficient health information systems to generate the needed data for decision-making. Improving data reporting systems can, therefore, strengthen the delivery of health programmes and health systems (Ledikwe et al., 2014). Information Communication Technologies (ICT) are currently being used to meet this need and aid the process of improving efficiency in reporting, improve access to healthcare in hard to reach places and making overall health delivery processes more efficient and effective (Mutale et al., 2013; Simba, 2004). The use of ICT for healthcare delivery encompassing clinical care, public health and other health services has been termed eHealth (Eysenbach, 2001b; World Health Organisation, 2005). The benefits of eHealth include but not limited to the ability to collect and manage large amounts of data to inform decision making, training, communication and surveillance (AbouZahr & Boerma, 2005; Piette et al., 2012; Shih, Fan, Chiu, Shih, & Wang, 2014). Mobile health (mHealth) is a component of eHealth which is gaining popularity rapidly and involves the use of mobile technologies (mobile telephones and other wireless handheld devices) for health service delivery (mHealth) (Mendoza, Okoko, Morgan, & Konopka, 2013).

Mobile phones have shown great promise in healthcare with various pilots and full-scale projects being implemented in countries around the world (Fiordelli, Diviani, & Schulz, 2013). The increased use is due to the high proliferation of mobile phones, especially in developing
countries (Mendoza et al., 2013). Mobile phones have also become the most prevalent technology in most rural areas (Mechael et al., 2012). The International Telecommunication Union (ITU) estimates about 5.8 billion mobile–cellular subscriptions in developing countries with an estimated 772 million mobile phone subscriptions in Africa (International Telecommunication Union, 2016). In Ghana, approximately 38 million mobile cellular subscriptions were reported at the end of October 2016 from a mere 900 subscriptions in 1992 (National Communications Authority, 2016b). This growth in mobile phone subscriptions has prompted attempts to incorporate mobile technology into healthcare delivery. The Ghana Health Service (GHS) has developed an Enterprise Architecture to define the structure and governance of ICT solutions in healthcare delivery with mHealth included (Atweam, 2012). Currently, there are approximately 40 separate mHealth projects ongoing in Ghana (Atweam, 2014). These are mostly driven by Non-governmental Organisations (NGOs) such as USAID, Grameen Foundation, John Snow Inc. and other mobile telecommunication operators such as Vodafone and Airtel (Atweam, 2014; GSMA, 2014). A Groupe Speciale Mobile Association (GSMA) report on mHealth feasibility in Ghana, indicated that mHealth services are reaching approximately 628,000 persons (GSMA, 2014).

Mobile health applications can be grouped into five thematic areas (Mechael et al., 2010). These are treatment compliance, data collection and disease surveillance, health information systems and point-of-care support, health promotion and disease prevention and emergency medical response. Studies and pilots, using mHealth have been instituted to assess treatment adherence for conditions such as HIV, TB and malaria (Chi & Stringer, 2010; De Tolly, Skinner, Nembaware, & Benjamin, 2012; Zurovac et al., 2011). Clinical health information systems are also aiding in laboratory investigations, clinical care and training of health professionals (Asangansi & Braa, 2010; Tuijn, Hoefman, van Beijma, Oskam, & Chevrollier,
There have been diverse results with health promotional campaign pilot studies. A study by Chib, Wilkin, Ling, Hoefman, and Van Biejma (2012) showed marginal success in increasing participants’ knowledge levels in HIV/AIDS. Other studies have also been conducted to assess how well mobile phones can be used for data collection, disease management and patient reminders (Chi & Stringer, 2010; Crawford, Larsen-Cooper, Jezman, Cunningham, & Bancroft, 2014; Lester et al., 2010; Stanton et al., 2015; Tomlinson et al., 2009). This study fits into the data collection thematic area. Most of these studies were successful but a few also identified a number of challenges and gaps for further research which include issues such as scale-up of initiatives.

In spite of widespread enthusiasm for mHealth, few projects have scaled-up successfully (Mechael et al., 2010). One of the reasons being poor acceptance (by health workers) of the mHealth tools in spite of evidence of benefits (Chaiyachati et al., 2013). Health workers, who are stakeholders for these pilots have diverse experiences with mobile phones and their use for healthcare delivery activities (Braun, Catalani, Wimbush, & Israelski, 2013; Chaiyachati et al., 2013; Gagnon, Ngangue, Payne-Gagnon, & Desmartis, 2015). Few feasibility studies have been conducted, focussing on how health workers respond to these mHealth tools (Vélez, Okyere, Kanter, & Bakken, 2013). Feasibility studies provide in-depth details about the viability of an intervention given specific circumstances. It allows researchers to determine if findings from the study can be sustainable (Bowen et al., 2009). Mobile health studies usually focus on benefits of using mobile phones for health service delivery. While there have been positive results, it is necessary to determine what is viable within specific locations, users and type of mobile technology. Determining the feasibility of health workers use of mobile phones for healthcare delivery will afford programmes and health departments the opportunity to identify factors that promote or impede implementation of mHealth strategies. Findings on
feasibility will also help determine the effect of mHealth on investment and policy decisions (Jimoh, Pate, Lin, & Schulman, 2012).

1.2 CONTEXT OF THE STUDY

The Neglected Tropical Diseases Control Programme (NTDP) is situated within the Ghana Health Service with a core responsibility to control the five prevalent NTDs in Ghana; lymphatic filariasis (LF), trachoma, onchocerciasis, schistosomiasis and soil-transmitted helminths. The LF arm of the programme is responsible for the control and elimination of lymphatic filariasis. It began in 2001, having gone through various stages of case finding in various parts of Ghana, mapping the prevalence of the disease and developing drug distribution and control strategies towards the goal of interrupting transmission of the disease and improving the management of morbidity (Gyapong, 2000). These goals are being achieved through a community-based approach for drug distribution and morbidity management (Gyapong, Gyapong, & Owusu-Banahene, 2001). The Programme depends on the health system to deliver these interventions. Drugs (ivermectin and albendazole) and financing are provided by donor organisations through the World Health Organisation. These are distributed using the regional and district health administration distribution channels to ensure logistics are made available in the sub-districts and communities for treatment. The regional and district health administrations also provide leadership and supervision on behalf of the Programme. Community health volunteers (CHV) are then engaged to conduct house-to-house drug distribution of albendazole and ivermectin for the treatment and management of lymphatic filariasis on an annual basis (LF). The communities are usually rural and sometimes hard to reach (Gyapong, 2000).
The volunteers are trained and given specially designed mass drug administration (MDA) registration notebooks in which they are expected to register members of the community when administering the drug. They record data such as name, age, sex, the height of individual and drug dosage given, in these registers. When drugs have been distributed to every household, they summarise the data collected and submit the notebooks to the sub-district offices for report compilation. The CHVs are given five – seven days to distribute drugs and complete reports. The programme uses the country’s designated health administration levels for the supervision. Data is reported through the same channels starting from the community, up to the national programme office.

1.3 PROBLEM STATEMENT
Timely submission of MDA reports is a challenge for the LF Programme (Dembélé et al., 2012). Data collection and reporting are expected to be completed in three to four weeks from community level to Programme office. However, delays of about eight to twelve weeks can occur before data reaches the NTDP office (Personal Communication). The effect of late reporting on the NTDP is threefold. Firstly, plans for mop-up in the communities are hampered when treatment coverages are reported late. On occasion, mop-up is conducted after reports have been submitted to the NDTP and data on the late treatment ends up being excluded for the years’ statistics. Secondly, donors usually expect to receive MDA reports two to three months after the expected end of the MDA. This enables timely evaluation of resources provided for the beneficiary countries. Thirdly, drug requisitions to the World Health Organisation (WHO) for the next year’s MDA can take not less than six months from requisition to final delivery of the drug stocks. Thus late reporting has a negative impact on the logistics planning and decision making for the next MDA. The cause of these delays has not been documented. Literature and anecdotal evidence have also shown that treatment coverage
reported is not always accurate and complete (Baker et al., 2013; Worrell & Mathieu, 2012). In order to improve reporting timeliness, it has been suggested that data could be transmitted directly from the community level by the CHVs using mobile phones. However, little is known about the feasibility of data reporting using mobile phones, among this unique group of health workers and its potential effect on health information generated. Dembélé et al. (2012) made brief mention of CHVs using mobile phones for reporting MDA data in Mali in their paper. However, no literature exists on how CHVs performed the task and the outcome of the trial. Other studies on mHealth in the NTD literature with a focus on CHVs as the main actors do not focus on the acceptability of the mobile phones for the work they do annually (Madon, Amaguru, Malecela, & Michael, 2014; Stanton et al., 2015). There is, therefore, the need to assess the feasibility of CHVs using mobile phones for reporting MDA data.

1.4 RATIONALE OF THE STUDY

Findings from this study can provide evidence for policymakers in NTD programmes on how mHealth strategies can be applied to the programmes to improve efficiency in service delivery. CHVs provide important health services in the rural areas and mobile phones could be used to support their activities (Agarwal, Perry, Long, & Labrique, 2015). Having evidence on the viability of mHealth for the activities of these health workers will be important for health administrations and programmes especially in developing countries on defining the pathways for mHealth acceptance in health programmes. The feasibility study will provide details about the viability of the intervention for the Programme.

Findings from this study will also provide literature on mechanisms for acceptance of mHealth at individual and sociocultural levels of analysis (Chib, van Velthoven, & Car, 2014). The linkage between technology, individual factors and health system factors could be useful for
the Ghana Health Service as acceptance of ICT becomes important for health service delivery in the country. Ghana’s eHealth strategy and the Health Sector ICT Policy include mHealth as an important tool that can enable service delivery in remote areas of Ghana (Ministry of Health, 2005, 2010). Operationalisation of these strategies and policies will benefit from details that determine the viability of such interventions in other health programmes.

There is also a paucity of mHealth studies with theoretical basis and this study seeks to improve on that (Chib, 2013). Studies with theoretical basis allow for generalisation beyond the confines of a particular context and also allow for the explanation of the complete pathway for the acceptance of mobile health strategies (Chib, 2013; Chib et al., 2014). Theoretically based studies provide evidence to persuade policymakers and practitioners. Tomlinson, Rotheram-Borus, Swartz, and Tsai (2013) also identified the many benefits of mHealth but recognised the need to find features and factors that contribute to variation in an intervention based on theory.

1.5 STUDY OBJECTIVES

1.5.1 General Objective

The general objective of this study was to assess the feasibility of using mobile phones for reporting treatment coverage data for the lymphatic filariasis (LF) control programme.

1.5.2 Specific Objectives

The specific objectives were:

1. To explore the causes of delay in LF treatment data reporting.
2. To assess community health volunteers’ mobile phone usage patterns.
3. To assess community health volunteers’ acceptance to use mobile phones for LF treatment data reporting.

4. To assess accuracy and completeness of treatment data submitted with mobile phones.

1.6 RESEARCH QUESTIONS

This study sought to answer the following research questions;

1. What are the causes of delay in reporting treatment coverage data?
2. What are CHVs mobile phone usage patterns and factors associated with the use?
3. Will community health volunteers be willing to use mobile phones to report LF MDA data?
4. What is the accuracy and completeness of LF MDA data submitted through mobile phones?

1.7 STRUCTURE OF THE THESIS

This thesis consists of nine chapters. Chapter 1 provides an introduction to the thesis by giving a background to the study, stating the problem and rational or justification for the study. The research objectives and questions are also presented in this section. Chapter 2 reviews literature on eHealth, mHealth, community health volunteers, data reporting and the lymphatic filariasis control programme. The theoretical foundations for this study are also presented in this chapter. Based on the discussion, a conceptual framework is developed to guide the study. The research paradigm, approach and methods applied in conducting this study are further described in Chapter 3, including the study settings, data collection process and instruments, data analysis and ethical considerations for this study. Chapters 4 to 7 are journal article manuscripts emanating from the research objectives. Chapter 8 shows conclusions drawn from the findings.
as well as recommendations to relevant stakeholders. The chapter concludes by identifying the study’s contribution to knowledge and future research areas.
CHAPTER 2
LITERATURE REVIEW

2.0 INTRODUCTION

This chapter reviews the literature on eHealth and mobile health (mHealth) applications, community health volunteers, data reporting in the health sector, and particularly focuses on lymphatic filariasis Programme which is the focal programme of interest in the current study. There is also a review of technology acceptance literature which forms the basis for the theoretical foundations for aspects of this study. The chapter ends with a summary of gaps identified in the literature which have formed a basis for this study. The conceptual framework of the study is also presented in this chapter.

2.1 EPIDEMIOLOGY OF LYMPHATIC FILARIASIS

Lymphatic filariasis, also known as elephantiasis is a vector-borne parasitic disease of public health importance. It is caused by nematode parasites Wuchereria Bancrofti, Brugia Malayi and Brugia Timori and is transmitted by the Anopheles, Culex and Aedes mosquitos (World Health Organisation, 2013). W. bancrofti accounts for about 90% of LF cases in the world and B. Malayi causing the remainder of the cases (Taylor, Hoerauf, & Bockarie, 2010). Lymphatic filariasis is endemic in Africa, Asia, India, the western Pacific Islands, some places in Latin America and the Caribbean (predominantly Haiti and the Dominican Republic) (Fox & King, 2013). About 1.39 billion are said to be at risk of this disease in 72 countries in the world (Sodahlon, Malecela, & Gyapong, 2016).

Clinical manifestations of the disease are acute adenolymphangitis, lymphoedema (legs, arms, breast), elephantiasis and hydrocele (Dunyo et al., 1996). These parasites dwell in the lymphatic nodes and damage the lymphatic system causing elephantiasis, lymphoedema and
hydrocele in people (Bockarie, Taylor, & Gyapong, 2009). A lot of individuals with active worms never develop clinical symptoms or signs of the disease (Taylor et al., 2010).

2.1.1 Treatment Regimen for LF

Treatment of LF is by administering a single-dose, 2-drug regimen of ivermectin with albendazole or ivermectin with diethylcarbamazine annually. The safety of this regimen was assessed through a multi-country assessment and found to be safe with minor adverse events (Horton et al., 2000). Places, where LF is co-endemic with Loa loa, treatment with ivermectin, is not feasible so vector control is chosen as the intervention of choice (World Health Organisation, 2012). In endemic countries, treatment is provided through MDA by going door to door in various communities. The drugs are distributed by community health volunteers to individuals who are 5 years old and above. Persons who are seriously sick, pregnant and below five years of age are ineligible for treatment. Data on geographic and therapeutic coverages are monitored after each MDA. The targets are to achieve 100% geographical coverage and at least 65% treatment coverage. MDA can be stopped in an endemic area after 5 rounds of MDA achieve more than 65% treatment coverage and transmission assessment surveys show a microfilaraemia load of less than 1% in the population.

2.1.2 Lymphatic filariasis in Ghana

In 1993, a baseline study on the prevalence of bancroftian filariasis was undertaken in the Kassena-Nankana District in the Upper East region of Ghana (Gyapong, Badu, Adjei, & Binka, 1993). A microfilaraemia prevalence rate of 41.1% was found in the district after night blood surveys were conducted on 531 inhabitants who had lived in the district for not less than ten years. (Gyapong et al., 1993). Wuchereria bancrofti was the filarial species identified. This high prevalence of microfilaraemia was of great public health concern and was found to have
a high socio-economic impact on the population in the district. The study established the need to conduct further prevalence studies in the country to determine the prevalence of filariasis in Ghana.

Pursuant to the baseline study on the prevalence of bancroftian filariasis in the Kassena-Nankana district by Gyapong et al. (1993), another study to determine the extent and distribution of lymphatic filariasis in Ghana was conducted (Gyapong, Adjei, & Sackey, 1996). The study formed a basis for the planning and designing of a control programme for the disease. The national prevalence of LF was 3.0% (95% confidence interval [CI] 2.5-3.5). Infection was found to be in 8 of the 10 administrative regions in Ghana with 20% prevalence in the Upper West Region. This study enabled the establishment of LF as a disease of public health importance in the country (Gyapong et al., 1996).

Mapping the geographical distribution of a disease is important for advocacy, planning and costing towards the elimination of the condition in a population (Gyapong et al., 2002). An inter-country spatial analysis of the distribution of LF was conducted among four countries namely, Ghana, Burkina Faso, Togo and Benin. This study made it possible to predict the prevalence of LF at all points within the four countries mapped. Areas of northern Ghana, Togo and Benin that shared a border with Burkina Faso showed a high level of endemicity (5% - 30%). Two transmission zones were revealed; first in Burkina Faso and stretching to northern Ghana and the second along the coastline of Ghana in areas west of Accra. The forest zone and Volta regions of Ghana were surprisingly found to be apparently free from transmission of LF. This study recommended for a regional approach to be used for mapping of LF (Gyapong & Remme, 2001b). This was necessary to help define areas of active transmission and provide the basis for planning large-scale treatment of the disease (Gyapong & Remme, 2001a).
2.1.3 Data Reporting in the LF Programme

The LF programme depends on data collected by CHVs for decision making and planning. Globally, CHVs are relied upon to deliver treatment in their communities and keep accurate records which are collated for decision-making (Amazigo, Leak, Zoure, Njepuome, & Lusamba-Dikassa, 2012). The volunteers record details of household members in communities in specially designed forms or MDA registers and submit to the immediate health unit (de Souza et al., 2016; Fleming, Matovu, Hansen, & Webster, 2016). The data is collated and compiled at community or village level and reported using the country’s health data reporting structures to the national programme office (Dembélé et al., 2012; Madon et al., 2014). Reporting strategies appear to be the same in the various countries where LF programmes exist. However, there may be minor modifications made in various countries to the standardised forms being used, to suit country health reporting needs (Gyapong et al., 2000). Timeliness of reporting has been identified as a challenge with this method of reporting (Dembélé et al., 2012). There appear to be bottlenecks along the reporting channel that prevent data from reaching the national programmes on time (de Souza et al., 2016; Dembélé et al., 2012). Dembélé et al. (2012) mentioned a successful trial of mobile text messages for data reporting, though no evidence was provided on the trial. A mobile phone intervention for data collection in Tanzania was also shown to be successful (Madon et al., 2014). Other challenges identified with LF MDA reporting are poor data accuracy and completeness (Baker et al., 2013; de Souza et al., 2016; Worrell & Mathieu, 2012). These articles show that data collection by CHVs has an important role to play in LF programmes.
2.2 COMMUNITY HEALTH VOLUNTEERS (CHV) AND DATA REPORTING

2.2.1 Who is the CHV?

Community health volunteers are lay community members recruited and trained to assist with healthcare delivery in their communities (Nkonki, Cliff, & Sanders, 2011). They are also occasionally referred to as community-directed distributors (CDDs) or lay community health workers (CHW) (Alam, Khan, & Walker, 2012; Emukah et al., 2008). They are usually unpaid and provide volunteer services to their communities, bridging the gap where trained health professionals are minimal (Gopalan, Mohanty, & Das, 2012). They provide services in nutrition, maternal and child health, malaria, tuberculosis, HIV/AIDS and other non-communicable diseases (Nkonki et al., 2011). Community health volunteers usually receive allowances or honorarium for training and providing health services to their communities (Alam et al., 2012). Studies, such as by Gallo et al. (2013), have shown they are sometimes given the opportunity to earn some income from some socially-marketed products such as contraceptives. Miller, Musominali, Baganizi, and Paccione (2014) also indicated village health workers were paid either a monthly salary or paid based on number of households they visited. Most of these volunteers are usually nominated by their communities to provide these services (Abbey et al., 2014).

Some level of literacy is an important characteristic for one to be chosen as a CHV. The WHO definition of a CHV in Abbatt (2005) indicates that they “should have had a level of primary education that enables them to write, read and do simple mathematical calculations.” This is important because CHVs are not just responsible for delivering healthcare but are also expected to collect and report data as part of their duties (Bhattacharyya, Winch, LeBan, & Tien, 2001). Some CHVs have lower than primary education or none at all (Abbatt, 2005; Abbey et al., 2014). Literate CHVs tend to be younger and also have higher attrition rates (Bhattacharyya et
Community health volunteer’s level of education has been found to have an impact on how well they execute their duties and literate volunteers are shown to have better skills at health delivery (Acharya, Singh, Adhikari, & Jain, 2016). Crispin et al. (2012) found that literate CHVs tended to keep better records, use job aids correctly and counsel their clients more appropriately. Very little is known about CHVs ICT literacy and how it will impact their work. A few programmes or projects have engaged CHVs in various mHealth pilots to capture and report data (DeRenzi et al., 2012; Tomlinson et al., 2009). A systematic review indicated that when CHVs are equipped with mobile devices, they produce better quality data which are timely and less prone to errors (Braun et al., 2013).

Sex distribution of CHVs also tends to vary in various countries. Silva et al. (2016) reported an all-female CHV population in Ethiopia, Malawi had 50% females and 28% female CHVs were reported in Mali. This was similar to Crispin et al. (2012) who also reported a predominantly female CHW population. This is described in Table 2.1. This was different among CHWs in the rural Quechua communities in Peru where they were predominantly male (Brown et al., 2006). Females in that community were expected to keep the house and raise children so most husbands forbade their wives from taking up roles as CHWs. Interestingly, Crispin et al. (2012) reported male CHWs reported more accurate data than females, while females provided better services. This was, however, not reported in other studies.

Table 2.1 provides a summary of the characteristics of CHVs, their impact on data reporting, especially in developing countries, challenges encountered while working with CHVs to collect data and gaps in CHV data reporting studies. These issues are discussed further in the ensuing sections.
<table>
<thead>
<tr>
<th>Author</th>
<th>Purpose of Study</th>
<th>Characteristics of CHV</th>
<th>Country</th>
<th>Impact of CHV in Data Reporting</th>
<th>Challenges of CHV in Data Reporting</th>
<th>Recommendations for Future Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Munyaneza et al. (2014)</td>
<td>To use an existing CHW network to map drinking water sources in villages in a mountainous region.</td>
<td>Primary level education.</td>
<td>Rwanda</td>
<td>Lower cost compared to using trained GIS team. Better engagement with the community through local capacity building. Mapping was integrated into the regular CHW activities. Feedback loop of data for local decision making.</td>
<td>Difficulty validating villages that are far from known features like rivers etc. Possible under or overestimates of safe drinking water.</td>
<td>Assess accuracy of maps with that collected by a trained team.</td>
</tr>
<tr>
<td>Admon et al. (2013)</td>
<td>To assess the quality of data reported by CHWs.</td>
<td>Trained as health educators, accompany patients for clinic visits, case finding for priority diseases and data collection</td>
<td>Malawi</td>
<td>CHW supervisors aggregated data and produced high-quality data.</td>
<td>Not all CHW could be co-opted to aggregate data.</td>
<td>Study to determine if data collected in source forms are correct. Continuous assessments to ensure data quality achieved is maintained.</td>
</tr>
<tr>
<td>Crispin et al. (2012)</td>
<td>To assess the effects of socio-demographic characteristics on the performance of home visits by CHWs</td>
<td>Predominantly female, most aged below 40 years, majority had completed secondary school, 80% had 3 – 5 years’ work experience.</td>
<td>Kenya</td>
<td>Being aged 30 – 50 years, being male, having secondary school education and having 3 – 5 years’ work experience were highly associated with keeping good records.</td>
<td>None stated.</td>
<td></td>
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<tr>
<td>Silva et al. (2016)</td>
<td>To explore the viability of CHWs reporting of births and child deaths as a prelude to real-time measurement of under-five mortality and scale-up of CRVS in low-income countries.</td>
<td>All females in Ethiopia, about 50% females in Malawi and 28% in Mali. Paid workers in Malawi and Ethiopia but volunteers in Mali. About 10 years of schooling. 26% of volunteers had formal education.</td>
<td>Ethiopia, Malawi and Mali</td>
<td>Strong supervision and community engagement ensured data accuracy in Mali. Enables accurate tracking of under-5 mortality rates.</td>
<td>High turnover of staff has a negative impact on data quality. Task-shifting of the CHWs and assignment to large geographic areas impedes accurate data reporting.</td>
<td>How to scale-up these methods to ensure the accuracy of vital statistics over time. Investigation, using full pregnancy histories and the routine reporting of pregnancies by CHWs, is needed to evaluate</td>
</tr>
<tr>
<td>Author</td>
<td>Purpose of Study</td>
<td>Characteristics of CHV</td>
<td>Country</td>
<td>Impact of CHV in Data Reporting</td>
<td>Challenges of CHV in Data Reporting</td>
<td>Recommendations for Future Study</td>
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<td></td>
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<td>education. Most lived in the catchment area of the study. All had training in reporting vital statistics as well as other health work.</td>
<td></td>
<td></td>
<td>reported high neonatal deaths and misclassification of stillbirths (as neonatal deaths) by CHWs. Costing of community-based vital events tracking.</td>
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</tr>
</tbody>
</table>
2.2.2 Impact of CHVs on data reporting

As shown in Table 2.1, some studies engaging CHVs for data collection and reporting have seen positive impacts such as good record keeping and improved data accuracy. They were shown to provide good records if they had some secondary school education, were employed, male and aged 30-50 years (Crispin et al., 2012). A multi-country study in Ethiopia, Mali and Malawi also identified data accuracy as a benefit of CHV reporting (Silva et al., 2016). However, these results were possible due to strong supervision and field data quality checks conducted during the study. Admon et al. (2013) found poor data quality at baseline but this was improved after some interventions were established. Field sites that showed high data quality, had supervisors aggregating the data collected by the CHVs.

In the Munyaneza et al. (2014) study, engaging CHVs for data collection was found to be a cheaper option compared to a trained geographical information systems (GIS) team. The main cost items that differentiated a trained GIS team from the CHV supervisors, were salaries and transportation. The CHV supervisors worked in their communities and combined their core duties with this data collection exercise.

These varied findings show that data captured cannot be assumed to be free of errors without including adequate training and supervision of CHVs. The data errors seen may be an impact of low literacy levels which have been explained above. However, these can be combated when appropriate tools and training are provided for CHVs to use in collecting the data.

2.2.3 Challenges of CHVs in Data Reporting

A number of challenges have been identified in the summary in Table 2.1 that affect data reporting by CHVs. This was mainly associated with the accuracy of data reported. Even
though data quality was not assessed in the Munyaneza et al. (2014) study, there was the suspicion of potential underreporting or overreporting of safe drinking water sites. Community health volunteers in this study had to walk long distances in their catchment areas to map these drinking water sites and this could have impacted data accuracy. Similarly, assigning CHVs to work in large geographical areas had an adverse effect on accurate data reporting (Silva et al., 2016). This means they would have to travel further, and some CHVs may choose not to trek long distances. In such cases, some community members may not be captured in the statistics.

Most health programmes have recorded high attrition of CHVs (Silva et al., 2016). This also affects the accuracy of data reported. This is because newly engaged CHVs may not have adequate training before going out to the field, unlike the CHVs they replaced who might have had multiple exposures to the data collection exercise. Most CHVs complain about low remuneration and often take up other assignments that would provide better incomes. Emukah et al. (2008) indicated attrition as a challenge to the CDD programme in Nigeria. Though there was no direct reference to data reporting in their study, it was indicated that CDDs who were involved in other programmes took longer to complete their tasks compared to CDDs who were only involved in ivermectin distribution. Time spent on other health programmes could affect the data collation and reporting component of their work as CDDs of the NTD programme.

Data reporting challenges outlined are likely to occur in studies where CHVs are the main actors for data reporting. The characteristics of CHVs are similar in various countries and programmes and so will be no different in Ghana. It is expected that various measures would be put in place to minimise the occurrence of such challenges.
2.2.4 Quality of data reported by CHVs

Community health volunteers (CHVs) collect and report on large volumes of data on a routine basis, however, there are concerns about the quality of data generated for health programme management (Mitsunaga et al., 2013). The study found 59%, 58 % and 71% respectively of total sick children, fever and pneumonia indicators to be of “good” quality. “Good” quality reports were defined as ≥90% of reports in a health centre that were concordant with the registers. Health centres were generally classified as having “poor” quality reports for all three indicators. In a study in Upper East region of Ghana, significant errors were found in data aggregated by CHVs. Over-reporting and under-reporting of some data elements were found when CHV summary data was compared with summary data by researchers (Helleringer, Frimpong, Phillips, Avoonor-Williams, & Yeji, 2010a).

Another challenge identified is the potential for fictitious data that can go a long way to hamper health services. A study by Mahmood and Ayub (2010) found only 47.5% of reports by Lady Health Workers in Lahore for family planning and primary health care to be accurate. Missed entries were 35% and misreported and fictitious data was discovered. Tomlinson et al. (2009) also inadvertently discovered reporting of fictitious data by a CHW during a study. These show data quality issues in health cannot be ignored. They need to be critically studied to ensure decisions based on these data are credible.

Gimbel et al. (2011) studied data collected by community health workers in Sofala Province in Mozambique. They described the availability, validity and reliability of routine primary healthcare data across nine districts. They found availability to be high (97%) for immunisation reports, and 99% of maternity monthly facility reports were on file at the facility level. At the district health department, 99% of immunisation reports and 100% of maternity reports were
The validity of data was found to be 81% for health facility clinical registries and monthly facility reports of five indicators. Again, 80% of health facility clinical registry data matched with the monthly facility reports on five indicators. They determined at the end of the study that reliability, validity and availability of data in the study sites were adequate. This is in contrast with most studies found on quality of data reported by CHVs. These studies show there are challenges that need to be surmounted if data collected by these first-line health workers can be used for decision-making and planning.

### 2.3 DATA QUALITY IN HEALTH SERVICES

Data are defined as the “facts and figures associated with customers, products and services...indeed every aspect of life in the information age” and is a crucial input to decision making and planning (Redman, 2004). Data used for decision-making should have a high quality in order to ensure a basis for development and bring about change for the stakeholders in question (Dreisler, Schou, & Adamsen, 2001). A lot of data is generated on a daily basis by organisations but anecdotal reports indicate that achieving good data quality is a challenge. The attributes of data quality as outlined by American Health Information Management Association (AHIMA) are accessibility, consistency, currency, granularity, precision, accuracy, comprehensiveness (completeness), definition, relevancy and timeliness (AHIMA, 2012). Of these attributes, completeness, accuracy and timely flow of data among stakeholders are said to be important for effective monitoring and supervision of health programs (Gimbel et al., 2011).

A search of literature databases revealed that timeliness, accuracy and completeness appear to be the most studied data quality attributes for health data. Studies have also tried to identify reasons why some of these data quality attributes are not achieved especially for health data (Arts, de Keizer, & Scheffer, 2002; Hashemi, Nasrabadí, & Asghari, 2012; Rust et al., 2008).
These characteristics are important in ensuring that data collected for healthcare delivery is useful and contributes to effective decision making. While reliability and relevance are ensured by the relevant stakeholders of the data, accuracy, completeness and timeliness are greatly influenced by external factors.

Data accuracy is defined as “the extent to which registered data is in conformity to the truth” and completeness as “the extent to which all necessary data that could have been registered have actually been registered” (Arts et al., 2002). The potential impact of decisions made from poor data quality makes it imperative that continuous assessments are carried out to assess the quality of data being generated by and for health programmes. Data quality has been assessed for various programmes in health including immunisation. Studies have shown over reporting of immunisation coverage reports in developing countries (Crabb, 2003; Mavimbe, Braa, & Bjune, 2005). Mavimbe et al. (2005) found differences between facility reports and district reports. They found facilities were over reporting for all vaccine types ranging from 44% for BCG to 95% for DPT+HepB. Some of the reasons for over-reporting were attributed to an overemphasis on achieving targets to show “good performance”, lack of motivation of health personnel, lack of feedback, no concern for quality information and no data validation mechanism. Shengalia et al. in Crabb (2003) compared vaccination coverage from 1990 to 2000 in official reports of 45 developing countries against their Demographic and Health Surveys (DHS). They found vaccination coverage to be 20% higher than was recorded for the DHS. They attributed the over reporting to weak information systems for transferring and aggregating data, intentional inflation of rates for financial incentives and reporting of all vaccinations not just what is needed by the recommended schedule.
2.4 ELECTRONIC TECHNOLOGIES IN HEALTH SYSTEMS (eHealth)

Technology in health is seen as a tool to enhance human activities in delivering healthcare (Oh, Rizo, Enkin, & Jadad, 2005). The first use of technology in healthcare was recorded in 1890, where Herman Hollerith developed a punch-card data processing system for the US census (Shortliffe & Blois†, 2006). Most early health information systems (HIS) were called clinical information systems, developed by academic medical centres for billing and patient management (Atherton, 2011; Saranummi, 2013). Subsequently, ICT has been used in all aspects of clinical care and administration, public health, medical education and research (Aanensen, Huntley, Feil, al-Own, & Spratt, 2009; Dentzer, 2010). Current trends are viewing the patient or client as a partner with health professionals in managing their health through the use of mobile health technology (Dobkin & Dorsch, 2011; Saranummi, 2013).

The use of ICT to deliver healthcare in all its forms has been coined as eHealth (Eysenbach, 2001a). This term has become popular and almost synonymous with better and efficient healthcare delivery (Piette et al., 2012; Verbeke, Karara, & Nyssen, 2013). While varied definitions have been propounded, there is still a lack of consensus on how eHealth should be defined (Showell & Nøhr, 2012). Table 2.2 presents definitions of eHealth and its’ various components. Generally, eHealth is classified into four distinct components; telemedicine, health information systems (HIS), mobile health (mHealth) and distance learning (Mendoza et al., 2013). While a number of the definitions focus on healthcare services, others focus on the technology, including the use of the Internet and other communication tools for the delivery of health services. The definition advocated by Eysenbach (2001a) encompasses a broader spectrum of applications, highlighting more fully, the convergence of ICT with health. Another definition considers the concept of a new thinking and attitude since eHealth methods change depending on the setting or context (Boogerd, Arts, Engelen, & van de Belt, 2015). Al-Shorbaji
and Geissbuhler (2012) and Della Mea (2001) both put forth the aspect of e-commerce and eHealth as a business term that is easy to market. Boogerd et al. (2015) however, have proposed the redefinition of eHealth, citing the fact that terms being used overlap and that the definitions change or vary from one setting or context to the next. Subsequently, Bateman and Keef (2016) have also described the inconclusiveness of the definition and described eHealth as an enabler in improved healthcare delivery.
<table>
<thead>
<tr>
<th>Terminologies</th>
<th>Author(s)</th>
<th>Definition</th>
<th>Focus of Definition</th>
</tr>
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<tbody>
<tr>
<td>eHealth</td>
<td>Eysenbach (2001a)</td>
<td>“An evolving field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve healthcare locally, regionally, and worldwide by using information and communication technology.”</td>
<td>Healthcare, Technology, Technology</td>
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<td>Ahern, Kreslake, and Phalen (2006)</td>
<td>“The use of emerging interactive technologies (e.g., Internet, CD-ROMs, personal digital assistants, interactive television and voice response systems, computer kiosks, and mobile computing) to enable health improvement and healthcare services.”</td>
<td>Technology, Healthcare evaluation</td>
</tr>
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<td>Al-Shorbaji and Geissbuhler (2012)</td>
<td>“The cost-effective and secure use of information and communication technologies in support of health and health-related field.”</td>
<td>Health and technology, eHealth evaluation</td>
</tr>
<tr>
<td></td>
<td>Della Mea (2001)</td>
<td>eHealth is a broad availability of medical information systems that can interconnect and communicate.</td>
<td>Technology</td>
</tr>
<tr>
<td></td>
<td>Boogerd et al. (2015)</td>
<td>No specific definition was proposed. A proposal was put forth to redefine eHealth.</td>
<td>No clear definition was arrived at</td>
</tr>
<tr>
<td></td>
<td>Shiferaw and Zolfo (2012)</td>
<td>eHealth is the application of Information Communication Technology in health.</td>
<td>Health</td>
</tr>
<tr>
<td></td>
<td>Bateman and Keef (2016)</td>
<td>“It is the delivery of health information, for both professionals and consumers, through the Internet and telecommunications. Secondly, it is the use of information technology (IT) and e-commerce to improve public health services, and e-business practices in health system management.”</td>
<td>Information technology, e-commerce</td>
</tr>
<tr>
<td></td>
<td>AbouZahr and Boerma (2005)</td>
<td>“Health Information System (HIS) integrated effort to collect, process, report and use health information and knowledge to influence policy-making, programme action and research.”</td>
<td>Health</td>
</tr>
<tr>
<td>Health Information Systems</td>
<td>Mbondji et al. (2014)</td>
<td>HIS takes data from multiple sources that help to measure and describe accurately the health of a society.</td>
<td>Health</td>
</tr>
<tr>
<td>(HIS)</td>
<td>Mutale et al. (2013)</td>
<td>“HIS are one of the six essential and interrelated building blocks of a health system that produce reliable and timely information on health determinants, health status and health system performance, and are capable of analysing this information to guide activities across all other health system building blocks.”</td>
<td>Health system</td>
</tr>
<tr>
<td></td>
<td>Mendoza et al. (2013)</td>
<td>“HIS is a system to gather, aggregate, analyse and synthesize data from multiple sources to report on health. This can include information related to patient records, disease surveillance, human resources, management of</td>
<td>Health system</td>
</tr>
<tr>
<td>Terminologies</td>
<td>Author(s)</td>
<td>Definition</td>
<td>Focus of Definition</td>
</tr>
<tr>
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<td>------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Mobile Health (mHealth)</td>
<td>Whittaker, Merry, Dorey, and Maddison (2012)</td>
<td>“Mobile health (mHealth) is defined as medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices.”</td>
<td>Health</td>
</tr>
<tr>
<td></td>
<td>Akter, D’Ambra, and Ray (2013)</td>
<td>mHealth implies the use of mobile communications such as personal digital assistants (PDAs) and mobile phones for health information services. A new paradigm of emerging information technology (IT), transforms healthcare delivery around the world by making it more accessible, affordable and available.</td>
<td>Technology</td>
</tr>
<tr>
<td></td>
<td>Chib (2013)</td>
<td>Mobile communication technologies that have revolutionized healthcare service delivery and improved beneficiary health.</td>
<td>Health</td>
</tr>
<tr>
<td></td>
<td>Estrin and Sim (2010)</td>
<td>“Mobile communication devices that work in conjunction with the Internet and social media, present opportunities to enhance disease prevention and management by extending health interventions beyond the reach of traditional care.”</td>
<td>Health and technology</td>
</tr>
<tr>
<td></td>
<td>Kumar et al. (2013)</td>
<td>mHealth is the application of wireless devices and sensors (including mobile phones) either by consumers or providers, for monitoring health status or improving health outcomes, including wireless diagnostic and clinical decision support.</td>
<td>Health and technology</td>
</tr>
<tr>
<td></td>
<td>Mendoza et al. (2013)</td>
<td>mHealth is the provision of health services and information via mobile and wireless technologies.</td>
<td>Health and technology</td>
</tr>
<tr>
<td>Telemecine</td>
<td>Waegemann (2010)</td>
<td>Connected health through the Internet and other communication patterns.</td>
<td>Technology</td>
</tr>
<tr>
<td></td>
<td>Mendoza et al. (2013)</td>
<td>Telemecine is the provision of healthcare services at a distance. It can be used for peer to peer professional communication, patient-physician communication and remote consultation</td>
<td>Health</td>
</tr>
<tr>
<td></td>
<td>Shiferaw and Zolfo (2012)</td>
<td>“Telemecine is the delivery of healthcare services, where distance is a critical factor by all healthcare professionals using information communication technology for the exchange of valid information for diagnosis, treatment and prevention of diseases and injuries, research and evaluation and for continuing education of healthcare providers all in the interest of advancing the health of individuals and communities.”</td>
<td>Health and technology</td>
</tr>
<tr>
<td></td>
<td>Gardiner and Hartzell (2012)</td>
<td>Telemecine is a rapidly expanding technology involving the exchange of medical information via electronic communications to assist diagnosis and treatment at a distance.</td>
<td>Technology</td>
</tr>
<tr>
<td>Terminologies</td>
<td>Author(s)</td>
<td>Definition</td>
<td>Focus of Definition</td>
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</tr>
<tr>
<td>Telemedicine</td>
<td>Kifle, Payton, Mbarika, and Meso (2010)</td>
<td>Telemedicine is most commonly defined as the use of information and communications technology (ICT) to deliver healthcare services at distance.</td>
<td>Technology and health</td>
</tr>
</tbody>
</table>
2.4.1 eHealth in Ghana

Ghana has made strides in applying eHealth to healthcare delivery. There are various reports of eHealth pilot interventions, particularly for telemedicine and mHealth (Grameen Foundation, 2015; GSMA, 2014; Novartis Foundation, undated). However, there is a dearth of peer-reviewed literature on these projects. A review by Afarikumah (2014) identified 22 eHealth projects at various levels of implementation in Ghana. Twelve of these were mHealth projects designed for teleconsultation, data collection and logistics and supply chain management. The Mobile Technology for Community Health (MOTECH) project, a successful pilot in the Kassena-Nankana District, has been introduced in six other districts in Ghana reaching 71,000 community members and 1,100 health staff (Grameen Foundation, 2015).

Another eHealth project that has proven successful is the telemedicine project which was implemented as part of the Millennium Villages Project (MVP) (Novartis Foundation, undated). This improved community’s access to healthcare and developed capacity of community health extension workers as human resource for eHealth in the country.

District health information reporting is also being facilitated by ICT. Health indicators from the sub-district and districts in Ghana are being reported through the introduction of the District Health Information Management System version 2 (DHIMS2). This was a collaboration with the University of Oslo to develop a Health Management Information System that would enable health data reporting and analysis of district-level aggregate data (Nyonator, Ofosu, & Osei, 2013). Similar to MOTECH and other eHealth projects in the country, there is very little peer-reviewed literature on DHIMS2. A few studies have focussed on the data quality issues such as accuracy and completeness of the data reported and benefits accrued from the implementation of the system (Adokiya, Awoonor-Williams, Barau, Beiersmann, & Mueller, 2013).
The implementation of these eHealth projects has been made possible through the enabling policy environment created by the Ministry of Health and Ghana Health Service. In 2005, the Health Sector ICT Policy and Strategy was launched as a roadmap to achieve the vision and goals of the Information Communication Technology for Accelerated Development (ICT4AD) policy (Ministry of Health, 2005). Subsequently, in 2010, a National eHealth Strategy was also launched to guide the use of ICT in bridging the human resource and infrastructure inequities in Ghana’s health sector (Ministry of Health, 2010). These express the need to improve data collection, especially at the community level, using relevant ICT tools. There is also the emergent need in these policies to introduce mHealth as a means of increasing access to healthcare delivery in remote communities.

2.5 MHEALTH IN DEVELOPING COUNTRIES

The review of mHealth literature in developing countries has been synthesised in Table 2.3. Each study has been described by its purpose or objective, the type of mHealth application used in the study, the country of implementation, impact of the intervention, challenges faced during the conduct of the intervention and recommendations made by the authors of the study. Each of these has been discussed in the subsections.

2.5.1 Overview of mHealth

This sub-section discusses mHealth studies that have been undertaken in developing countries. Mobile health is medical and public health supported by the use of mobile devices such as mobile phones, Personal Digital Assistants (PDAs) and other wireless devices to implement
interventions (World Health Organisation, 2011a). As can be seen in Table 2.3, mHealth has been applied to maternal care, treatment adherence, medical logistics and supply chain, health worker training and data collection (Lau et al., 2014; Madon et al., 2014; Otieno et al., 2014; Rajput et al., 2012; Tomlinson et al., 2009).

Due to the pervasiveness of mobile phones, a number of studies have tested and determined the feasibility of using them as tools to remind and educate health workers on guidelines and protocols for some diseases. Conditions such as malaria and HIV/AIDS have also been focal diseases for some mHealth studies. Since adherence to medication treatment guidelines is important for recovery, studies using mobile phones to remind and educate health workers would be useful especially for community-level healthcare. Zurovac et al. (2011), Otieno et al. (2014), Rajput et al. (2012) and Chang et al. (2011) focussed on health worker education in their studies.

Other studies have also considered the feasibility of mobile phones as data collection tools for health professionals and low-cadre health workers. Vélez et al. (2013) worked with rural midwives to develop a mHealth prototype, using user-centred design methods for patient care. Other studies also considered the feasibility of SMS for reporting routine and non-routine health information. Stanton et al. (2015) had community health volunteers (CHVs) and health surveillance assistants (HSA), use mobile phones to report cases of hydrocele and lymphoedema in communities in Ghana and Malawi. The CHVs and HSAs submitted reports successfully with minimal errors.

Different cadres of health workers have been engaged in mHealth studies with most being formal health workers with professional training (Rajput et al., 2012; Zurovac et al., 2011).
They are usually highly educated so the level of literacy does not become a barrier to the success of these studies. However, a few studies also engaged non-professionally trained health workers such as community health volunteers. They play a mediating role between the health system and their communities, providing maternal and child health services, mass drug distribution, health promotion activities and others (Alam et al., 2012; Gallo et al., 2013). They usually have varied levels of literacy with most having a minimum of primary school education (Acharya et al., 2016). Madon et al. (2014) engaged VHWs to collect data during the annual NTD MDA in Tanzania while Stanton et al. (2015) also worked with CHVs to submit data on lymphoedema and hydrocele cases from the community. In other studies, both formal and non-formal health workers were compared. Perosky et al. (2015) engaged certified midwives and traditional midwives to collect data on pregnancies in rural Liberia. There were differences in data submitted by the two groups, with formally trained highly literate health workers producing better output. Since these volunteer health workers generate the data at the community level, most studies look to them as the key actors in improving data capture at the community level with mHealth tools.

The literature reviewed showed that most mHealth studies were pilot studies or proof of concepts. No literature was found on scale-up activities of these interventions. This challenge of scale-up and sustainability has been a key issue for mHealth’s progress despite the promise (Chib et al., 2014). Mecheal et al. (2010) have indicated that well-informed policies and strategies need to be developed to enable both public and private health and IT stakeholders to drive scale and sustainability of mHealth projects. They postulated that governments should ensure mHealth is an integral part of the national eHealth framework thus ensuring it integrates well with a health system. The evidence provided on mHealth’s prospects has shown it as a
potential tool for health system strengthening (Labrique, Vasudevan, Kochi, Fabricant, & Mehl, 2013).
<table>
<thead>
<tr>
<th>Author</th>
<th>Purpose of Study</th>
<th>mHealth Application</th>
<th>Country</th>
<th>Impact of mHealth</th>
<th>Challenges Faced</th>
<th>Recommendations for Future Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomlinson et al. (2009)</td>
<td>To determine the feasibility, extent and ease of implementation of training community health workers to use mobile phones as data collection device.</td>
<td>Mobile phone and Application</td>
<td>South Africa</td>
<td>Real-time quality control and data collector supervision are possible with mobile devices.</td>
<td>One instance of data fabrication by one data collector.</td>
<td>Suggest controlled-trials to assess future studies, studies on quality of data submitted using mHealth tools.</td>
</tr>
<tr>
<td>Zurovac et al. (2011)</td>
<td>To test whether text-message reminders sent to health workers’ mobile phones could improve and maintain health-workers’ adherence to national guidelines for the management of outpatient paediatric malaria with the recommended Artemisinin-based combination treatment in Kenya.</td>
<td>SMS</td>
<td>Kenya</td>
<td>There was an improvement in health workers’ adherence to national guidelines for the management of outpatient paediatric malaria.</td>
<td>None stated.</td>
<td>A qualitative study to understand the effect of the high dose of SMS during the 6-month trial. Need to understand reasons that affected health workers behaviour.</td>
</tr>
<tr>
<td>Vélez et al. (2013)</td>
<td>To determine the usability and applicability of a mHealth application for midwives.</td>
<td>mClinic, Open Data Kit (ODK) Collect, smartphone</td>
<td>Ghana</td>
<td>Provided background to cultural and organisational factors to consider when deploying mClinic in other settings.</td>
<td>The small form factor of phones was a challenge.</td>
<td>A larger study with non-MVP midwives will have to be conducted to assess the perceived usefulness of the application.</td>
</tr>
<tr>
<td>Stanton et al. (2015)</td>
<td>To test an SMS tool for reporting cases of lymphoedema and hydrocele by community-based health workers.</td>
<td>SMS</td>
<td>Ghana and Malawi</td>
<td>The community health workers successfully reported morbidity cases in their communities by SMS.</td>
<td>Data entry errors, poor network quality.</td>
<td></td>
</tr>
<tr>
<td>Perosky et al. (2015)</td>
<td>To assess the feasibility of implementing SMS reporting by literate and non-literate midwives.</td>
<td>SMS</td>
<td>Liberia</td>
<td>Literate midwives had a better SMS success sending rate than the non-literate and low literate participants.</td>
<td>Poor network quality.</td>
<td>Similar experiments with other cadres of none or low-literate health workers.</td>
</tr>
<tr>
<td>Author</td>
<td>Purpose of Study</td>
<td>mHealth Application</td>
<td>Country</td>
<td>Impact of mHealth</td>
<td>Challenges Faced</td>
<td>Recommendations for Future Study</td>
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</tr>
<tr>
<td>Otieno et al. (2014)</td>
<td>To assess the feasibility, use and acceptability of mobile phone text-messaging to improve treatment adherence and post-treatment review of children with uncomplicated malaria.</td>
<td>SMS</td>
<td>Kenya</td>
<td>Favourable conditions for the use of mHealth were found in this study; being high mobile phone ownership and access, good network quality and high literacy in at least one of three common languages.</td>
<td>None stated.</td>
<td>Measuring literacy as a factor in determining participants’ ability to send SMS for data collection.</td>
</tr>
<tr>
<td>Madon et al. (2014)</td>
<td>To test the feasibility of using village health workers (VHW) to collect data with mobile phones.</td>
<td>Smartphones</td>
<td>Tanzania</td>
<td>Enabled conceptual clarity on social processes that are associated with the deployment of mobile phones for data collection in the NTD setting.</td>
<td>Poor network quality, damaged smartphones, digital divides between VHWs and village leaders and other VHWs who were unable to adapt to the mobile phones.</td>
<td>Studies on providing feedback on data collected to VHWs for local health activities. Impact evaluation on the NTD mobile MIS. A quantitative study in another region of the country to determine generalisability of results attained in this study.</td>
</tr>
<tr>
<td>Chang et al. (2011)</td>
<td>To assess the impact of mHealth intervention for Peer Health Workers (PHW) to support AIDS care.</td>
<td>Voice calls, SMS</td>
<td>Uganda</td>
<td>Improved communication between patients and PHW and between PHW and health staff.</td>
<td>Charging of mobile phones, patient access to phones and privacy concerns. Lack of phone ownership. Theft of phones.</td>
<td>Further studies on mHealth studies towards patient-centred outcomes. Conduct similar studies with a larger sample size so quantitative effects can be identified.</td>
</tr>
<tr>
<td>Crawford et al. (2014)</td>
<td>To determine the user experience and acceptability of SMS and voice messaging and</td>
<td>Voice messaging, SMS</td>
<td>Malawi</td>
<td>SMS and voice messages can be used to send health promotion messages to pregnant women and</td>
<td>Configuration challenges, some participant moved away from their villages, phones given to participants and community</td>
<td>Investigation of models to increase access to phones by rural low-literate populations.</td>
</tr>
<tr>
<td>Author</td>
<td>Purpose of Study</td>
<td>mHealth Application</td>
<td>Country</td>
<td>Impact of mHealth</td>
<td>Challenges Faced</td>
<td>Recommendations for Future Study</td>
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<tr>
<td>Rajput et al. (2012)</td>
<td>To develop a mobile device-based tool to aid community health workers in screening the population for HIV and other health risks in their homes.</td>
<td>Open Data Kit (ODK) Collect, Smartphone</td>
<td>Kenya</td>
<td>Users with little or no experience with computers can be trained to use this tool to provide clinical care. There were cost savings from using paper forms.</td>
<td>Difficulty with acquiring GPS coordinates, lighting, ease of navigation and battery life in areas of weak cellular network signal.</td>
<td>Economic evaluation of the study is needed. Examination of how the health information has impacted health outcomes for participants. Develop and test tools on treatment-adherence for HIV infected patients who are lost to follow-up care.</td>
</tr>
<tr>
<td>Lau et al. (2014)</td>
<td>To evaluate whether antenatal information delivered through SMS would increase health knowledge among pregnant women.</td>
<td>SMS</td>
<td>South Africa</td>
<td>No difference in knowledge between the control and the intervention group at the exit of the study. The experimental group indicated SMS as their main source of knowledge. Focus group discussions also showed positive impact and actual benefits experienced by participants.</td>
<td>Substantial loss to follow up. Some SMS were undelivered. Phone sharing within households may also have prevented participants from seeing SMS.</td>
<td>Follow-up study to determine if self-reported behaviour change has been sustained. The possibility of conducting a similar study in a rural area among a population that is not well exposed to antenatal information.</td>
</tr>
</tbody>
</table>
2.5.2 Applications of mHealth in Developing countries

Mobile health applications used are mainly voice, text messages (SMS) and data access which are unidirectional, bidirectional or omnidirectional (Kallander et al., 2013). Text messaging or SMS appears to be the most predominant mHealth application reported in literature (Kallander et al., 2013). This is mostly because every mobile phone has text messaging capability and this makes it a relatively cheap tool for data collection or disseminating health information. Text messages have been used to send reminders for medication adherence as done by Otieno et al. (2014) in Kenya. They sent text messaging reminders to caregivers to maintain treatment adherence and post-treatment follow-up for children with uncomplicated malaria. Similarly, Zurovac et al. (2011) sent text messages to health workers, reminding them about treatment guidelines for artemisinin-based therapies in Kenya. This also proved successful in increasing adherence. Text messages for data collection had to be formatted in specific ways to ensure the receiving server could translate the data submitted. This was the case in the Stanton et al. (2015) study which used MeasureSMS and the Perosky et al. (2015) study which used FrontlineSMS. Both platforms offered an intermediary service of receiving the SMS into a centralised database with a Web service so data can be viewed in real time.

Other studies also used mobile applications that run mostly on Android platforms. Android is an open source operating system made for mobile devices (Rajput et al., 2012). The type of data being collected or the purpose of the study sometimes determined the choice of using the relatively cheaper SMS or developing applications. The choice also had an impact on the cost of handsets, since applications tend to run on feature phones with Java or smartphones. Community health workers in the Tomlinson et al. (2009) study used entry level phones that were enabled for Java programming language for household data collection. Vélez et al. (2013) and Madon et al. (2014) used applications installed on smartphones. These studies had to
collect individual-level data on a great number of persons, and SMS would not have been the best application for such data collection. Applications have friendly user interfaces that allow the use of drop-down menus, data selection and checkboxes. These features make data entry relatively easier.

A relatively less used application in mHealth is voice messaging or voice calls. These applications have been found to be preferred by low literate or illiterate health workers who are mostly volunteers. Peer health workers preferred making voice calls to health workers for information than text messaging (Chang et al., 2011). Less literate or illiterate participants also had a preference for voice messages over SMS (Crawford et al., 2014). However, there was a lower preference for retrieved voice messages since participants had to actively make the effort to receive the messages.

For mHealth to scale-up, it has been suggested that it should be used in conjunction with other platforms to ensure maximum gains are made (Chib, 2013). As part of the Millennium Villages Project (MVP) in Ghana, Vélez et al. (2013) worked with midwives to develop a prototype that connects to the MVP Network. The mClinic as it was called, was meant to aid midwives, collect data about patients and patient encounters as well as generate reports on individual patients and aggregate monthly reports. mClinic was designed to work in conjunction with OpenMRS, an electronic health record system. In the same way, Rajput et al. (2012) developed a tool using the ODK Collect platform on an Android-based smartphone for home-based clinical care. This was also used in conjunction with an EHR to create a complete patient record. It is recognised that literacy played a role in determining the success or not of such applications for mHealth. The above discussion points to the fact that the type of application used has an impact on the mHealth project. It also indicates that the target users and their literacy levels have to be
considered before an application is chosen. This would help ensure acceptability of the application and therefore, potential success of the project. It is important to consider the task at hand as this can also be a determinant of the type of application used. This study had to take cognizance of these issues when a choice of application was needed to suit the target population, the task to be performed and the setting of the study.

2.5.3 Impact of mHealth in Developing Countries

One of the many demonstrated benefits of mHealth is timely data reporting as summarised in Table 2.3. This was demonstrated by Tomlinson et al. (2009) when mobile phones were used to conduct a survey of 39,665 households. A similar survey conducted with paper forms would have required data entry at a later date into an electronic system which would have caused the need for more resources for data entry. Madon et al. (2014) also used mHealth to demonstrate timely data reporting for the NTD MDA. Treatment coverage reports were received in real time as opposed to reports reaching the programme office about two to three months after drug distribution.

Closely tied to the timeliness of data is the accuracy of data reported. The lack of accurate data on pregnancies from the rural areas of Liberia was hampering decision-making by the Ministry of Health (Perosky et al., 2015). The study identified the certified midwives as being best capable of providing this data instead of traditional midwives who were less literate. The midwives successfully reported pregnancies from the rural areas over a one year period with very few errors. Most studies focusing on mHealth for data collection rarely consider the accuracy of data collected, rather focusing on benefits of using mHealth. The need for data quality assessments of data submitted by SMS is therefore necessary (Perosky et al., 2015).
Mobile health has also been shown to be a great learning tool when used for health promotion. Study participants who received antenatal information deemed it the best source of information that helped them learn about pregnancy management as opposed to information from family, friends or health promoters (Lau et al., 2014). Caregivers and mothers of children with uncomplicated malaria in Otieno et al. (2014) also appreciated receiving reminders and information about artemisinin-based therapies.

Chang et al. (2011) also found mHealth to be a good tool that removed communication barriers between peer health workers (PHW) and HIV patients and between the PHW and health staff. The patients had peer support in adhering to ARTs and when they weren’t feeling well. PHWs were also able to call health staff for further instructions and advice on handling patients when those cases were beyond their capabilities. This communication gap was also bridged in the study by Madon et al. (2014). VHWs could easily communicate with their district level supervisors if they had problems or drug stock-outs. Previously, this would have to be communicated by physically sending someone with a letter to the official.

Community health workers have always been considered important in developing countries for bridging the gap between the community and the health system (Abbey et al., 2014). Their roles as insecticide-treated net (ITN) distributors, drug distributors for MDAs and vaccinations can be enhanced if equipped with mHealth tools for data collection. This expands their role to being data producers and users. Stanton et al. (2015) engaged salaried health surveillance assistants (HSAs) in Malawi and community health volunteers (CHVs) in Ghana to identify and report cases of LF lymphoedema and hydrocele. This was beyond their regular assignment of distributing the LF prophylactic drugs. Through this study, these workers were able to report a lot more hydrocele cases, than had been identified during the annual MDA.
The real-time data delivery also helped in the supervision of data collectors or the frontline workers. In the Madon et al. (2014) study, one district-level supervisor commented that it helped them identify which VHW was working well and who wasn’t. Tomlinson et al. (2009) were also able to quickly identify a case of data fabrication by a data collector. The time gaps between data submissions by this person was less than what had been simulated. This also made it possible to check the data quality in real-time and make corrections quickly to prevent further issues from cropping up.

Various impacts of mHealth have been identified in the studies such as improved supervision of field staff, timeliness of data reporting, improved accuracy and improved communication among the users and health staff. On the other hand, the study participants also found mHealth as useful learning tools. These documented impacts are expected outcomes that can be anticipated from this study. It is possible that seeing mHealth as a learning tool could make it acceptable to study participants in this study. The current study is also considering timeliness and accuracy of data reporting as important outcomes. The methods by which the reviewed studies achieved these outcomes were adopted for this study.

2.5.4 Challenges of mHealth in Developing Countries

As shown in Table 2.3, a number of challenges were identified that appeared to be a common trend in mHealth studies. Researchers found some data entry errors on examination of data submitted by their study participants. This was found by Stanton et al. (2015) and the Perosky et al. (2015). Both studies used SMS as the medium for data capture and communication. The format of SMS data is usually dependent on how the receiving server has been programmed to receive data. Data entry errors are usually only noticed when it’s been received on the server.
These errors usually tend to be formatting errors where the data might be less or more than the required characters, or placement of variables are exchanged thus changing the meaning of the data transmitted. Though SMS data reporting is usually structured, this is controlled by the study participants. There is usually no validation during the data entry process and this results in most errors.

The ubiquitous nature of mobile phones has made them sought-after tools in developing countries. However, poor network signals have been the bane of a number of mHealth studies conducted in the rural areas. The poor network signals may not be able to support health management information systems. This means data packets can be dropped in transmission or data submitters would have to wait till signals with reasonable strength are received before attempting a submission. These challenges were all identified in the Madon et al. (2014), Stanton et al. (2015) and Perosky et al. (2015) studies. These issues tend to occur in the rural areas where telecommunication masts are few.

Maintenance issues such as damaged phones and keeping phones charged were highlighted in a number of studies as well. Reasons for the damage were not outlined but in such cases, new phones would have to be given to study participants or repaired. This tends to become an added cost which may undermine the project and future scale-up plans (Madon et al., 2014). About 60% of phones given to community volunteers were damaged by the end of a two-year study, while others had malfunctioning keypads (Crawford et al., 2014). In the Chang et al. (2011) study, the peer health workers had to replace stolen phones themselves. Keeping phones charged was also important in ensuring continuity of projects. Some study sites may not have electricity so new ways would usually have to be devised such as charging with car batteries.
or engaging phone charging shops to ensure project success is not undermined (Chang et al., 2011).

It has also been noted that the size of the phone, its screen size and keyboard are challenges for some study participants. The small form factor of phones used in the MVP project in Ghana affected data entry by the midwives (Vélez et al., 2013). They complained that the size of the phone made it difficult to press the right buttons, read the keypad and select numbers using the function keys. This study used both a QWERTY phone and touchscreen phone and midwives had better ease of use with the touchscreen phones.

Study participant literacy is also a challenge for mHealth projects. The learning curve was quite steep for study participants with no or low-literacy skills. Most studies usually use level of education as a measure of literacy but as was identified by Perosky et al. (2015), literacy will have to be a determining factor in a person’s ability of to engage mHealth. Other studies also identified that low-literate persons preferred pushed voice messages as opposed to SMS for receiving health messages (Crawford et al., 2014).

Challenges to mHealth identified are participant’s poor literacy, small form factor of some phones, poor network signals, maintenance of handsets and data entry errors. These challenges would have to be considered in the light of the current study. The study will be conducted in rural areas that could have similar network connectivity challenges. Again, literacy of study participants is not well known even though CHVs are expected to read and write. Data entry errors because of the small form factor of the phones used or the use of SMS could also be potential challenges that would have to be addressed.
2.5.5 mHealth in NTD Programmes

Mobile phones have been touted to improve the quality of health information and effectiveness of health workers (Braun et al., 2013). There appears to have been little engagement with mHealth to test its publicised benefits on NTD programmes. However, a few studies have shown benefits to programmes. Madon et al. (2014) conducted a study to assess the extent to which mobile phones could be leveraged to support the NTD programme in Tanzania. Village health workers (VHW) were given mobile phones to use in place of manual registers for their drug distribution. VHWs indicated the use of mobile phones boosted their morale and improved efficiency of their work.

Another data collection platform, that has been engaged in efficient data capture and transmission in NTD programmes is the LINKS (Pavluck, Chu, Mann Flueckiger, & Ottesen, 2014). This is an Android application that works on Android-based smartphones. It has been deployed in over 20 countries by a number of partner organisations. Daily data error rates were found to be low (0.14%) and results of data collection were received earlier. However, implementation challenges of network connectivity in remote areas were experienced as with most mHealth solutions.

Similar to Madon et al. (2014), Stanton et al. (2015) tested a tool for reporting cases of LF morbidity in communities. However, SMS was used in this study instead of an application. In this study, salaried health surveillance assistants (HSAs) (Malawi) and CHVs (Ghana) were asked to find and report cases of hydrocele and lymphoedema in their communities. The SMS tool was well received and used effectively by the HSAs and CHVs. Most HSAs (93%) and CHVs (88%) owned mobile phones. Though all HSAs had experience sending SMS, only 44%
of CHVs had ever sent an SMS. However, ability to submit SMS, improved by the end of the data collection in the communities.

From the above, it can be seen that there are very few studies that have leveraged mHealth in NTD programmes. The Madon et al. (2014) and Stanton et al. (2015) studies appeared to be proof of concept studies. The LINKS tool in Pavluck et al. (2014), on the other hand, has been scaled and used in other NTD mapping projects in Ethiopia and other countries (Rebollo et al., 2015; Sime et al., 2014). This study, while hoping to prove a concept, will be conducted through the lens of implementation research and will hopefully provide evidence for the feasibility of mHealth for the setting of the study. Again, while study participants were provided with smartphones in the Madon et al. (2014) study, this may be expensive for NTD programmes that usually have thousands of CHVs collecting data during MDAs. This study will thus be exploring cheaper options that will be financially feasible for NTD programmes.

2.6 MHEALTH IN GHANA

A few studies and reports on mHealth have been reported in Ghana (Grameen Foundation, 2015; Ofosu & Nyonator, 2011; Vélez et al., 2013). They vary in context; from maternal and child health, Neglected Tropical Diseases and adolescent health. Afarikumah (2014) identified twelve (12) mHealth projects in Ghana, most of which are pilots and proof of concept projects. Atweam (2014) stated in a report that there were about 40 mHealth projects ongoing in the country. However, very little literature has been published on these projects in peer-reviewed or grey literature. Some peer-reviewed articles have been synthesised in Table 2.4 and reviewed.
One mHealth project that has garnered a lot of attention in Ghana’s health industry is the Mobile Technology for Community Health (MOTECH). This project began in the Kassena-Nankana district in the Upper East Region of Ghana in 2009-2010 (Grameen Foundation, 2015). The aim of the project was to improve the quality of maternal and child health care with the aid of mobile phones and reduce improve on documentation and reporting associated with such care by health workers (Stone, Schmitt, Awoonor-Williams, Phillips, & Yeji, 2011). The number of pilot districts were increased to seven by the end of the project and number of peer-reviewed articles have been published on various aspects of the project (Entsieh, Emmelin, & Pettersson, 2015; Grameen Foundation, 2015; Mechael, 2009; Rothstein et al., 2016; Stone et al., 2011; Vélez et al., 2013).

Literature on mHealth projects in Ghana showed the use of various applications. The MOTECH platform was developed with a demand side that utilised voice messages for pregnant and nursing mothers and a client data side application used by health workers (Entsieh et al., 2015; Rothstein et al., 2016). Automated voice messages were sent to the clients based on the stage of pregnancy, and postpartum for the care of newborns. The client data application was used by community health nurses to enter, summarise and query client data. Ginsburg et al. (2016) assessed the feasibility, acceptability and usability of mPneumonia, an application that integrates WHO’s integrated management of childhood illness protocols with a software breathe counter and a pulse oximeter to detect pneumonia among children. Mobile phone application was also used with ultrasound machines to follow-up pregnant women in rural communities and in some cases taking ultrasound images for interpretation by gynaecologists. Voice calls are also useful applications for undertaking mHealth projects. Kukula et al. (2015) followed up patients to assess adverse events associated with antimalarials. Voice calls through a closed user group (CUG) was also created to enable communication between health workers.
at a telemedicine site (Kaonga et al., 2013). Text messages have also been used to test the use of reminders for patients to improve ACT treatment adherence.

These studies showed some positive impacts and appeared to hold promise if efforts of scaling up were achieved. Communication among health workers was shown to improve and they indicated how well using the CUG helped improve their caregiving efforts (Kaonga et al., 2013). The workers were relieved of using personal airtime credit to consult with peers and superiors and also reduced transportation costs. Rothstein et al. (2016) reported that Client Data Kit in MOTECH improved client follow-up and automated monthly reports for CHNs. Mobile Midwife components of MOTECH also improved pregnancy and child health knowledge among pregnant and nursing mothers (Entsieh et al., 2015). Technology is also expected to improve care in clinical settings. This was shown through the use of mPneumonia application that helped improve clinical diagnosis of pneumonia among children (Ginsburg et al., 2016).

A number of challenges were also identified in these studies that would have to be addressed for the successful rollout of these mHealth tools in non-project settings. Age appeared to have an effect on CHWs understanding of the use of the mHealth application in Amoah, Anto, Osei, Pieterson, and Crimi (2016). Their understanding improved over time, albeit slower than the younger CHWs. Coupled with age as a challenge to mHealth, low mobile phone literacy may have impacted the effectiveness of text messaging programme to improve medication adherence (Raifman, Lanthorn, Rokicki, & Fink, 2014). There were also challenges with lack or inadequate electricity to charge tablets for the mPneumonia app. Staff had to travel distances of about 15km to charge the devices (Ginsburg et al., 2016). Healthcare providers in this study indicated that the app would increase their workload because the steps for using the app were more than the standard practice. Poor network connectivity is a well-known challenge with
most mHealth projects in developing countries. Both Kaonga et al. (2013) and Rothstein et al. (2016) reported poor connectivity in the rural communities and districts where the tools were deployed. While network connectivity is widespread in Ghana, some rural communities still have poor and intermittent connections which could be a major hindrance to mHealth projects. A local telecommunication company provided network services for the Millennium Villages Project (MVP) but this appeared to be inadequate in some instances.

Rothstein et al. (2016) detailed challenges associated with CHN attrition which led to frequent retraining for new staff and the small form factor of the mobile phones used for the project. These concerns raise issues regarding how mHealth projects can be fully integrated into the local health system. A number of factors could lead to health staff attrition and the effect on mHealth projects could lead to increased costs due to lag time for new staff to acquire knowledge and use these tools effectively for caregiving, and time spent during training instead of attending to patients. Future studies on how this integration would be done and what factors to consider in implementing mHealth fully within specific health programmes or for general healthcare delivery would have to be investigated. It may necessitate changes in human resource training and allocation especially in situations where the tools were found to increase workload in spite of their usefulness.

This section on mHealth projects in Ghana has highlighted the key objectives, mobile phone applications used, the impact of these studies, challenges encountered and directions for future research suggested in the articles. It has been shown that a variety of applications have been used to conduct healthcare delivery activities. Each of the tools had their nuances and had effect participants reacted to. Though all tools had positive impacts, a number of challenges were identified that would have to be addressed in future studies. Challenges of network connectivity, age of health workers, literacy and other technology and human resource
allocation challenges pertinent to Ghana’s health system would have to be addressed in future studies to ensure successful mHealth deployment.
<table>
<thead>
<tr>
<th>Author</th>
<th>Purpose of Study</th>
<th>mHealth Application</th>
<th>Impact of mHealth</th>
<th>Challenges Faced</th>
<th>Recommendations for Future Study</th>
</tr>
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<tbody>
<tr>
<td>Entsieh et al. (2015)</td>
<td>To investigate the role that Mobile Midwife played in the lives of pregnant and nursing mothers in Awutu Senya district of Ghana</td>
<td>MOTECH: Voice SMS</td>
<td>Mobile Midwife appeared to help improve pregnant and nursing mothers knowledge and perception of pregnancy and childcare</td>
<td>A high number of participants engaged for an FGD posed a challenge in encouraging participation.</td>
<td>Studies to help identify challenges that are posed by the integration of such tools in health systems of low-income countries.</td>
</tr>
<tr>
<td>Kukula et al. (2015)</td>
<td>To assess the feasibility and cost of using mobile phones instead of traditional home visits for client follow-up on adverse events associated with the use of anti-malarial for uncomplicated malaria in peri-urban settings.</td>
<td>Telephone voice calls</td>
<td>Mobile phones were successfully used to follow-up clients. More adverse events were reported via telephone calls compared to those reported during home visits. Telephone monitoring costs were less compared to home visits.</td>
<td>Home visits had to be conducted on some study participants who could not be reached by phone after 3 attempts.</td>
<td>None stated</td>
</tr>
<tr>
<td>Amoah et al. (2016)</td>
<td>To increase ANC visits, reduce home deliveries, and supplement care using low-cost mobile phones and portable ultrasound scan machines.</td>
<td>Mobile application and portable ultrasound machine</td>
<td>Increase in ANC attendance, the convenience of having an ultrasound taken in the community. Early detection and reporting of pregnancy-related adverse events.</td>
<td>Age of community health workers appeared to affect the level of understanding of the use of the mobile phone application.</td>
<td>Cost-benefit analysis of such an intervention in the health system</td>
</tr>
<tr>
<td>Ginsburg et al. (2016)</td>
<td>To understand the feasibility, acceptability and usability of mPneumonia in primary health care facilities.</td>
<td>Application on tablet plus pulse oximeter</td>
<td>Improved accuracy of diagnosis. Improved caregiver health-seeking behaviour.</td>
<td>Lack and inadequate access to electricity to charge tablets. Use of application took time.</td>
<td>Further lessons on using mHealth for Integrated Management of Childhood Illness.</td>
</tr>
<tr>
<td>Author</td>
<td>Purpose of Study</td>
<td>mHealth Application</td>
<td>Impact of mHealth</td>
<td>Challenges Faced</td>
<td>Recommendations for Future Study</td>
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<tr>
<td>Raifman et al. (2014)</td>
<td>A randomised trial to assess the impact of text message reminders on ACT treatment completion</td>
<td>Text message reminder</td>
<td>Simple text message reminder may increase adherence to antimalarial medication.</td>
<td>Limited mobile phone literacy. Study participants were self-selected and results may not show adherence in the regular population.</td>
<td>To determine the effective content of text message reminders for medication adherence. To determine the mechanism that impact of text message reminders on different subgroups.</td>
</tr>
<tr>
<td>Kaonga et al. (2013)</td>
<td>To use social network analysis to assess the flow of communication among the Millennium Villages Project (MVP) health team</td>
<td>Voice calls within a closed user group (CUG)</td>
<td>Improved communication efficiency among health team. Ability to consult with colleagues or superiors on cases. Avoiding unnecessary transportation costs.</td>
<td>Blocked SIMs, poor connectivity, other persons not being on the CUG. Most calls were for personal rather than professional purposes.</td>
<td>The use of a control group or prior communication flow assessment between the group members prior to the use of the CUG to determine the impact of CUG on health worker communication.</td>
</tr>
<tr>
<td>Rothstein et al. (2016)</td>
<td>To evaluate feasibility, usability and acceptability of the Client Data Application that was part of MOTECH program to support frontline health workers in the delivery of maternal, neonatal, and child care in rural Ghana</td>
<td>MOTECH: Application</td>
<td>Automated monthly reporting was important. Efficiency in client follow-up</td>
<td>Poor network connectivity, small phone form factor. CHN attrition led to frequent retraining. Challenges with workload.</td>
<td>Research on mHealth innovations to address challenges related to infrastructure, human resources and technology before and during program deployment.</td>
</tr>
</tbody>
</table>
2.7 ICT KNOWLEDGE AND USE AMONG HEALTH WORKERS

Health workers have been known to be slow adopters of ICT (Gagnon et al., 2012). A study in Ethiopia found low knowledge and utilisation of ICT among health professionals there. Factors such as own computer possession, training, marital status, average monthly income, job satisfaction and age were statistically significantly associated with computer knowledge (Mohammed, Andargie, Meseret, & Girma, 2013). Nilseng et al. (2014) also found some level of computer experience among rural health staff in Tanzania. These health workers also had a desire to improve their knowledge through continuing medical education (CME). Mobile phones were the most used ICT tool among them. Generally, studies have shown low ICT knowledge among health staff in most developing countries (Bello et al., 2004; Gour & Srivastava, 2010; Shiferaw & Zolfo, 2012; Sukums et al., 2014). This has been attributed to low computer possession and lack or inadequate training in ICT in health training schools (Adeleke et al., 2015). However, as expected, the younger staff have adequate knowledge. In spite of the generally poor knowledge, studies have shown that they have a good attitude towards the use of ICT for healthcare delivery and expect it to be the panacea for improved healthcare delivery (Nilseng et al., 2014; Sukums et al., 2014).

There is a wide digital divide between developing and developed countries (Chinn & Fairlie, 2010). This is well reflected in the low use of ICT in health facilities in developing countries and low health worker personal usage of ICT (Bello et al., 2004; Sukums et al., 2014). Unlike a number of studies in African countries, health workers at National Hospital in Abuja exhibited high computer usage (95%) and high internet use (94%) (Adeleke et al., 2015). A study among health workers in Kenya found 100% mobile phone ownership and 99% SMS use just as the Nilseng et al. (2014) study in Tanzania (Zurovac et al., 2013).
2.8 THEORETICAL FOUNDATIONS

This section discusses the theoretical foundations of this study. The technology acceptance models are discussed with emphasis on the Unified Theory of Acceptance and Use of Technology (UTAUT). There is also a discussion that brings together the various perspectives that were necessary for creating the conceptual framework to explain the feasibility of CHV’s using mobile phones for MDA reporting.

2.8.1 Technology Acceptance Models

Information systems are expected to help organisations improve performance but the expected efficiency does not occur when users reject the new systems (Davis, 1993). Technology acceptance is a well-researched area in information systems (IS) and has been studied across many domains. They are important in the Management Information Systems field for explaining and predicting system use by vendors or information system managers (Davis, 1989). One of the most validated models for predicting technology acceptance is Davis’ Technology Acceptance Model (TAM) (Chuttur, 2009). This was developed based on the Theory of Reasoned Action (TRA) which considers the antecedents for consciously intended behaviour (Davis, Bagozzi, & Warshaw, 1989). The TRA, theorised by Ajzen and Fishbein (1980), has been used to forecast and explain human behaviour in various fields. The basis of this theory is that an individual’s intention to engage in specific behaviour is dependent on their positive or negative attitudes towards the behaviour and subjective norms (SN) which indicates the extent of external influence to perform the behaviour. The TRA is a general predictor of various user behaviours. However, TAM was specifically developed for computer technology acceptance. A number of external variables were identified from prior research to deal with the cognitive and affective determinants of computer acceptance using TRA as the basis (Davis et al., 1989). The decision to use or not use a system, according to TAM, is one’s perception of
its usefulness and its ease of use for the specific task (Davis, 1989). These were perceived ease of use (PEOU) and perceived usefulness (PU). PEOU is the degree to which a user may weigh the effort needed to accomplish a task by the benefits of its application (Davis, 1989). Perceived usefulness, on the other hand, is the degree of a user’s perception of the usefulness of the application for the task at hand (Davis, 1989). PEOU is also expected to have an effect on PU. As shown in Figure 2.1, PEOU and PU are necessary predictors of attitude which in turn become predictors for the user’s Behavioural intention (BI) and actual use of the technology in question.

![Technology Acceptance Model](image)

Figure 2.1- Technology Acceptance Model (Davis, 1989)

TAM has received considerable empirical support and criticisms and was noted that PU consistently proved a strong determinant of user’s behavioural intentions (Venkatesh & Davis, 2000). However, the antecedents that make PU strong were not well understood. It also failed to take cognizance of other external factors such as subjective norms (Heart & Kalderon, 2013). The criticisms led Venkatesh and Davis (2000) to extend TAM to include the core drivers of PU and to gain insight into how their effect changes over time. The new model TAM2 fits in theoretical constructs of social influence (image, voluntariness and subjective norm) and cognitive instrumental processes (job relevance, output quality, result demonstrability and PEOU).
Further research has resulted in a multitude of models on user acceptance of technology. One such model sought to unify eight prominent models into one, calling it the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003). This model combined the TRA, TAM, TAM2, Theory of Planned Behaviour (TPB), Combined TAM-TPB (C-TAM-TPB), Motivational Model (MM), Model of PC Utilisation (MPCU) and the Innovation Diffusion Theory (IDT) (Ajzen, 1991; Ajzen & Fishbein, 1980; Compeau & Higgins, 1995; Davis, 1989; Moore & Benbasat, 1991; Taylor & Todd, 1995a; Thompson, Higgins, & Howell, 1991; Vallerand, 1997; Venkatesh & Davis, 2000). In framing this model, new data was analysed using all the eight models of technology acceptance individually. Scales from the eight models were also adapted for the new model to aid in validating the data. Results showed that the UTAUT outperformed all eight models by explaining as much as 70 percent of the variance in intention to use the technology. Seven constructs were adopted from the eight models and four were found to play significant roles as direct determinants of user acceptance and behaviour. These four were performance expectancy, effort expectancy, facilitating conditions and social influence. The four moderators; age, gender, experience and voluntariness were found to have varied influence on each of the constructs.

Performance expectancy was the strongest predictor of user’s intention to use, among all the four constructs. This was expected to be greatly influenced by age and gender; particularly for men and younger men. Performance expectancy is defined as “the degree to which an individual believes that using the system will help them attain gains in job performance”. The Effort expectancy construct was also found to be strong but had decreasing strength over time. This was defined as “the degree of ease associated with the use of the system”. Effort expectancy was found to be moderated by age, gender and experience. Social influence deals with “the degree to which the user believes important others believe he or she should use the
system”. This was said to be influenced by voluntariness of the task. Voluntary tasks were found to be less strong than uses that were mandatory.

2.8.2 Technology acceptance in healthcare settings

Health technology acceptance has been assessed using theoretical models such as TAM and UTAUT by determining or predicting health professionals’ behaviour toward a new technology for specific tasks (Day, Demiris, Oliver, Courtney, & Hensel, 2007; Dünnebeil, Sunyaev, Blohm, Leimeister, & Krcmar, 2012; Joo & Sang, 2013). In healthcare, a lot of these studies have focused on acceptance of EHRs or eHealth in general. Dünnebeil et al. (2012) conducted a study in Germany among physicians to determine their readiness to adopt eHealth in ambulatory care. There was resistance to the acceptance of eHealth projects among physicians and this study sought to identify issues affecting acceptance. Their results showed PEOU and PU were strong determinants of intentions to use eHealth. Other moderators adopted for their specific study such as the importance of standardisation, documentation, eHealth knowledge, data security, process orientation and IT utilisation were all strong influencers for PU and PEOU.

Ward (2013) conducted a review of technology acceptance literature and models in healthcare and identified a number of deficiencies in the application of the models in healthcare contexts. The review showed physicians based their acceptance decisions on the usefulness of the technology rather than its ease of use. So while both PU and PEOU were strong determinants in most acceptance studies, PEOU appeared weaker in healthcare-related studies. It was suggested that the predictive power of TAM may be lower in healthcare studies than in other fields. The review also suggested that healthcare professional groups have nonlinear work processes and are sometimes highly autonomous. New processes were also inherent in the new systems being implemented which needed clarification of roles and responsibilities. All these
make it difficult to find models that can incorporate all the many factors affecting technology acceptance in the healthcare sector. In spite of the limitations, a focus on PU rather than PEOU and individual and organisational culture issues can play a significant role in health information technology (HIT) acceptance among health professionals (Ward, 2013).

Other researchers have also proposed a modified model for developing countries since all the known models were developed and tested in developed country settings. Ami-Narh and Williams (2012) have proposed a modification of UTAUT for eHealth in developing countries by adding a geographic location, satisfaction of eHealth by users and African culture as moderators in the model. Another moderator that has been considered in a number of studies on technology-acceptance is education. It has been noted that persons with high educational level tend to have a higher usage of technology (Abu-Shanab, 2011). Banda and Gombachika (2013) found that Malawian health surveillance assistants’ (HSA) attitude was moderated by their level of education. HSAs with low levels of education had a lower rate of mobile phone technology acceptance. Abu-Shanab (2011) also found education influenced behavioural intention, performance expectancy, self-efficacy, perceived trust and locus of control of bank customers in Jordan. These studies were conducted in developing countries and go to show there are peculiarities with study settings. These are important considerations for the setting and target population being studied.

From the discussion above, it can be deduced that technology acceptance studies in healthcare settings should be conducted with a different lens. Technology acceptance studies in healthcare should consider other constructs and moderators to suit the setting and the population under study. Moderators such as education, culture and geographical location are potentially important for developing country settings.
2.8.3 mHealth and Technology Acceptance

It is important for mHealth researchers to study mobile phone acceptance and appropriation to ensure critical health staff found at the periphery can fully accept and use these tools to provide much-needed services in rural areas (Chib, 2013). The use of mobile phones for healthcare delivery in rural areas have generated substantial evidence. However, few studies assess its actual feasibility and the potential mHealth user acceptance prior to its implementation. Table 2.5 describes a number of mHealth technology acceptance studies. The discussion of these studies is based on the theories used, mHealth applications employed for the intervention, research methods employed, the outcomes of the studies and the recommendations made.

A number of the mHealth studies reviewed, employed more than one theoretical model to aid in understanding acceptance of mHealth. This appears to stem from the call of Holden and Karsh (2010) for researchers to investigate modified models of technology acceptance to suit the healthcare context. Sun, Wang, Guo, and Peng (2013) unified the TAM, TPB and Protection Motivation Theory (PMT) to explain technology acceptance by consumers of mobile health services. This was deemed necessary because they considered the “consumption” of mobile health services as a health behaviour and sought to include a model of health behaviour with technology acceptance. Wu, Li, and Fu (2011) combined TAM and TPB to investigate mobile device acceptance in health professionals in different hospital settings. They explained that mobile devices are usually used voluntarily and for health professionals to adopt them for professional use, there may be the need to consider their psychological states which could play a role in their decision to use. The modified models in these studies appear to have higher explanatory power than the individual models, thus encouraging researchers to consider their healthcare context before applying the models as is. Other studies did not employ any theoretical models (Chaiyachati et al., 2013; Chang et al., 2013; Dehzad, Hilhorst, de Bie, &
Claassen, 2014). The factors determining mHealth acceptance in these studies were generally derived from study specific conceptual frameworks.

Research methods employed varied among the studies. While the original TAM, UTAUT, TPB and other technology acceptance studies were quantitatively derived, a number of studies have translated these into qualitative studies to suit the context within which the studies are being conducted. These were done to provide deeper insight into the subject and populations being studied. Hwabamungu and Williams (2010) employed a qualitative approach, using the UTAUT, Technology Task Fit (TTF) and Fit between Individuals, Tasks and Technology (FITT) models as a basis for the study. Using qualitative studies for technology acceptance studies allows for an interpretation of the context or social phenomenon that could influence the known acceptance factors. Al Ayubi, Parmanto, Branch, and Ding (2014) employed a mixed methods approach, using qualitative methods of in-depth interviews to clarify issues identified from the quantitative results. It opened up new areas of investigation on physical activity promotion. Wu (2012) suggested that mixed methods studies in technology acceptance studies deserve more attention. An interpretivist’s approach is needed to give more meaning to constructs or a rethinking of them.

The studies reviewed also showed congruence with the original studies, with the antecedents of intention to use being positive. In the Lim et al. (2011) study, PEOU, PU and SE were strong predictors of behavioural intention (BI) even though BI was not a good predictor of actual use. Wu, Wang, and Lin (2007) also had positive effects on intention to use in their study just as Gilbert and Namagembe (2013) found in their application of the UTAUT model. However, one common thread that appeared to ring through a number of the reviewed studies was the use of small samples sizes or homogeneous samples (Chang et al., 2013; Wu et al.,
These were identified as limitations that needed to be addressed in future studies. Small sample sizes tend to make results less generalizable. Homogeneity of the sample, for example studying only women, may cause a bias in the findings of the study. A number of them also employed convenience sampling which may have an effect on the power of the studies (Lim et al., 2011; Sun et al., 2013; Wu et al., 2011; Wu et al., 2007).

Due to the shortcomings indicated, recommendations on future research centred on the use of other statistical sampling methods to improve the power of future studies. There was also a call by Lim et al. (2011), Sun et al. (2013), Wu et al. (2007) and Wu et al. (2011) for longitudinal studies to adequately measure use behaviour over time. This was deemed necessary since various factors, such as prolonged exposure to the technology have the potential to encourage use. Such factors cannot always be measured adequately within the time periods most studies are conducted. Heterogeneous samples of males and females with varied age groupings and educational or literacy levels may also throw more light on mHealth technology acceptance studies, providing the right contexts and settings for mHealth deployments to become potentially sustainable over long periods.

While mobile phones for healthcare delivery is intuitively appealing, it is important to determine if the target users would willingly adopt it for their regular healthcare delivery tasks. This section sought to discuss mHealth technology acceptance studies in order to draw conclusions towards an acceptable model for this study. This review showed that various theoretical models have been employed in the study of mHealth acceptance. No specific model stood out as being the best for mHealth acceptance studies. The TAM has appropriately predicted technology acceptance and use in a number of settings but it fails to take into account key individual factors that could impact the determinants of intention to use. Sociodemographic
factors such as age, sex and prior experience with the technology at hand are important in determining the extent of the predictors on intention to use. UTAUT provides a flexible model on which various moderators important to the study could be assessed. Again, most studies in this review showed PEOU and PU were positive and strong thus indicating the robustness of the various models to explain mHealth acceptance. There appeared to be a high intention to use, expressed by study participants. Translation of intention to use to actual use was a shortcoming in some studies. The intention actual use gap brought to the fore, the need to deal with individual characteristics, external issues such as small form factor of some mobile phones and other health programme associated issues such as health worker motivation (Lim et al., 2011). These are important in ensuring sustainable mHealth programmes. The moderators of importance could be sex, education, experience with the use of mobile phones and age of participants. It is critical that these are identified and duly incorporated in future models, especially in developing country settings.
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<thead>
<tr>
<th>Author</th>
<th>Purpose of the study</th>
<th>mHealth Application</th>
<th>Theory used</th>
<th>Country</th>
<th>Research Methods</th>
<th>Outcome and Shortcomings</th>
<th>Recommendations for future research and gaps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lim et al. (2011)</td>
<td>To determine Singaporean women’s acceptance of mobile phones to seek health information.</td>
<td>Mobile website containing health topics</td>
<td>TAM with added variables from SCT</td>
<td>Singapore</td>
<td>Quantitative</td>
<td>PEOU, PU and SE were strong predictors of BI. BI was not a good predictor of actual use. Convenience sampling of participants.</td>
<td>Use of other statistical sampling methods. Use of longitudinal studies to adequately measure Actual Use of technology. Other dimensions of measuring Actual Use. Identify reasons for the Intention-Use gap.</td>
</tr>
<tr>
<td>Banda and Gombachika (2013)</td>
<td>To examine the relationship between usability and acceptability of using mobile phones for health service delivery.</td>
<td>Not specified.</td>
<td>TAM</td>
<td>Malawi</td>
<td>Quantitative</td>
<td>Attitude towards using mobile phones for health service delivery was positive. Education was a positive influence in acceptance. There was a negative relationship between usability and acceptability.</td>
<td>Study sample should be have mixed sex, age groups and varied educational levels.</td>
</tr>
<tr>
<td>Wu et al. (2011)</td>
<td>To study acceptance of mobile healthcare by clinical health professionals in hospitals.</td>
<td>Not specified.</td>
<td>TAM and TPB</td>
<td>Taiwan</td>
<td>Quantitative</td>
<td>High explanatory power of intention to use. There was potential sampling bias due to a high number of females. The response rate was lower than expected.</td>
<td>Behavioural intentions of users with varied experience and awareness of mobile healthcare will have to be examined. Longitudinal studies to observe the theoretical framework over time. Specific features for clinical tasks will have to be investigated.</td>
</tr>
<tr>
<td>Wu et al. (2007)</td>
<td>To determine mobile healthcare systems acceptance by healthcare professionals.</td>
<td>Health Information Systems available through mobile devices.</td>
<td>TAM and IDT</td>
<td>Taiwan</td>
<td>Quantitative</td>
<td>Compatibility, PU and PEOU had an effect on intention to use. Snowball and convenience sampling were employed. Low familiarity with MHS during study period could have led to low intention to use. No measurement of intention to use over time.</td>
<td>Conduct studies to measure intention to use over time.</td>
</tr>
<tr>
<td>Al Ayubi et al. (2014)</td>
<td>To review mHealth for physical activity, develop an app</td>
<td>Mobile app for physical activity</td>
<td>TAM, SCT, TRA/TPB, UTAUT</td>
<td>USA</td>
<td>Quantitative</td>
<td>Participants found the app useful and usable. Limited utility features such as low battery life,</td>
<td>Conduct similar study with a heterogeneous sample in terms of sex, age groups, education</td>
</tr>
<tr>
<td>Author</td>
<td>Purpose of the study</td>
<td>mHealth Application</td>
<td>Theory used</td>
<td>Country</td>
<td>Research Methods</td>
<td>Outcome and Shortcomings</td>
<td>Recommendations for future research and gaps</td>
</tr>
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<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Sun et al. (2013)</td>
<td>To compare and adapt different models to explain mobile health technology acceptance behaviour</td>
<td>Not specified</td>
<td>TAM, TPB, PMT</td>
<td>China</td>
<td>Quantitative</td>
<td>The unified model explained 43.6% the variance of intention to use which was higher than the individual models. The sample was made up of elderly persons only.</td>
<td>Encourages future research to investigate the new model further. There is the possibility of enhancing the explanatory power of the model through the introduction of additional factors.</td>
</tr>
<tr>
<td>Gilbert and Namagembe (2013)</td>
<td>To use UTAUT model to examine health professionals adoption of mobile health in a resource-limited environment</td>
<td>Not specified</td>
<td>UTAUT</td>
<td>Uganda</td>
<td>Quantitative</td>
<td>Mobile health tools are being used by health professionals. Performance expectancy, effort expectancy and disturbance concerns were significant adoption factors.</td>
<td>Specific mobile health tools and uses could have focused the discussion.</td>
</tr>
<tr>
<td>Hwabamungu and Williams (2010)</td>
<td>To determine the plausibility of mHealth for HIV/AIDS care adoption and long-term use from both caregivers’ and patients’ viewpoint.</td>
<td>None</td>
<td>TTF, FITT and UTAUT</td>
<td>South Africa</td>
<td>Interpretive qualitative methods</td>
<td>There was a fit between technology and task. However, patients and caregivers have the perception that donors and government should bear all associated costs of deploying mHealth</td>
<td>Financial models for deploying mHealth have to be investigated.</td>
</tr>
<tr>
<td>Chaiyachati et al. (2013)</td>
<td>To assess the feasibility and acceptability of recording and tracking MDR-TB patients’ adverse events with a mobile health tool.</td>
<td>Mobile health application on low-cost and function phones.</td>
<td>No theory applied</td>
<td>South Africa</td>
<td>Quantitative and qualitative methods.</td>
<td>Form submission was low at 27%. The healthcare workers (HCWs) expressed enthusiasm about the data reporting tool. However, the level of enthusiasm expressed did not match the data reported.</td>
<td>Further research on why the HCWs failed to use the tool in spite of high enthusiasm. Studies to understand motivations of HCWs for using mHealth tools are needed. Studies on objective outcomes for assessing mHealth</td>
</tr>
<tr>
<td>Author</td>
<td>Purpose of the study</td>
<td>mHealth Application</td>
<td>Theory used</td>
<td>Country</td>
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<td>Recommendations for future research and gaps</td>
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</tr>
<tr>
<td>Chang et al. (2013)</td>
<td>To conduct a formative research to inform the development of a mHealth HIV/AIDS care interventions to be used by community health workers (CHWs)</td>
<td>Mobile health application on a smartphone</td>
<td>No theory applied</td>
<td>Uganda</td>
<td>Quantitative and qualitative methods.</td>
<td>There was general intervention acceptability. Participants also perceived benefits such as improved communication between CHW and clinician and patient, improved patient tracking. There were concerns about job security, confidentiality, theft and others. Participants expressed the need for training. Qualitative and quantitative results matched well. This study was conducted with a relatively small sample so this affects generalisability of results. There may have been social and response bias since interviews were conducted by staff members.</td>
<td>The need for an investigation into motivation and remuneration for health workers when faced with us of mHealth interventions.</td>
</tr>
<tr>
<td>Dehzad et al. (2014)</td>
<td>To identify barriers to adoption to mHealth adoption from stakeholder’s perspective.</td>
<td>None</td>
<td>No theory applied.</td>
<td>Netherlands</td>
<td>Quantitative and qualitative methods.</td>
<td>Main barriers identified were “Interoperability and Integration” and “Business case”. There were differences in the importance of barriers between the Dutch and what was found in international literature.</td>
<td>Future research should focus on causes of the barriers. More knowledge on barriers of mHealth acceptance in developing countries is needed since developing countries are rapidly engaging mHealth.</td>
</tr>
</tbody>
</table>

TAM= Technology Acceptance Model, SCT = Social Cognitive Theory, RUTAM = Rural Use of Technology Acceptance Model, TPB= Theory of Planned Behaviour, IDT= Innovation Diffusion Theory, TTF=Task Technology Fit, FITT= Fit between Individuals, Tasks and Technology (FIT) framework UTAUT=Unified Theory of Acceptance and Use of Technology, PMT= Protection Motivation Theory
2.8.4 The Technology Acceptance Theoretical Model

Following the literature view, the UTAUT model was chosen for this study due to its robustness and high performance in determining an individual’s technology acceptance. It is also flexible in allowing the introduction of new moderators that could help explain the technology acceptance in a specific context. Constructs in the UTAUT model for this study are performance expectancy (PE), effort expectancy (EE), social influence (SI) which are direct determinants of behavioural intention (BI) to use. Two other constructs; facilitating conditions (FC) and behavioural intention (BI) are direct determinants of actual use of the technology. Moderators that influence these are age, sex, experience and voluntariness. These have been shown in Table 2.6.

Table 2.6 – UTAUT constructs, moderators and definitions

<table>
<thead>
<tr>
<th>Construct</th>
<th>Definition</th>
<th>Moderators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Expectancy (PE)</td>
<td>The extent to which a person considers using a technology will help him/her perform well at their job.</td>
<td>Age, Sex</td>
</tr>
<tr>
<td>Effort Expectancy (EE)</td>
<td>The ease of using a tool in relation to the job to be performed.</td>
<td>Age, Experience, Sex</td>
</tr>
<tr>
<td>Social Influence (SI)</td>
<td>The extent to which a person considers that persons who matter to him/her expect them to use the tool.</td>
<td>Age, Experience, Sex, Voluntariness of use</td>
</tr>
<tr>
<td>Facilitating Conditions (FC)</td>
<td>The degree to which an individual trusts that technical, organisational and other conditions exist to support their use of the technology.</td>
<td>Age, Experience</td>
</tr>
<tr>
<td>Behavioural Intention (BI)</td>
<td>An individual’s intent to use a specific technology tool for a specific job function</td>
<td>None</td>
</tr>
</tbody>
</table>

The original model was maintained for this study along with the moderators. However, owing to the population being studied, education was included as a possible moderator of EE. Use of mHealth has been found to be associated with higher levels of education in a study among ethnically diverse Americans (Bender et al., 2014). Khatun et al. (2015) also identified
educational level to be significant predictors of text messaging use and awareness of mHealth services in a rural Bangladesh community. Similarly, Haghshenas, Chatroudi, and Njeje (2012) found educational level to play an important role in the acceptance of online education in Malaysia. In a study with traditional midwives and certified midwives in Liberia, the certified midwives found it easier to use mobile phones to report pregnancies from the rural areas compared to the traditional midwives who were less educated (Perosky et al., 2015). Based on the literature, it was posited that persons with higher levels of education would have more comfort using mobile phones for reporting. This is also in line with calls to provide a richer understanding of users’ technology acceptance by the inclusion of other theoretically motivated moderators, new user groups or new technology (Venkatesh et al., 2003). It was, therefore, important to determine if education would moderate the effort expectancy construct since it has been shown to be a strong determinant of an individual’s intention to use. Since participants were going to be trained, it was believed they would have ample understanding of the benefit of using mobile phones to report the MDA data so education level was not anticipated to influence performance expectancy. Education was also not anticipated to moderate social influence. The final model adapted for this study is shown in Figure 2.2.
2.9 CONCEPTUAL FRAMEWORK FOR THE STUDY

Following the theoretical review, a conceptual framework was developed to guide this study. In order to gain an understanding of the feasibility of mobile phone reporting by CHVs for the NTD programme, three main issues had to be explored for this implementation research (IR) study. The framework is depicted in Figure 2.3. The CHVs current roles in reporting had to be understood, their current use of mobile phones needed to be assessed and their readiness to accept the mobile phone for MDA reporting had to be assessed as well. It was also deemed necessary to determine the impact on data quality for the programme as a consequence of the use of mobile phone for reporting. A systematic review of community health workers and mobile technology identified the need for more studies that did not just show technological
feasibility but also assessed impacts and outcomes (Braun et al., 2013). It was important in this study to assess feasibility beyond technological feasibility and gain an understanding of what it would mean for the CHVs to be involved in using these tools for their regular MDA reporting. Khatun et al. (2015) studied a rural community’s readiness to adopt mHealth in Bangladesh. While acknowledging the importance of technology acceptance models such as TAM, they indicated the limitation of such models as generally not considering other variables such as the influence of human factors, external environment and ecological factors, policy and the economic environment. They asserted that an effective mHealth implementation needed to ensure access to mobile devices and knowledge of its applications. A conceptual framework with three categories namely, technological, motivational and resource readiness was developed to assist in their study.

For the first objective, it was important to comprehensively study the role of CHVs in the reporting chain for NTD programmes. It was also important to gain an understanding of the facilitators and barriers to reporting for the programme. Such an understanding would enable the choice of an appropriate solution for the programme. This study took place in a real non-experimental setting so an understanding of the study’s context was important (Gyapong, Kamau, Najjemba, & Ogundahunsi, 2014). CHVs play a critical role in data reporting for health programmes, especially in rural areas. Their specific reporting roles and challenges they encounter performing those roles are relevant for future modifications to data reporting for the programme.
It was also necessary to determine the CHVs experience with using mobile phones since this was unknown. An individual’s experience with a technological tool has an influence on their decision to use it for other purposes (Afari-Kumah & Achampong, 2010). This experience entails their ownership or access to the technology, usage patterns and facilitators of their use of the technology. Challenges to their effective use of the technology will also have to be well understood as this could have an impact on the decision to use it for work-related tasks. It is expected that CHVs acceptance of mHealth for MDA data reporting would be shown by the high rate of actual participation in the intervention. CHVs would have to have high ownership and use of mobile phones for these devices to be considered for data reporting for the NTDP. This is also influenced by the telecommunication network quality in the various communities. There is a direct correlation between mobile phone use and network connectivity. Good quality
signals in the various communities could be motivation for the CHVs to submit the MDA reports through mobile phone technologies.

A few studies have indicated the need to assess the accuracy and completeness of data collected, using mobile phones (Andreatta, Debpuur, Danquah, & Perosky, 2011; Patnaik, Brunskill, & Thies, 2009; Perosky et al., 2015). This has been deemed necessary because health data should meet strict data quality standards to ensure usability of the data for decision making. It is also anticipated that some challenges encountered during the data collection and reporting may have an impact on the data generated. Using technology may or may not improve the quality of the data for programme decision making. Data is of essence to the NTD programme as this becomes an indicator of MDA treatment success. The role of the actors in generating the data and the quality of data generated has to be closely monitored. For this study, the validated reports at the district and regional level were considered the gold standard for comparison. Data should be 100 percent complete and key indicators should be accurate within 5% of post-coverage surveyed indicator results.

Benchmarks for feasibility in this study would include:

- Network connectivity: adequate network signals in every community in the study areas
- Mobile phone use: CHVs should have high ownership and use of mobile phones
- Technology acceptance: CHVs should demonstrate acceptance by submitting MDA reports by mobile technologies used for this study.
- Data completeness: Expected indicators should have 100 percent completeness
- Data accuracy: expected indicators should be within 5% range of reported district data
2.10 CHAPTER SUMMARY

This chapter sought to review literature associated with issues in this study. It began with a discussion on the various definitions of eHealth and looked further at the components of eHealth. Mobile health, which is a major subject in this study, was discussed in the context of developing countries and Ghana specifically. The review consisted of an overview of mHealth studies, mHealth applications used in these studies, the impact of the studies and associated challenges. There was also a discussion on the definition of community health volunteers, their characteristics, impact of their role in data reporting and associated challenges. Data quality in health reports was discussed as well as ICT knowledge among health workers. This chapter built a framework based on theoretical and practical models for studying the feasibility of CHVs reporting MDA data with mobile phones. A thorough discussion on technology acceptance was conducted. This was followed by a description and discussion on the modified UTAUT model for this current research. The elements within both the theoretical and conceptual framework are also discussed.

From the literature review, it can be deduced that mobile phones have shown immense benefits in both routine and non-routine healthcare delivery situations (Stanton et al., 2015; Vélez et al., 2013). Health workers have found them useful for their particular tasks and generally accepted their use in spite of some challenges. Some expected benefits have been; improved data quality and clinical benefits. Few studies have been conducted to determine how health workers will respond to mHealth tools (Vélez et al., 2013). Most studies have also reported these mHealth trials with professional or mainstream health workers such as nurses, physicians and community health workers / nurses. In developing countries, shortage and maldistribution of health workers have led to the involvement of community health volunteers who provide basic services in remote and rural communities to help bridge gaps in health care delivery (Lehmann
& Sanders, 2007). These CHVs can use mHealth to assist in their work but very little literature is available on their involvement in mHealth projects. Even fewer studies are available on the use of mHealth in NTD programmes involving CHVs even though these tools could enable their work as drug distributors and data collectors. The literature review also indicated that health system factors need to be considered in the deployment of mHealth tools but not much literature was found that focused on identifying factors that could make mHealth sustainable for the settings they were being tested. There is the need to identify what factors will help ensure health worker acceptance to utilise mobile phones for their routine tasks (Khatun et al., 2015). Some studies that assessed feasibility were also gauged at professional health workers and not community health volunteers. It was also noted in the review that most mHealth studies did not have strong theoretical basis (Chib, 2013). This will make mHealth studies sound and justified for public investment. Summarily, there are gaps in literature regarding mHealth use among CHVs in NTD programmes and factors necessary for successful deployment of such an initiative. Such studies should also be backed by strong theories that will make results generalizable.
CHAPTER 3
METHODS

3.0 INTRODUCTION
This chapter discusses methods applied in undertaking this study. The chapter begins with a discussion of the research philosophy adopted for this study as well as a description of the research process. There is a description of the study sites, design and research methods adopted, the population under study, data collection methods and analysis methods applied. Ethical considerations made are also described.

3.1 RESEARCH PHILOSOPHY
Research should be based on well-defined methods founded on scientific principles (Eldabi, Irani, J. Paul, & Love, 2002). The approach to research should incorporate philosophical assumptions as well specific methods and procedures that translate the approach into practice (Creswell, 2014). A number of philosophical worldviews are proposed in health research such as positivism, post-positivism, interpretivism and pragmatism. A researchers’ worldview on an issue of enquiry will determine why a quantitative, qualitative or mixed methods approach will be chosen (Creswell, 2014). Researchers take up various epistemological and ontological positions, situated in various paradigms and apply various methods or combination of methods to develop knowledge that allows us to understand the world (Racher & Robinson, 2003).

Positivism as a worldview or paradigm accepts knowledge as directly observable and measurable (Ross, 2012). Logical principles and reasoning are applied and every phenomenon is expected to be measured. Subjective phenomenon is not accepted as these are not considered measurable. Post-positivism, which is a thinking that proceeds from positivism, challenges the notion that knowledge is an absolute truth. Post-positivists agree that absolute truth cannot be
found such that knowledge is considered conjectural (Creswell, 2014). This paradigm tries to explain why events occur the way they do and creates tools that enhance objectivity and reduce bias as much as possible (Ross, 2012). Positivists and post-positivists lean toward quantitative research methods, where every phenomenon is viewed objectively and measured. Research using this approach is basically experimental or survey design which is conducted in various forms with varying levels of complexity (Creswell, 2014). Some examples of these designs are quasi-experimental studies, randomised-controlled trials, cross-sectional studies, longitudinal studies, among others.

The interpretivist paradigm contends that knowledge is subjective and socially constructed (Saks & Allsop, 2007). In this worldview, both the enquirer and object of enquiry are important, as well as the interaction between the two, the context, events, phenomenon and time of the enquiry contribute to developing knowledge of the subject matter (Tavakol & Zeinaloo, 2004). The interpretivist researcher is more interested in explaining a subject or the subject matter and believes such an enquiry goes beyond numbers; the approach is inductive and does not develop a hypothesis but rather seeks to develop a theory (Creswell, 2014). Interpretivists rely on qualitative methods of enquiry. Qualitative methods seek to answer questions on “how”, “what” and “why” of a phenomenon (Green & Thorogood, 2013). This method is also employed when nothing or very little is known about a phenomenon. Research designs usually employed in qualitative studies include narrative research, phenomenology, grounded theory, ethnographies and case studies (Creswell, 2014).

Pragmatism focuses on the consequences of actions and solutions to problems (Creswell, 2014). This worldview seeks to integrate various interpretations of life and believes in the role of the human experience in every endeavour (Scheffler, 2013). It is real-world oriented and
adopts multiple paradigms based on the problem. To study reality, the pragmatic researcher should interact with the world in which the study is being conducted and emphasise the end result of the study. Pragmatism resonates with applied health research, such as health services research (Ebrahim & Bowling, 2005). Pragmatists need to define the beneficiaries of the findings for the study to be useful. Multiple methods of enquiry are used in advancing knowledge from this worldview. Mixed methods are used in collecting and analysing data rather than acceding to one way. The need for comprehensiveness in addressing a set of research questions draws researchers to the use of mixed methods (O'Cathain, Murphy, & Nicholl, 2007). Pragmatism was considered the best approach to adopt for this study. This was because the study was situated in a real-life setting and multiple enquiries were required to answer the research question. Some objectives were exploratory in nature while others had to be measured quantitatively. This meant a mixed research approach would be needed to address the main research objective.

3.2 RESEARCH DESIGN

Research design is a plan or strategy that determines how a research study will be conducted. It provides a blueprint for the organisation, data collection, analysis and interpretation of data. The research design will thus enable the researcher to effectively answer the research questions. It helps to determine the best approach or methodology towards the realisation of the objectives. Specific study designs are definite in the types of questions it can answer. Two main categories of study designs occur in health research; descriptive and analytical. Descriptive study designs generate hypothesis, are not comparative and may sometimes be followed by analytical studies (Jehan & Kazi, 2012). They usually consist of case series or reports and cross-sectional studies. Analytical studies are usually observational and experimental. Examples of
these are randomised controlled trials, quasi-experimental studies, cohort studies and case-control studies.

Considering the discussions in the previous section, this study is premised from the pragmatic perspective. It is real-life oriented and sought to deal with a real problem. This was an implementation research (IR) that employed multiple cross-sectional studies and an intervention. Cross-sectional studies allow a phenomenon to be studied at a point in time within a short time frame. Implementation research studies attempt to understand and work in real-world settings without controlling various variables and effects (Peters, Adam, Alonge, Agyepong, & Tran, 2013). It was a mixed methods study that used quantitative and qualitative data collection techniques. Mixed methods were deemed necessary because it was a way to gain a complete understanding of the problem (Creswell, 2014). The study design is depicted in Figure 3.1.
3.3 RESEARCH PROCESS

The studies were conducted in a sequence as shown in Figure 3.2. It describes the study in detail, showing the design, data collection methods and study population involved at every stage of the study. The initial study on exploring data reporting constraints was conducted first and was followed by the quantitative study on CHVs mobile phone use and technology acceptance studies. The intervention was implemented simultaneously at this stage. The intervention was repeated about twelve months after the first trial. The first quantitative study and intervention were followed by the qualitative study that sought to further explain findings from the quantitative study.
3.4 STUDY SITES

The study was carried out in two districts in the Western Region of Ghana. These were; the Ahanta West District and Nzema East Municipality. The two study sites are shown on a map in Figure 3.3.
3.4.1 Ahanta West District

The Ahanta West District is located at the southernmost tip of Ghana with the Gulf of Guinea as its southern border. The district shares boundaries with the Sekondi-Takoradi Metropolis to the East, Mpohor Wassa East to the North East, Tarkwa Nsuaem Municipality to the North West and Nzema East Municipality to the West. The district has 123 communities with Agona Nkwanta as the district capital.

In the 2010 housing and population census, the population of Ahanta West was 106,215, comprising 52% (55,216) females and 48% (50,999) males (Ghana Statistical Service, 2012). The estimated average household size is 4 persons. The district is inhabited mainly by the Ahanta, Wassa, Nzema, Ewes and Fanti ethnic groups. The Ahanta are the predominant ethnic group. The district is mostly rural (71%) with a literacy rate of 33% in English and 3% in a Ghanaian language (Ghana Statistical Service, 2013).

Approximately 47% of the population is engaged in agriculture (Ghana Statistical Service, 2013). The main crops grown include oil palm, rubber, cassava, plantain and vegetables. The remaining population are engaged in small-scale trading, fishing and the formal sector. Women dominate small-scale trading in agricultural produce, fish and other general goods. Crude oil production started in December 2011 in the District, following oil discovery in commercial quantities offshore Cape Three Points in 2007. Approximately 76% of the population are economically active (Ghana Statistical Service, 2013).

There are four sub-districts for the purpose of implementation of health activities: Princess, Apowa, Agona and Dixcove. A District Health Committee, together with the District Health Management Team (DHMT) plans, implements and monitors, all health interventions in the
district, under the leadership of the District Director of Health Services. The team is supported by community health volunteers (CHVs) in the various communities in the district. There are approximately 160 CHVs for various community health programs. This number varies from programme to programme and year to year. There are three health centres and ten community-based health planning services (CHPS) compounds in the various communities. There is also a district hospital located in Dixcove which serves as a referral hospital for the health centres and the CHPS zones. There are a few private clinics and maternity homes as well. The district is endemic for most common diseases found in the country such as malaria, diarrhoea and also endemic for NTDs such as LF, schistosomiasis and soil-transmitted helminthiasis (STH). Ahanta West was one of the first five districts in Ghana to commence LF elimination activities in the year 2000 (Offei & Anto, 2014). Initial LF surveys conducted in the district found a microfilaraemia prevalence of 18 – 25% (Dunyo et al., 1996).

3.4.2 Nzema East Municipality

The Nzema East Municipality in the Western Region of Ghana covers an area of 2194 sq. km. It is bounded to the West by the Ellembele District, East by Tarkwa-Nsuaem Municipality, Prestea Huni-Valley and Ahanta West, North by the Wassa Amenfi West District and South by the Gulf of Guinea. There are 79 communities in the district and the district capital is Axim.

The Municipality has a population of 60,828 with a growth rate of about 2% (Ghana Statistical Service, 2012). The population density is higher in the southern sector of the district, where there is greater access to improved drinking water sources, schools, health facilities, electricity, telecommunication and transportation. It is mainly rural (66%) with a literacy rate of 22% in English and 4% in a Ghanaian language (Ghana Statistical Service, 2013).
The economy of Nzema East is predominantly agricultural. Fishing is predominant on the coast and farming is predominant in the hinterland. About 57% of the population is involved in agriculture, forestry and fisheries. Commercial crops grown are coconut, cocoa, rubber and oil palm. Women dominate the service industry at 22% compared to 4.2% males. Other industries are mining and quarrying, craft and other trade works and sales and repairs of motorbikes. About 5.5% work in the public sector and 90% in the private informal sector. The unemployed is about 4% of the population (Ghana Statistical Service, 2013).

There are five (5) health sub-municipal areas including Axim/Nsein, Gwira Banso, Gwira Eshiem, Kutukrom and Bamiankor. The Municipal Health Directorate is managed by a Municipal Director of Health Services. Each sub-municipality has either a health centre or community-based health planning and services (CHPS) compound. These are usually managed by a midwife or community health officer and community health nurses. The Bamiankor Health Centre is, however, managed by a Medical Assistant. The district hospital is located in Axim and serves as the referral centre for cases from all CHPS zones within the Municipality. There are approximately 60 CHVs in the Municipality with Axim having the highest number of about 25 persons. The Municipality is endemic for LF, schistosomiasis and soil-transmitted helminthiasis (STH). The LF Elimination programme began in the year 2002 in this municipality.
3.5 STUDY POPULATION

The study population consisted of CHVs from Ahanta West and Nzema East districts. In exploring the causes of late reporting of LF MDA data, sub-district supervisors, district disease control officers, the regional focal person and a programme officer at the NTDP office were also recruited.

3.5.1 Eligibility Criteria

CHVs for the FGDs in the initial qualitative study were required to have been drug distributors at least once in their community before the study and be willing to participate in the discussion. All CHVs recruited by the sub-district supervisor to distribute LF MDA drugs in an assigned community for the years’ MDA were eligible. The supervisors at the various health administration levels were needed because they had the requisite knowledge and experience
with the LF MDA due to their job roles. Community health volunteers for the in-depth interview conducted after the first experiment should have answered the survey, participated in the training for the intervention during the annual sub-district MDA review programme and consented to participate in the study.

3.6 QUANTITATIVE METHODS

3.6.1 Sample Size

Due to the small number of CHVs in both study sites, all available and interested CHVs were included. Sixty and 160 CHVs were recruited for the MDA by Nzema East Municipality and Ahanta West respectively. The districts choose these numbers based on the financial resources budgeted by the NTDP as allowance and transportation costs for CHVs. Attempts were made to recruit the total number of CHVs engaged by the districts for the MDA in this study.

3.6.2 Sampling

The Ahanta West district and Nzema East Municipality were considered suitable for the implementation of the study because results of Transmission Assessment Surveys (TAS) in 2011, indicated microfilaraemia was more than 1% in the endemic population (Personal Communication). This meant that transmission of the infection was still likely ongoing and annual mass drug administration (MDA) in the endemic communities had to be continued for at least five more years from the inception of this study (World Health Organisation, 2011b). Based on this information, the two districts were chosen to ensure there would be MDAs ongoing for about 5 years in order to meet the objectives of this study. All CHVs included in the 2014 and 2015 annual MDA sub-district training and thus selected for participation in the MDA, were approached and recruited as study participants for the quantitative study.
3.6.3 Data Collection

The structured questionnaires were mostly administered by research assistants in English and the local language. However, a few (n=22) were self-administered. Study participants who had not texted their MDA reports a week after the scheduled end of the MDA were called up by telephone and reminded to do so. Those who indicated difficulty with the texting were guided on phone to help them accomplish the task. Such difficulties were noted and documented. A few participants had difficulty submitting to the shortcode provided (possibly due to network challenges) and chose to submit the data to the researcher’s phone number (n=10).

Figure 3.4 - MDA training in Gwira Eshiem sub-municipality in Nzema East Municipality.

Figure 3.5 - Data collection after MDA training in Dixcove sub-district in Ahanta West district.

In the second year of the study, the same process was repeated for the second round of the intervention. Questionnaires were only administered to new CHVs who had been recruited for
that year. Previous years’ participants’ phone numbers were updated and they answered a question confirming their intention to submit the MDA report using their mobile phone. New cue cards were given to each participant to aid them in formatting the message. However, participants in the Nzema East Municipality were trained to submit their MDA reports using Unstructured Supplementary Service Data (USSD) instead of SMS. This change in data submission method was based on lessons learned during the first phase of the intervention in the preceding year (Gyapong et al., 2014).

3.6.4 Data Collection Instrument

The questionnaire had seven sections covering socio-demographic details (6), knowledge of ICT (8), ICT device ownership (4), ICT shared Access (8), Usage (2), Readiness to adopt mobile phones for data collection (2), ICT Expenditure (2) and ICT Usage challenges (2). This instrument was developed based on literature review and expert opinion. Questions were a combination of close-ended questions and five scale Likert-scale and Likert-type responses. This is attached as Appendix 5.

3.6.5 Data Analysis

Quantitative data were entered in Ms Excel 2013 by a research assistant and validated by the researcher to ensure the accuracy of entries. Quantitative data were analysed using Stata 13©, SPSS® version 22 and Ms Excel© 2013. Frequencies and proportions were used to describe the data. Measures of associations were analysed using Pearson chi-square tests. The strength of associations was measured using logistic regression for binary data and ordered logistic regression for categorical data. Reliability of Likert scale responses was assessed using Cronbach’s alpha test. Construct validity of the scales was also assessed using principal
component analysis in SPSS 22. Generalised structural equation modelling (GSEM) was used to assess CHVs acceptance of mHealth technology for reporting MDA data.

3.7 QUALITATIVE METHODS

3.7.1 Sample Size

Four FGDs were conducted with CHVs with participants ranging from five – seven for each group. Focal persons who participated in the IDIs for the initial qualitative study at the various health administration levels were seven. Sixteen persons who submitted their data via SMS and 11 persons who were unable to submit the SMS were interviewed for the IDIs. Data saturation had been reached by the time these number of participants were interviewed.

3.7.2 Sampling

Participants for the FGDs were conveniently sampled from two sub-districts each in Ahanta West and Nzema East Municipal Assembly. Together with the district supervisors, sub-districts were chosen based on physical location and the district supervisors’ ability to reach the sub-district supervisor via telephone to determine their willingness to host the interview. Study participants for the in-depth interviews were sampled purposively. The participants at the sub-district, district, region and national offices were chosen because of the role they play in supervising activities of the programme. Community health volunteers who participated in the IDIs were sampled conveniently. They were only selected from sub-districts where both respondents and non-respondents to the intervention were present.

3.7.3 Data Collection

In-depth interviews with the LF focal persons were conducted in English while FGDs and IDIs with CHVs were mostly conducted in Twi and Fanti, both local languages in the study sites.
Open-ended interview guides were used in guiding discussions and interviews. Probes were used to elicit further details and obtain clarity following answers to questions posed. Interviews and discussions were recorded with a digital audio recorder. Experienced research assistants with qualitative interviewing skills were engaged to assist with interviews. Interviews lasted 30 – 45 minutes each. Interview guides are attached as appendices 2A, 2B, 2C, 3A and 3B.

3.7.4 Data Analysis

Qualitative interviews were translated and transcribed verbatim into English using a Word processor. Data were analysed using thematic content analysis. The transcripts were uploaded into NVivo® 11 Pro by QSR International to store and organise the data.

3.8 COMMUNITY ENTRY AND TRAINING

In preparation for the surveys, the sub-district supervisors from Ahanta West and Nzema East were informed of the study objectives and procedures during the LF MDA training in their district level training. Following that, sub-district training was scheduled, during which the supervisors introduced the study team to the CHVs. The purpose of the study was explained and questionnaires were administered to those who agreed to participate. After administering the questionnaires, participants were trained on how to submit their summarised MDA reports via text messaging. Participants who were not conversant with text messaging were trained in how to send text messages on their phones. They were given an opportunity to practise the procedure under supervision. Each CHV was expected to send the MDA report once their drug distribution was completed and data fully summarised. Each CHV was given a cue card (Figure 4.5) with instructions on the format of the text message. For both episodes of the data collection, CHVs who had been selected to participate in the MDA but could not attend the MDA training at the sub-district level were followed up in their homes or workplaces,
interviewed and trained. The sub-district supervisors provided information about where the CHVs resided and in some instances, their phone numbers as well.

### 3.9 THE INTERVENTION

The purpose of the intervention was to enable the CHVs to submit LF MDA data using mobile phones so actual use of the tools can be tested as part of technology acceptance. A third-party content aggregator provided toll-free telephone shortcodes for sending MDA reports via short message service (SMS). Short message service was chosen because it is a standard application that can be found on any type of phone. The CHVs were also supposed to use their own phones so the application of choice had to be simple and something most would be familiar with. Those who did not own phones but could borrow from a family member or friend were allowed to do so. Participants’ phone numbers that were expected to be used to submit the SMS were written on the structured questionnaires. Two toll-free numbers were provided; one was set up to work with only MTN (a mobile phone service provider) while the other was set up for Airtel and Vodafone which are also mobile phone service providers. In the second year of the study, the provider added access for other service providers: Glo and Expresso users. Each participant provided their phone number which was matched to their community in a sub-district to help determine which communities had submitted their reports. Data submitted were received through a server owned by the aggregator. The data could be viewed via the Web and downloaded as Ms Excel files. The format of the message was based on the summary form on the last few pages of each MDA register. Pre-existing codes used for reporting in the register were used.
A customised Unstructured Supplementary Service Data (USSD) platform was used for the second round of data collection. This platform was integrated with an instance of the open-source District Health Information Management System (DHIMS2) being used by the Ghana Health Service. A short-code was also provided for study participants to dial to connect to the USSD platform. This works as a pull-push system. Once the server received the call, the first variable was pushed to the participant to enter the values (Figure 3.7). This process continued until all the questions had been answered. Once the process was completed, the participant was given the option to review the data they had entered and close the session. Poor network connectivity was anticipated so the system was designed such that participants could dial-in and continue the data input from where a session dropped. The same summary variables in the MDA register were pushed one after the other on the USSD platform to participants to input values.
3.10 TRAINING AND PRETESTING

The questionnaire and SMS intervention were pretested in Mpohor District in Western Region with five CHVs from the district and a disease control officer. The pre-test was conducted to assess clarity and appropriateness of the questions. The pre-test was also conducted in the local language to test how easily participants would understand the questions. Back translation was also practised to ensure the meaning of questions had not been lost while translating questions from English to the local language. Notes were taken during this process. Appropriate corrections were made and the final questionnaire prepared. The CHVs also tried out submitting test MDA data using the SMS format. Comments on ease of use and performance were obtained from the participants. In Nzema East, participants who could access a network at the training site practised dialling and sending responses to the queries via USSD. Research assistants were also trained on how to administer the questionnaires, send the SMS message and send data using the USSD.

3.11 ETHICAL CONSIDERATIONS

Ethical clearance was obtained from the Ghana Health Service (GHS-ERC: 13/11/12). Informed consent was obtained from all participants in this study. Objectives of the study were explained, as well as what would be expected of participants. Participants were assured of the
confidentiality of their responses. CHVs were served snacks during the training in each sub-district. They were also given allowance for transportation to the training site. This was matched to what the NTDP was giving them as transportation allowance for attending the training at the sub-district. Participants who submitted their MDA reports via SMS or USSD received airtime credit of GHS 5.00 directly on their phones. This was announced to them during the training in the sub-district. All who agreed to participate were given informed consent forms to sign. Permission was obtained from the District Health Administrations and the NTDP as well. Consent forms used have been attached as Appendix 1.

3.12 CHAPTER SUMMARY

This chapter established the research paradigm, research approach and methods used for this study. This study was set within a pragmatic philosophical worldview. It was an implementation research study that employed multiple cross-sectional studies and interventions to answer the research questions. In-depth interviews and focus group discussions were used in attaining data to answer qualitative research questions while a structured questionnaire was used for attaining data to answer quantitative based research questions. The subsequent four (4) chapters are manuscripts based on the research questions. A detailed description of methods applied for each research objective is described in each manuscript.
CHAPTER 4

PUBLISHED JOURNAL ARTICLE

DATA REPORTING CONSTRAINTS FOR THE LYMPHATIC FILARIASIS MASS DRUG ADMINISTRATION ACTIVITIES IN TWO DISTRICTS IN GHANA: A QUALITATIVE STUDY

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Abstract

Background - Timely and accurate health data is important for objective decision making and policy formulation. However, little evidence exists to explain why poor quality routine health data persists. This study examined the constraints to data reporting for the lymphatic filariasis (LF) Mass Drug Administration (MDA) programme in two districts in Ghana.

Methods - This qualitative study focused on timeliness and accuracy of MDA reports submitted by community health volunteers (CHV’s). The study is nested within a larger study focusing on the feasibility of mobile phone technology for the LF programme. Using an exploratory study design, data were obtained through in-depth interviews (n=7) with programme supervisors and focus group discussions (n=4) with CHVs. Results were analysed using thematic content analysis.

Results - Reasons for delays in reporting were attributed to poor numeracy skills among CHVs, difficult physical access to communities, high supervisor workload, poor adherence to reporting deadlines, difficulty in reaching communities within allocated time and untimely release of programme funds. Poor accuracy of data was mainly attributed to the inadequate motivation for CHVs and difficulty calculating summaries.
**Conclusion** - This study has shown that there are relevant issues that need to be addressed in order to improve the quality of LF treatment coverage reports. Some of the factors identified are problems within the health system, others are specific to the CHVs and the LF programme. Steps such as training on data reporting should be intensified for CHVs, allowances for CHVs should be re-evaluated and other non-monetary incentives should be provided for CHVs.

**Keywords: data quality, reporting, barriers, constraints, lymphatic filariasis, mass drug administration**

**4.1 INTRODUCTION**

Disease control and elimination programmes depend on prompt reporting of data from the field or communities to monitor progress, treatment coverage and facilitate decision-making for public health (Heunis et al., 2011). It is therefore important for public health programmes to have reliable data for decision making and planning in order to ensure targets are being met (AbouZahr & Boerma, 2005). Data which is generated, thus ought to be timely, accurate, complete, legible and accessible in order to meet the requirements of the stakeholders (World Health Organisation, 2003).

Health information systems in resource-limited countries are however challenged in producing high-quality data for health programmes (Ledikwe et al., 2014). This is due to factors such as limited trained personnel, inadequate supervision, limited financial resources and lack of investment in monitoring and evaluation (Heunis et al., 2011; Wilkins, Nsubuga, Mendlein, Mercer, & Pappaioanou, 2008). Data quality (DQ) assessment studies in resource-limited settings have been conducted on programmes such as antiretroviral treatment, tuberculosis (TB) and malaria (Chilundo, Sundby, & Aanestad, 2004; Heunis et al., 2011; Kunimitsu, 2009; Makombe et al., 2008). Other DQ assessments have been conducted on data from primary healthcare, Expanded Program on Immunisation (EPI) and other infectious disease surveillance
(Crabb, 2003; Curtis, McCray, McKenna, & Onorato, 2001; Jajosky & Groseclose, 2004; Mahmood & Ayub, 2010; Mavimbe et al., 2005; Randrianasolo et al., 2010; Reijn, Swaan, Kretzschmar, & van Steenbergen, 2011). They have usually focused on timeliness, accuracy and completeness of the surveillance systems. In all these studies, it was demonstrated that poor data quality affected the ability of programmes to effectively monitor targets for these disease control programmes.

A number of Neglected Tropical Diseases (NTDs) such as lymphatic filariasis, onchocerciasis, soil-transmitted helminthiases and schistosomiasis have the potential to be controlled and eliminated from society (World Health Organisation, 2012). This can be made possible through preventive chemotherapy, vector control, health systems strengthening, improved hygiene and proper case-management of diseases (World Health Organisation, 2010b). However, for these strategies to work effectively, reliable data should be available to help programmes manage the diseases. The Neglected Tropical Diseases Control Programme (NTD) is responsible for the annual mass drug administration (MDA) of ivermectin and albendazole in LF and Onchocerciasis endemic areas in Ghana. The MDA is conducted annually using the Community-Directed Treatment approach where drugs are distributed house-to-house by community health volunteers (CHVs) (Gyapong et al., 2001).

Studies on NTD data accuracy by authors like Worrell and Mathieu (2012) and Allen and Parker (2011) have raised questions about the quality of treatment coverage data. While these are important, it is equally necessary to identify reasons why the data may be of poor quality. An assessment of clinical malaria records in the Solomon Islands found a vast discrepancy between clinical records and government statistics which was attributed to high numbers of
patients, illegible writing, the disuse of tally sheets and insufficient resources (Kunimitsu, 2009).

Lymphatic filariasis MDA data reporting has been considered a problem for the programme for a number of years. Anecdotal evidence also suggests that there may be discrepancies in reported treatment coverage and actual treatment coverage in endemic areas in Ghana. It was, therefore, necessary to investigate these issues in order that solutions can be devised to resolve them. Determining the factors influencing data quality can impact the design of new approaches to improve data quality. This study, therefore, set out to identify reasons for the poor state of data reported for LF MDA in two districts in Ghana.

4.2 MATERIALS AND METHODS

4.2.1 Study design

This was an exploratory study that employed two qualitative data collection techniques; focus group discussions (FGDs) and in-depth interviews (IDIs). It was conducted as part of a larger study whose objective is to determine the feasibility of mobile phone technology for reporting LF treatment coverage.

4.2.2 Study Setting

The study was conducted in the Nzema East Municipality and Ahanta West District of the Western Region of Ghana. The two districts have a population of 60,828 and 106,215 respectively (Ghana Statistical Service, 2012). The Nzema East Municipality is made up of 79 communities which are managed under five sub-municipalities. The Municipality has approximately 60 CHVs who distribute drugs during the MDA. The LF elimination programme began in the year 2002 in this Municipality. The main economic activities in the district are
farming, fishing, trading and small-scale mining. It is made up of mostly rural communities (66%) with a literacy rate of 42.5% (literacy in both English and local language) (Ghana Statistical Service, 2013). The roads are mostly 3rd Class roads and travelling in the wet season can be quite difficult.

The Ahanta West District has 123 communities managed through four sub-districts for implementation of health activities. It was one of the five districts that began the LF elimination programme in 2001. This district has approximately 160 CHVs for the LF MDA. The main economic activities in the district are farming, small-scale trading, fishing and few formal sector workers. This district is also mostly rural (71%) with a literacy rate of 37% in both English and the local language (Ghana Statistical Service, 2013). Communities are larger and closer to each other in the Ahanta West district and this makes travelling between communities relatively easier. In both districts, the LF programme is managed at the sub-district level by community health officers who are in turn supervised by the district disease control officers.

**4.2.3 Sampling and Sample Size**

Four (4) FGDs were conducted with the CHVs in four sub-districts. The groups were drawn from two sub-districts in Ahanta West district and two in the Nzema East Municipal Assembly. The sub-districts were chosen with the help of the district supervisors. The sub-district supervisors at the chosen sub-districts were contacted and asked to recruit eight to ten CHVs for the FGDs. However, the FGDs in the Nzema East had six participants and five participants each. The interviews were scheduled on the market days in the sub-district when the population usually has easy access to transportation to the sub-district capitals. In the Ahanta West, the two groups were five and seven participants respectively. The FGDs were organised in the evening during a weekday. An ongoing electricity load shedding exercise in the country caused
a power outage in one of the communities on the day of the FGD. This may have affected the participants’ decisions to leave their homes for the FGD. The CHVs had to have been drug distributors for more than one year and willing to participate in the discussion.

Seven IDIs were conducted with supervisors at the sub-district, district, regional and NTD programme office. Two district level supervisors (from each district), three sub-district supervisors, one regional officer and one national programme officer participated in the IDIs.

4.2.4 Data Collection

A trained research assistant conducted the IDIs and FGD’s. The principal researcher took notes and framed follow-up questions to clarify some points during the discussions. One FGD was conducted by the principal researcher. The FGDs were conducted at the community-based health planning services (CHPS) compounds in the two sub-districts in Nzema East. The Ahanta West FGDs occurred at a community meeting venue in Busua and at a community health centre. The supervisors were also responsible for choosing the venue for the discussions since they had better knowledge of the communities. Permissions were obtained to record the discussion on the digital recorder. The FGDs were conducted in the local languages of the study areas while IDIs were done mostly in English. The interviews lasted approximately 45 minutes. IDI’s were conducted with the supervisors at the sub-district, district, regional and national levels with an interview guide. The interviews were conducted at the participants’ workplaces. Others were done in private meeting rooms or after working hours to ensure privacy. Interviews were recorded with a digital audio recorder. Probes were used to clarify information as the interviews progressed. Questions focused on determining their understanding of the LF MDA programme, data reporting process, problems encountered during the MDA and reporting, specific issues that affect reporting timelines, CHVs approach to the MDA and
reporting, the state of reports received and possible solutions to the problems of data quality enumerated.

4.2.5 Data Analysis

All the data were analysed manually by the principal investigator. The interviews in English were transcribed verbatim by a research assistant after listening to the audio recordings several times. The discussions in the local languages were translated into English. The principal investigator listened to the local language interviews and compared with the transcripts to ensure the full meaning of statements had been conveyed. The transcripts were analysed using a thematic content analysis approach (Green & Thorogood, 2014). Common themes based on the subheading of reporting process, problems encountered during MDA and reporting, reasons for untimely and inaccurate reports were identified and grouped.

4.2.6 Ethical Clearance

Ethical clearance was obtained from the Ghana Health Service Ethical Review Committee (GHS-ERC: 13/11/12). Verbal consent was obtained from all participants in the study both to participate and record the interview sessions. Permission was also obtained from the NTDP and the District Health Directorates. Codes were used to identify participants in the IDIs and FGD transcripts were only identified by the venue of the discussions.

4.3 RESULTS

4.3.1 Characteristics of Participants
The supervisors of the programme were made up of 5 males and 2 females. Three of them had been with the programme since the inception of the LF MDA (12 years). The remaining four supervisors had between one - five years’ experience managing the programme as part of their
job schedules. The majority of CHVs who participated were males (n= 14). Majority of them had one - five years (n=14) experience as CHVs. The CHVs were generally literate and worked as farmers, traders, teachers, community health nurses, self-employed and unemployed persons.

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4.3.2 Selection of CHVs for MDA

CHVs are chosen in two ways; by the community or through self-volunteering. In the early years of the LF elimination programme, community members, chiefs and elders were given the opportunity to nominate individuals with some level of literacy to distribute the drugs. However, this practice was not always appreciated by the community because it appeared relatives of these elders were being favoured over other community members. A literate person in these settings is defined as an individual who can read and write basic English and demonstrate the ability to write their own name. Those usually chosen to fill this role were teachers, retired workers, farmers, traders and secondary school graduates or any other literate person who was willing to participate. One of the sub-districts also had community health nurses acting as volunteers for public health outreach programmes due to the small number of volunteers in that sub-district. Other requirements were their ability to keep confidential
information, being approachable and having the respect of the community. All the CHVs interviewed had more than two rounds experience in distributing the drugs in the community.

4.3.3 LF MDA process and reporting as described by the CHVs and Supervisors

The annual LF MDA begins with a National Review and Stakeholder’s Meeting. At this meeting, regional focal persons and other stakeholders from the LF affected regions in Ghana are invited to review the previous year’s MDA and plan the next MDA. Training is also provided on how to report the treatment coverage, financial and other technical reporting. Training is cascaded from the regional supervisors to district supervisors to the sub-district supervisors who then train the CHVs. After training, a period is set for the MDA, then drugs and registers for the communities are allocated to each volunteer for drug distribution to begin. Even though there is no written down time frame for drug distribution and reporting, the whole process (training to reporting) is usually not expected to exceed four weeks. The CHVs record data on household members in each household they visit. At the end of the distribution period, the CHVs summarise the data in each register and record in the summary section at the end of the register. Sub-district supervisors collect the registers, collate the data and submit to the district health supervisors. District health supervisors also collate data for their districts then submit these to the regional supervisors who ensure treatment coverage has been correctly estimated based on the data they have received. They finally submit the regional data to the programme office at the national level. All interviewees gave similar accounts of the MDA process in their respective districts and did not show a deviation from standard procedure. They were able to recount attending training facilitated by programme officers, which is cascaded down to the volunteers at the community level. CHVs were able to explain how to summarise the data and fill the summary sheets at the end of the registers.

“The supervisor goes for training at Axim DHO (district health office) and when she returns she also comes to organize a workshop for us. After, she tells us the date for the
drug administration so when the date approaches we come for the drugs at the CHPs compound and send to our various target. After administering the drug we bring the outcomes to the supervisor so that she can accumulate the results and write her report.” (CHV, FGD, Nzema East)

“Yes, we were trained before we started to distribute the drugs. Our supervisors made us understand that when we go, we have to write the name of the household head and then we use the stick I talked about to measure the height of the rest of the household. According to the measurement, if you deserve to be given four (tablets of ivermectin), we give you and then add one of the big ones (albendazole tablet)”. (CHV, FGD, Ahanta West)

“.Ok in the first place you see you will be called to the region for TOT (Training of trainer) training and after that, you also come down to train the supervisors. So after training the sub-district supervisors too, we also go to the ground and train the volunteers. We also give them training before maybe we give them the drugs. We do the training in three stages, the region, the district and the sub-district”. (District Supervisor, IDI)

4.3.4 Reasons for delayed reporting

No specific date is set for reporting when the MDA is rolled out by the programme. However, submitting reports 4 weeks after MDA was considered unacceptable. Usually, reminders are sent to Regional focal persons approximately three weeks after completion of MDA in a bid to encourage timeliness. CHVs are given five days to distribute drugs and two extra days for mopping up and reporting. At the end of the seven days, supervisors in the various sub-districts are expected to collect registers from CHVs and compile summaries for each community within the sub-district. The final data is expected to be delivered to the National Programme office within 3-4 weeks after the MDA. The most common reasons given for delayed and inaccurate reporting were:

Low numeracy skills

According to the supervisors, Even though most CHVs are able to write their own names, numeracy skills are generally very low. They are able to fill in records of household members but have difficulty calculating the number of tablets used. Supervisors in both districts indicated that they sometimes calculate the drug doses and this prolongs the
collation process, thereby causing delays in reporting. Interestingly, the CHVs did not readily admit having low numeracy skills affects their ability to calculate properly. In the Nzema East, no CHV expressed difficulty in calculating the summaries. However, those in the Ahanta West indicated it was a tedious process.

“...the common one is the counting of the ivermectin. Sometimes they don’t count them well. As for the albendazole, you can go through and you can pick based on the number of people in the household, but with the ivermectin, always, there are differences.” (District Supervisor, IDI, Ahanta West)

“I don’t have a challenge calculating the summaries.” (CHV, FGD, Nzema East)

“We have to use the pencil to work out the numbers. Especially the ivermectin, you have to give 4, 3, 1. We need calculator to do that. We have to use pencils to do that calculation. The albendazole is easier because those are just one tablet each, so you can easily tell the final figure but calculating the ivermectin is difficult.” (CHV, FGD, Ahanta West)

The CHVs manual method of calculating the summaries gives rise to inaccuracies in the summaries presented. Even though they all appeared confident that they reported accurately, they did indicate that the calculations were tedious and using calculators would make their work much easier.

“When you give the drugs, example you give ivermectin 3 and albendazole 1, the books are big, the population is big so you have to calculate a lot. And that alone can take about 2 days. We have to calculate a lot and it makes the work difficult.” (CHV, FGD, Ahanta West)

“I think we should be given a “Makola” calculator (calculators used in shops). This is not a serious calculation where we’ll need a scientific calculator. Just the regular “Makola” calculator will help make it easier.” (CHV, FGD, Nzema East)

**Physical access to communities in the district**

Distances between communities in the Nzema East Municipality are wide. Roads and paths leading to some of these communities also pass through forests and across rivers. Accessibility is worsened during the rainy season when rivers overflow their banks and become dangerous to cross. These reasons tend to hinder early collection of the MDA
registers from CHVs. Physical accessibility was a concern for CHVs in the Ahanta West district as well. Communities in this district have been expanding due to population growth. This expansion over the years has made drug distribution more tedious and so affects timely drug administration and reporting.

“Instead of crossing the river, I have to use the road, walk 4-5 miles to the community before I get the report and that also causes delay” (District Supervisor, IDI, Nzema East)

“...The places we have to walk is not easy...... there is a lot of mud in our communities”. (CHV, FGD, Ahanta West)

Accessibility is also affected by inadequate access to vehicles and motorcycles. Supervisors in the districts and sub-districts do not always have access to vehicles or motorcycles to enable them to collect reports from the various sub-districts. Even when vehicles or motorcycles are available, funds to buy fuel into them may not be available. This can result in reports being left at the community level for long periods of time until there is resource allocation. This was a general problem in both districts. Sub-district supervisors who usually commute by motorbike complained the most about the meagre fuel allocated for supervisory visits and report collection.

“…getting registers from the community level also delays because most of them (district supervisors) complain of transport to go to the remote areas to pick the registers.” (Regional Supervisor, IDI)

“Our supervisor suffers a lot. Sometimes his motor would not be in good condition so he cannot go round to collect the books. So the supervisor should be equipped so he can go round to collect the books. The other time our supervisor’s (own words) bike got spoilt on the road. We had to take off the tyre and put it in a car to go to the next town (own words) for it to be fixed.” (CHV, FGD, Nzema East)

Inadequate Motivation

The LF MDA gives a minimal monetary incentive compared to other public health programmes so some CHVs volunteer reluctantly. They indicated that even though it was voluntary work, they had to be adequately motivated financially and in other forms. Inadequate motivation or
late payment was not considered a reason to hold on to registers but the low remuneration was a factor in CHVs opting out of the programme. This results in fewer number of CHVs to distribute the drugs, making it difficult to reach the target population within the required time and causing delays in reporting.

“We know it is voluntary work. We serve our nation and our community. The work is difficult. But it’s all part of God’s work. The walking is difficult. Sometimes we go in the morning then we go in the evening. Sometimes we leave our jobs to do this. So there should be a better motivation for the volunteers so it can boost our morale and we can have love for the work.” (CHV, FGD, Ahanta West)

“I believe if we’re given bicycles, it’ll be helpful. That way if our supervisor is unable to come for the books on time, we can bring them to the health centre ourselves.” (CHV, FGD, Nzema East)

“…some opt out when the program starts because when it coincides with cocoa harvesting and the “galamsay” (small-scale gold mining) period, most of them stop and go for the “galamsay” because that one pays better than the MDA so at times because of that it prolongs the treatment” (Regional Supervisor, IDI)

“…..they think the work is so tedious. They think the remuneration is so small and they have to come back to do all those things (calculate summary data)” (District Supervisor, IDI, Ahanta West)

“The money has to come. The volunteers have to get something to motivate them. If funds are raised for them, it’ll increase their “taste” for the job. And we to, (supervisors) you should help us too, we will do our best to spread the message more so we can do the one-on-one and door-to-door” (Sub-district Supervisor, IDI, Nzema East)

Inability to reach community members within given timeframe

The main economic activities in the two districts are fishing, farming, trading and mining. Hence, most households cannot be reached during the day. Suitable times for drug distribution appear to be early morning and evening and this may not give sufficient time to reach the entire population. Some of these communities are also not connected to the national electricity grid so drug distribution at night is not a feasible option for the CHVs in these communities.
“…Because we don’t get the people early. Sometimes when they give you a target to achieve, at the end of the five days you would observe you only have half of the target so sometimes we hold on to the report and announce to people to see if we can achieve our target before we release the report” (CHV, FGD, Nzema East)

“At times we if we are not able to finish before the supervisor comes, we can tell him that some people have not had some of the drugs and because it is important that everyone gets some of the drugs, we add some of the days to it ourselves. Then we go round to do the revisiting.” (CHV, FGD, Ahanta West)

“Some of the problems are to do with absenteeism. When they go to distribute the drugs and they don’t meet anybody, they have to go back. And then they also want their coverage so they keep going back until they meet them and this delays the submission of the returns” (District Supervisor, IDI, Ahanta West)

“… They go to the house and do not meet them. Where I am is a mining area and a farming area so most of the time they go and do not meet them”. (Sub-district Supervisor, IDI, Nzema East)

Supervisors’ workload

Supervision is expected to take place during the MDA to ensure the CHVs are adhering to the protocols and to help solve any problems that may arise. Unfortunately, due to the sub-district and district supervisors’ high workload, these visits do not always occur. This means inspection of registers to ensure accuracy may not take place. Again, CHVs do not always summarise the treatment coverage data at the end of the MDA. This task is thus left to the supervisors who are already burdened with multiple activities. This causes delays in preparing sub-district and district reports. One sub-district supervisor recounted having to summarise data in the registers after realising the CHVs had made a lot of mistakes.

“…We have problems. After giving the medicine, the volunteers, don’t summarise the ivermectin and albendazole. You’ll see that you’ll have to do everything and come and add up” (Sub-district, Supervisor, IDI, Nzema East).

“…the same set of district officers are engaged in other activities so they are multi-sectorial officers and therefore data entry prolongs” (Regional Supervisor, IDI)

Supervisors are not always able to verify and ensure summary data is correct. They indicated that it was tedious checking all the entries before preparing the reports. This also invariably affects the accuracy of the reports submitted.
Timely Release of Implementation Funds

Donor funding delays affect the MDA implementation calendar. The programme sometimes coincides with other Ghana Health Service (GHS) Programmes. The districts may decide to complete these before implementing the LF MDA. These other programmes may also offer more incentives than the LF MDA leading to less attention for the programme.

“Because when there are several activities that coincide with the time of the MDA, and the program comes in with very little money, it is pushed aside and then they go to work on those “rich” programmes before they later look at it so all these cause delays”
(National Supervisor, IDI)

Adherence to reporting deadlines

Regional offices and districts negotiate with the programme office on a schedule which appears to be estimated at two-four weeks. The programme office indicated about 50% of all reports reach the programme office within two-three months after the drug distribution. The minimum number of days mentioned by a CHV for drug distribution was three days in one sub-district, but others indicated a five - ten-day timeframe. Most of the CHVs indicated that they are able to meet their treatment targets within the time they are given.

“We are given three days, so I divide the community into three and use one day for each part. I believe I am able to distribute to about 98% in my target zone.” (CHV, FGD, Nzema East)

There was also an indication that the agreed timetable is usually not adhered to by the districts. So when a two-week schedule is decided on, reports start trickling into the regional health office after a month. Both programme officers and regional supervisors indicated they have made trips to some districts to collect data because the reminders were not being adhered to.

“Reporting, as usual, is also a problem because we have a timeline, timeline for training the districts, timeline for training volunteers, timeline for data submission and timeline for distribution but then they all violate the timelines. Some submit on time but some do not so at times it takes the whole month for instance when it starts on 10th October the report should be submitted at the month end of October. But at times it goes into the following month”. (Regional Supervisor, IDI)
The CHVs also indicated a longer timeframe of about two weeks for drug distribution would be sufficient to achieve a higher coverage. This would ensure there would be fewer absentees in the reports. This may also give supervisors more time to thoroughly check the data that has been collected.

“Yes we are given five days to do the work….. this town is very big, so before you can distribute and do your calculations, you realise that you haven’t completed the work within the five days. So they should give us more time because the work is difficult”.

(CHV, FGD, Ahanta West)

4.4 DISCUSSION

This study set out to identify reasons for the state of poor data quality for the LF control programme. The data quality elements for which barriers were examined are timeliness and accuracy of data.

It was clear that all stakeholders in the implementation process were very familiar with the drug distribution and reporting. The data flow of MDA reports is also well defined and adhered to by all stakeholders. The CHVs understanding of procedures of distribution and reporting was consistent with Gallo et al.’s findings where CHVs showed a good understanding of their role in delivering contraceptive services in Madagascar (Gallo et al., 2013). However, the disparity between the two studies is that actual compliance with reporting procedures was not measured our study.

The standard timeframe agreed on by the programme office and districts, from training till data reporting is approximately two-four weeks, by which time reports were expected to reach the programme office. This does not provide an objective way of measuring timeliness for the programme. This is quite different from a number of studies where timeliness of data was
clearly determined electronically in the health information systems being used. The timestamps
were used to document dates for reporting (Jajosky & Groseclose, 2004; Lo, Yang, Chou,
Chuang, & Chiang, 2011; Yoo et al., 2009). In this study, we found out CHVs regarded their
reporting as timely while supervisors agreed reports are usually submitted late.

Low numeracy skills were found to be one of the factors for delayed reporting and report
inaccuracies. The LF program requires its CHVs to be literate with demonstrated ability to
write their name, which is the norm for many programmes worldwide (Bhattacharyya et al.,
2001; Njomo, Amuyunzu-Nyamongo, Magambo, & Njenga, 2012). The programme and
districts did not have any method of determining numeracy skills even though this was crucial
for the quality of data produced by the CHVs. Based on the professions of some of the CHVs
interviewed, low numeracy skills should not have been a problem for the programme. The
accuracy of data has an enormous impact on the quality of data for any health programme.

The problem of inaccessibility could be solved through the provision of improved access to
transport in the communities. Study participants called for the provision of bicycles and fuel
for motorcycles to make travelling easier. Unfortunately, CHVs in these communities have to
tavel by foot in order to distribute drugs. Supervisors also on the other hand sometimes do not
have the means to move from their offices to these communities to collect registers from CHVs.
Bhattacharyya et al. (2001) indicated some programmes offered bicycles and motorcycles for
CHVs to use for their duties but not to own. This would in itself, serve as motivation for the
CHVs. In 1983, Ofosu-Amaah (1983) also identified inaccessibility of villages and lack of
vehicles or fuel as reasons for difficulties in supervising CHVs. It is interesting to note that this
problem, though identified 30 years ago, is still prevalent today in community health
programmes.
CHVs had also indicated calculating the summaries manually was challenging and would prefer using calculators. Gopalan et al. (2012) reported CHVs difficulties in monitoring community surveys due to their low educational levels. The CHVs in that study found recording community surveys as time-consuming and tricky. CHVs complaint of tedious data calculation and desire to use calculators is a good predictor of the quality of data being submitted. More emphasis should be laid on the reporting component of training. This will ensure CHVs have a better appreciation of the impact of poor reporting.

Low literacy and numeracy is also a reason identified by Mitsunaga et al. (2013) for data inaccuracy and is consistent with our results. Arts et al. (2002) also identified inaccurate data transcription, typing errors, ineligible handwriting, insufficient training, insufficient data checks and calculation errors as reasons for data inaccuracies in medical registries. They acknowledged that these occur during the data collection process.

The major reasons found for delayed reporting suggests that most delays occur after the reports have been submitted to the sub-district and district levels. The numerous challenges faced by the health systems in these communities tend to affect the MDA reporting as well. There was a general complaint regarding tedious compilation of MDA reports and this appears to influence the supervisors’ expected data quality checks. Since this was a qualitative study, findings cannot be generalised for all districts in Ghana. However, reasons like the limited access to transportation, which is a systemic problem in the health sector, could possibly explain delayed reporting in most districts in Ghana. An integrated healthcare delivery approach could be helpful in ensuring resources are maximised by the districts for public health services (Dudley & Garner, 2011; Hope, Kendall, Langer, & Barnighausen, 2014). This will ensure all programmes can be executed with the aim of providing health for all.
Inadequate motivation which was closely related to attrition of CHVs was also considered a factor for delayed and inaccurate records. The researcher did not identify any study on attrition rate of CHVs for NTD programmes. However, a study by Abbey et al. (2014) established an attrition rate of 21.2% in a study on the community-based management of fevers in children under five in the Dangme West District of Ghana. The volunteer community health workers in this study gave reasons such as low remuneration, possible weak sense of social responsibility and negative attitude of caregivers as reasons for attrition. Though attrition was not directly investigated in this study, CHVs indicated low remuneration, arduous task of covering large geographical areas to distribute drugs and lack of other non-monetary incentives as reasons for wanting to leave the programme. The same reasons were shared by supervisors when they discussed attrition of CHVs as one of the causes of delayed and inaccurate reporting. CHVs indicated non-monetary incentives like identification cards, t-shirts, hats, bicycles and preferential treatment at the district hospitals or health centres would compensate for the low remuneration they received for the work they did. These thoughts were expressed even though they understood they were volunteers. Similar findings were reported by Gopalan et al. (2012) in their study on performance motivations of community health workers in India and Bhattacharyya et al. (2001) on community health workers incentives and disincentives.

4.5 CONCLUSIONS

Reasons for the poor state of data for the LF programme are both intrinsic in the CHVs and extrinsic (occurring within the health system). It is also clear from the study that CHVs fully understand their role in the LF MDA process and treatment coverage reporting. Reasons for the present state of the LF MDA treatment reports were; low numeracy skills among CHVs, poor physical access to communities, poor adherence to reporting deadlines, untimely release of implementation funds and supervisor’s workload. Possible remedies to the barriers identified
could be reorienting CHVs on reporting quality data and other non-monetary incentives such as raincoats, boots and identification for CHVs. An integrated healthcare delivery approach, where public health resources are pooled and shared among various health programmes could also help reduce the problem of limited resources. As part of health reforms, the health system can consider creating an opportunity for CHVs to earn wages from activities performed for their communities. Other local donors could also be identified to support the LF MDA programme in the districts. The study has provided an avenue for poor data quality generated through district-level MDAs to be addressed. Understanding the reasons for the poor data quality will help carve ways of improving the quality of the data.
CHAPTER 5

JOURNAL ARTICLE MANUSCRIPT

MOBILE PHONE USE BY COMMUNITY HEALTH VOLUNTEERS IN RURAL GHANA: PATTERNS AND ASSOCIATED CHALLENGES

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Abstract

Background - Community health volunteers (CHVs) deliver important health services to their communities and mobile phones could enhance the tasks they perform. However, little is known about mobile phone use patterns among this group of health service providers in Ghana. This study aimed to determine CHV’s mobile phone use patterns and user reported challenges.

Methods - This was a descriptive cross-sectional study that employed quantitative research methods. All CHVs participating in sub-district mass drug administration (MDA) training and who consented to participate in the study were enrolled. Structured questionnaires were administered to participants. Frequencies and proportions were used to describe the data. Mean, medians and standard deviation were calculated for Likert type questions. Chi-squared tests were used to measure associations. Data were analysed using Stata® 13.

Results - Mobile phone ownership was 94%, with voice calls being the most used function (73%) of the mobile phone, followed by text messages (33%). Use of voice calls was associated with the district of residence while the use of text messaging was associated with education, age, occupation and length of service as CHV. Poor network connectivity was significantly associated with the district (p=0.046), age (p=0.046) and mobile phone ownership (p<0.001).

Conclusion - Mobile phone ownership and use are almost universal among CHVs. Major use challenges were poor network connectivity and lack or inadequate electricity. The high
ownership and usage of mobile phones may be an opportunity for engagement in harnessing mHealth for health service delivery in the communities during the MDA.

**Keywords:** community health workers, mobile phone ownership, mobile phone use challenges

### 5.1 INTRODUCTION

Worldwide, mobile phones have become important tools for healthcare delivery in both developed and developing countries (Grameen Foundation, 2015; Mechael et al., 2010). Mobile phones have been reported as useful for data collection, health promotion, clinical point-of-care, disease surveillance and many more (Mechael et al., 2010). Due to these reasons, a number of studies have been conducted to assess the potential for use among specific healthcare cadres. Perosky et al. (2015) found improved data reporting as a benefit of health workers using mobile phones. Jennings, Ong’ech, Simiyu, Sirengo, and Kassaye (2013) and Martínez-Ramos, Cerdán, and López (2009) also identified positive impacts on health promotion and improved post-operative follow-up respectively in their studies.

Physicians, nurses, midwives and other health professionals have been the cadres usually engaged in using mobile phones for healthcare delivery (Andreatta et al., 2011; Gautham, Iyengar, & Johnson, 2015; Tuijn et al., 2011; Zurovac et al., 2011). Other studies utilising mobile phones have involved caregivers in home management of disease conditions (Haberer, Kiwanuka, Nansera, Wilson, & Bangsberg, 2010; Otieno et al., 2014; Zurovac et al., 2013). An important group of health workers who can potentially use mobile phones for health service delivery are community health volunteers (CHVs). They are not considered health professionals since they are not formally trained. However, CHVs provide essential health services in developing countries, especially in settings where there are known shortages and mal-distribution of trained health professionals (The Earth Institute, 2013). Community health
volunteers are typically community members who have been trained to offer limited health-related services such as the distribution of insecticide-treated nets (ITN), mass drug administration (MDA), maternal and child health and primary healthcare (Nkonki et al., 2011). They may also be referred to as community health workers (CHWs) or community drug distributors (CDDs). In this paper, they will be known as CHVs.

One of the foremost reasons for the use of mobile phones for healthcare delivery is to overcome disparities in access to health services in remote communities. Therefore, a better understanding of access, ownership and usage patterns of mobile phones among CHVs is warranted. Ghana’s ICT for Accelerated Development (ICT4AD) policy has an objective “to utilize ICTs as a tool for collecting community information, linking healthcare professionals and enhancing health administration, remote diagnostics, and distribution of medical supplies” (Government of Ghana, 2003). Community health volunteers have become important for capturing data at the community level for a number of public health programmes, which is later used for decision making. Therefore, the country’s bid to incorporate ICT into health sector activities needs to harness CHVs as an opportunity. A few studies have engaged CHVs in using mobile phones to support one public health programme or another. Some studies have shown positive outcomes such as improved data collection while others were less successful due to poor uptake by the targeted users (Chaiyachati et al., 2013; Madon et al., 2014). One important aspect of determining technology acceptance among any group of people is to determine their level of knowledge and engagement of ICT tools in general or for their specific task. This can help gauge potential success and type of training needed to achieve successful implementation of the technology. Currently, little is known about CHVs use and access to mobile phones in Ghana. This study thus set out to determine the CHVs mobile phone
ownership and use, factors associated with use and challenges associated with the use of mobile phones.

5.2 MATERIALS AND METHODS

5.2.1 Study design

This was a cross-sectional study. Data was collected from the first group of study participants in the first year while the remainder of the participants who joined the study in the second year were interviewed with the same tool in the second year of the study. Each CHV was interviewed once at each round of data collection.

5.2.2 Sampling and sample size

All CHVs attending the lymphatic filariasis (LF) mass drug administration (MDA) training in their sub-districts were recruited to participate. Community health volunteers who could not attend the MDA training and could be traced to their communities were interviewed in their respective communities. A total of 226 CHVs were interviewed; 153 from the Ahanta West district and 73 from Nzema East Municipality. In 2014 (T1), 157 CHVs participated in the study, while 155 participated in 2015 (T2). This was a survey of all CHVs participating in MDA training from the selected locations.

5.2.3 Data Collection and Instrument

The questionnaires (Appendix 5) were administered in both English and the local language. All CHVs who were present at the sub-district MDA training who consented were interviewed using a structured questionnaire. A few who were not present at the training were followed up in their communities and interviewed as well. In the second year of the study, new CHVs who had not participated in the previous years’ MDA were interviewed (n=69). The questionnaires
were structured and were mostly interviewer-administered by trained research assistants. The data collection instrument had 6 questions covering socio-demographic characteristics of study participants, 6 questions on mobile phone use, 9 Likert-type statements on usage challenges and 3 questions on the mobile phone sharing patterns. Questions on mobile phone functions used, sharing patterns and usage challenges were 5-scale Likert-type statements.

5.2.4 Data Analysis

Data were entered into MS Excel 2013 for cleaning and validation and analysed using Stata® version 13. Variables such as age, occupation and number of years working as CHV transformed into appropriate categorical data for analysis. Occupation was categorised according to the DHS 2008 criteria (Ghana Statistical Service, Ghana Health Service, & ICF Macro, 2009). Frequencies and proportions were used to describe the data. Pearson chi-square tests were calculated to determine relationships across districts. Functions used on the mobile phone were measured using a 5-point Likert-type scale where “Never” was coded as 1 to “Always” which was coded as 5. The mode, median and frequencies were calculated to analyse this variable. Mobile phone usage challenges were also coded as 1 for “Strongly disagree” to 5 as “Strongly Agree”. Reliability of Likert scales was measured using Cronbach’s alpha coefficient.

5.2.5 Ethical Clearance

Ethical clearance was obtained from the Ghana Health Service for this study (GHS-ERC: 13/11/12). Permission was sought from the District Health Directorate in each study site. Each participant provided informed consent prior to each interview.
5.3 RESULTS

5.3.1 Socio-demographic characteristics

The CHVs were mostly male (73%) with Nzema East having the highest percentage of male participants (89%). The mean age was 35 years with a higher proportion (41.2%) between ages 20 to 29. Thirty-six percent (36%) had Senior High School or Vocational education. This was same in both districts with Ahanta West having 57 (37.3%) CHVs who have completed High School or Vocational training and Nzema East with 24 (33%). This was closely followed by participants with Middle School education in the Ahanta West district (31.4%). In both districts, 27% of CHVs were employed in the agricultural sector. However, Nzema East had 29% of participants in the Professional and Technical sector. Participants had served for an average of 6 years in Nzema East as CHVs. In Ahanta West, 37% of participants had served for over 11 years in their communities. Table 5.1 shows the socio-demographic characteristics of study participants.
Table 5.1- Socio-demographic characteristics of study participants in Ahanta West and Nzema East

<table>
<thead>
<tr>
<th>Variable</th>
<th>Districts</th>
<th>Ahanta West n (%)</th>
<th>Nzema East n (%)</th>
<th>Total n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age Group (N = 221)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below 20</td>
<td></td>
<td>10 (6.76)</td>
<td>2 (2.74)</td>
<td>12 (5.43)</td>
</tr>
<tr>
<td>20 – 29</td>
<td></td>
<td>58 (39.19)</td>
<td>33 (45.21)</td>
<td>91 (41.18)</td>
</tr>
<tr>
<td>30 – 39</td>
<td></td>
<td>24 (16.22)</td>
<td>18 (24.66)</td>
<td>42 (19.0)</td>
</tr>
<tr>
<td>40 – 49</td>
<td></td>
<td>16 (10.81)</td>
<td>13 (17.81)</td>
<td>29 (13.12)</td>
</tr>
<tr>
<td>Above 50</td>
<td></td>
<td>40 (27.03)</td>
<td>7 (9.59)</td>
<td>47 (21.27)</td>
</tr>
<tr>
<td><strong>Sex (N = 226)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td>100 (65.36)</td>
<td>65 (89.04)</td>
<td>165 (73)</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td>53 (34.64)</td>
<td>8 (10.96)</td>
<td>61 (26.99)</td>
</tr>
<tr>
<td><strong>Highest Education</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle School</td>
<td></td>
<td>48 (31.37)</td>
<td>17 (23.29)</td>
<td>65 (28.76)</td>
</tr>
<tr>
<td>JSS/JHS</td>
<td></td>
<td>31 (20.26)</td>
<td>11 (15.07)</td>
<td>42 (18.58)</td>
</tr>
<tr>
<td>SSS/SHS/Vocational</td>
<td></td>
<td>57 (37.25)</td>
<td>24 (32.88)</td>
<td>81 (35.84)</td>
</tr>
<tr>
<td>Tertiary</td>
<td></td>
<td>17 (11.11)</td>
<td>21 (28.77)</td>
<td>38 (16.81)</td>
</tr>
<tr>
<td><strong>Occupation (N = 210)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clerical / Secretarial</td>
<td></td>
<td>6 (3.92)</td>
<td>4 (5.48)</td>
<td>10 (4.42)</td>
</tr>
<tr>
<td>Professional / Technical</td>
<td></td>
<td>10 (6.54)</td>
<td>21 (28.77)</td>
<td>31 (13.72)</td>
</tr>
<tr>
<td>Sales / Services</td>
<td></td>
<td>26 (16.99)</td>
<td>8 (10.96)</td>
<td>34 (15.04)</td>
</tr>
<tr>
<td>Skilled manual craftsman</td>
<td></td>
<td>15 (9.8)</td>
<td>7 (9.59)</td>
<td>22 (9.73)</td>
</tr>
<tr>
<td>Unskilled manual labour</td>
<td></td>
<td>5 (3.27)</td>
<td>6 (8.22)</td>
<td>11 (4.87)</td>
</tr>
<tr>
<td>Agricultural</td>
<td></td>
<td>40 (26.14)</td>
<td>20 (27.4)</td>
<td>60 (26.55)</td>
</tr>
<tr>
<td>Student</td>
<td></td>
<td>12 (7.84)</td>
<td>3 (4.11)</td>
<td>15 (6.64)</td>
</tr>
<tr>
<td>Unemployed</td>
<td></td>
<td>24 (15.69)</td>
<td>3 (4.11)</td>
<td>27 (11.95)</td>
</tr>
<tr>
<td><strong>Service as CHVs (years)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 1 year</td>
<td></td>
<td>12 (7.84)</td>
<td>16 (21.92)</td>
<td>28 (12.39)</td>
</tr>
<tr>
<td>1 – 5</td>
<td></td>
<td>54 (35.29)</td>
<td>32 (43.84)</td>
<td>86 (38.05)</td>
</tr>
<tr>
<td>6 – 10</td>
<td></td>
<td>34 (22.22)</td>
<td>18 (24.66)</td>
<td>52 (23.01)</td>
</tr>
<tr>
<td>11+</td>
<td></td>
<td>53 (34.64)</td>
<td>7 (9.59)</td>
<td>60 (26.55)</td>
</tr>
<tr>
<td><strong>Other MDA Experience</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td></td>
<td>134 (87.58)</td>
<td>54 (73.97)</td>
<td>188 (83.19)</td>
</tr>
<tr>
<td>No</td>
<td></td>
<td>19 (12.42)</td>
<td>19 (26.03)</td>
<td>38 (16.81)</td>
</tr>
</tbody>
</table>

*Missing values for age and occupation
JSS / JHS : Junior Secondary School / Junior High School
SSS / SHS : Senior Secondary School / Senior High School

5.3.2 Mobile phone and other ICT use among CHVs

Mobile phone ownership was 94% among participants and those who have access but do not own mobile phones were 5%. This was followed by computer ownership and access (laptop/desktop) at 31%. A third of participants (32%) spent less than GHS 5 on mobile phone airtime per week and between 10 minutes to 1 hour talk time on their phones. About 123 (60%) had computer use history and 58% usage was for playing games, followed by browsing the internet (55%) and word processing (54%). The details of mobile phone and other ICT use can be found in Table 5.2.
### Table 5.2 - CHVs Mobile Phone and other ICT devices used in the study areas

<table>
<thead>
<tr>
<th>Variable</th>
<th>Districts</th>
<th>Distincts</th>
<th>Total</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ahanta West n (%)</td>
<td>Nzema East n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ever Used Computers (n=204)</td>
<td>Yes</td>
<td>80 (57.14)</td>
<td>43 (67.19)</td>
<td>123 (60.29)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>60 (42.86)</td>
<td>21 (32.81)</td>
<td>81 (39.71)</td>
</tr>
<tr>
<td>Type of Usea (N=123)</td>
<td>Word processing</td>
<td>47 (58.75)</td>
<td>19 (44.19)</td>
<td>66 (53.66)</td>
</tr>
<tr>
<td></td>
<td>Email</td>
<td>19 (23.75)</td>
<td>9 (20.93)</td>
<td>28 (22.76)</td>
</tr>
<tr>
<td></td>
<td>Internet browsing</td>
<td>47 (58.75)</td>
<td>21 (48.84)</td>
<td>68 (55.28)</td>
</tr>
<tr>
<td></td>
<td>Play games</td>
<td>48 (60.0)</td>
<td>23 (53.49)</td>
<td>71 (57.72)</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>16(20.0)</td>
<td>5 (11.63)</td>
<td>21 (17.07)</td>
</tr>
<tr>
<td>Device Useda (Own / Have access)</td>
<td>Mobile Phone</td>
<td>150 (98.04)</td>
<td>73 (100.00)</td>
<td>223 (98.67)</td>
</tr>
<tr>
<td></td>
<td>Landline Telephone</td>
<td>7 (4.58)</td>
<td>10 (13.70)</td>
<td>17 (7.52)</td>
</tr>
<tr>
<td></td>
<td>Laptop/Desktop computer</td>
<td>48 (31.37)</td>
<td>21 (28.77)</td>
<td>69 (30.53)</td>
</tr>
<tr>
<td></td>
<td>Tablet</td>
<td>7 (4.58)</td>
<td>3 (4.11)</td>
<td>10 (4.42)</td>
</tr>
<tr>
<td></td>
<td>Internet modem</td>
<td>24 (15.69)</td>
<td>13 (17.81)</td>
<td>37 (16.37)</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>7 (4.58)</td>
<td>2 (2.74)</td>
<td>9 (3.98)</td>
</tr>
<tr>
<td>Do you own a smartphone?</td>
<td>Yes</td>
<td>83 (54.25)</td>
<td>44 (60.27)</td>
<td>127 (56.19)</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>42 (27.45)</td>
<td>25 (34.25)</td>
<td>67 (29.65)</td>
</tr>
<tr>
<td></td>
<td>Don’t know</td>
<td>17 (11.11)</td>
<td>1 (1.37)</td>
<td>18 (7.96)</td>
</tr>
<tr>
<td>Average Mobile Phone Talk time per day</td>
<td>Up to 10 minutes</td>
<td>15 (9.8)</td>
<td>8 (10.96)</td>
<td>23 (10.18)</td>
</tr>
<tr>
<td></td>
<td>&gt;10 min &lt; 1 hour</td>
<td>55 (35.95)</td>
<td>25 (34.25)</td>
<td>80 (35.4)</td>
</tr>
<tr>
<td></td>
<td>1 – 2 hours</td>
<td>37 (24.18)</td>
<td>18 (24.66)</td>
<td>55 (24.34)</td>
</tr>
<tr>
<td></td>
<td>Over 2 hours</td>
<td>28 (18.3)</td>
<td>14 (19.18)</td>
<td>42 (18.58)</td>
</tr>
<tr>
<td></td>
<td>Don’t know</td>
<td>18 (11.76)</td>
<td>8 (10.96)</td>
<td>26 (11.50)</td>
</tr>
<tr>
<td>Average Expenditure on airtime per week</td>
<td>Less than GHC5</td>
<td>60 (39.22)</td>
<td>12 (16.44)</td>
<td>72 (31.66)</td>
</tr>
<tr>
<td></td>
<td>GHC5 – GHC9</td>
<td>39 (25.49)</td>
<td>20 (27.4)</td>
<td>59 (26.11)</td>
</tr>
<tr>
<td></td>
<td>GHC10 – GHC14</td>
<td>29 (18.95)</td>
<td>25 (34.25)</td>
<td>54 (23.89)</td>
</tr>
<tr>
<td></td>
<td>More than GHC15</td>
<td>20 (13.07)</td>
<td>12 (16.44)</td>
<td>32 (14.16)</td>
</tr>
<tr>
<td></td>
<td>Don’t know</td>
<td>5 (3.27)</td>
<td>4 (5.48)</td>
<td>9 (3.98)</td>
</tr>
</tbody>
</table>

aMultiple answers possible

The most common use of mobile phones was for voice calls (73%) and text messaging use was 33%. As shown in Figure 5.1, use of other functions such as social networking, emails, Internet browsing and camera were minimal.
Most used functions being voice calls were associated with district CHVs belonged to. Text messaging was associated with education, age, occupation and length of service as CHV. This is shown in Table 5.3.

**Table 5.3: Association between most used phone functions and socio-demographic factors**

<table>
<thead>
<tr>
<th>Socio-demographic factors</th>
<th>Voice Calls X²</th>
<th>P - value</th>
<th>Text X²</th>
<th>P - value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>12.93</td>
<td>0.678</td>
<td>58.98</td>
<td>0.000</td>
</tr>
<tr>
<td>Sex</td>
<td>1.81</td>
<td>0.771</td>
<td>1.37</td>
<td>0.849</td>
</tr>
<tr>
<td>Education</td>
<td>11.3315</td>
<td>0.501</td>
<td>52.81</td>
<td>0.000</td>
</tr>
<tr>
<td>Occupation</td>
<td>31.698</td>
<td>0.287</td>
<td>64.44</td>
<td>0.000</td>
</tr>
<tr>
<td>Length of Service as CHV</td>
<td>17.72</td>
<td>0.125</td>
<td>32.07</td>
<td>0.001</td>
</tr>
<tr>
<td>Other MDA Experience</td>
<td>2.33</td>
<td>0.676</td>
<td>4.71</td>
<td>0.319</td>
</tr>
<tr>
<td>District</td>
<td>14.03</td>
<td><strong>0.007</strong></td>
<td>3.45</td>
<td>0.485</td>
</tr>
</tbody>
</table>

**5.3.3 Challenges with using Mobile Devices**

A number of mobile phone usage challenges were identified in this study as seen in Table 5.4. These included dropped calls and inadequate network coverage, poor electricity supply, inadequate privacy when using the phone, and fear of losing mobile phones.
Telecommunication network challenges (p=0.046) and electricity access (p=0.008) were both significantly associated with the districts. Age was significantly associated with all the mobile phone usage challenges analysed in this study. Sex and education were not significantly associated with the mobile usage challenges outlined. Having difficulty using phones (p=0.034) and not trusting the use of mobile phones (p=0.047) was associated with occupation. Mobile phone ownership had a highly significant relationship with all the mobile phone usage challenges (p<0.001).
Table 5.4 – Association between mobile phone use challenges and other factors

<table>
<thead>
<tr>
<th>Statement</th>
<th>Median*</th>
<th>Frequency n (%)</th>
<th>District</th>
<th>Age</th>
<th>Sex</th>
<th>Education</th>
<th>Occupation</th>
<th>Mobile Phone Ownership</th>
<th>Mobile Phone Talk time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Network problems – dropped calls, network failure – affect mobile phone usage</td>
<td>4</td>
<td>71 (31.42)</td>
<td>0.046</td>
<td>0.046</td>
<td>0.636</td>
<td>0.928</td>
<td>0.794</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>b. Lack of constant electricity/Power outages affect mobile phone usage</td>
<td>4</td>
<td>65 (28.76)</td>
<td>0.008</td>
<td>0.004</td>
<td>0.266</td>
<td>0.238</td>
<td>0.538</td>
<td>0.000</td>
<td>0.063</td>
</tr>
<tr>
<td>c. Access to electricity affects mobile phone usage</td>
<td>4</td>
<td>75 (33.19)</td>
<td>0.274</td>
<td>0.02</td>
<td>0.92</td>
<td>0.284</td>
<td>0.309</td>
<td>0.000</td>
<td>0.120</td>
</tr>
<tr>
<td>d. I am not very good in using mobile phones</td>
<td>2</td>
<td>84 (37.17)</td>
<td>0.297</td>
<td>0.000</td>
<td>0.646</td>
<td>0.144</td>
<td>0.034</td>
<td>0.000</td>
<td>0.038</td>
</tr>
<tr>
<td>e. I do not trust in mobile phones</td>
<td>2</td>
<td>81 (35.84)</td>
<td>0.405</td>
<td>0.010</td>
<td>0.7</td>
<td>0.444</td>
<td>0.047</td>
<td>0.000</td>
<td>0.041</td>
</tr>
<tr>
<td>f. I think someone can monitor my calls</td>
<td>2</td>
<td>65 (28.76)</td>
<td>0.160</td>
<td>0.007</td>
<td>0.533</td>
<td>0.583</td>
<td>0.316</td>
<td>0.000</td>
<td>0.425</td>
</tr>
<tr>
<td>g. I am afraid my mobile phone will be stolen</td>
<td>4</td>
<td>74 (32.74)</td>
<td>0.199</td>
<td>0.081</td>
<td>0.89</td>
<td>0.648</td>
<td>0.065</td>
<td>0.000</td>
<td>0.374</td>
</tr>
<tr>
<td>h. My mobile phone has been stolen before</td>
<td>4</td>
<td>57 (25.22)</td>
<td>0.600</td>
<td>0.009</td>
<td>0.178</td>
<td>0.489</td>
<td>0.243</td>
<td>0.000</td>
<td>0.108</td>
</tr>
<tr>
<td>i. I know of someone whose mobile phone has been stolen</td>
<td>4</td>
<td>83 (36.73)</td>
<td>0.745</td>
<td>0.011</td>
<td>0.798</td>
<td>0.322</td>
<td>0.756</td>
<td>0.000</td>
<td>0.014</td>
</tr>
</tbody>
</table>

*Likert scale ranged from 1-Strongly Disagree to 5 – Strongly Agree
5.4 DISCUSSION

Mobile phones were the most commonly used ICT tools. There were high ownership and access to mobile phones among participants. These findings are not surprising owing to international statistics that indicate high mobile phone subscriptions in both developed and developing countries (International Telecommunication Union, 2016). Recent data from the National Communications Authority (NCA) also shows high mobile phone subscriptions in Ghana, even though this data has not been disaggregated by region or communities (National Communications Authority, 2016a). A study in Uganda also showed high mobile phone ownership (93%) among CHWs (Chang et al., 2013). The ubiquitous nature of mobile phones in the country shows these devices could be potentially harnessed in many ways. Community health volunteers could be potential actors or receivers of a number of mHealth initiatives such as data collection or receiving health education messages for health promotion activities. It provides an opportunity for innovation in mHealth that could benefit communities that have inadequate access to healthcare.

A lack or inadequate access to electricity appeared not to have an effect on mobile phone ownership. Some participants from these communities reported the ability to use their phones in spite of this challenge. While lack of electricity has been reported by Gagnon, Ngangue, Payne-Gagnon, and Desmartis (2016) as a barrier to mHealth acceptance, this study reveals residents in rural areas appear to have adopted innovative ways of keeping their mobile phones functional in spite of this challenge. It must be noted that this study was conducted during a period of national electricity load shedding in Ghana. Some communities in the study areas were also not connected to the national electricity grid. Lack of electricity and network connectivity challenges were associated with the district. Though there is high ownership, actual everyday use of the phones may be low. This study, however, did not measure the
frequency of phone use or total cost of maintaining the phones. The cost of maintaining the phone could impact on an individual’s income and may determine how often the phone may be used. A mHealth project will, therefore, need to make provision for energy backup to ensure mobile phones can be kept on for project activities.

Among mobile phone owners, voice calls were the most used function followed by text messaging. This is comparable to the study by Zurovac et al. (2013) who found a similar pattern among caregivers and adult patients in Kenya. Profile of these caregivers and adult patients are similar to the CHVs in this study who are not professional health workers. Voice calls were associated with the district of residence of the CHV while SMS was associated with education, age, occupation and time served as CHV. Minimal use of text messaging among the CHVs has implications for mHealth projects that may utilise SMS as a medium for communication. SMS is a common protocol available on all types of phones and has been used for data collection in a number of settings (Andreatta et al., 2011; Anhoj & Moldrup, 2004). A lot of time may be needed to train CHVs first to familiarise them with SMS and secondly to help them gain an understanding of the required task. This could increase the length of time for project implementation and translate into high cost of projects. While some level of literacy is needed to effectively use SMS as shown by the association with education, enhanced training for less literate health workers could be provided. Aggregated data can easily be submitted by CHVs via SMS, given that they are provided with the requisite training. Also, SMS is cheaper than some other forms of data reporting, such as voice messaging and interactive voice response (IVR) (Crawford et al., 2014). This makes it a more sustainable platform to use for communication in mHealth programmes.
The most noted challenge of mobile phone usage was poor network connectivity. This was associated with the district the CHVs belonged to. This, however, does not seem to be a deterrent to mobile phone ownership and use. Participants possibly had devised ways of overcoming the poor network quality, thus reducing the impact of the challenge. There are usually hills or areas of high elevation in the communities where an adequate network signal could be obtained. These challenges become important when mobile phone users in these areas are being engaged in activities such as data collection or other surveillance activities. Large-scale mHealth projects may need government support to engage telecommunication network companies to improve service in those rural areas (Novartis Foundation, undated). A review by Ganesan, Prashant, and Jhunjhunwala (2012) identified network connectivity in rural areas as a major challenge. Data collection and submission could delay or result in undelivered messages. Communication among health teams could also be affected and hamper the success of mHealth programmes.

5.5 CONCLUSION
This study found that the most used ICT tool among CHVs is the mobile phone. The use of SMS was associated with age, education, occupation and length of service as CHVs. Usage challenges identified did not necessarily hamper ownership and use of the phones. The high ownership and usage of mobile phones may also be an opportunity for further engagement in harnessing this resource for data collection in the communities during the LF MDA. Measures would have to be put in place to manage the challenges identified. Network challenges should be assessed in specific communities before the roll-out of any mHealth project.
5.6 RECOMMENDATIONS

The CHVs in this study are not averse to technology. Their high ownership and access to mobile phones can be harnessed by training them in ICT to enable them play a bigger role in ensuring mass public health data quality is improved from the communities. Efforts will have to be made by the government and relevant stakeholders to improve telecommunication services in these areas. This will further enhance the use of ICT in fields such as health, agriculture and many other sectors. There also appears to be an age group shift, with younger CHVs gradually replacing the older CHVs for public health functions. Their expertise in using more functions on their phones will further enhance the ability of the Ghana Health Service to implement its ICT strategy of improved data capturing from community level into its HMIS.
CHAPTER 6
JOURNAL ARTICLE MANUSCRIPT

COMMUNITY HEALTH VOLUNTEERS ACCEPTANCE AND USE OF MOBILE PHONES FOR MASS DRUG ADMINISTRATION DATA REPORTING

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Proposed Journal: BMC Medical Informatics and Decision Making

Abstract

Background - Few mHealth projects have shown promise of scale-up. One challenge leading to this is the end-users unwillingness to accept the mobile phone as a tool for healthcare delivery. The lymphatic filariasis control programme is seeking to improve community level data reporting through community health volunteers (CHVs). However, CHVs acceptance to use mobile phones for health data reporting is not known. Using the UTAUT model, this study sought to assess CHVs willingness to accept and use mobile phones to report mass drug administration (MDA) reports.

Methods - This was a cross-sectional mixed methods study with data collected over two consecutive years. All CHVs attending the pre-MDA training in the sub-district were recruited to participate in this study. A structured questionnaire was administered to CHVs in the first year (T1). They were also trained to submit their summary MDA report via SMS. In-depth interviews were conducted on a selection of CHVs after the first round data collection. In year two (T2), new CHVs who had joined the existing group of CHVs for MDA were also recruited into the study and the questionnaire was administered to them. Frequencies and proportions were used to describe the data. The determinants of UTAUT were analysed using generalised
structural equation modelling (GSEM). In-depth interviews were coded and analysed by themes.

**Results** - The determinants of intention to use were not significant in this study. However, behavioural intention was a significant determinant of actual use in T1. Experience using mobile phones was also a determinant of actual use in T2. Qualitative results showed a mostly positive performance expectancy, while effort expectancy garnered more negative comments. The main determinants of actual use were incentives and volunteerism.

**Conclusion** - This study has shown that behavioural intention, effort expectancy moderated by sex and facilitating conditions should be considered when considering deployment of mobile phones for LF MDA reporting among CHVs.

**Keywords:** UTAUT, community health workers, mHealth, technology acceptance

### 6.1 INTRODUCTION

Mobile phones have become essential tools in public health service delivery (Khatun et al., 2015). These tools are being used for health education and promotion, data collection and reporting, disease surveillance, treatment adherence, emergency medical response and clinical point-of-care (Aggarwal, 2012; Andreatta et al., 2011; Chib et al., 2012; Crawford et al., 2014; Kelly, 2009; Mechael et al., 2010; Yu, de Courten, Pan, Galea, & Pryor, 2009). While mobile phones have shown great promise, few projects and pilots have shown scalability and sustainability (Tomlinson et al., 2013). One identified barrier for sustainability is the end-users unwillingness to adopt the new technology (Mechael et al., 2010). Technology acceptance has been defined as an attitude towards the technology being introduced and is a process that leads to adoption (Renaud & Biljon, 2008). This attitude is influenced by various factors such as demographics, perceived usefulness and ease of use, the intention to use and actual use of the technology (Davis, 1989; Venkatesh & Davis, 2000; Venkatesh et al., 2003). Determining an
individual or group of users’ acceptance of a specific technology is a step towards ensuring successful deployment of the technology.

Research is needed to clarify how the benefits of technology for health care delivery can be translated into acceptance and sustained. One of the ways of ensuring sustainability is determining acceptance of the technology after piloting (Schaper & Pervan, 2007). Theories such as the technology acceptance model (TAM), theory of planned behaviour (TPB), unified theory of acceptance and use of technology (UTAUT) and others have been useful in identifying determinants of technology acceptance (Ajzen, 1991; Davis, 1989; Venkatesh et al., 2003). Determinants of technology acceptance are perceived usefulness of the technology for a task, the perceived ease of using the technology, attitude, subjective norm or social influence, external variables or facilitating conditions and the individual’s intention to use the technology. Additional factors have been considered in these models based on the population and context of the study.

The acceptance of mobile phones for specific jobs or activities have also been studied among different populations (Carlsson, Carlsson, Hyvönen, Puhakainen, & Walden, 2006; Ndayizigamiye & Maharaj, 2016). In healthcare, it has mostly focused on doctors and nurses with little attention to other healthcare fields (Schaper & Pervan, 2007). It has been noted that different factors influence different cadres of health professionals (Ward, 2013). In this study, community health volunteers (CHVs) were engaged to submit lymphatic filariasis (LF) mass drug administration (MDA) data reports using mobile phones. The reports are normally summarised from the MDA in specially designed registers and submitted to the Neglected Tropical Diseases Control Programme (NTDP) through the sub-district, district and regional health administrations. The CHVs are an extension of the health workforce and play an
important role in liaising between the formal healthcare delivery system and the community (Bhattacharyya et al., 2001). The CHVs perform activities such as health promotion, case management, home visits, drug distribution and many other roles (Acharya et al., 2016; Brown et al., 2006; Crispin et al., 2012). They are not formally trained health professionals but receive training based on activities they are required to perform (Lehmann & Sanders, 2007). The NTDP depends on the CHVs not only to distribute the preventive chemotherapy drugs to the population but also provide a report of their activities which informs decision making and planning for the programme. Using mobile phones for reporting could prove valuable to the programme, however, there is no evidence that reporting with mobile phone technology would be acceptable to this group. The literature review did not identify studies that have assessed mobile phone technology acceptance for MDA reporting among CHVs even though CHVs are being engaged in mHealth pilots worldwide (Braun et al., 2013). There is also little evidence for mHealth in the Neglected Tropical Diseases (NTD) mass drug administration (MDA) context and this study seeks to fill the identified knowledge gap and to assess CHVs willingness to accept and use mobile phones to submit MDA reports (Madon et al., 2014; Pavluck et al., 2014; Stanton et al., 2015).

6.1.1 The model

The Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT) have proved useful for assessing technology acceptance in healthcare (Holden & Karsh, 2010; Kijsanayotin, Pannarunothai, & Speedie, 2009). The two models are grounded in psychology and sociology and seek to study human attitudes and antecedents to planned behaviour. The TAM is based on the Theory of Reasoned Action (TRA) and states that a person’s behaviour is predetermined by their behavioural intention which is a function of their attitude and subjective norm towards that behaviour. The TAM postulates that
perceived usefulness (PU) and perceived ease of use (PEOU) are determinants of a users’ intention to use a specific type of technology. PU is the user’s perception that a specific type of technology would improve their performance on a job or activity and PEOU is the degree to which the user expects the use of the technology to be free of effort (Davis et al., 1989). TAM proved useful and has gained considerable support in the field of Information Systems. A detailed assessment of TAM’s determinants of usage intentions showed PU was a strong determinant of usage intentions. It was, therefore, necessary to have a better understanding of the determinants of PU and understand how the effects of these determinants change over time (Venkatesh & Davis, 2000). This resulted in the extended TAM called TAM2. This model included other determinants such as social influence, experience, voluntariness, job relevance, output quality and result demonstrability. In further assessing acceptance models, Venkatesh et al. (2003) combined eight prominent technology acceptance models and proposed the Unified Theory of Acceptance and Use of Technology (UTAUT) (Ajzen, 1991; Bandura, 1986; Davis, 1993; Davis, Bagozzi, & Warshaw, 1992; Fishbein & Ajzen, 1975; Rogers, 1995; Taylor & Todd, 1995b; Thompson et al., 1991; Venkatesh & Davis, 2000). The UTAUT final model consists of three direct determinants of behavioural intention (performance expectancy (PE), effort expectancy (EE), social influence (SI)); and two direct determinants of actual use (behavioural intention (BI) and facilitating conditions (FC)). In addition, four moderator variables; age, sex, experience and voluntariness influence the determinants of behavioural intention and actual use in the model (Figure 6.1).
The UTAUT was found to outperform all the eight other models by predicting about 70% of the variance in intention to use (Venkatesh et al., 2003). Due to its robustness, it has since been used to assess technology acceptance in a number of settings and contexts (Carlsson et al., 2006; Ndayizigamiye & Maharaj, 2016; Simeonova, Bogolyubov, Blagov, & Kharabsheh; Tibenderana, Ogao, Ikoja-Odongo, & Wokadala, 2010). Venkatesh et al. (2003) however, suggested it was important for other studies to extend the usefulness of this model. There was the need to assess it in developing country settings, using other emerging technology and in various work settings.

UTAUT has been applied in various studies such as those assessing determinants of health information technology acceptance, acceptance of telemedicine among patients and clinicians and acceptance of internet banking among others (Kijsanayotin et al., 2009; Kohnke, Cole, & Bush, 2014; Sok Foon & Chan Yin Fah, 2011). In these examples, other moderators or direct
determinants of BI and actual use were introduced to suit their specific contexts. Other factors that have been included in the UTAUT and TAM model by other researchers include threat appraisals, culture, education, attitude and the healthcare context (Carlsson et al., 2006; Holden & Karsh, 2010; Lee & Rho, 2013; Sun et al., 2013). In most studies, perceived usefulness and perceived ease of use have been found to play important roles in determining technology acceptance (Brown, Dennis, & Venkatesh, 2010; Jimoh et al., 2012). In studying acceptance of mobile technology, prior exposure to mobile phones has been noted as a factor that influences mHealth acceptance and adoption alongside the known determinants (Ndayizigamiye & Maharaj, 2016). Gilbert and Namagembe (2013) studied mHealth acceptance among health workers in Uganda and found performance expectancy (PE), effort expectancy (EE) and disturbance concerns as the factors predicting acceptance. Carlsson et al. (2006) also studied mobile devices and mobile services acceptance among Finnish adults and found PE, EE and Attitude to successfully predict BI. Behavioural intention also predicted actual use.

6.1.2 Hypothesis

Based on the literature review the following hypotheses were generated.

H1 – Performance expectancy will have a positive influence on the behavioural intention (acceptance) to use mobile phones to report LF MDA.

H2 - Effort expectancy will have a positive influence on the behavioural intention (acceptance) to use mobile phones to report LF MDA.

H3 – Social Influence will have a positive influence on the behavioural intention (acceptance) to use mobile phones to report LF MDA.
H4 – Behavioural intention will have a positive influence on the actual use of mobile phones to report LF MDA.

H5 – Facilitating conditions will have a positive influence on the actual use of mobile phones to report LF MDA.

6.2 MATERIALS AND METHODS

6.2.1 Study Design

A cross-sectional mixed methods study design was used to collect data over two consecutive years.

6.2.2 Sampling and Sample Size

A total of 226 CHVs were interviewed; 153 from the Ahanta West district and 73 from Nzema East Municipality for both years. There were approximately 160 CHVs in Ahanta West and 60 in Nzema East distributing LF preventive chemotherapy drugs every year. All CHVs who had been recruited for the annual MDA by the sub-district in that year were eligible to participate in the study. All CHVs who provided consent were enrolled in the study. In the first year, there were 157 CHVs in total (107 from Ahanta West and 50 from Nzema East). There were 161 participants in the second year (112 from the Ahanta West and 49 from Nzema East). Ninety-two (92) of the second year participants belonged to the first batch of CHVs enrolled, while the remaining 69 were new.

Two main groups of CHVs were selected for the in-depth interviews; those who were able to submit their reports (respondents) via text messaging and those who were unable to (non-respondents). An initial expected sample of 10 participants for each group was proposed from each study site. A number of participants who fell into either group were called up on the
telephone for recruitment for the qualitative interviews. Contact with them in their communities revealed that some of the supposed non-respondents had actually made attempts to submit the data. These were reclassified as respondents and new participants were recruited for the non-respondent group by calling up more CHVs. A total of twenty-seven CHVs were interviewed until data saturation was reached. In Nzema East, ten CHV respondents and three non-respondents were interviewed while in Ahanta West, six respondents and eight non-respondents were interviewed.

6.2.3 Data Collection

Data collection period was linked to the annual lymphatic filariasis (LF) MDA in the two selected districts. Questionnaires were administered to CHVs recruited in the first year of study (T1) and they were trained to report LF MDA coverage data using short message service (SMS) in a specified message format. In the second year (T2), new CHVs recruited by the sub-districts, who did not participate in the first round of data collection and consented to participate in the study were also interviewed and trained to submit the LF MDA coverage data using their mobile phones. Study participants in the second year were made up of some first-year participants and second-year participants. The structured questionnaire was administered by trained research assistants. Community health volunteers recruited, but who could not attend their sub-district training were followed up to their communities to be interviewed. Most of the questionnaires were researcher administered and some were conducted in the local language. Study participants who were comfortable reading and answering the questionnaire in English, completed the questionnaire by themselves especially when CHVs at the training were many. The questionnaire was pretested in the Mpohor Wassa West district with five CHVs. The pre-test interviews were conducted in both English and the local language. Feedback from the pre-
test was used to modify the questionnaire and help the researcher translate the questions appropriately.

For the qualitative interviews, CHVs selected were contacted via telephone and inquired about their willingness to participate. Those who consented were visited individually in their communities during which the purpose of the interview was explained and informed consent was obtained. An interview guide was used for the interviews. Most interviews were conducted in the local language (Fante) as most participants felt they could express themselves better in Fante. Socio-demographic data were collected using the interview guide at the start of each interview. The interviews were recorded with a digital audio recorder.

At the end of the MDA, each CHV who consented to participate in the intervention was expected to submit their MDA report as a text message in a specified format to a toll-free shortcode. In the first year (T1), an SMS platform was used for the data submission. Lessons learnt from the first year concerning the network quality in the study sites, necessitated the use of an Unstructured Supplementary Service Data (USSD) platform in the Nzema East for the second round of data collection (T2) while Ahanta West maintained SMS as the mode of data transmission (Gyapong et al., 2014).

6.2.3.1 The SMS Reporting

A toll-free shortcode was acquired from a third party content aggregator for the SMS reporting. Each CHV was given a cue card with the list of variables to be reported. The format for the SMS is shown in Figure 6.2.
Each CHV was required to summarise the MDA report per the format in the MDA registers. This summary was translated into the SMS format in Figure 6.2. Each SMS was expected to represent a summary from one MDA register.

### 6.2.4 Data Collection Instrument

The questions in the survey covered socio-demographic factors, mobile phone functions used, five Likert-scale constructs and four moderating or interacting variables. The data collection instrument was adapted from the Venkatesh et al. (2003) UTAUT model tool. All constructs in the original model were retained. These are performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating conditions (FC) and behavioural intention (BI) as well as the moderator, voluntariness. The moderators, age, sex, and experience were measured. An additional moderator of education was added to determine the moderating effect of user educational level on intention to use technology. All items in the constructs were measured on a 5-point Likert scale ranging from 1 (Strongly disagree) to 5 (Strongly agree). While most items within the constructs were adapted from the original study by Venkatesh et al. (2003), other sources pertinent to mHealth or mobile phones for health were reviewed and adapted as well. Some specific items in the construct pertinent to mobile phones were adapted from other sources as shown in Table 6.1. Data for “actual use” of mobile phones for submitting MDA reports was measured by full or partial data submitted and received on the server irrespective of the accuracy of the data. This was measured as a binary variable using responses “yes” or “no”.

![Figure 6.2 - SMS Format](image-url)
Table 6.1 - Construct definitions and sources of Likert-scale items

<table>
<thead>
<tr>
<th>Construct</th>
<th>No of Items</th>
<th>Definition</th>
<th>Source adapted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Expectancy</td>
<td>4</td>
<td>The degree to which an individual believes using a technology will help him/her perform well at their job.</td>
<td>Venkatesh et al. (2003)</td>
</tr>
<tr>
<td>Effort Expectancy</td>
<td>4</td>
<td>The ease of using a tool in relation to the job to be performed.</td>
<td>Venkatesh et al. (2003) Kijsanayotin et al. (2009)</td>
</tr>
<tr>
<td>Social Influence</td>
<td>3</td>
<td>The extent to which an individual believes important others expect him/her to use the tool.</td>
<td>Venkatesh et al. (2003)</td>
</tr>
<tr>
<td>Facilitating Conditions</td>
<td>6</td>
<td>The degree to which an individual believes that there are technical, organisational and other conditions that support their use of the tool.</td>
<td>Venkatesh et al. (2003) Sun et al. (2013)</td>
</tr>
<tr>
<td>Voluntariness</td>
<td>2</td>
<td>The degree to which use of the technology is perceived as being of free will</td>
<td>(Venkatesh et al., 2003)</td>
</tr>
<tr>
<td>Behavioural Intention</td>
<td>2</td>
<td>An individual’s intent to use a specific technology tool for a specific job function</td>
<td>Joo and Sang (2013), Dünebeil et al. (2012)</td>
</tr>
</tbody>
</table>

6.2.5 Data Analysis

Socio-demographic characteristics were analysed using frequencies and proportions. Construct validity was assessed using principal component analysis of SPSS 22 by examining convergent and discriminant validity between and within constructs. Convergent validity tests the agreement of items within a construct independent of one another, while discriminant validity assesses how the constructs differ from each other. Item loadings were extracted by principal component analysis (PCA) with rotation converging after eight iterations. Internal consistency reliability was obtained using Cronbach’s alpha test. The coefficient of determination was obtained by squaring the correlation coefficients of the constructs. Correlation coefficients were obtained using Spearman correlation analysis at 0.05 significance level. Structural equation modelling (SEM) was used to conduct the goodness of fit test with BI as the final outcome and Generalised Structural Equation Modelling (GSEM) via the Bernoulli distribution was used to assess the entire model with all interacting variables. Bernoulli distribution was
applied to predict the final binary outcome “Use”. Data were analysed using Stata 13© (StataCorp LP).

Qualitative data were translated and transcribed by a research assistant. The researcher validated the translation and transcription to ensure accuracy. The UTAUT theoretical framework for the quantitative analysis was a guide for coding the data. Thematic content analysis was done to deduce the themes from the transcripts. The researcher manually read through and coded each transcript. A second coding cycle was done to filter and organize the already generated codes. This also allowed for missed codes to be identified. The codes were then organised into themes based on the UTAUT model. The themes generated were then organized under each construct of the theory. The transcripts were then uploaded into NVivo® 11 Pro by QSR International to store and organise the data.

6.2.6 Ethical Issues

Ethical clearance was obtained from the Ghana Health Service for this study (GHS-ERC: 13/11/12). Permission was sought from the District Health Directorate in each study site. Each participant provided informed consent prior to each interview. Permission was also obtained to record interviews with a digital audio recorder.

6.3 RESULTS

6.3.1 Socio-demographic Characteristics of Study Participants

Study participants were mostly in the 20 – 29 age group (41.2%). They were mostly male (73%) and 36% of them had Senior High School or Vocational level education. About 34.1% of participants reported sending text messages sometimes, 24% reported always texting and 20.1% had never sent a text message. Twenty-seven percent (27%) of participants worked in the
agricultural sector followed by 15% in the sales and service industry. A third (38%) of participants had served one to five years as CHVs in their communities followed by 27% who had served for more than eleven years.

6.3.2 The Measurement Model

Internal consistency reliability (ICR) tests revealed construct reliability of 0.59 to 0.99. Following the guidelines of Fornell and Larcker (1981), all constructs were shown as internally reliable, exceeding the recommended threshold of 0.7, except for facilitating conditions. There was a similarity in the Cronbach’s alpha values for each construct for data collected during the first round (T1) and second round (T2). Convergent validity results all exceeded 0.5 showing items are internally valid. The discriminant validity was the correlation squared for each composite and construct and these supported the validity of the scales. These are shown in Table 6.2.

Table 6.2 - Reliability and Validity Test Results

<table>
<thead>
<tr>
<th>Results from T1</th>
<th>PE</th>
<th>EE</th>
<th>SI</th>
<th>FC</th>
<th>VOL</th>
<th>BI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ICR</td>
<td>AVE CS</td>
<td>AVE CS</td>
<td>AVE CS</td>
<td>AVE CS</td>
<td>AVE CS</td>
</tr>
<tr>
<td>PE</td>
<td>0.93</td>
<td><strong>0.89</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE</td>
<td>0.87</td>
<td>0.82</td>
<td>0.19</td>
<td><strong>0.76</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SI</td>
<td>0.94</td>
<td>0.81</td>
<td>0.28</td>
<td>0.74</td>
<td>0.21</td>
<td><strong>0.72</strong></td>
</tr>
<tr>
<td>FC</td>
<td>0.64</td>
<td>0.79</td>
<td>0.07</td>
<td>0.72</td>
<td>0.13</td>
<td>0.7</td>
</tr>
<tr>
<td>VOL</td>
<td>0.77</td>
<td>0.89</td>
<td>0.06</td>
<td>0.83</td>
<td>0.17</td>
<td>0.81</td>
</tr>
<tr>
<td>BI</td>
<td>0.99</td>
<td>0.96</td>
<td>0.11</td>
<td>0.88</td>
<td>0.12</td>
<td>0.86</td>
</tr>
<tr>
<td>Results from T2</td>
<td>PE</td>
<td>EE</td>
<td>SI</td>
<td>FC</td>
<td>VOL</td>
<td>BI</td>
</tr>
<tr>
<td>-----------------</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>-----</td>
<td>----</td>
</tr>
<tr>
<td></td>
<td>ICR</td>
<td>AVE CS</td>
<td>AVE CS</td>
<td>AVE CS</td>
<td>AVE CS</td>
<td>AVE CS</td>
</tr>
<tr>
<td>PE</td>
<td>0.91</td>
<td><strong>0.94</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE</td>
<td>0.86</td>
<td>0.9</td>
<td>0.3</td>
<td><strong>0.86</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SI</td>
<td>0.94</td>
<td>0.72</td>
<td>0.22</td>
<td>0.68</td>
<td>0.25</td>
<td><strong>0.5</strong></td>
</tr>
<tr>
<td>FC</td>
<td>0.59</td>
<td>0.81</td>
<td>0.00</td>
<td>0.77</td>
<td>0.11</td>
<td>0.59</td>
</tr>
<tr>
<td>VOL</td>
<td>0.83</td>
<td>0.93</td>
<td>0.22</td>
<td>0.89</td>
<td>0.08</td>
<td>0.71</td>
</tr>
<tr>
<td>BI</td>
<td>0.96</td>
<td>0.97</td>
<td>0.06</td>
<td>0.93</td>
<td>0.08</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Bold diagonals are Convergent Validity (CV) results. ICR = Internal Consistency Reliability. PE=Performance Expectancy, EE=Effort Expectancy, SI=Social Influence, FC = Facilitating Conditions, VOL=Voluntariness, BI= Behavioural Intention. AVE = Average Variance Extracted, CS = Correlation Squared.
Correlation coefficients show weak but significant relationships between constructs in T1 and T2. The correlation matrices are shown in Table 6.3. There was a slightly stronger significant relationship between performance and effort expectancy \((r = 0.54, p < 0.05)\) and performance expectancy and social influence \((r = 0.64, p < 0.05)\) in T1. All other correlations between constructs were below \(r = 0.5\). In T2, the correlation between PE and SI was moderately strong and significant \((r = 0.63, p < 0.05)\). All other correlations in T2 were also below 0.5 and mostly significant. The model fit tests for both the direct model for T1 and T2, showed the data fitted the model well. These indices are shown in Table 6.4, all exceeded the recommended threshold levels and so indicate the model is a good fit.

### Table 6.3 - Correlation Coefficients of Constructs for T1 & T2

<table>
<thead>
<tr>
<th></th>
<th>PE</th>
<th>EE</th>
<th>SI</th>
<th>FC</th>
<th>VOL</th>
<th>BI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PE</strong></td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>EE</strong></td>
<td>0.54*</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SI</strong></td>
<td>0.64*</td>
<td>0.47*</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>FC</strong></td>
<td>0.22*</td>
<td>0.23*</td>
<td>0.30*</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>VOL</strong></td>
<td>0.12</td>
<td>0.30*</td>
<td>0.21*</td>
<td>0.21*</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td><strong>BI</strong></td>
<td>0.20*</td>
<td>0.07</td>
<td>0.17*</td>
<td>0.18*</td>
<td>0.1</td>
<td>1.00</td>
</tr>
</tbody>
</table>

**Results for T2**

<table>
<thead>
<tr>
<th></th>
<th>PE</th>
<th>EE</th>
<th>SI</th>
<th>FC</th>
<th>VOL</th>
<th>BI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PE</strong></td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>EE</strong></td>
<td>0.45*</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SI</strong></td>
<td>0.63*</td>
<td>0.45*</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>FC</strong></td>
<td>0.26*</td>
<td>0.27*</td>
<td>0.37*</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>VOL</strong></td>
<td>0.09</td>
<td>0.26*</td>
<td>0.09</td>
<td>0.20*</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td><strong>BI</strong></td>
<td>0.17*</td>
<td>0.22*</td>
<td>0.21*</td>
<td>0.08</td>
<td>0.11</td>
<td>1.00</td>
</tr>
</tbody>
</table>

*Significant at \(p < 0.05\). PE=Performance Expectancy, EE=Effort Expectancy, SI=Social Influence, FC = Facilitating Conditions, BI= Behavioural Intention

### Table 6.4 - Model Fit Tests using SEM

<table>
<thead>
<tr>
<th>Goodness of Fit Tests</th>
<th>T1</th>
<th>T2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Root mean squared error of approximation (RMSEA)</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Comparative fit Index (CFI)</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Tucker-Lewis Index (TFI)</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Standardised Root mean squared residual (SRMR)</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

*Acceptable Threshold levels: RMSEA < 0.08, CFI >=0.95, TFI >=0.95, SRMR < 0.08
6.3.3 Socio-demographic Characteristics of Participants in the Qualitative Study

Most participants of the qualitative study were above 30 years of age and mostly male (81%). Majority had senior secondary or vocational level education (41%) followed by 26% with Middle School level education. Thirty percent (30%) of them were working in the agricultural sector and had served one to five years as CHVs in their communities (48%) as seen in Table 6.5.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Districts</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age Group</strong></td>
<td><strong>Districts</strong></td>
<td></td>
</tr>
<tr>
<td>20 – 29</td>
<td>Ahanta West n (%)</td>
<td>2 (15.38)</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>6 (46.15)</td>
</tr>
<tr>
<td>30 – 39</td>
<td>Ahanta West n (%)</td>
<td>6 (46.15)</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>4 (30.77)</td>
</tr>
<tr>
<td>40 – 49</td>
<td>Ahanta West n (%)</td>
<td>1 (7.69)</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>4 (28.57)</td>
</tr>
<tr>
<td>50 +</td>
<td>Ahanta West n (%)</td>
<td>4 (28.57)</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>1 (7.69)</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td><strong>Districts</strong></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>Ahanta West n (%)</td>
<td>4 (28.57)</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>5 (35.71)</td>
</tr>
<tr>
<td>Female</td>
<td>Ahanta West n (%)</td>
<td>4 (28.57)</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>1 (7.69)</td>
</tr>
<tr>
<td><strong>Education Level</strong></td>
<td><strong>Districts</strong></td>
<td></td>
</tr>
<tr>
<td>Middle School</td>
<td>Ahanta West n (%)</td>
<td>5 (35.71)</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>2 (15.38)</td>
</tr>
<tr>
<td>JSS/JHS`</td>
<td>Ahanta West n (%)</td>
<td>5 (35.71)</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>-</td>
</tr>
<tr>
<td>SSS/SHS`/Vocational</td>
<td>Ahanta West n (%)</td>
<td>4 (28.57)</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>7 (53.85)</td>
</tr>
<tr>
<td>Tertiary</td>
<td>Ahanta West n (%)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>4 (30.77)</td>
</tr>
<tr>
<td><strong>Occupation</strong></td>
<td><strong>Districts</strong></td>
<td></td>
</tr>
<tr>
<td>Clerical / Secretarial</td>
<td>Ahanta West n (%)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>-</td>
</tr>
<tr>
<td>Professional / Technical</td>
<td>Ahanta West n (%)</td>
<td>1 (7.14)</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>38 (46.15)</td>
</tr>
<tr>
<td>Sales / Services</td>
<td>Ahanta West n (%)</td>
<td>5 (35.71)</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>6 (46.15)</td>
</tr>
<tr>
<td>Skilled manual craftsman</td>
<td>Ahanta West n (%)</td>
<td>2 (14.29)</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>-</td>
</tr>
<tr>
<td>Unskilled manual labour</td>
<td>Ahanta West n (%)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>1 (7.69)</td>
</tr>
<tr>
<td>Agricultural</td>
<td>Ahanta West n (%)</td>
<td>4 (28.57)</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>4 (30.77)</td>
</tr>
<tr>
<td>Unemployed</td>
<td>Ahanta West n (%)</td>
<td>2 (14.29)</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>1 (7.69)</td>
</tr>
<tr>
<td><strong>Service as CHVs (years)</strong></td>
<td><strong>Districts</strong></td>
<td></td>
</tr>
<tr>
<td>1 – 5</td>
<td>Ahanta West n (%)</td>
<td>6 (42.86)</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>7 (53.85)</td>
</tr>
<tr>
<td>6 - 10</td>
<td>Ahanta West n (%)</td>
<td>2 (14.29)</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>3 (23.08)</td>
</tr>
<tr>
<td>11+</td>
<td>Ahanta West n (%)</td>
<td>6 (42.86)</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>3 (23.08)</td>
</tr>
<tr>
<td><strong>Submitted SMS</strong></td>
<td><strong>Districts</strong></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>Ahanta West n (%)</td>
<td>6 (42.86)</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>10 (76.92)</td>
</tr>
<tr>
<td>No</td>
<td>Ahanta West n (%)</td>
<td>8 (57.14)</td>
</tr>
<tr>
<td></td>
<td>Nzema East n (%)</td>
<td>3 (23.08)</td>
</tr>
</tbody>
</table>

6.3.4 Structural Equation Modelling Findings

The analysis was conducted in two parts; first to examine the factors and strength of the relationships without the interacting variables and secondly to examine the relationships with

141
the interacting variables. Figure 6.4 depicts the structural model without interactions for T1 showing the factor loadings for the constructs. All the beta path coefficients were positive in T1, as was expected by the hypothesis generated for each path, except for Facilitating Conditions. Performance expectancy and Effort expectancy had positive but non-significant influence on Behavioural Intention. Social influence, however, had a positive and statistically significant influence on behavioural intention ($\beta = 0.16$, $p<0.05$). Behavioural Intention had a positive and highly significant influence on Use ($\beta = 1.2$, $p<0.001$). Facilitating condition, however, had a negative influence on Use which was not statistically significant ($\beta = -0.011$).

![Figure 6.3 - Structural model without interactions for T1](image)

Significance levels: *$p<0.05$, **$p<0.01$, ***$p<0.001$. PE=Performance Expectancy, EE=Effort Expectancy, SI=Social Influence, FC = Facilitating Conditions, BI= Behavioural Intention, Use=Actual Use of Technology

In T2, Performance Expectancy had a negative and non-significant influence on Behavioural Intention ($\beta = -0.019$). Effort expectancy had a positive and statistically significant influence on Behavioural Intention ($\beta = 0.16$, $p<0.001$). Social influence and Behavioural Intention had a positive influence on Use and Facilitating Conditions had a negative influence on Use but none were statistically significant. Figure 6.4 depicts the structural model without interactions for T2 as well as factor loadings for each construct.
Results showing the relationship between the determinants of technology acceptance and *Behavioural Intention* and *Use* are shown in Table 6.6. The model was estimated in the initial analysis with all direct effects and moderating variables. All non-significant variables were subsequently dropped and the model was re-estimated. Variables depicting direct effects, moderators and direct effect interactions and full variable interactions were maintained in the model. Results revealed that except for Behavioural Intention and Facilitating Conditions with its moderators, all other factors were not strong determinants of CHVs intention to use mobile phones for MDA reporting.
Table 6.6 - Re-estimated model showing the relationship between factors and Behavioural Intention and Use

<table>
<thead>
<tr>
<th>Dependent Variable: Behavioural Intention</th>
<th>T1 Exp(B)</th>
<th>T1 p-value</th>
<th>T2 Exp(B)</th>
<th>T2 p-value</th>
</tr>
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### Dependent Variable: Use

| Facilitating Conditions (FC) | 1.38 | 0.517 | 1.87 | 0.121 |
| Behavioural Intention (BI) | 3.52 | **0.000** | 0.91 | 0.514 |
| AGE | 1.21 | 0.408 | 1.56 | 0.052 |
| EXP | 93.78 | 0.158 | 285.34 | **0.033** |
| FC x AGE | 0.99 | 0.397 | 0.98 | 0.054 |
| FC x EXP | 0.81 | 0.154 | 0.79 | **0.041** |
| FC x AGE x EXP | 1.01 | 0.099 | 1.01 | **0.031** |
| AGE x EXP | 0.87 | 0.109 | 0.85 | **0.028** |

PE=Performance Expectancy, EE=Effort Expectancy, SI=Social Influence, FC = Facilitating Conditions, BI=Behavioural Intention, VOL=Voluntariness, Use=Actual Use of Technology, Exp(B)=Exponentiated Odds Ratio. Shaded areas indicate variables that were dropped from the model after the first estimation.

### 6.3.2.1 Performance Expectancy with Interacting Variables

Performance Expectancy was not found to have a significant effect on CHVs intention to use mobile phones to report MDA data. Results were similar in the face of the moderating variables, age and sex for both time periods.

#### 6.3.2.1.1 Qualitative findings on Performance Expectancy

In exploring participants’ views on performance expectancy, two main themes emerged. Community health volunteers perceived that using text message as a medium for data reporting would help improve data reporting for the programme. It was also an opportunity for them to gain new knowledge or add on to their already existing knowledge on mobile phone functionalities. However, there were other CHVs who also perceived that submitting their
MDA reports via text message would impact negatively on the programme and not aid them in performing their tasks.

- **Text Messaging Improves Reporting**

Community health volunteers (CHVs) indicated that using mobile phones would improve reporting procedures for the programme. They acknowledged that delays in reporting could be eliminated or minimised, thereby improving data reporting. This idea was almost universal among the participants with 26 out of 27 interviewees alluding to this fact.

*I basically think this method is good because as soon as you’re done with the process, you just send it via text. At first, when you’re done with the distribution, the report keeps long with us before they finally come to collect them. So the text makes the process faster – Dixcove, Did not Submit*

*With this method as soon as you finish, the results pass through the air and it gets to where it’s supposed to go. So you don’t have to carry documents anywhere and it’s faster. The quickness is that it goes through the phone and quickly it’s transmitted in the air – Axim, Submitted*

*We saw that that will be easy for us because after the MDA you will not board a car to any place to submit the report but rather, you just have to text the report. We saw it to be easy – Axim, Submitted*

A number of CHVs also expressed the view that texting the reports would help improve the accuracy of the data. They recognised the importance of ensuring an accurate summary of the data and careful verification before submitting the text message.

*You have to do your calculations and compare with the ones in the book before you send the message – Apowa, Submitted*

*Before you can do all that (submit text) you also have to ensure that the records are genuine records that can be sent. – Axim, Submitted*
Participants were also of the view that submitting their reports via text message would help them become more accountable to the programme. They acknowledged they needed to account for drugs given to them for distribution in their communities.

...some people just give out the drugs without records, but with the text message, the person will know that they have to keep records. Because if you don’t keep good records you won’t have a message to send. With the text message, people will recognize that if they give the drugs to even one person, they have to take records. –Axim Submitted

Yes. So that the authority will know the actual drugs left such that next time when they are coming, they’ll know that there is still some stock of the drugs.. –Axim, Submitted

In every work, there should be an improvement and so my thinking was that as we call something accountability, we cannot just work in isolation without accountability. It might well be that the work was not done. –Agona, Submitted

Texting their reports was also another opportunity for the CHVs to show the NTD programme, evidence of the work they were doing in their communities. For them, it was an indirect way of being recognised for the role they play in the LF elimination programme. This way, data could be traced to a person in the community and not an unnamed individual. This, they felt would improve their performance on the job. This perception was also similar among those who submitted and those who did not submit.

“On that, my mind tells me that when we do that, someone who does not live in our district will know the work we are doing. That is why I had wanted to do the texting for you to know the work we were doing”. –Apowa, Did not submit

“The benefit will be that the government will know that someone is working on elephantiasis in Kegina (community name) here”. –Axim, Submitted

- Text messaging adds new knowledge

Participants also acknowledged there were personal gains to be made by texting MDA reports. For some of them, it was an opportunity to learn something new or add to their
knowledge of mobile phone use. A number of them (21%) had never sent text messages and this project helped them gain new knowledge and experience in SMS use. Others also had experience but were limited in their view of how SMS messages could be formatted or used for other purposes.

“…… the few I can say is that it has given those of us sharing the drugs more knowledge and those who did not know how to do text messages could learn how to do it and this has become attractive to others that the volunteering work has now introduced more knowledge”. – Apowa, Submitted

“With our personal text messages, it’s usually something very short we send and it does not entail so much, and I did not know that the phone I have can take a lot of words like that. Thereafter, I became aware that, my phone can take more words.” – Axim, Submitted

They perceived it as an innovation that showed the LF programme was advancing and growing. CHVs acknowledged the programme has not changed much since its inception in their communities. They realised that technology is being used in a variety of ways and it was interesting for them to see its application in their LF MDA data reporting.

Using text message to send the summary meant the work (volunteering for LF MDA) was advancing. – Bamiankor, Submitted

- Text messaging will impact negatively on performance

There were some participants, however, who also anticipated texting would have a negative effect on their work. They indicated that it would increase their workload. Drug distribution and summarizing data was quite tedious so any additional task felt like an increased workload. This sentiment was expressed most by those who did not submit data by SMS.

Yes, I think it entails more work. – Agona, Did not submit

I know how to do text message but my personal workload prevented me from doing it. – Axim, Did not submit
Others also indicated that the lack of phones or having a damaged phone would make it difficult to participate in such an exercise. They indicated it was best to have a personal phone in order to undertake this task. They did not necessarily subscribe to the idea of borrowing a phone from a family member or friend.

*When the person takes the information it cannot be texted and if the person doesn’t have a phone it will be waste of time.* – Dixcove, Submitted

*There are challenges. Not all of us going round know how to use the phone. So those who do not know how to use the phone will face difficulty in texting.* – Apowa, Submitted

*As for the text messages at that time my phone was not in good order so I couldn’t do it. I didn’t have a phone.* – Apowa, Did not submit

Some CHVs were also of the view that, texting their reports could result in erroneous data for the programme. They preferred having the data verified by their supervisors prior to text submission. Some indicated their supervisors took the responsibility of summarising the data for them. Some supervisors also verified the summaries and made corrections in the registers before collating summaries from all communities. The CHVs indicated the possibility of errors and indicated that these would have to be corrected before data transmission.

*When they collect the books, we have the opportunity to go through and if there is a mistake, it is corrected there. But in case of the text messaging, you wouldn’t have any chance to correct anything so the text message and the book I don’t know…which will be best.* – Apowa, Did not submit

*Yes, it could bring problem because, in texting, you could text the wrong thing. Even though the text will go alright but the information could be wrong so what needed to be done was to be careful in sending the message.* - Apowa, Did not submit
6.3.2.2 Effort Expectancy with Interacting Variables

Effort expectancy did not also have a significant effect on intention to use in T1. Males who had perceived more effort was needed in submitting the MDA report via SMS had a 9% higher odds of the intention to do so compared to women in T1. However, in T2, males who perceived less effort would be needed in submitting the MDA report via SMS or USSD had 35% lower odds of having the intention to use mobile phones to submit the MDA report compared to females in T2. Thus sex had a significant moderating effect in T2 (β=0.65, p<0.05). Neither education nor experience had a significant effect on behavioural intention.

6.3.2.2.1 Qualitative findings on Effort Expectancy

Three main themes emerged from the qualitative findings of effort expectancy. Effort was needed to use the phone, support was an important factor, importance of personal effort and ones’ readiness to use the phone. These are meant to explain the CHVs perceived effort needed to accomplish the task of submitting the LF MDA data via SMS or USSD.

- **Effort needed in keying data on the phone**

Some participants indicated that keying in LF MDA reports into the phone required a great deal of effort. They considered it a cumbersome and difficult task to undertake. It was tedious because they had to combine letters and numbers and it was difficult reading the keypad.

> *So that, inputting the information on the phone itself was a bit tedious. – Bamiankor, Submitted*

> *The basic difficulty is when you, for example, want to key in ‘t’ then maybe it will key another character aside that, I think there was no problem. – Agona, Submitted*

> *That is the thing that annoys me about text messaging. If I am not using glasses I have to rely on others to get something typed. So if I tell you texting doesn’t worry me then I am not telling you the truth. – Apowa, Did not submit*

There were others who felt the size of the phone could impact a person’s ability to key in data for submission. The small form factor of some phones meant effort was needed to make entries.
Basic phones usually have small screens and keypads that share keys with letters and numbers, unlike a QWERTY keypad on a smartphone where alphabets and numbers are laid out like a keyboard.

Looking at the phones on the market there are small, medium and large ones especially this palmtop. The smaller phones have smaller inscriptions that make it very difficult to see. So it will be a problem for some of them. – Bamiankor, Submitted

If care is not taken in sending them you may make a mistake and as for the phones, they are not of the same kind. Some have smaller numbers so as you press it, it can pick different number altogether. – Agona, Submitted

Again, there were others who thought older CHVs would have difficulty submitting the data via text message. Older CHVs were expected to have less experience with mobile phones and with technology in general. Younger CHVs may have had exposure to technology in school or in the community and are usually more ready to adopt new technologies or new ways of doing things.

For me, I don’t think there is a problem for any youth because we are more used to text messaging. - Dixcove, Submitted

To me, I think it is because he is a little old. Even we (young ones) were having difficulty so you can imagine it would be a little difficult for him. – Agona, Did not submit

Ease of use was also associated with the level of the individuals’ knowledge of mobile phone use and texting experience. Prior knowledge on how to send and receive text messages would affect an individuals’ view of the level of effort or difficulty with the task. Prior knowledge and experience would help build understanding and possibly make it easier for the CHV to participate fully in the exercise.

To me, I think how to search for stuff on the phone was my problem. - Agona, Did not submit
As for texting, before God and man since I started using phones I never bothered to do it. I don’t have time for such things. It is better, to tell the truth and be free! – Apowa, Did not submit

There are lots of people who do not know how to use the phone. All that they know is using it for calls. So if you ask such people to make text message, they will spoil it. So if there is anything other than the text message you can add that. – Axim, Did not submit

A number of those who could not submit the text and thought it a difficult task also suggested alternative means of reporting the data, rather than text messages. They considered these alternative methods would be easier for themselves or others than text messaging. Alternative methods suggested, included calling and reading out the report to a person, having fillable forms on phones or having a contact person in the community or sub-district who would collate summaries and submit on their behalf.

Yes, I would have preferred to call and give the figures. Apowa, Did not submit

Under normal circumstances, you should supply us with phones with everything on it such that the TR or HF’s (variable headers), everything is already on the phone so that as soon as you finish you send it without typing any abbreviation. – Agona, Submitted

Again if you feel you can ask them to get in touch with your project contact person, so this person will organize them, meet them and text it for them to make it easier. So maybe if they are about twenty (20) in number they can contact someone who will also take their report and text it for them to help the project. – Axim, Submitted

- **Personal Effort impacts the ease of use**

The individuals’ willingness to learn also played a role in reducing the perceived difficulty to text a message. Some CHVs showed excitement at the prospect of learning a new thing. They willingly practised during the training session and asked questions. They acknowledged it was a new thing and their willingness to learn, reduced the learning curve for some of them.

Actually, you realize that when something new is introduced it has its own methods and ways of operation but with time, as you get familiar with the process, it becomes easy
to understand and operate it. So I think it’s because the process was new to me that is why it couldn’t go through. – *Agona, Did not submit*

*It wasn’t going to be difficult because when you learn, you will know the trick in it to do the work.* – *Dixcove, Did not submit*

*Yes, I understood it because of the card you gave to us. When I came home and studied the card and compared it with the book and saw the abbreviation like SS meaning seriously sick and PR meaning pregnancy, I saw that I could do it.* – *Apowa, Did not submit*

Some individuals were unable to understand the process as it was explained during the training. A lack of understanding was bound to restrict a person’s ability to participate. A few who had experience with text messaging also had difficulty understanding the process since it appeared to vary from the way normal text messages are composed.

*It wouldn’t be very difficult. It all depends on the explanation or training given.* – *Apowa, Did not submit*

*I had a problem with the texting because from the beginning I didn’t understand it ...* - *Apowa, Did not submit*

- **Readiness for phone use**

An individuals’ readiness to use a phone also plays a role in his/her perception of ease of use of texting the MDA report. Findings show that prior texting knowledge, adequate training and formal education were all reported as reducing the level of difficulty that was experienced by participants. Participants who had experience sending text messages found the level of difficulty to be minimal or did not experience any difficulty. Prior experience submitting data for research projects or NGO’s was also helpful in reducing the level of difficulty.

*I used to work for a group. We used to write and submit the report until we were asked to now submit via text. There was this time also some people came with some researchers ........ so they came for me and another girl so I took part in that exercise too. So yours will be the third one I’ve participated in.* - *Dixcove, Submitted*
Yes, I knew how to do it “paaa” (emphasis). I can send text easily – Axim, Submitted

However, a few expressed difficulty even though they indicated they had experience sending and receiving text messages. They were of the view that the format of text messages they send are different from the format being required of them so they had difficulty comprehending the process.

We sent the results through text messages. So if the political party had 10 votes, you type in Party X 10 or Party Y 10. So basically, it just inputting figures against their corresponding members and that was easy. I think if the information on the card was a form on the phone, all we’ll have to do will be to input the numbers. That will have been much easier and simpler and even faster. In that case, the figures or information will be placed to correspond with its member. - Agona, Did not submit

Having formal education was also helpful in reducing the perception of difficulty. It appeared participants who had at least Junior High School education found the process less difficult. Being literate helped them understand the process during the training and subsequently helped them understand the cue card given them to assist in formatting the message.

My text message compared to the one, if I remember it was normal, I have been to school, if I have not been to school then that will be difficult for me. So the text messaging was normal. – Agona, Submitted

6.3.2.3 Social Influence

Social influence did not have a significant effect on intention to use. Moderating effects of age, experience, sex and voluntariness on social influence also had no effect on intention to use.

6.3.2.3.1 Qualitative findings on Social Influence

Social influence appears to have played a varied role among this population in determining their decision to adopt mobile phones for their MDA reporting task. The two main themes that emerged were positive and negative influences. There were those who didn’t discuss the text
messaging exercise with anyone and so this factor may not have influenced them one way or the other.

- **Positive Social Influence**

A number of CHVs received positive comments and support from their family members, peers and colleagues in the communities. They believed using their mobile phones to submit their results would give them prestige in their communities or earn them respect as being learned and advanced in technology use. It also appeared to improve the image of the NTD programme from the perspective of their peers and family.

Participants generally seemed to receive approval from friends and family. This may have boosted their morale or made them feel it was a worthwhile exercise to participate in. They willingly informed family members and friends about the process either to seek their approval or as a way to convey information about the new knowledge they had gained.

Okay, I first informed those I am working with that this time around when we went for the training a new technology was added that we have to record before we text through a mobile phone. They also commented that it was a good method. – Apowa, Submitted

Yes, because all that, they say is nowadays we are into high-tech everything is about the phone, phone and texting information. I think everything has gone into technological advancement. – Bamiankor, Submitted

Peers and family members see the experience as a prestigious exercise. While CHVs generally appear to have prestige in their communities due to the role they play in their communities, they were of the opinion that respect given to them would or had been elevated by their family members and friends with whom they had shared the information. This meant they would become tutors for others whenever they needed assistance in using their phones.
They started to see me as a high tech lady because now I will have to text my results to the district rather than sending the report the normal way. – Dixcove, Did not submit

Yes, it has raised my level in the community. Because not everyone in the community can do it so if you can text then you are ahead of a lot of people. - Axim, Submitted

Among the CHVs, there was also positive reinforcement among them. The positive comments made by their peers could have enhanced their desire to participate.

Oh, we had a lot of conversation, some even said now we are moving to computers, we are moving into technology, high tech. Now, everything is into computer and if that is the case then, they need to give us more money to chop. For that one, we had a lot of conversation based on that. – Axim, Submitted

There was also the perception that the programme was advancing. Their peers’ impression about the exercise meant that they were happy the programme was being innovative. Innovation usually connotes progress and this was a positive sign to the participants.

He thought it was good because you need to do the summary before you can send the text. Using text message to send the summary meant the work was advancing. – Biamankor, Submitted

- Negative Social Influence

There were negative comments made by peers and family members that may have influenced participants’ thinking. Some comments from peers could have been discouraging to other participants. While it is not clear what these comments were, it appears some participants were generally not happy about the process.

We have two teams here, one up there and one down there. We were ok with the new process but some members of the other team had a little complains but they still did it. – Dixcove Did not submit

Other comments bordered on incentives that were being given to participants. They were of the view that additional incentives had to be given for the work they were being asked to do. Even though airtime was given as an incentive to every CHV who submitted their MDA report
via text message, it appears they would have appreciated having tangible incentives they could easily show off.

*We didn’t discuss with lots of people but the few we discuss with said the process needs phones to accomplish the task. They asked if we were given phones and we said “no”, and they said it will be difficult for those who do not own phones.* – **Apowa, Submitted**

*If I had had such a conversation with other people, I’m sure such things would have been said. Like, “how much are they really giving to us to do all this”? So you’ll see everyone will be speaking their mind.* – **Axim, Submitted**

*Yes, we will not use a computer, but for the majority of us, we felt you should supply us with phones. If you had brought phones we would have been happy.* – **Bamiankor, Submitted**

However, there were others who did not discuss the exercise with anyone because they felt it was not necessary to do so. These participants possibly did not need approval or encouragement from others to urge them on with the task. They considered this as an extension of their regular MDA reporting activities which they don’t usually discuss with other parties.

*Actually, those in the community didn’t know of the text messaging. All they know is that you supply them drugs. How you get your report done is not their problem.* – **Dixcove, Submitted**

*I do the work all alone so I did not discuss it with anyone.* – **Bamiankor Submitted**

*No, I didn’t discuss it with any of them because what I needed to do was what I did.* – **Dixcove Submitted**

### 6.3.2.4 Facilitating Conditions

Facilitating conditions (FC) without any moderating effects was not significant for use of mobile phones for reporting MDA data. However, experience as a moderating variable had a significant effect on FC in T2. Participants who had experience with the tools and also developed experience submitting data from the previous year had 285 times higher odds (p<0.05) of using mobile phones to report MDA data compared to those who did not have the
requisite experience. The interacting effect of experience with facilitating conditions showed that those who did not agree with the adequacy of the organizational and technical structures and did not have experience had 21% (p<0.05) lower odds of using their mobile phones to report the MDA data compared to those who agreed with facilitating conditions and had experience. The three-way effect of age, experience and facilitating conditions in T2, had little effect on use but this was statistically significant (p <0.05). Again, younger participants with little experience had 15% lower odds of sending their MDA report via their mobile phones in T2 (p < 0.05) compared to the older and more experienced participants.

6.3.2.4.1 Qualitative findings on Facilitating Conditions

Facilitating conditions considers the extent to which participants perceive technical and organizational structures exist to support technology acceptance in a setting. For technical structures that exist, findings were associated with network, airtime and other work aids given to CHVs. Organisational structures identified were based on various types of support for CHVs, training provided and the use of props as reminders.

- Organisational Structures

Training was provided for all participants to enable them accomplish the task. A number of participants indicated the time spent on training to text the MDA report was inadequate. While they acknowledged that the explanations given during the training session were understandable, they still contended that it should have occurred over a longer period. They would have preferred training over a couple of days as this would give them more time to practice and understand the whole concept. A number of them had prior texting experience but reported inability to understand what was required of them in this exercise. A number of those who submitted the report via SMS spoke in favour of more training for those who had little knowledge of text messaging, especially the elderly.
.... they explained it well but if you are not clever ....... They gave us one hour and they taught us all this process. It was just one hour or two hours. If we had more time, it would be better than this. – **Axim, Submitted**

........ because the period for the training was too short. Some of us anticipated that the training programme should take at least 3 days so that, we can fully digest and understand it better. But the training too was just 1 day, for workshops it should be such that, we will understand it – **Bamiankor, Submitted**

I think it’s all about training. For some people, texting could be a problem so if there’s training as time goes on, it’ll help. – **Dixcove, Submitted**

I think there should be more training. Sometimes you may not come to meet us the youth, just the elders. And they have difficulties texting. Even my Mum here she can do a little bit but others can’t do much. So with more training, you’ll be able to teach the elders to do their own texting in case we are not around. - **Dixcove, Submitted**

A number of those with prior texting experience quickly understood the concept and were able to apply them accordingly. Their experience made the learning curve for this experiment smoother.

The thing is if you don’t have the idea you can’t do it. First, they have to educate you on that. .......they educated us that we should do this and that. – **Axim, Submitted**

Yes, it was ok for me. Because we were taught that for this when you get the figure, you add it to it......before sending. And I already know how to send a text message so, it wasn’t a problem for me. They (research assistants) explained so clearly that, even those who did not understand at all were able to gain understanding and the person who expressed misunderstanding, they asked him to come for further tutorial. They made everybody to understand it and everybody agreed to participate. – **Axim, Submitted**

A number of CHVs also indicated the need for local support for challenges they would encounter. Some acknowledged that further tutoring on how to format and send the message was needed. This they indicated, could be local support given by their immediate supervisors.

I think if any assistance is needed all we should do is to contact the council for help. They have our names there already. Also, I think they (locals) should call us and follow up. – **Agona, Did not submit**
.......my supervisor would have helped me because we work together on other projects. We have a good relationship so if I needed assistance I would have gone to him. – Dixcove, Did not submit

Ok... for support I would have needed it because sometimes if you have someone around you can fall on for help, it’s good. It’s good when there’s someone around to help. – Axim, Submitted

Others were also of the view that having external support from the project or programme office would suffice. They thought since the report was being texted to the programme, the best support should come directly from the implementers.

Oh...if I would have a problem since, you gave this to me, the best person to contact is you (researcher); I would have to call you and tell you I don’t understand this part so, just contact you to direct me. - Agona, Submitted

I think the phone number (of the researcher) added also helps because with our supervisor, he is always here and some may say it’s always the same person so having another person to contact may also be helpful. – Dixcove, Submitted

Others also felt peer support would be appropriate. A number of older CHVs have identified younger persons in their communities who assisted them in the MDA and texting the MDA report. Others also sought help from fellow CHVs who were younger and more experienced with mobile phone use and who were also in the same or neighbouring communities.

For that I agree, in that case, I will contact anyone from the other team for assistance.- Dixcove, Did not submit

....... even, my senior colleague that I called right now, because, he is not used to texting message. ... when I was texting, he had the line (phone number)... then I texted my own and then, and because he is not used to text message I was the one who did everything while he was there. – Axim, Submitted
The cue cards given appeared to play an important role in helping participants format the messages appropriately. This aid was designed to help CHVs with message formatting and provide basic instructions on how to submit the text message. A number of them compared the variables on the card with their registers and it aided them in gaining a good understanding of what was required of them. Others also referred to it while entering the data as a text message on the phone.

…….. So later that, I consulted you and you told me you didn’t receive any message from me. Meanwhile, it has gone out of my phone that I have sent it. But I was fortunate that that time I have not thrown the card ... away... so I took it and used it to send it again. – Bamiankor, Submitted

Yea it really helped me in formatting the text message. – Agona, Submitted

- Technical Structures

The technical structures that could have facilitated the exercise were network quality, airtime availability and availability of phone for texting the report. A number of communities especially in the Nzema East Municipality were found to have poor network quality. Community members usually identify specific areas in their communities which are on high ground in order to receive network signals. A number of CHVs indicated having submitted the report but these were not received on the third party aggregator’s server.

I actually sent mine but I think there was bad network that interrupted the sending process – Agona, Did not submit

In a case where there is bad network, the text messages can delay or may not deliver at all. So, sometimes you will be called that the information didn’t come so you will have to re-send or go through the process again. – Dixcove, Submitted

A typical example was how I texted mine twice but it could not go through. These are all forms of problems associated with the texting. – Agona, Submitted
Another facilitating condition that had an impact on the study was the participants’ access to a mobile phone. A few of them had damaged phones and so were unable to send the text message. A few others also indicated that they didn’t own phones. The phone numbers they had given during the training were actually for friends or family members but this was not made known to the researcher at the time.

*Oh yes, it was very helpful but the challenge was that some of us didn’t have their own phones.* – *Bamiankor, Submitted*

*Unfortunately, my phone got spoiled. After keying the details of the report I knew it was on the phone which I can send it later but because the phone got spoiled that was the reason why I found it difficult to key in the details again.* – *Axim, Submitted*

There was also a suggestion that the study should have given out mobile phones to participants to enable them participate.

*But for the majority of us, we felt you should supply us with phones. If you had brought phones we would have been happy.* - *Bamiankor, Submitted*

Another technical structure that could support the intervention, was the use of alternative technical methods for submitting the reports. A number of participants indicated that using other methods such as reporting through voice call or having an application or form on the phone would have been easier than sending text message.

*What I will be comfortable with is to text you the number of people that were served but look at the book to text will be difficult for me.* – *Apowa, Did not submit*

*........if the process could be made much simpler just as I said about the information being put in a form on the phone or something of that sort so that input of information will be faster and easier.* - *Agona, Did not submit*

Some CHVs also indicated that having mobile phone airtime could help facilitate the task. This was needed in case they had to call supervisors or other persons for assistance. They intimated it was very important since not having the airtime could hamper the progress of the work. A
few CHVs also sent the SMS to the wrong shortcode and thus ended up having their airtime deducted. They had the impression the shortcode would cost them money even though they had been informed about the toll-free shortcode during the training.

"........ but one thing that I will add is that those who will be doing the texting should be given some credits because if I need some clarification and want to call the leaders and there is no credit then I can’t call." – Apowa, Did not submit

What I think can be done is, for the work, we will definitely do it, so, for the bonus, even if it is GHS 1.00 it should be given to us outright and not to wait till after the text message is sent in order to avoid this troubles and everything will be fine. .... So, the bonus, if you give it to us right there, it will be fine. - Bami ankor, Submitted

6.3.2.5 Behavioural Intention

Behavioural Intention had a statistically significant effect on Use of mobile phones to text LF MDA reports in T1. Results showed that participants who had strong intentions to use mobile phones to report MDA data had 3.5 times higher odds of actually using their mobile phones to send the MDA data by SMS (Exp(β) = 3.52, p<0.001). Behavioural Intention’s effect on Use waned over time, showing a non-significant effect in T2.

6.3.2.5.1 Qualitative findings on Behavioural Intention

Behavioural Intention is the individual’s intent to use mobile phones to report LF MDA reports. Three themes were identified from the data for factors influencing Behavioural Intention. The themes were incentives as motivators to participate, positive attitude and submission to authority.

- Incentive as motivator

A number of CHVs indicated that the attraction of receiving free mobile phone airtime once they submitted the data was an incentive. A number of them expressed misgivings for not receiving the airtime even though they indicated they had submitted the report and assumed it
had been received. These participants’ text messages were not received on the aggregator’s server.

   When they explained to us that we would receive airtime credit when we send the text message, we were happy to do it but after the texting, we never received the credits. - *Axim, Did not submit*

   ... you told us to text and you will give us some bonus (airtime) but when we sent the message nothing came. - *Bamiankor, Did not submit*

Other CHVs also anticipated being given phones as an incentive. They felt this was a better motivator and would have been more satisfactory.

   Yeah, if you had brought us a phone, we would have been happier....more motivated. – *Bamiankor, Submitted*

For others, incentives were not a motivation to participate in the study. Other altruistic reasons were given as their motives to use mobile phones to report their MDA data.

   That MTN credit, in fact, I was really happy; that was the highest credit I’ve ever received but that, alone cannot serve as bait to attract me. – *Bamiankor, Submitted*

- **Positive attitude towards the study**

A number of the CHVs were generally happy to submit their reports using the mobile phone. For some of them, their intention was based on having done similar exercises for other research groups.

   Actually, nothing really motivated me. I have done this type of thing before. So if another person comes to ask you to do something similar, you shouldn't bounce them, you should help to ensure their work also moves forward. So, in the same way, I helped others in the past with something similar, in the same way, I can help you to achieve your aim. – *Dixcove, Submitted*
Others indicated that they felt the idea was good and they had to support it. They perceived it was advancing the programme and they had to play their role in the advancement.

As I said, personally, I didn’t have any limitations. I think it was a good idea and it needed to be encouraged. - Dixcove, Did not submit

As time goes on, there has to be advancement. So if the advancement means introducing this new technology, then we should also advance with it. – Axim, Did not submit

In fact, when you came, the explanations offered was so touching and we all said, it was a good practice that can enhance our work so, that was the reason why I decided to participate. – Bamiankor, Submitted

For others, their intentions were motivated by an attitude of volunteerism. They considered it another service to the community since they had already signed up to perform similar voluntary activities for their communities and the nation. They considered this as part of their regular job as CHVs.

As for me, I don’t have anything to say on it. It was voluntary and a new thing that has come. -- Dixcove, Submitted

Ok, when they came they said the texting of the report is part of the work so we accepted it. After the training, we also accepted the idea of texting the result. – Axim, Submitted

I was already doing the work so if any technology has been added I had to be part to help my community. So for the love of my community, I decided to be part of any additions to the programme. - Apowa, Submitted

A few CHVs also decided not to participate in the exercise due to lack of confidence in their ability to use their phones, perceived difficulty with text messaging and perception that one needed to be intelligent to understand and participate in the process.

When we went for the training at Dixcove, one boy an Ahanta who sat by me said my phone has a lot of functions and it isn’t simple like another boy who sat by me. That disturbed me a lot and made it unattractive for me to try. – Dixcove, Did not submit
Yes, I discussed with them but I thought it was going to be a bit difficult so I did not pursue it further. - Axim, Did not submit

In fact, I will say that my brain is not sharp that was why; because during my schooling days I was very dull; I wasn’t intelligent and therefore I was always the last person in class till I completed school. - Axim, Did not submit

- Submission to authority

The CHVs appeared to show deference to authority by showing a willingness to do what their supervisors or superiors asked of them. A number of them had the intention to submit the report via SMS because they perceived the request as coming from others higher up in authority. They associated the researcher with the NTD programme and so considered the team as being superiors from the programme head office.

Oh, I will do it. It is our work so whatever instructions our superiors bring we have to work with it. - Bamiankor, Submitted

I cannot suggest any other thing. You are the leaders. Whatever you bring for us to work with to bring peace that is what we will work with. - Axim, Submitted

<table>
<thead>
<tr>
<th>Hypothesis</th>
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<td>Not significant</td>
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</tr>
<tr>
<td>H5</td>
<td>Usage</td>
<td>Behavioural intention</td>
<td>None</td>
<td>Significant but waned from T1 to T2.</td>
</tr>
</tbody>
</table>
6.4 DISCUSSION

This study sought to determine CHVs willingness to accept and use mobile phones to submit MDA reports. This assessment was done with reference to the UTAUT, a validated model for assessing technology acceptance. None of the three predictors of intention to use technology, identified by Venkatesh et al. (2003) was significantly predictive in this study. Similar to Niehaves and Plattfaut (2010), our findings showed non-significant direct effects of performance expectancy, effort expectancy and social influence on intention but highly significant influence of behavioural intention on actual use which waned over time. Also, similar to Dulle and Minishi-Majanja (2011), moderators were directly analysed to establish their effect on behavioural intention and Use. This study adopted a cross-sectional design with data collection at two-time points, similar to Venkatesh et al. (2003) who conducted the acceptance assessment in three different time periods. This is considered necessary because as they explained, both direct and moderating effects could change over time. This would then allow an implementer to gauge acceptance of technology as users engaged with the tool over a period.

Unlike a number of studies where PE was a strong predictor of BI, this study showed a non-significant influence on BI (Al-Gahtani, Hubona, & Wang, 2007; Venkatesh et al., 2003). In the presence of the interacting variables; age and sex, PE was shown to have no effect on the behavioural intention. Venkatesh et al. (2003) found PE to be important in predicting younger males’ intention to use behaviour. Findings from this study were similar to Vanneste, Vermeulen, and Declercq (2013), who studied health professionals’ acceptance of a nursing care system and found PE having a negative influence on BI. Similarly, Tibenderana et al. (2010) also found PE to be a negative contributor to BI in their study on acceptance of e-library services in Uganda. Schaper and Pervan (2007) also did not find support for PE in their study.
on technology acceptance among occupational therapists. While the qualitative data showed some positive perceptions of the use of the technology, the negative impact of perceived increased workload may have weighed heavier on participants intention to use. The interacting variables; age, sex and experience may have unexplained effects on PE and may have to be studied further to determine the reason for the variation.

The direct effects of EE on BI was also non-significant and does not support findings by Venkatesh et al. (2003) where EE was a strong predictor of BI. This implies that CHVs who perceived sending MDA reports with the mobile phone to be difficult did not have the intention of participating in the intervention in T1. However, this effect improved over time as seen by the positive change in T2 contrary to the original UTAUT study where the effect of EE reduced over time (Venkatesh et al., 2003). The moderating effect of sex, however, corroborated findings from the original UTAUT study. It appeared to be more important for women, over time since there appeared to be no effect in T1. It is possible the participants chose not to exert effort since the text messaging of the MDA report was voluntary and not a job requirement (Vanneste et al., 2013). Similar to Haghshenas et al. (2012), study participants educational level was expected to have a moderating effect in this study. However, while it was a significant moderator on all variables in their study, the moderating effect on effort expectancy in this study was almost negligible. The moderating effect of education with EE on BI shows that the more educated a CHV was, the more likely they were to have the intention to use mobile phones to send the MDA report but this was unfortunately not significant. While it was acknowledged that formal education was important in helping one accomplish such a task, issues like the form factor of the phone being used, understanding the procedure and perhaps needing glasses to read the screen all played contributory roles in how much effort they perceived was needed to submit the report. Generally, findings from the qualitative study expressed negative opinions
on how much effort was required to complete the task and this strengthens the quantitative EE findings of the perception of measure of effort needed. The qualitative results also indicate that age and experience with mobile phones and texting play a role in the perception of ease of use even though this was not obvious in the quantitative results. Similar results were identified in a qualitative study by Scheibe, Reichelt, Bellmann, and Kirch (2015) on elderly diabetic patient’s acceptance of a diabetic app where prior experience was an important factor in the study. EE with its moderating variables cannot be completely overlooked when considering technology acceptance for mobile phone reporting in the LF MDA context. Even though there were fewer women in this study than men, it may be necessary to intensify training or pay particular attention to women CHVs when planning to deploy mobile phones for reporting in the NTDP context.

The direct effect of SI on BI was in agreement with the Venkatesh et al. (2003) study where SI was not significant in voluntary use settings. The direct effect without moderators on SI reduced over time. The four moderators; age, sex, experience and voluntariness had minimal to no effect over time in moderating SI on BI. There was also no support for SI in studies by Dulle and Minishi-Majanja (2011) and Schaper and Pervan (2007). Dulle and Minishi-Majanja (2011) established SI as a determinant of use behaviour and not Intention to use. This implies that participants did not necessarily rely on the influence of important others to make a decision to accept to submit MDA data using mobile phones. According to Ward (2013), a number of studies applying UTAUT to healthcare have not found support for social influence especially when the target were physicians. The context of reporting health data is an individual activity not needing input or involvement of family or friends in the same way physician’s would not ordinarily need input from important others before rendering service. Islam and Grönlund (2011), however, showed strong social influence among farmers in their decision to adopt
mobile phones. Their finding is at par with this study because it was conducted in a rural setting just as this present study. Though social influence was not significant, the perception of prestige attached to using mobile phones for reporting could be harnessed to encourage CHVs if intervention is to be sustained. However, negative comments made by other CHVs about the programme providing meagre allowances in spite of the workload associated with it may have had an influence on their behavioural intention. Such negativity could cause resistance from CHVs towards any innovation. Health care worker resistance to technology due to organisational dysfunction has been studied by Stam, Stanton, and Guzman (2006).

Facilitating conditions in this study, considered the organisational and technical infrastructure that was available for this project. The direct effect of experience was very important for actual use and this increased with time. This was most likely due to the exposure to the intervention a second time by first-round participants. This group made up about 57% of the total participants in T2. At the training for T2, challenges that may have been encountered during T1 were most likely addressed and this could have improved their desire to participate in the intervention thereby resulting in increased actual use in T2. This was marked by the increase in the number of persons who participated in T2 in both study sites. Experience also had a significant two-way effect with facilitating conditions on Use behaviour. The effect of facilitating conditions is expected to increase with experience, such that individuals would find many avenues of support to help them overcome any challenges encountered (Venkatesh et al., 2003). Organisational support in the form of training was therefore vital in increasing actual use. However, experience did not have a direct effect in the original study by Venkatesh et al. (2003). There was also a change in technology in the Nzema East Municipality which may have aided in a lot more CHVs participating during T2. The USSD technology employed, ensures a two-way network connection for communication, unlike SMS which maintains a
unidirectional connection for communication. With the USSD, a participant could be assured that data inputted had been submitted to the server. Poor network quality in some sub-municipals in the Nzema East Municipality prevented SMS from being delivered even though the participants could see it had been delivered in T1. The other sub-districts in the Municipality had poor network signals. Some SMS were, however, successfully submitted from the Axim sub-municipality which is relatively urban compared to the other sub-municipalities in the Nzema East Municipality. Fewer communities in the Ahanta West district had electricity and network related challenges. Network challenges were salient in most communities and these were confirmed in the qualitative study. Network quality was objectively investigated by Perosky et al. (2015) in a study in Liberia. Similar challenges of undelivered SMS were encountered in their study too. In this study, network connectivity was not measured as an objective variable so it is difficult to ascertain how many SMS were actually undelivered. The strong effect of experience is similar to findings by Brown et al. (2010), in both direct and moderating effect with age and facilitating conditions on actual use behaviour. Interestingly, the three-way interaction of FC, experience and age showed almost no difference but was significant. Age most likely did not matter when the participants felt they had all the necessary organisational and technical resources to perform the task. These findings imply that the choice of technology for data reporting is important in rural areas where network connectivity challenges occur. Strong organisational support for CHVs would also be needed, in terms of enhanced training and a helpline to address concerns that may crop up during the data reporting.

Behavioural intention proved positive and significant for determining actual use of mobile phones for reporting LF MDA results just as in Venkatesh et al. (2003). Similar to the original study, behavioural intention also waned over time, this being shown by non-significant odds ratio in T2. Even though the effect waned in T2, it still showed that those who did not have the
behavioural intention to use were 9% less likely to use their mobile phones to submit the MDA report. Similar to a number of studies, behavioural intention showed a strong influence on an individuals’ actual use of mobile phones to submit their MDA reports (Carlsson et al., 2006; Im, Hong, & Kang, 2011; Kijsanayotin et al., 2009). An intention-use gap was identified in Lim et al. (2011) just like T2 in this present study. Both technical and design factors were attributed to the gap. Behavioural Intention was also significant in all three time periods in the original study by Venkatesh et al. (2003) while Duyck et al. (2010) showed non-significant behavioural intention. Qualitative findings for behavioural intention showed some CHVs intention to use was based on factors such as incentives, submission to authority and general willingness to volunteer for public good. Literature explains that generally, individuals who are more likely to volunteer do so because of external incentives or an intrinsic desire to do good (Geiser, Okun, & Grano, 2014). Both intrinsic and extrinsic incentives appear to have played a role in this study. While some CHVs intention to use was borne out of a desire to volunteer and offer service, others were also motivated by the airtime credit they had been promised once the message was received. This could explain the relatively weaker determinants of behavioural intention but strong behavioural intention on use behaviour. The issue of CHVs motivation; financial or non-financial, appears to have played a critical role in this study. CHVs appear willing to serve but would like to feel their services are appreciated. Bhattacharyya et al. (2001) stated that volunteer health workers operate within a larger cultural and political environment and that their specific tasks can affect their motivation and retention. Based on this, it can be deduced that extra activities CHVs are tasked with should be implemented with their expectations of incentives and motivation in mind.
6.5 CONCLUSION

In this study, effort expectancy moderated by sex was found to be a determinant of behavioural intention, behavioural intention was a determinant of actual use and facilitating conditions moderated by experience also had a positive effect on the actual use of mobile phones for reporting LF MDA data. It can be suggested that CHVs motivation to use their mobile phones to submit the MDA report, was associated with their perception of ease of use and other factors such as support, technical structures and programme related factors such as incentives and volunteerism. Adequate training will have to be provided for CHVs while technical infrastructure would have to be strengthened to ensure a successful deployment of a new reporting process.
CHAPTER 7

JOURNAL ARTICLE MANUSCRIPT

ASSESSING LYMPHATIC FILARIASIS TREATMENT DATA REPORTING QUALITY USING DATA SUBMITTED FROM MOBILE PHONES

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Abstract

Background - Mobile phones have been found to aid in the collection and reporting of data especially from remote areas. Little research has been conducted to assess the quality of data reported with mobile phones. After conducting a technical feasibility of reporting lymphatic filariasis mass drug administration (MDA) data with mobile phones, it is also important to assess data quality to determine if this mode of reporting is viable for the programme.

Methods - MDA data collected over two consecutive years (T1 and T2) through SMS and unstructured supplementary service data (USSD) was collated across communities. Validated paper-based MDA data for the same period was obtained from the district and regional health administration. Data completeness was assessed by comparing the number of variables expected with the total number of variables reported through mobile phone platform. Accuracy was assessed by comparing the differences in proportions between community-level data received and validated reports.

Results - Data completeness in T1 ranged from 65 – 100% in both study sites. In T2, it ranged from 0 – 100%. Thirty-two (32) messages were 100% complete in the Ahanta West dataset while 14 messages in Nzema East were 100% complete. In T1, inaccurate data reported was 89.4% for both study sites. In T2, Ahanta West had 56% inaccurate data while Nzema East had...
75% inaccurate data. Overall data inaccuracy was 68.4%. Data received through USSD had higher completeness.

**Conclusion** - MDA data generated in the two study sites exhibited poor data accuracy and completeness. The use of mobile phones does not guarantee improved data accuracy. However, the type of mobile technology used may aid in improving data completeness. Measures would have to be put in place to train CHVs to improve the quality of the data they submit.

**Keywords:** accuracy, completeness, mass drug administration, health data, mobile phones

### 7.1 INTRODUCTION

Good quality data for decision making and planning is needed for the success of health programmes (Nonvignon, Mensah, da-Costa Vroom, Adjei, & Gyapong, 2016). This can be achieved if data collected and reported is timely, accurate and complete. Decision makers in developing countries over the years have had challenges obtaining timely, accurate and standardised data for resource allocation and decision making (Shiferaw & Zolfo, 2012). Overcoming this will enable health programmes and ministries of health to respond and address health priority needs of the population, conduct disease surveillance and evaluate health policies (Wilkins et al., 2008). Braa, Heywood, and Sahay (2012) noted that data quality is related to data use and having poor data could result in the data not being used for planning and decision-making.

Poor data quality (timeliness, accuracy and completeness) in developing countries have been noted in a number of studies (Braa et al., 2012; Makombe et al., 2008; Mavimbe et al., 2005; Mphatswe et al., 2012). Makombe et al. (2008), in a study in Malawi, found poor data accuracy in anti-retroviral treatment centres in the country showing a 12% undercount on the number of
persons receiving first-line treatment in the country. HIV prevention of mother-to-child-transmission (PMTCT) data in health facility registers were found to be inaccurate compared to data in the District Health Information System (Mphantswe et al., 2012). Similarly, data quality issues have been identified with mass drug administration (MDA) data from Neglected Tropical Diseases (NTD) programmes from scientific and anecdotal evidence. Using the Data Quality Assessment (DQA) tool for NTD programmes, de Souza et al. (2016) compared reported data to extracted data from MDA registers and found 40% over reporting and 22% underreporting of data. Data completeness and timeliness were also found to be poor in the study sites. Worrell and Mathieu (2012), through coverage surveys, also identified 73% over-reporting of treatment coverage data from 37 coverage estimates assessed. Health data in most countries is captured by both electronic and paper-based methods and both can be prone to errors (Kayode, Amoakah-Coleman, Brown-Davies, Grobbee, & Agyepong, 2014).

Mobile phones have been shown to improve timeliness and accuracy of data reported for a number of health data collection interventions (Asangansi et al., 2013; Mechael et al., 2010; Stanton et al., 2015). It is also an innovative way of receiving health data from the periphery (Andreatta et al., 2011; Mechael et al., 2010). There have been calls for a critical look at health data being generated through mHealth (Perosky et al., 2015). This is because the type of data, context of the data collection and persons generating and reporting the data are important factors in ensuring data quality. Timely reporting of data can usually be effected with the use of mobile phones. However, data completeness and accuracy cannot be guaranteed. It is therefore important that an assessment of the feasibility of mHealth for a health programme should include an assessment of the data being generated through the mHealth intervention. This can help improve the intervention to ensure the full potential of mHealth is harnessed for the programme.
Currently, the NTD programme in Ghana receives LF MDA treatment coverage data from the community health volunteers (CHVs) at the community level through the sub-district, district and regional health administrations. Using this paper-based method has resulted in delayed reporting and mobile phones are being suggested as tools that could enable this challenge to be solved. A data reporting intervention using mobile phones to report LF MDA data was tested to determine the feasibility of CHVs reporting the data directly. In testing mHealth as a tool, it was important to assess the data generated to determine if the quality of data would be appropriate for decision making and planning. This study, therefore, aimed to assess three data quality parameters; timeliness, accuracy and completeness of MDA data submitted using mobile phones by the CHVs.

7.2 MATERIALS AND METHODS

7.2.1 Study Design and Sites

This was a cross-sectional interventional study conducted during two consecutive years. The study sites were Ahanta West district and Nzema East Municipal Assembly.

7.2.2 Sampling and Sample Size

Every community for which one or more CHVs was represented and trained to submit data using SMS or USSD was eligible for inclusion in the data quality assessment. One hundred and forty-four (144) communities were represented in this study from both study sites.

7.2.3 Data Collection

Validated paper-based district level data for 2014 (T1) and 2015 (T2) MDAs were obtained from the District Health Administration (DHA) in both districts. However, 2014 data for
Nzema East was obtained from the Regional Health Administration (RHA) since the data could not be located at the Municipal health office. In the first year of the study (T1), summarised LF MDA data in registers were submitted by SMS. In the second year (T2), SMS and Unstructured Supplementary Service Data (USSD) were the modes of reporting the LF MDA data. Data for comparison was obtained from the servers that had been set up to receive the SMS and USSD sent from CHVs mobile phones.

### 7.2.4 Data Collection Instrument

The MDA data was received through Short Message Service (SMS), using a toll-free shortcode provided by a third party data aggregator. In T1, both districts reported data using SMS. The SMS formatting structure used can be seen in Figure 7.1. However, in the second round (T2), Ahanta West submitted their MDA reports via SMS while Nzema East participants submitted their reports using USSD. USSD establishes a connection between the user’s phone and the network provider’s computer. The session remains open while the two-way sequence of data is exchanged between the phone and the network provider’s computer. This ensures each field is populated by the user before the session ends. Data received on these two electronic platforms were downloaded and saved as MS Excel files for data management and analysis.

![Figure 7.1 - SMS Format](image)

### 7.2.5 Data Analysis

Differences in proportions between the validated programme data and data received by SMS and USSD were calculated for all the communities using the DHA validated data as the
standard for comparison. The p-values were calculated to determine the significance of the differences in the data at 95% confidence interval. Accuracy was defined in this study as a data value that was within a 5% range of the reported district or regional value (Makombe et al., 2008; USAID, 2013). In consonance with Data Quality Assessment guidelines for NTD programmes, eight (8) suggested indicators were chosen from the dataset for analysis. Variables assessed were total number of persons treated, ivermectin tablets (received, used, remaining), albendazole tablets (received, used, remaining) and total number of persons refusing treatment. Completeness was defined as the degree to which all fields required for observation were completed (USAID, 2013). The communities were the unit of analysis for the completeness and accuracy assessment. Data from 3 communities in the T1 dataset and 5 communities in Nzema East in T2 were not analysed because there was no comparison data from the District MDA data. Timeliness was defined as the percentage of source documents that have been compiled for the correct assessment period, and the percentage of reports that were submitted by the due date (USAID, 2013). Timeliness was measured using the expected due date set by the programme as an indicator of timely reporting or not. Data were analysed in Stata 13® (StataCorp LP) and MS Excel 2013.

7.2.6 Ethical Issues

Ethical clearance was obtained from the Ghana Health Service for this study (GHS-ERC: 13/11/12). Permission was obtained from the DHA in each study site.

7.3 RESULTS

In T1, 109 communities in both study sites participated and 113 communities participated in T2. Also in T1, nineteen (19) SMS were received from study participants; thirteen (13) messages from Ahanta West, five (5) from Nzema East and one (1) from an unidentified
community, all representing a 17.4% response rate. The unidentified community was not included in the accuracy and completeness analysis. In T2, there was a quantum leap in messages received from both study sites. Ahanta West saw an increase to 62 messages while Nzema East increased to 23 messages in the same period being 75.2% response rate. Five unidentified communities in Nzema East and two in Ahanta West submitted data and these were excluded from the accuracy and completeness analysis. There was a total increase of 347.4% in messages received from T1 to T2.

7.3.1 Data Completeness

Overall, CHVs were expected to report on twenty (20) indicators from their MDA summaries in T1. Completeness of reporting was high for Ahanta West with eleven out of thirteen text messages reporting all (100%) expected indicators. One text message each reported 80% and 95% of expected indicators respectively. Out of the five text messages reported for Nzema East, one had 100% of expected indicators, two had 65%, one had 75% and the other, 95% of expected indicators. In T2, eighteen (18) indicators were expected to be reported in Ahanta West instead of twenty indicators expected in T1. Thirty (30) SMS received in T2 were 100% complete, having submitted data for all indicators, twelve SMS were 70 – 99% complete, fifteen were 30 - 69% complete, three were 0 – 29% complete. In Nzema East in T2, sixteen variables were expected to be reported. These results are shown in Table 7.1.
Table 7.1 – Percentage completeness of data reported for study sites.

<table>
<thead>
<tr>
<th>Study Year</th>
<th>Study Sites</th>
<th>% Completeness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0 - 29</td>
</tr>
<tr>
<td>T1</td>
<td>Ahanta West</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Nzema East</td>
<td>-</td>
</tr>
<tr>
<td>T2</td>
<td>Ahanta West</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Nzema East</td>
<td>3</td>
</tr>
</tbody>
</table>

Data completeness for the communities from Nzema East were relatively higher. A number of session timeouts occurred while CHVs were submitting data using USSD. This led to eight (33.3%) reports being terminated at the beginning of the session or in the middle of the session. There were ten (41.7%) messages with no session timeouts while five (20.8%) had session timeouts but still submitted data for all fields. Unfortunately, the fields being populated at the time of the session timeouts lost their data and were rather filled with ‘Session Timeout’ as the reported value.

7.3.2 Data Accuracy

Table 7.2 shows the percentage differences between programme data obtained from the DHA and the SMS submitted by CHVs in T1. Data accuracy was poor for the various indicators and communities. Two communities; Akango in the Nzema East Municipality and Nyameyiekrom in the Ahanta West District had the most data being accurate per the indicators assessed. Accuracy was measured as a value within 5% range of the district comparison value. Nyameyiekrom reported 100% accuracy for Total Persons Treated, Ivermectin Received and Total Number Refused Treatment. Akango also reported accurate data for all indicators except Albendazole Remaining and Total Number Refused Treatment. The indicator; Total Treated for Akango, was within 3% points of the programme data while the other indicators were 100%
accurate. Tumentu community in the Ahanta West district reported accurate data (4.95%) for Albendazole Remaining while Kanfokrom reported Albendazole Received accurately (-2.81%). Overall, most indicators for T1 were highly underreported and differences were highly significant. Total data inaccuracy was 89.4% for the reporting communities.

In T2, MDA reports in the form of SMS were submitted from the Ahanta West District. Indicators assessed were mostly inaccurate and largely underreported. The Ivermectin Received indicator was the most accurately reported among the communities, followed by Ivermectin Used and Albendazole Received. The Total Persons Treated which is an important indicator for NTD programmes was mostly underreported. Accurate data was reported by seven (7) communities. As in T1, Nyameyiekrom reported 100% accuracy for 3 indicators. Ghacem and Yabiw both reported three indicators accurately. Akatenchie in Princess sub-district reported the highest number of accurate indicators. Details of these results can be found in Table 7.3. Total data inaccuracy for Ahanta West in T2 was 55.9%.

Data accuracy in the Nzema East Municipality in T2 was poor. There was high underreporting of all five (5) indicators analysed in this study. Banso, a community in the Gwira Banso sub-district reported 100% accurate data for all the 5 indicators as shown in Table 7.4. The Total Persons Treated, Ivermectin Used and Albendazole Received had accurate data from 3 communities. Total Number Refused Treatment had two accurate data from two communities. One community reported Ivermectin Received accurately. Total data inaccuracy for Nzema East in T2 was 75%. Overall data inaccuracy for both districts over the two MDAs was 68.4%.
Table 7.2 - Percentage Differences between SMS data and Programme MDA Data for T1 from Ahanta West District and Nzema East Municipality

<table>
<thead>
<tr>
<th>District</th>
<th>Community</th>
<th>Total Treated</th>
<th>IVM Received</th>
<th>IVM Used</th>
<th>IVM Remaining</th>
<th>ALB Received</th>
<th>ALB Used</th>
<th>ALB Remaining</th>
<th>Total Refused</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahanta West</td>
<td>Fasin</td>
<td>-10.91</td>
<td>0.000</td>
<td>-16.67</td>
<td>0.000</td>
<td>-9.09</td>
<td>0.000</td>
<td>-8.28</td>
<td>0.000</td>
</tr>
<tr>
<td>Ahanta West</td>
<td>Gyabenkrom</td>
<td>-57.58</td>
<td>0.000</td>
<td>-26.00</td>
<td>0.000</td>
<td>-22.28</td>
<td>0.000</td>
<td>-100.00</td>
<td>0.000</td>
</tr>
<tr>
<td>Ahanta West</td>
<td>Nyameyiekrom</td>
<td>0.00</td>
<td>-0.00</td>
<td>0.00</td>
<td>20.08</td>
<td>-100.00</td>
<td>0.000</td>
<td>-33.33</td>
<td>0.000</td>
</tr>
<tr>
<td>Ahanta West</td>
<td>Kanfokrom</td>
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<td>-29.40</td>
<td>0.000</td>
<td>278.33</td>
<td>0.000</td>
<td>-2.81</td>
<td>0.000</td>
</tr>
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<td>Aketekyi</td>
<td>-67.42</td>
<td>0.000</td>
<td>-58.33</td>
<td>0.000</td>
<td>-64.79</td>
<td>0.000</td>
<td>-23.12</td>
<td>0.000</td>
</tr>
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<td>Ahanta West</td>
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<td>-33.71</td>
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<td>-99.55</td>
<td>0.000</td>
<td>-60.00</td>
<td>0.000</td>
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<td>Tumentu</td>
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<td>0.000</td>
<td>-99.71</td>
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<td>6.25</td>
<td>0.000</td>
<td>-99.50</td>
<td>0.000</td>
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<td>-79.98</td>
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<td>0.000</td>
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<tr>
<td>Nzema East</td>
<td>Brawire/Amanf ukum/Antyinim</td>
<td>-60.30</td>
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<td>-38.90</td>
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<td>-33.20</td>
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<td>Baniakor</td>
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<td>-57.50</td>
<td>0.000</td>
<td>-30.43</td>
<td>0.000</td>
<td>-70.03</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Bold figures meet the criteria for accuracy. - No p-value could be obtained because there was no difference between reported and programme data. IVM = Ivermectin, ALB = Albendazole
### Table 7.3 - Percentage Differences between SMS data and Programme MDA Data for T2 in Ahanta West (continued on next page)

<table>
<thead>
<tr>
<th>Subdistrict</th>
<th>Community</th>
<th>Total treated</th>
<th>IVM Rcvd</th>
<th>IVM Used</th>
<th>IVM Remaining</th>
<th>ALB Rcvd</th>
<th>Total Refused</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>% Diff</td>
<td>p-value</td>
<td>% Diff</td>
<td>p-value</td>
<td>% Diff</td>
<td>p-value</td>
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<td>Mosuma Zone 3</td>
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<td>17.95</td>
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<tr>
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<td>Gyabenkrom</td>
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<td>0.000</td>
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<td>0.000</td>
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<tr>
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<td>17.43</td>
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<td>0.000</td>
<td>0.00</td>
<td>-</td>
</tr>
<tr>
<td>Agona</td>
<td>Fie</td>
<td>0.00</td>
<td>-</td>
<td>4.65</td>
<td>0.000</td>
<td>18.03</td>
<td>0.000</td>
</tr>
<tr>
<td>Agona</td>
<td>Hotopo</td>
<td>-15.34</td>
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<td>-4.24</td>
<td>0.000</td>
<td>-11.47</td>
<td>0.000</td>
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<tr>
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<td>Nyameyekrom</td>
<td>100.25</td>
<td>0.000</td>
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<td>-</td>
<td>0.00</td>
<td>-</td>
</tr>
<tr>
<td>Agona</td>
<td>Adjumako</td>
<td>11.20</td>
<td>0.000</td>
<td>22.80</td>
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<td>4.46</td>
<td>0.000</td>
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<td>Ewusieje Jnctn</td>
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<td>10.91</td>
<td>0.000</td>
<td>1.20</td>
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<td>Akatenchie</td>
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<td>Fretsì</td>
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<td>Funkoe</td>
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<td>Ghacem</td>
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<td>-</td>
<td>0.00</td>
<td>-</td>
</tr>
<tr>
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<td>Beahu</td>
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<td>0.045</td>
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<td>0.00</td>
<td>-</td>
<td>-10.26</td>
<td>0.000</td>
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</tbody>
</table>

184
<table>
<thead>
<tr>
<th>Subdistrict</th>
<th>Community</th>
<th>Total treated</th>
<th>IVM Rcvd</th>
<th>IVM Used</th>
<th>IVM Remaining</th>
<th>ALB Rcvd</th>
<th>Total Refused</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dixcove</td>
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<td>-56.49</td>
<td>0.000</td>
<td>-54.82</td>
<td>0.000</td>
<td>0.000</td>
<td>-63.30</td>
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<td>Ntaakrom</td>
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<td>0.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Dixcove</td>
<td>Elobankata</td>
<td>-49.08</td>
<td>0.000</td>
<td>10.22</td>
<td>18.24</td>
<td>90.00</td>
<td>0.000</td>
</tr>
<tr>
<td>Dixcove</td>
<td>Ahuntamano</td>
<td>-6.61 0.000</td>
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<td>8.00</td>
<td>12.00</td>
<td>0.00</td>
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</tr>
<tr>
<td>Dixcove</td>
<td>Old Akwidade</td>
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<td>38.00</td>
<td>-44.46</td>
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<td>Dixcove</td>
<td>Sankor</td>
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<td>-92.80</td>
<td>24.44</td>
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</tr>
<tr>
<td>Princess</td>
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<td>-50.00</td>
<td>-100.00</td>
<td>39.40</td>
<td>0.000</td>
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<tr>
<td>Princess</td>
<td>Akatechie</td>
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<td>-0.40</td>
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<td>-100.00</td>
<td>3.30</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Bold figures meet the criteria for accuracy. - No p-value could be obtained because there was no difference between reported and programme data. Programme data could not be identified for communities with empty fields. IVM = Ivermectin, ALB = Albendazole
Table 7.4 - Percentage Differences between USSD data and Programme MDA Data for T2 in Nzema East Municipality

<table>
<thead>
<tr>
<th>Subdistrict</th>
<th>Community</th>
<th>Total treated</th>
<th>IVM Rcvd</th>
<th>IVM used</th>
<th>ALB Rcvd</th>
<th>Total Refused</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>% Diff.</td>
<td>p-value</td>
<td>% Diff.</td>
<td>p-value</td>
<td>% Diff.</td>
</tr>
<tr>
<td>Axim</td>
<td>Kegyina</td>
<td>0.00</td>
<td>-</td>
<td>ST</td>
<td>-99.80</td>
<td>0.00</td>
</tr>
<tr>
<td>Axim</td>
<td>Dadwen</td>
<td>-36.12</td>
<td>0.000</td>
<td>ST</td>
<td>-41.47</td>
<td>0.000</td>
</tr>
<tr>
<td>Axim</td>
<td>Bankyim/Grant Hill</td>
<td>-6.72</td>
<td>0.000</td>
<td>-28.57</td>
<td>0.000</td>
<td>ST</td>
</tr>
<tr>
<td>Axim</td>
<td>Ndatiem</td>
<td>21.40</td>
<td>0.000</td>
<td>-33.33</td>
<td>0.000</td>
<td>1.11</td>
</tr>
<tr>
<td>Axim</td>
<td>Amanfukumano</td>
<td>ST</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Axim</td>
<td>Accra Town</td>
<td>-68.73</td>
<td>0.000</td>
<td>-99.97</td>
<td>0.000</td>
<td>-100.00</td>
</tr>
<tr>
<td>Axim</td>
<td>Apatam/ Adukrom</td>
<td>-30.03</td>
<td>0.000</td>
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<td>0.000</td>
<td>-99.80</td>
</tr>
<tr>
<td>Axim</td>
<td>Police Quarters</td>
<td>-40.25</td>
<td>0.000</td>
<td>0.00</td>
<td>-</td>
<td>0.00</td>
</tr>
<tr>
<td>Axim</td>
<td>Brawire/Akyinim</td>
<td>-71.87</td>
<td>0.000</td>
<td>-95.85</td>
<td>0.000</td>
<td>-95.38</td>
</tr>
<tr>
<td>Bamiankor</td>
<td>Kakuasuazo</td>
<td>0.00</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bamiankor</td>
<td>Ampansie</td>
<td>-59.00</td>
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<tr>
<td>Bamiankor</td>
<td>Anyinase</td>
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<td>0.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bamiankor</td>
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<td>0.000</td>
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<tr>
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<tr>
<td>Gwira Banso</td>
<td>Gwira Banso</td>
<td>0.00</td>
<td>-</td>
<td>0.00</td>
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<td>0.00</td>
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<tr>
<td>Gwira Banso</td>
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<td>Kutukrom</td>
<td>Sikanasem</td>
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<td>0.000</td>
<td>-99.80</td>
<td>0.000</td>
<td>-99.80</td>
</tr>
</tbody>
</table>

Boldened figures meet the criteria for accuracy. - No p-value could be obtained because there was no difference between reported and programme data. Empty fields are showing no data was submitted for the fields probably due to Session Timeouts. ST = Session Timeout, IVM = Ivermectin, ALB = Albendazole
7.3.3 Timeliness of Reporting

All data received from Ahanta West in T1 was reported by the expected due date. This date was agreed on by stakeholders during the annual national MDA review meeting. All five (5) messages from Nzema East were delivered after the due date. In T2, 82.6% of messages were delivered by the agreed due date. Details of these results are reported in Table 7.5.

<table>
<thead>
<tr>
<th></th>
<th>No of Messages by Due date</th>
<th>No of Messages after due date</th>
<th>%age delivered by due date</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Ahanta West</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Nzema East</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>T2</td>
<td>Ahanta West</td>
<td>52</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Nzema East</td>
<td>19</td>
<td>4</td>
</tr>
</tbody>
</table>

7.4 DISCUSSION

This study set out to determine the timeliness, completeness and accuracy of data submitted by SMS and USSD by CHVs in two study sites over the two time points of the study. Data completeness from both study sites in both time periods ranged from 0 – 100% with some communities reporting 100% of indicators expected. Data accuracy, on the other hand, was poor across study sites. A few communities reported 100% accurate data for some indicators. Timeliness of reporting was poor in T1 and improved in T2.

The quality of LF MDA data has been assessed in a number of studies (de Souza et al., 2016; Hooper, Chu, Mikhailov, Ottesen, & Bradley, 2014; Worrell & Mathieu, 2012). In these studies, there were cases of under and over reporting. Results from this study are similar to findings by de Souza et al. (2016) who conducted their study in the same districts using 2010 MDA data.
Inaccuracy of data was 60% in their study which was similar to the overall inaccuracy of 68.4% of data identified in this current study. Completeness and timeliness were also poor. Inaccurate data poses a challenge to the authenticity of treatment coverage data reported by the country. Data collected during mass health campaigns by CHVs can help provide insights into overall programme success or failure (Mitchell, Dietz, Okwo-Bele, & Cutts, 2013). Cases of data inaccuracy, therefore, raise pertinent questions on the reliability of such data for decision making. Other countries have similar challenges in reporting accurate data for their MDAs as shown by Worrell and Mathieu (2012), therefore Ghana’s is not atypical. However, interventions would have to be put in place to ensure data reported are as accurate as possible to ensure true LF elimination by the projected 2020 target (Hooper et al., 2014).

Margins of error associated with the underreporting and overreporting of the MDA data were extremely high with some margins being as much as more than 90% of programme data. Potential reasons for the margins of error could be due to the programme receiving data from CHVs not accounted for in our study. Some communities may have enrolled additional CHVs after the sub-district training and their combined data would be shown in the validated programme data but not reflect in data received for the study. Some CHVs also had more than one MDA register for recording the drug administration in their communities. There is the likelihood that data was reported from only one register instead of combined data from all registers used for a community. Other data entry errors could have occurred while entering data on the mobile phones. It cannot be ascertained if the “Review” function on the USSD was used or how well SMS were reviewed before submitting. Further field assessments would have to be conducted to determine the cause of the high underreporting shown in this study. Surveyed and reported data analysed by Worrell
and Mathieu (2012) in countries such as Haiti showed noticeable differences just as this current study. Data inaccuracies have also been noted by Dreisler et al. (2001) in situations of voluntary data reporting.

As shown in this study, 100% data completeness was more likely when the USSD technology was applied. The process of interaction with USSD, ensures all fields are populated. This is because the data entry fields for the indicators are presented sequentially and the user is required to enter data before proceeding to the next variable. This occurs until all the necessary fields have been populated. Unlike the USSD, the SMS allowed the users to submit the data without any checks on number of fields submitted. SMS has been found to show more incomplete data compared to other data collection tools such as apps or online tools (Lim, Sacks-Davis, Aitken, Hocking, & Hellard, 2010; Marcano Belisario et al., 2015; Walsh & Brinker, 2016). This is because SMS does not have a method for checking skipped questions or items. Technology that allows a structured format for reporting will have to be engaged in any future studies to ensure all required indicators are submitted. A hundred percent (100%) data completeness was reported by Lo et al. (2011) because of “must enter” fields on the web-based notification system for tuberculosis in Taiwan.

A number of studies have raised issue with the validity and quality of mHealth data but few mHealth studies have assessed the quality of SMS data (Andreatta et al., 2011; van Velthoven, Car, Zhang, & Marušic, 2013). Perosky et al. (2015) recognised there was a dearth of such studies even though there is heightened momentum in using mobile phones for data collection especially in the developing countries. In a systematic review on evidence on feasibility and effectiveness of mHealth use by frontline health workers, Agarwal et al. (2015), noted that studies usually assessed
whether frontline health workers were able to submit data using the mobile phones but hardly reported on the accuracy of the data submitted. In this study, CHVs demonstrated the ability to submit data via SMS and USSD. However, until such data quality assessments are conducted to obtain evidence, national policies may be slow in recommending or institutionalising mHealth programmes. Issues of sustainability and scalability of mHealth pilots will have to include discussions on monitoring and evaluation of the data collection process and data received not just the benefits of SMS to deliver timely data, its availability on every type of phone and familiarity to most mobile phone users (Chib et al., 2012; Crawford et al., 2014). While timeliness of data submission can be guaranteed, other factors may be pertinent to achieving accuracy and completeness such as education or literacy, experience using the technology and support received in sending the message (Perosky et al., 2015).

Data reported by SMS and USSD was a reflection of poor data quality in the MDA registers submitted by CHVs. These findings are in agreement with a number of studies that have assessed health data collected by CHVs (Helleringer, Frimpong, Phillips, Avoonor-Williams, & Yeji, 2010b). Similarly, Tomlinson et al. (2009) also identified fictitious data submitted by CHVs during a data collection exercise. Data collectors may perceive data collection as time consuming and may not appreciate the importance of the data (van Velthoven et al., 2013). This study has shown results contrary to a review by Braun et al. (2013), that CHVs become proficient collectors of complete, high-quality health data from the field when equipped with mobile devices. The current workflow and possible health system challenges would have to be examined and resolved to ensure improved data quality from source. A health programme hoping to strengthen data reporting from the periphery through CHVs will have to intensify training. This would mean
engaging them in data use training in order that they gain an understanding of how the data reported impacts decision making. This would also be a good feedback mechanism that reverses the one-way data submission to national health programmes that currently exists with most paper-based data collection systems (Braa et al., 2012).

7.5 CONCLUSION

This study has shown both poor data accuracy and data completion rates for MDA reports submitted by SMS and USSD. Timeliness was, however, relatively good for a number of communities. It has confirmed a number of studies that have shown challenges with MDA data reported for NTD programmes. The poor data generated has the tendency to misrepresent the disease state and treatment coverage in the endemic communities. These are challenges that need urgent measures to ensure good health data for decision making. It can also be concluded that using technology is not a panacea for improved data quality. As seen in this study, it does not necessarily result in improved accuracy or completeness of data but rather reflects what currently occurs. Various technological innovations have their nuances and these will have to be brought to bear when choosing technology for data collection.

7.6 RECOMMENDATIONS

- Poor data submitted by CHVs indicates training should be improved. The component of the training on data collection may have to be emphasised with a specific focus on data use. This may help them gain an appreciation of the consequences of poor data quality.
• Data quality assessments (DQA) should be conducted at the community level after each MDA. Results of such should be disseminated to CHVs within a few weeks of the completion of the MDA, thus sensitising them to the importance of accurate reporting. Improving the data collected by CHVs may also lessen the burden of sub-district supervisors who have to audit each MDA register to ensure good data quality.

• This study did not assess the telecommunication network quality in the study sites. Future studies may find it useful to conduct such assessments prior to rolling out any mobile phone related intervention. This can help shape expectations of how data will be submitted and the potential for data losses during transmission. The network quality can also inform on the type of technology to employ for the given data collection exercise.

• Future research can objectively investigate the reasons for the dramatic increase in data submitted between the two time periods. A number of factors could have accounted for the increase and evidence is needed to shape future research.

• Innovation should also be investigated at the data collection point to alleviate the burden of data collation. If CHVs can be trained to use tablets to collect data from the households, this might improve the accuracy of data since collation or summaries for the various indicators would be computerised. Data completion could also be improved when all fields are set as required so they cannot be skipped during data entry.
Considerations such as geographical area, literacy of potential users, type of data to be collected and users prior experience with the technology should be carefully analysed. Various measures will have to be implemented to ensure data reported by CHVs can provide the needed data for decision making by the NTD programme.
CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

8.1 CONCLUSIONS

Mobile phones have been identified as an important tool for health service delivery, especially in resource-limited settings. This is due to the high proliferation of mobile phones in many areas both urban and rural. The many benefits realised in using these tools could be harnessed by the NTD programme in improving timeliness, accuracy and completeness of MDA data generated at the community level. Community health volunteers (CHVs) are the first line data collectors for the programme and could potentially be resourced to use these mobile phones to report data they collect as they undertake the drug distribution. However, little is known about the feasibility of CHVs using mobile phones for reporting MDA data for the programme.

The results of this study have shown that the data reporting bottlenecks occur upstream during the reporting chain at the sub-district and district levels. CHVs usually complete their drug distribution within the given timeframe and submit their reports to their supervisors in the sub-district. The validation and aggregation of data from various communities in the sub-district are done by supervisors at sub-district. This process is delayed for a number of reasons at the sub-district and even more so at the district level.

Mobile phone use among CHVs is almost universal. The function used most is voice calls followed by text messages. This high exposure to mobile phones did not necessarily translate to high data submission via mobile phones. Though submission of data through mobile phones increased over

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the course of the study, less than 50% of study participants submitted their MDA reports using mobile phone technologies employed by the study. This was partly due to motivational issues and technical issues. However, CHVs were shown to have positive intention to use mobile phones for LF MDA reporting. Performance expectancy, effort expectancy and social influence were not identified as significant factors determining CHVs' intention to use mobile phones to report MDA data in this study. Experience, however, made an impact on the actual use of mobile phones for reporting. This experience appeared to be related to exposure to the intervention over the course of the study, coupled with organisational and technical supporting factors. Their behavioural intention to use it to report MDA data was dependent on other factors such as the spirit of volunteerism, incentives and submission to authority. This goes to show that prevailing programmatic issues faced by CHVs in the programme have the potential to affect any additional task the programme assigns them.

There is telecommunication infrastructure in both study sites. However, a number of communities have poor network connectivity. This is likely to impact mobile phone MDA reporting. There were a number of SMS transmission failures as well as session timeouts with the USSD. The poor or lack of telecommunication services in some communities may have been a disincentive for some CHVs to attempt submitting their MDA reports via SMS or USSD.

Timeliness of data reporting was high. Community health volunteers reporting is prone to inaccuracy and data is moderately complete. They appear to have numeracy challenges and are unable to produce reports with the requisite accuracy needed by the NTDP. However, this study
has shown that choosing the right technology for mobile phone data reporting may ensure data completeness.

It can be concluded that MDA reporting using mobile phones is feasible. Considering the following conditions:

- There was high mobile phone usage among CHVs
- CHVs had the intention to use mobile phones for reporting MDA data
- Network connectivity was available albeit there were communities with poor connectivity
- There was timely data reporting, moderate completeness but low data accuracy

8.2 LIMITATIONS

Community health volunteers participated in this study on a voluntary basis and this may have had an effect on the response to the intervention. Studies on technology acceptance have asserted that mandatory or voluntary settings play a role in determining intention to use technology for a given task. For our participants, they understood they had a choice to participate or not and this was not affecting their role or jobs as CHVs in their communities. This may have influenced those who did not own phones or considered the exercise a tedious one.

There was no follow-up study after data collection in T2 to determine the exact reasons for the increased response rate to the data reporting. This may have confirmed if the technological changes made in T2 were the cause of the increase in actual use. Network quality was not quantitatively measured in this study. A thorough assessment of the network quality in the various communities
may have helped determine the actual SMS transmission failures per community. Again, results of this study may not be generalizable to rural areas with relatively better network connectivity.

Training of CHVs was conducted during their annual sub-district MDA training. This may not have been sufficient to help all CHVs understand what was required for reporting MDA data with their mobile phones. Extra training sessions on mobile phone reporting may have been needed for study participants.

The NTD focal person’s perspective on the mHealth intervention was not studied. They play an important role in ensuring drug distribution and reporting are completed successfully. Findings on their perspectives on the feasibility of using mobile phones for reporting and the role they would play would have strengthened the case for mobile phone reporting for the NTDP.

8.3 RECOMMENDATIONS

It has become clear that the CHVs in this study are willing and able to use mobile phones for reporting MDA data to some extent. However, there are challenges with poor accuracy and moderate completeness of data submitted. Robust training on data use will be needed to ensure data submitted directly by CHVs may be usable by the programme. Data use should also be included for them to gain an appreciation of what the data is used for and its impact on decision making.

To mitigate issues of data inaccuracy, it is recommended that the community health officers at the sub-district level, who immediate supervise CHVs and validate the data, could be given the tools to enable them submit the MDA reports directly to the programme. This could be done on the e-
Tracker being used by the Ghana Health Service at the sub-district level for reporting health indicators. This is a mHealth tool that is used to submit data directly into the DHIMS2 for decision-making.

Unstructured Supplementary service data should be tested as a potential mHealth application for data collection, especially in places with poor network connectivity.

8.4 CONTRIBUTION TO KNOWLEDGE

8.4.1 Implication for Theory

To the best of my knowledge, no studies have been conducted to assess CHVs technology acceptance using the UTAUT model. CHVs are a unique group of health workers playing an important role in health service delivery in developing countries, and any bid to introduce technology into their service delivery duties will have to be carefully studied based on the context of the health system they work in. This study has also provided empirical evidence of how the determinants of intention to use and actual use affect the model in the developing country healthcare delivery context. In applying this theory, education was included as a moderator and this study adds to the discourse on the influence of other moderators and factors that could potentially influence intention to use and actual use of technology for any given task. This adds strength to the call from the original study by Venkatesh et al. (2003), for more studies to test the UTAUT model and improve its relevance. This study has also shown that known sociodemographic factors such as age and sex may have little impact in mHealth acceptance studies.
The feasibility assessment conceptual framework for this study contributes literature for future studies. This framework suggests that technology feasibility studies may have to carefully evaluate the determinants of technology feasibility within the relevant context, as well as the impact of the technology on important variables for the Programme. This adds credence to the call by Chib (2013) on the importance of studying the input-mechanisms-output pathway of mHealth.

Literature on mobile applications for health appears restricted to SMS and smartphone applications with a few studies comparing other technologies such as IVR and voice messaging. Literature on the use of USSD for data collection appears minimal. Findings in this study showed a dramatic increase in response rate on the introduction of this technology. There appears to be potential for higher reliability of USSD compared to SMS for data transmission in poor network connectivity settings.

8.4.2 Implications for Practice and Policy

Implementation research affords implementers a clear direction on a course of action to take. This study has provided evidence for Ghana Health Service and the NTD programme in their discussions on adopting technology for capturing and managing MDA data from communities in Ghana. The pathways for engaging CHVs with mHealth and the appropriate mechanisms for reporting have been suggested.

Ghana’s Health Sector ICT Policy and Strategy, Objective 1, Strategy 1 and 2 indicate a need to provide ICT for all healthcare facilities and also needed resources to support the collection and
use of healthcare information” (Ministry of Health, 2010). This study provides evidence for possible action on this objective.

The study also brings to the fore the need to assess incentives for CHVs generally through the health system. Incentives appear to play a role in how CHVs execute their tasks and the health system may have to engage and find new strategies for motivating them. These could be either financial or non-financial incentives. Engagement with donors and other stakeholders on incentives provided through vertical health programmes may also have to be discussed.

This study has also made an artefact contribution of a USSD platform that integrates with DHIMS2 for data collection and transmission. This could be customised for various health programmes that require aggregate data reporting from the community level.

8.4.3 Future Research
This study has shown that the recognised determinants and moderators of Behavioural Intention in the UTAUT model may not adequately predict intention to use depending on the population, the context and technology within which the study is conducted. Future studies on technology acceptance in this population may have to include other moderators and reassess the determinants to find a suitable fit for this population. The CHVs deference to authority shown through qualitative results on actual use appears to show a possible influence of work culture. This could benefit from further studies using other theories on work culture in developing countries.
This study identified reasons or barriers to data quality for the MDA data using an exploratory qualitative approach. Future research with a quantitative approach can provide measurements for these factors identified and indicate which have a major influence on the data quality for MDA data. This can then lead to generalizable factors of importance that can be applied to various NTDP settings.

This study showed varied findings on the link between the data accuracy and completeness and education. Further studies could incorporate a measurement of literacy in data quality assessments in order to generate evidence specifically for mHealth studies.

Further studies on comparing SMS and USSD in data reporting will be important in decisions on appropriate technology for specific data reporting tasks. Issues such as ease of use of both mobile technology applications and a comparison of data transmission failures could also enable informed decision when deciding on mHealth application to use for reporting.

This study considered feasibility on the health system and individual level. An economic feasibility to assess both financial and non-financial costs of such a tool for NTD should be considered. Both direct and indirect costs associated with such a deployment can be assessed to enable informed decision making by the NTD programme.
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APPENDICES

APPENDIX 1 – CONSENT FORM

PROJECT TITLE: Assessing the feasibility of mHealth for treatment coverage reporting for the lymphatic filariasis control programme

Institutional Affiliation: School of Public Health, College of Health Sciences, University of Ghana, Legon. Neglected Tropical Diseases Control Programme, Ghana Health Service

Funding Source: Medical Research Council, London, United Kingdom.

Background
My name is __Baaba da-Costa Vroom. We are researchers from the School of Public Health. We are conducting research on using mobile phones to collect and report data collected during the mass drug administration for lymphatic filariasis (elephantiasis). This study is being conducted because there are challenges with timely submission of reports, incomplete data and lack of feedback to the community health volunteers. This academic research is part of a student project work towards a PhD in Public Health. This study has received ethical clearance from Ghana Health Service Ethical Review Committee.

Procedures:
We will be collecting information about your knowledge in Information Communication Technology and your intention to use ICT for your work as volunteers. This data collection will be ongoing for about six months (6) so we will interact with you over this period. If you agree to enrol in this study, we will ask you to provide information about yourself, education, knowledge in information communication technology and your perceptions about your work. You will be required to send text messages containing information you collected during the MDA. Your phone number will be registered on a computer so that you will be able to send the text messages. We will use surveys to collect the information. We will also organise in-depth interviews to find out your opinion about the intervention.

Subjects involved
The subjects involved in this study are CHVs, supervisors of the MDAs in the sub-districts, disease control officers in the districts, the regional disease control officer and staff of the NTDCP.

Potential Risks and Benefits:
We do not anticipate any risks to you in terms of injury or financial costs. We have recruited 300 CHVs to participate in this study. All participants will be given incentives in the form of mobile phone airtime. Phone numbers registered on the server will not be used for any other purpose than what has been stated. Regular use of your mobile phone will not be affected. You will receive confirmatory text messages when you submit data to the server. It is hoped that findings
of this study will inform on assessing the benefits of mobile health in low-income settings and help realise the impact of this technology.

**Right to refuse**
Giving us consent to participate is voluntary and you are not under any obligation if you do not want to do so. Refusal to enrol will not affect your status as a community health volunteer for this MDA or any other programme on which volunteers are needed. You are at liberty to withdraw from the study at any time after enrolment if you so wish.

**Anonymity and Confidentiality**
We assure you that the information collected will be handled with strict confidentiality. Your responses will not be shared with anybody outside the project team.

**Approval from study area**
Approval has been obtained from the District Health Directorate.

**Privacy**
Access control measures will be put in place to ensure only authorized persons have access to the treatment data online. Names of the CHVs will not be attached to phone numbers so CHVs cannot be identified individually.

**Data storage**
Audio files, transcripts of interviews and questionnaires will be locked in drawers which can be accessed by only the researcher.

**Conflicts of interest**
The researchers do not have any conflicts of interest.

**Funding**
The study is being funded by the United Kingdom Medical Research Council (MRC) through the Liverpool School of Tropical Medicine (LSTM-UK). This study is part of the umbrella project titled “Filariaasis Elimination in Africa: Refining the Strategies through Research” which is being managed by the School of Public Health, University of Ghana.

**Before taking consent**
Do you have any questions that you wish to ask? Yes / No…… (If yes, questions to be noted below)

……………………………………………………………………………………………
……………………………………………………………………………………………
If you have questions later, you may contact Mrs Baaba da-Costa Vroom on 0276338320.

**Consent**
I have understood the study, after having the consent form thoroughly explained to me in English /Fanti/Ahanta language. I do hereby agree to enrol and participate in this study. I consent to
voluntarily participate as a subject in this study and understand that I have the right to withdraw from the study at any time without it affecting me in any way.

Signature/Thumbprint of Respondent …………………… Date……………………

Interviewer’s statement:
I, the undersigned, have explained to the participant in the language that he/she understands the procedure to be followed in this study and the risks and benefits involved. H/She has agreed to participate in the study.

Signature of Interviewer ……………………………… Date ……………………
APPENDIX 2A – INTERVIEW GUIDE FOR SUB-DISTRICT AND DISTRICT SUPERVISORS / FOCAL PERSONS

1. Description of LF Mass Drug Administration
   a. Can you describe the MDA programme as it is conducted in the district?
   b. What time frame is given for conducting the MDA?
   c. Can you describe how the CHVs are recruited?
      i. What selection criteria do you use?
   d. How is training conducted within the district?

2. Reporting MDA treatment data
   a. What are some of the problems you encounter in preparing the reports?
   b. Can you tell us why reports do not reach the programme office within the agreed timeframe? On average, how long does it take to compile your report for the district?
   c. How has the size of the community influenced the way the MDA is conducted?
   d. What are some complaints the CHVs have made about getting their reports ready?
   e. In terms of completeness of reports, how well do the CHVs perform in completing their reports? (Probe: do you have a high number not completing their reports? How is this handled?)

3. Errors encountered during report collation
   a. What are the common errors the CHVs make when entering data in the register? What explanations do they usually give when queried about the mistakes? What is your take on why the errors occur?
   b. What common errors do the CHVs make when calculating the summaries? What explanations do they usually give when queried about the mistakes? What is your take on why the errors occur

4. How do you think the reporting can be improved?

5. Is there anything else you would like to add?
APPENDIX 2B - INTERVIEW GUIDE FOR REGIONAL / NATIONAL SUPERVISORS

1. Description of LF programme in the country / region.
   a. Can you tell me when the LF program began in the region?
      i. How many districts are currently conducting the MDA for the LF program?
   b. Can you describe how the LF programme is conducted in the districts?
   c. So how much time is allocated for the completion of the MDA?
      i. What happens when the treatment prolongs?

2. Reasons for delayed reporting
   a. On average how long does it take to compile your report for the district? In what format are the reports submitted?
   b. What are some of the peculiar reasons why reporting goes beyond the given time?
   c. How often do you have to contact the districts to submit the reports after the MDA?
   d. How often do you get prompts from the national programme office about late reports from your region?

3. Reasons for inaccuracies and incompleteness in the data reported
   a. What are some observations that you have made about the report that are submitted by the districts? How do you know when data submitted is inaccurate? How do you handle inaccuracies and incomplete data?
   b. What is your opinion of the treatment coverage that is reported?

4. Can you suggest ways the reporting can be improved? (Reporting in the registers, calculating summaries, specific to CHVs)

5. In what format are the reports submitted to the regional office?

6. Is there anything you would like to add?
APPENDIX 2C - FOCUS GROUP DISCUSSION GUIDE WITH COMMUNITY HEALTH VOLUNTEERS

1. Description of LF MDA
   a. How many years have you been a part of the LF MDA in this sub-district? (Individual responses required)
   b. Can you describe how you conduct the LF MDA? (Training, drug administration etc.) (any additional information from other participants)
   c. Are you usually able to cover all the households you are allocated within the time you are given for the distribution? What happens if you are not able to finish distributing the drugs before the allocated time is up?
   d. What kinds of problems do you encounter when distributing the drugs?

2. Problems with reporting
   a. Can you describe how you register the households?
   b. How do you record the drug administration in the registers and summarise the data?
   c. What prevents you from finishing your distribution and reporting on time?
   d. What issues crop up while filling the registers?
   e. What challenges do you face when calculating the summaries?

3. Can you suggest ways that you think these problems can be solved?

4. You have had the opportunity to participate in other public health outreaches, such as the polio immunisation. How different is the LF MDA from the other public health programmes, in terms of reporting?

5. Have you heard about using mobile phones to send data directly to the supervisors? Do you think this can help with data reporting

6. Is there anything you would like to add?
APPENDIX 3A – IN-DEPTH INTERVIEW GUIDE FOR COMMUNITY HEALTH VOLUNTEERS

IN-DEPTH INTERVIEW GUIDE FOR NON-RESPONDENTS

Questionnaire No:………………… Survey Questionnaire ID: ……………………………
Interviewer: …………………………… Date of interview: ……………………………
Sub-district: …………………………… Community……………………………………

<table>
<thead>
<tr>
<th>1. Age (years):</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Current occupation:</td>
</tr>
<tr>
<td>5. How long have you served as a community health volunteer with the LF programme?</td>
</tr>
<tr>
<td>6. Submitted report via SMS: [0] Yes [1] No</td>
</tr>
</tbody>
</table>

Thank you very much for accepting to participate in this study. I will be asking you questions about the text messaging exercise we did for last years’ LF MDA.

1. **Overview of the exercise**
   a. What was your impression about the text messaging activity when we first explained it to you? (Probe: first thoughts, feeling)
   b. After you thought about it, how did you feel about the text messaging exercise? (Probe: excitement, fear, no reaction)
   c. What did you anticipate it would entail? (Probe: long process, had experience)

2. **Performance Expectancy**
   a. Can you share your thoughts on the usefulness of text messaging for reporting LF MDA summaries?
   b. Do you think it would have been an additional benefit to your work? (Probe: Possible challenges / difficulties)

3. **Effort Expectancy**
   a. How did your previous text messaging experience impact on this exercise?
   b. Describe how difficult or easy it was to input the info on the phone?
c. How useful or otherwise were the cue cards given to you help in the text messaging? (Explain: the white card with the summary fields I gave you)

d. Did you need help entering the information on the phone? Who helped you in entering and sending the report on your phone?

4. Social Influence
   a. Who did you discuss the text messaging activity with? (Probe-family, friends, other CHVs)
      i. What was their feedback?
   b. Are there people you know who send information via text message beyond daily conversation?
   c. How did your family and friends react when you talked about sending your report by mobile phone? (Probe: excitement, no reaction, anger)

5. Facilitating Conditions
   a. What was your motivation to participate in the study?
   b. What else could we have done to make the experience better?

6. Support
   a. Did you try to get support/help? How useful was it?
   b. What can you say about the support you were given for the exercise? Was it adequate? Would you have preferred having support from your supervisor?
   c. Describe your perceptions about the explanations on how to input the text message. (Was it clear and understandable?)

7. Future Use
   How do you think we can improve the reporting using the text messaging?

8. Is there anything else you would like to add?
APPENDIX 3B – IN-DEPTH INTERVIEW GUIDE FOR COMMUNITY HEALTH VOLUNTEERS

IN-DEPTH INTERVIEW GUIDE FOR NON-RESPONDENTS

Questionnaire No: ……………… Survey questionnaire ID: ……………………………

Interviewer: ………………………… Date of interview: ……………………………

Sub-district: ………………………… Community……………………………………

<table>
<thead>
<tr>
<th>7. Age (years):</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. Sex: [0] Female</td>
</tr>
<tr>
<td>[1] Male</td>
</tr>
<tr>
<td>9. Highest education:</td>
</tr>
<tr>
<td>[1] Middle school</td>
</tr>
<tr>
<td>[2] JSS/JHS</td>
</tr>
<tr>
<td>[3] SSS/SHS</td>
</tr>
<tr>
<td>[4] Vocational</td>
</tr>
<tr>
<td>[5] Tertiary (e.g. Polytechnic, Training College)</td>
</tr>
<tr>
<td>[6] University</td>
</tr>
<tr>
<td>10. Current occupation:</td>
</tr>
<tr>
<td>11. How long have you served as a community health volunteer with the LF programme?</td>
</tr>
<tr>
<td>_______ years, _______ months</td>
</tr>
<tr>
<td>12. Submitted report via SMS: [0] Yes   [1] No</td>
</tr>
</tbody>
</table>

Thank you very much for accepting to participate in this study. I will be asking you questions about the text messaging exercise we did for last years’ LF MDA.

9. **Overview of the exercise**
   a. What was your impression about the text messaging activity when we first explained it to you? (Probe: first thoughts, feeling)
   b. After you thought about it, how did you feel about the text messaging exercise? (Probe: excitement, fear, no reaction)
   c. What did you anticipate it would entail? (Probe: long process, had experience)

10. **Performance Expectancy**
    a. Can you share your thoughts on the useful of text messaging for reporting LF MDA summaries?
    b. How do you think it would have been an additional benefit to your work?
    c. How do you think it would have caused difficulties?

11. **Effort Expectancy**
    a. What limitations if any do you think would have affected your ability to send the text message?
    b. In what way did you anticipate sending a text message would be a difficult task?
12. Social Influence
   a. Who did you discuss the text messaging activity with? (Probe-family, friends, other CHVs)
      j. What was their feedback?
   b. Are there people you know who send information via text message beyond daily conversation?
   c. How did your family and friends react when you talked about sending your report by mobile phone? (Probe: excitement, no reaction, anger)

13. Facilitating Conditions
   a. We realised you didn’t send the report through text message. What prevented you from doing so? (Probe: airtime, access to a phone, network, small screen size, small keyboard, lack of personal contact)

   b. Did you try to get support/help? How useful was it?

   c. What else could we have done to help you participate?

14. Is there anything else you would like to add?
APPENDIX 4 – CODES AND THEMES FOR IN-DEPTH INTERVIEW WITH COMMUNITY HEALTH VOLUNTEERS

<table>
<thead>
<tr>
<th>Category</th>
<th>Theme</th>
<th>Codes / Storyline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Expectancy</td>
<td>Texting improves reporting</td>
<td>Reduces delayed reporting&lt;br&gt;Improves data accuracy&lt;br&gt;Ensures accountability to the programme&lt;br&gt;Evidence of work done by CHV</td>
</tr>
<tr>
<td></td>
<td>Additional / New knowledge</td>
<td>Opportunity to acquire knowledge&lt;br&gt;Perception of programme advancement</td>
</tr>
<tr>
<td></td>
<td>Negative effect on performance</td>
<td>Increased workload&lt;br&gt;Lack of phone/resource&lt;br&gt;Submission of inaccurate data</td>
</tr>
<tr>
<td>Effort Expectancy</td>
<td>Effort required to key in data</td>
<td>Effort in using keypad&lt;br&gt;Small form factor&lt;br&gt;Effort association with age&lt;br&gt;Prior texting experience&lt;br&gt;Alternative technology for submission</td>
</tr>
<tr>
<td></td>
<td>Personal Effort Required</td>
<td>Willingness to learn&lt;br&gt;Difficulty understanding concept</td>
</tr>
<tr>
<td></td>
<td>Readiness for phone use</td>
<td>Prior texting experience&lt;br&gt;Difficulty texting in spite of experience&lt;br&gt;Importance of formal education</td>
</tr>
<tr>
<td>Social Influence</td>
<td>Positive social influence</td>
<td>Approval from family &amp; friends&lt;br&gt;Peer reinforcement&lt;br&gt;Improve image of the programme</td>
</tr>
<tr>
<td></td>
<td>Negative social influence</td>
<td>Discouragement from peers&lt;br&gt;Peer and family expectation of additional incentives</td>
</tr>
<tr>
<td></td>
<td>No discussion with others</td>
<td></td>
</tr>
<tr>
<td>Facilitating Conditions</td>
<td>Organisational Structures</td>
<td>Longer training for participants&lt;br&gt;Prior texting experience&lt;br&gt;Local support from supervisors&lt;br&gt;Preference for external support from programme office&lt;br&gt;Support from peers&lt;br&gt;Cue cards to aid in data entry</td>
</tr>
<tr>
<td></td>
<td>Technical Structures</td>
<td>Telecommunication network quality&lt;br&gt;Airtime availability for communication&lt;br&gt;Mobile phone ownership&lt;br&gt;Supply of mobile phones for participants&lt;br&gt;Other technical methods for submission</td>
</tr>
<tr>
<td>Behavioural Intention</td>
<td>Incentives as motivation</td>
<td>Airtime incentives were motivators&lt;br&gt;Preference for mobile phone incentive&lt;br&gt;Incentives were not motivation&lt;br&gt;Good impression of research team</td>
</tr>
<tr>
<td></td>
<td>Positive attitude</td>
<td>Similar experience with other research studies&lt;br&gt;Contributing to a cause&lt;br&gt;Attitude of volunteerism&lt;br&gt;Lack of confidence in ability to use phones</td>
</tr>
<tr>
<td>Submission to authority</td>
<td>Deferece to authority</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX 5 – QUANTITATIVE DATA COLLECTION INSTRUMENT
TO ASSESS KNOWLEDGE AND READINESS OF COMMUNITY HEALTH VOLUNTEERS ON UTILISATION OF INFORMATION COMMUNICATION TECHNOLOGY

<table>
<thead>
<tr>
<th>Questionnaire no:</th>
<th>Date (dd/mm/yyyy):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant Phone No:</td>
<td>Community Name:</td>
</tr>
</tbody>
</table>

### A. Demographic Details

1. Age (years):


3. Highest education:
   - [0] None
   - [1] Middle school
   - [2] JSS/JHS
   - [3] SSS/SHS
   - [4] Vocational
   - [5] Tertiary (e.g. Polytechnic, Training College)
   - [6] University

4. Current occupation:

5. How long have you served as a community health volunteer with the LF programme?
   —— years, —— months

6. Other MDA experience (e.g. NID):

### B. Knowledge of Information Communication Technology (ICT)

7. Do you know what a computer is?  [0] No  [1] Yes

8. How did you get to know about computers?
   - [1] My children talk about computers
   - [2] I own a computer
   - [3] I have attended computer training school
   - [4] I see it on TV
   - Other:

9. Have you ever used a computer?  [0] No  [1] Yes

10. If yes, what did you use it for? *(Choose all that apply)*
    a. [1] To type a letter
    b. [1] To send email
    c. [1] To browse the internet
    d. [1] To play games
    Other:

11. Have you undergone any computer training?  [0] No  [1] Yes

12. What training have you had? *(Choose all that apply)*
    a. [1] None
    b. [1] Short course at IT institution (e.g. NIIT)
    c. [1] Workshops/conferences on computers
    d. [1] Self-guided learning about computers

13. Which software have you trained in? *(Choose all that apply)*
    a. [1] Microsoft Word
    b. [1] Microsoft Excel
    c. [1] Microsoft Access
    d. [1] Internet access
    e. [1] Microsoft PowerPoint
    Other:
14. What is your level of confidence in using the following to perform each of the following tasks?

<table>
<thead>
<tr>
<th></th>
<th>Not confident</th>
<th>Quite confident</th>
<th>Confident</th>
<th>Very confident</th>
</tr>
</thead>
<tbody>
<tr>
<td>d. E-mail</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
</tr>
<tr>
<td>e. Microsoft Excel/other spread sheet</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
</tr>
<tr>
<td>f. Writing reports using MS-Word or other word processor</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
</tr>
</tbody>
</table>

C. ICT Ownership

15. Which of the following ICT equipment do you own or have access to?

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Own</th>
<th>Have Access</th>
<th>N/A</th>
<th>Duration of ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Mobile Phone</td>
<td>[1]</td>
<td>[2]</td>
<td>[99]</td>
<td>_____ years, _____ months</td>
</tr>
<tr>
<td>b. Landline Telephone</td>
<td>[1]</td>
<td>[2]</td>
<td>[99]</td>
<td>_____ years, _____ months</td>
</tr>
<tr>
<td>c. Laptop Computer</td>
<td>[1]</td>
<td>[2]</td>
<td>[99]</td>
<td>_____ years, _____ months</td>
</tr>
<tr>
<td>d. Desktop Computer</td>
<td>[1]</td>
<td>[2]</td>
<td>[99]</td>
<td>_____ years, _____ months</td>
</tr>
<tr>
<td>e. Tablet</td>
<td>[1]</td>
<td>[2]</td>
<td>[99]</td>
<td>_____ years, _____ months</td>
</tr>
<tr>
<td>f. Internet USB Modem</td>
<td>[1]</td>
<td>[2]</td>
<td>[99]</td>
<td>_____ years, _____ months</td>
</tr>
<tr>
<td>g. Other:</td>
<td>[1]</td>
<td>[2]</td>
<td>[99]</td>
<td>_____ years, _____ months</td>
</tr>
</tbody>
</table>

16. Which of the following ICT services or applications do you own or have an account with?

<table>
<thead>
<tr>
<th>Service/Application</th>
<th>Own/Have account</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. E-mail Accounts (Yahoo, Google, Hotmail, etc.)</td>
<td>[1]</td>
<td>[99]</td>
</tr>
<tr>
<td>b. Website</td>
<td>[1]</td>
<td>[99]</td>
</tr>
<tr>
<td>c. Social Networking (Facebook, YouTube, Twitter, etc.)</td>
<td>[1]</td>
<td>[99]</td>
</tr>
<tr>
<td>d. Instant Messaging (Skype, WhatsApp, Viber, etc.)</td>
<td>[1]</td>
<td>[99]</td>
</tr>
<tr>
<td>e. Search Engines (Google, Bing)</td>
<td>[1]</td>
<td>[99]</td>
</tr>
<tr>
<td>f. Mobile Money (MTN Money, Tigo Cash, Airtel Money, etc.)</td>
<td>[1]</td>
<td>[99]</td>
</tr>
<tr>
<td>g. Desktop Applications (MS Word, Excel, PowerPoint etc.)</td>
<td>[1]</td>
<td>[99]</td>
</tr>
<tr>
<td>h. Photo and Video Editing Software (Photoshop, Corel Draw)</td>
<td>[1]</td>
<td>[99]</td>
</tr>
<tr>
<td>i. Other:</td>
<td>[1]</td>
<td>[99]</td>
</tr>
</tbody>
</table>
17. Do you know what Internet is? [0] No [1] Yes

18. How do you connect to the internet? (Choose all that apply)
a. [1] Mobile Phone d. [1] Internet Café
c. [1] Landline Telephone f. [1] I do not use the Internet

D. ICT Shared Access


21. In what situations are you likely to share your mobile phone?

<table>
<thead>
<tr>
<th>Situation</th>
<th>Not at all</th>
<th>Probably not</th>
<th>Maybe</th>
<th>Quite likely</th>
<th>Definitely</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. When I know the person – friend, family – and it is an emergency (e.g. battery rundown)</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>b. When I do business with the person – business partner – and it is an emergency</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>c. When I know the person – friend, family – and it is not an emergency</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>d. When I do business with the person – business partner – and it is not an emergency</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>f. Stranger – I do not know the person and it is an emergency</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>g. If only the person will use his/her own SIM</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>h. If only the person will pay for my airtime used</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
</tbody>
</table>

22. Is your mobile phone a smartphone or can it connect to the internet? [0] No [1] Yes [98] Don’t know

23. Who is your mobile network provider? / Which of the following mobile networks do you subscribe to? (Tick based on the order of preference)

<table>
<thead>
<tr>
<th>Mobile Network</th>
<th>Primary (first)</th>
<th>Second</th>
<th>Third</th>
<th>Fourth</th>
<th>Fifth</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. MTN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Vodafone</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Airtel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Glo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Tigo</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Expresso</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

A smartphone is a cellular phone that is able to perform many of the functions of a computer. Typically the screen is relatively large and the operating system is capable of running general purpose applications.
24. Which of the following brands is your mobile phone handset?
(Select based on the number of mobile phones you own)

<table>
<thead>
<tr>
<th></th>
<th>Primary (first)</th>
<th>Second</th>
<th>Third</th>
<th>Fourth</th>
<th>Fifth</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Samsung</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>b.</td>
<td>Apple</td>
<td></td>
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<tr>
<td>c.</td>
<td>Nokia</td>
<td></td>
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<td></td>
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<tr>
<td>d.</td>
<td>Techno</td>
<td></td>
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<tr>
<td>e.</td>
<td>LG</td>
<td></td>
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<td></td>
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<tr>
<td>f.</td>
<td>rLG</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g.</td>
<td>HTC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h.</td>
<td>Siemens</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i.</td>
<td>Alcatel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j.</td>
<td>Google</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>k.</td>
<td>Mobile Network</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Branded (e.g.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Expresso, Vodafone)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>l.</td>
<td>Other Chinese Phone</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

25. Is the screen clear for sending messages? (Ask to see the phone and examine)

26. What is the current state of the phone?
(Indicate if it appears damaged or not. e.g. damaged keypad, damaged screen)

E. ICT Usage

27. For approximately how long on an average do you talk on your mobile phone daily?
[1] Up to 10 minutes
[2] More than 10 minutes but less than an hour
[3] 1 to 2 hours
[4] Over 2 hours
[98] Don't know
28. To what extent do you use the following functions of your mobile phone?

<table>
<thead>
<tr>
<th>Function</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>g. Sending money (mobile money)</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>h. Social networking (Facebook, Twitter, YouTube)</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>i. Instant messaging (Skype, WhatsApp)</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
</tbody>
</table>

29. To what extent do you agree with the following mobile phone usage factors for your LF MDA reporting? SD=Strongly disagree, D=Disagree, N=Neutral, A=Agree, SA=Strongly agree

<table>
<thead>
<tr>
<th>Performance Expectancy</th>
<th>SD</th>
<th>D</th>
<th>N</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE1 I find mobile phones useful for my job as a volunteer.</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>PE2 Using a mobile phone will enable me accomplish my tasks more quickly.</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>PE3 Using a mobile phone will enhance my effectiveness as a volunteer.</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>PE4 Using a mobile phone will increase my productivity.</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Effort Expectancy</th>
<th>SD</th>
<th>D</th>
<th>N</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE1 My interactions with mobile phone are clear and understandable.</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>EE2 It is easy for me to become skilful at using the mobile phone.</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>EE3 I find mobile phones easy to use.</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>EE4 Learning to use a mobile phone is easy for me.</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Social Influence</th>
<th>SD</th>
<th>D</th>
<th>N</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>SI1 Most people who are important to me think I should use a mobile phone for work as a CHV.</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>SI2 Most people who are important to me would want me to use a mobile phone for work as a CHV.</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>SI3 People whose opinions I value would prefer that I use a mobile phone for my work as a CHV.</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td><strong>Facilitating Conditions</strong></td>
<td>SD</td>
<td>D</td>
<td>N</td>
<td>A</td>
<td>SA</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>----</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>----</td>
</tr>
<tr>
<td>FC1 I have the resources and knowledge to help me use the mobile phone.</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>FC2 Central support will be available to help with problems with the mobile phone.</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>FC3 Supervisors of the project will provide most of the necessary help and resources for using the mobile phone.</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>FC4 Mobile phones are expensive to maintain.</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>FC5 I will be willing to spend a few pesewas to submit data for the MDA programme because I think it is worth it.</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>FC6 I have to spend a lot of time learning how to use a mobile phone.</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Voluntariness</strong></th>
<th>SD</th>
<th>D</th>
<th>N</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1 My supervisor does not require me to use a mobile phone for the job.</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>V2 Although it might be helpful, using a mobile phone for data reporting is certainly not compulsory in the job.</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Behavioural Intention</strong></th>
<th>SD</th>
<th>D</th>
<th>N</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1 I intend to use my phone to send the MDA report.</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Uncertainty Avoidance</strong></th>
<th>SD</th>
<th>D</th>
<th>N</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>UA1 It is important to have job requirements and instructions spelled out in detail so that people always know what they are expected to do</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>UA2 Rules and regulation are important because they inform workers what the organization expects of them</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>UA3 Order and structure are very important in a work environment</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>UA4 Working in a structured environment is better than working (rules and regulations) in an unstructured work environment</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Power Distance</strong></th>
<th>SD</th>
<th>D</th>
<th>N</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>PD1 Managers should be careful not to ask the opinions of subordinates too frequently, otherwise the manager might appear to be weak and incompetent</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>PD2 Manager should make most decisions without consulting subordinates</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>PD3 Employees should not question their manager’s decisions</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>PD4 Manager should not ask subordinates for advice, because they might appear less powerful</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
</tbody>
</table>
30. Which of the following sources of knowledge or education has helped you in using the following ICTs?

<table>
<thead>
<tr>
<th></th>
<th>Mobile Phones</th>
<th>E-mail</th>
<th>Website</th>
<th>Social Networking (Facebook)</th>
<th>Instant Messaging (WhatsApp)</th>
<th>Mobile Payments</th>
</tr>
</thead>
</table>

F. ICT Expenditure

31. What kind of cell phone plan do you have?
   Other: ____________________________

32. How much do you spend on a mobile phone for voice calls per week?
G. ICT Usage Challenges

To what extent do you agree that the following challenges affect your ability to use ICT effectively?

*SD=Strongly disagree, D=Disagree, N=Neutral, A=Agree, SA=Strongly agree*

<table>
<thead>
<tr>
<th>33. Mobile Usage</th>
<th>SD</th>
<th>D</th>
<th>N</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>m. I am not very good in using mobile phones</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>o. I think someone can monitor my calls</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>p. I am afraid my mobile phone will be stolen</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>q. My mobile phone has been stolen before</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>r. I know of someone whose mobile phone has been stolen</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>34. Internet Usage</th>
<th>SD</th>
<th>D</th>
<th>N</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>d. The internet is not safe, someone could steal my information</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>e. I don't know how my information will be used</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>f. I don't know who I'm dealing with</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>g. I don't trust the website with my information</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>h. I'm unfamiliar with how the internet works</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>i. My privacy has been violated online</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
<tr>
<td>j. I know of someone whose privacy has been violated online</td>
<td>[1]</td>
<td>[2]</td>
<td>[3]</td>
<td>[4]</td>
<td>[5]</td>
</tr>
</tbody>
</table>