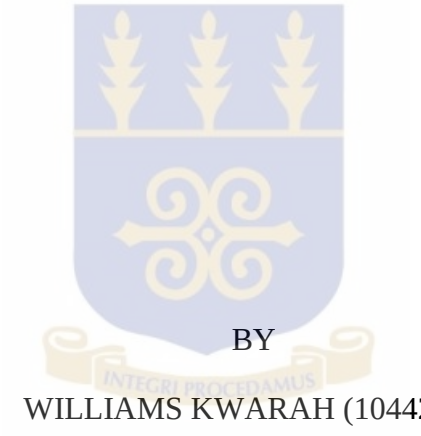
SCHOOL OF PUBLIC HEALTH

COLLEGE OF HEALTH SCIENCES

UNIVERSITY OF GHANA

EFFECTIVENESS OF MOBILE TECHNOLOGY FOR COMMUNITY HEALTH INTERVENTION ON PERFORMANCE OF FRONTLINE HEALTH WORKERS IN FIVE MOTECH DISTRICTS IN GHANA



BY

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DECLARATION

I, WILLIAMS KWARAH, declare that with the exception of references to the literature and work of other researchers which have been duly cited, the work is the result of my original research, and that this dissertation, either in whole or in part has not been presented elsewhere for another degree.

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DATE: ……	DATE: ……

DEDICATION

I dedicate this work to God and Wilberforce Kwarah.

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Conducting research is much more than just putting words into sentences. This research work has been an incredible learning process. Many people contributed to this effort, both in kind and in cash. I have attempted to list some of them here as a small way to express my appreciation and gratitude.

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ABSTRACT

Background: Deployment of Frontline health workers (FHWs) has been shown to be an effective and powerful intervention for improving community health in rural settings in Ghana. However, several challenges still persist in the performance of FHWs. Mobile health interventions such as the Mobile Technology for Community Health (MOTECH) project are implemented to enhance health worker performance and reduce maternal and child mortality in these rural areas. MOTECH delivers health messages to pregnant women and mothers of infants as well as sending defaulter alert SMS messages to frontline health workers. Though the health impact of the messages delivered to the clients has been evaluated, the effect of the defaulter SMS messages on performance of frontline health workers has not been assessed.

Purpose: The purpose of this study was to assess the effectiveness of MOTECH on the performance of frontline health workers in five MOTECH Districts.

Methods: A mixed methods study design was used. Both qualitative and quantitative data were collected, analyzed and related. Qualitative content analysis using Nvivo 10 Qualitative Software; bivariate analysis using chi square test, univariate logistic regression and multivariate logistic regression models using Software and Stata Statistical Software version 12 were used to determine associations at 5% level of significance.

Findings: Community Health Nurses used the messages from the MOTECH system more than Community Health Officers, enrolled nurses and Health Extension Workers. Frontline health workers who felt the defaulter alert messages improved performance were more

likely to use the defaulter alert messages (AOR=1225.0, p = 0.001 95% confidence interval: 22.101 – 67896.160). Similarly, frontline health workers who felt the query messages improved performance were more likely to use the query messages to plan and conduct home visits (AOR=6.9, p = 0.001, 95% confidence interval: 2.194 – 21.984).

Conclusion: Alert messages sent to health workers made their work easier, and motivated the tracing of clients who missed scheduled appointments. It also improved community outreach activities such as home visits. However, to attain the full effect of these interventions, supportive supervision and providing logistics and resources to strengthen health systems were critical.

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LIST OF ABBREVIATIONS

3G	-	Third Generation mobile communication
4G	-	Fourth Generation mobile communication
ART	-	Anti-Retroviral Therapy
CBHI	-	Community-Based Health Insurance
CDA	-	Client Data Application
CHN	-	Community Health Nurse
CHO	-	Community Health Officer
eIMCI	-	Electronic Integrated Management of Childhood Illness
FHW	-	Frontline Health Worker
GPRS	-	General Packet Radio Service
GPS	-	Global Positioning Systems
HIV/AIDS	-	Human Immune Virus / Acquired Immune Deficiency Syndrome
IHISM	-	Integrated Healthcare Information Service through Mobile Telephony
MDGs	-	Millennium Development Goals
MM	-	Mobile Midwife
MOH	-	Ministry of Health
MOTECH	-	Mobile Technology for Community Health
PDA	-	Pocket Digital Assistant
RCT	-	Randomized Controlled Trial
SMS	-	Short Message Service
SRs	-	Simplified Registers
WHO	-	World Health Organization

DEFINITION OF TERMS

Community Health Nurse

A nurse trained in community health to provide preventive health care services such as immunizations, health promotion and health education.

Community Health Officer

A community health nurse who has received additional training on the CHPS, standard conversion courses with additional midwifery skills.

Defaulter

This is a client, pregnant mother or a child under five years, who has missed a scheduled appointment at a health facility

Frontline Health Worker

Health workforce directly providing essential services where they are most needed, forming the essential link to health services in rural areas

Mobile health

A subset of e-health and is the use mobile communication devices such as mobile phones, tablet computers and Personal Digital Assistant for health services and information

Prioritized home visits

These are targeted home visits where FHWs identify key community issues and clients most in need of care but do not come to the health facilities.

Performance

Reducing defaulters observed in a facility to zero (0) and prioritizing the number of home visits, making a minimum of 10 home visits in a day

Upcoming care

Service that will be due for a client/patient

CHAPTER ONE: INTRODUCTION

1.1 Background

Africa faces severe health sector human resources crisis. Out of a global estimate of 59.2 million health workforce, only 3% are found in Africa. In 2009, the health sector workforce density per 1000 population was 2.3 in Africa compared to 24.8 in developed continents like the Americas. This has affected universal access to good quality healthcare and service delivery in Africa. The consequence is that most African countries are far from achieving the health-related Millennium Development Goals (MDGs) by 2015 (Ooms et al., 2010).

Ghana is making progress towards universal access to quality healthcare, but inadequate health sector workforce poses a challenge to achieving the health-related MDGs 4 & 5 (Alhassan et al., 2013). Though the doctor-patient and nurse-patient ratios have improved over the past decade, rural–urban inequities still exist. About 68% of the health workforce in Ghana are found in urban areas, leaving only 32% to attend to the 50% of Ghanaians living in rural areas (Alhassan et al., 2013).

The training and deployment of Frontline Health Workers (FHW), also known as Community Health Nurses (CHNs) and / or Community Health Officers (CHOs), have been shown to be an effective and powerful intervention for improving community health especially in these rural areas. FHWs are the cadre of health workforce who directly provide essential services where they are most needed, forming an essential link to health services in rural areas (S. Anderson et al., 2008). In Ghana, these cadre of health workforce are placed in Community-Based Health Planning and Services (CHPS) zones or facilities in rural communities to provide essential primary health care

services (Nyonator et al., 2005). FHWs provide services such as family planning, immunizations, health promotion and the treatment of minor illnesses through static clinics and routine home visits (Nyarko, Pence, & Debpuur, 2001).

Over the past decade, several interventions have been implemented to improve the performance of these FHWs in Ghana by increasing the quantity and quality of community outreach activities such as static and outreach clinics, home visits, health education and reducing immunization defaulter rates. These interventions included the provision of staff accommodation, financial incentives such as study leave with salary, and motorbikes for home visits (Ghana Ministry of Health, 2011). Though these interventions have improved the working conditions of FHWs in deprived areas, their usefulness in improving performance and quality of care has been minimal (Alhassan et al., 2013). The provision of essential health services and information to rural dwellers is still a barrier to healthcare delivery.

It has been observed that FHWs work in far places where physical access is a challenge to the community. Also, these FHWs can be busy with other clinical duties that they do not conduct community outreach activities where immunization defaulter tracing, home visits and health education are primary components. Ideally, FHWs should identify and trace clients who miss scheduled care appointments and provide this care. But this is often not possible particularly in rural settings where FHWs are poorly resourced to identify defaulters, are not motivated to trace defaulters or carry out home visits, and there is lack of supervisory support and oversight (MacLeod et al., 2012a).

Mobile phone technology has been shown to improve the scope and efficiency of field health workers in low income regions (Braun, Catalani, Wimbush, & Israelski, 2013a).

Mobile health (m-health) is the use of mobile communication devices such as mobile phones, tablet computers and Personal Digital Assistant for health services and information (Free et al., 2010). M-health interventions have been found to enhance the performance of healthcare workers in underserved rural areas in Uganda, Kenya, Mozambique and other places in Africa (Källander et al., 2013a).

In Ghana, several m-health interventions have been implemented to enhance health worker performance, improve health information systems, and increase access to health information. These interventions include the SMS for Life project implemented in the Upper East Region, the Personal Digital Assistant Data capture project in the Brong Ahafo Region, and the Technology for Maternal Health programme in Northern Region (Achampong, 2012; Agbenyo & Kuwornu, 2013; Novartis, 2013).

The Mobile Technology for Community Health (MOTECH) project is another m-health programme which has been implemented in 7 rural districts across 3 regions in Ghana. The main aim of MOTECH was to use the mobile phone to increase the quantity and quality of antenatal, neonatal and postnatal care in rural Ghana (Awoonor-Williams, 2013). The Project was a response to address key challenges facing healthcare delivery in rural areas, leveraging on the rapid expansion of CHPS zones/facilities, and the proliferation of mobile phone technology coverage in rural areas. The project provided a suite of services to support FHWs in CHPS facilities and health centers to track care that is provided to clients, efficiently manage client data collection and reporting, and support the provision of clinical care (Awoonor-Williams, 2013).

MOTECH provided the health facilities with simplified paper registers for client data capture, and low-cost java-supported mobile phones for electronic data capture and

registration of clients. Clients' information were recorded in simplified paper registers and transferred electronically into a central electronic database using the mobile phones pre-installed with the MOTECH mobile application. With this information in the system, MOTECH essentially provided two interrelated services to pregnant women, mothers of infants, frontline health workers and supervisors at the District Health Directorates. These services were Mobile Midwife and Client Data Application (Frimpong et al., 2011).

Mobile Midwife (MM) is the service that delivered individualized health messages and upcoming appointment reminders to pregnant women and mothers of infants weekly. These messages were pre-recorded voice messages in the local language or Short Message Service (SMS) text in the English language. The messages span the full duration of pregnancy and the first twelve months of a newborn's life and were tailored to be suitable to the gestation of the pregnancy or the age of the infant.

The Client Data Application (CDA) is the service that allowed the FHWs to electronically collect client data and services provided into a central database. When an appointment is missed by a client who was registered into MOTECH, a defaulter alert message was delivered to mobile phones provided at the health facilities, encouraging the FHWs to trace and provide care to this client. This defaulter alert message was repeatedly sent 3 consecutive weeks if no data were entered to indicate care has been provided to the client. The CDA also allowed FHWs to send query messages to the MOTECH system requesting for specific information in order to provide care, plan and conduct community outreach activities such as home visits ("MOTECH Lessons Learned," n.d.).

This study assessed the effect of delivering these defaulter alert messages and providing feedback to the query messages on the performance of Frontline Health Workers. The study explored if FHWs used the defaulter alert messages to trace and provide care to defaulters, and whether the additional information from the query messages were used to plan and conduct home visits. A convergent mixed methods study design was used where both quantitative and qualitative data were collected parallel, analyzed separately and then related.

1.2 Statement of the Problem

Baseline surveys prior to the implementation of MOTECH showed that FHWs were not placing priority on community outreach activities including home visits and defaulter tracing. Instead, they waited for the clients to come to their facilities for care (Frimpong et al., 2011). This was due to the difficulties faced by FHWs in identifying these clients in their paper registers. Thus, clients who did not come to the facilities were often missed and never received care. (MacLeod, Phillips, Stone, Walji, & Awoonor-Williams, 2012b).

There are clinical and economic consequences when clients miss scheduled appointments. The continuity and effectiveness of healthcare delivery is reduced, appropriate monitoring of health status lapses, and the cost of health services increases. First, studies have shown that missed appointments have been associated with poor disease management outcomes (Detman & Gorzka, n.d.; Karter et al., 2004). For example, the effectiveness of a vaccine is reduced when doses are not taken according to the prescribed schedules. Second, vaccine wastage has been a huge source of concern to health managers due to the huge economic losses involved (Guichard et al., 2010; Mukherjee, 2013). For example, a vial of BCG vaccine has about 20 doses for 20

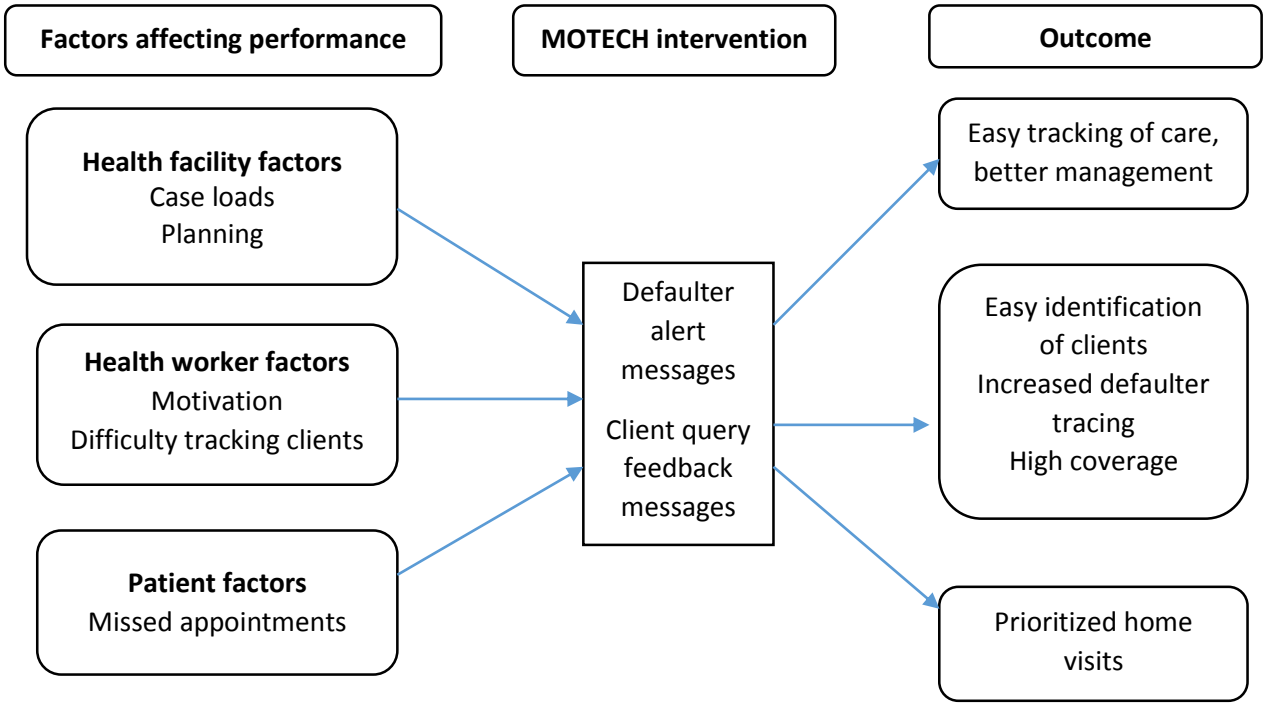
clients. When clients miss appointments and these numbers are never met, huge wastage are counted since the current policy in Ghana is to provide the care to the client present. Third, immunization coverages was used as an indicator of frontline health worker performance at district level. Missed appointments consequently reduces immunization coverages (Ada East District Health Directorate, 2013).

Several m-health interventions have been implemented in the health sector to enhance health worker performance and the quality of care across Africa, but limited research has been done on majority of them to help understand their effectiveness (DeRenzi et al., 2011). MOTECH was implemented to address challenges faced by FHWs by providing defaulter alert messages to help FHWs easily identify, trace and provide care; as well as allow FHWs the opportunity to easily retrieve essential information about clients (query messages) to plan and conduct home visits. No research has yet been conducted to assess the effectivities of providing these messages to FHWs.

1.3 Conceptual framework

Several factors have been reported to affect the performance of FHWs especially in rural areas. Some of these factors are interrelated and need multifaceted approaches (Rowe, de Savigny, Lanata, & Victora, 2005a). Some of these factors include staff motivation, inadequate logistics like means of transport to conduct community outreach activities, client factors (forgetfulness to attend scheduled appointments), geographical distance, lack of supportive supervision, high caseloads and no job satisfaction. If these factors were addressed, FHW performance will be improved. Figure 1 illustrates how MOTECH relates to these factors and FHW performance.

Figure 1: Relationship of MOTECH to factors affecting health worker performance



1.4 Rationale of the study

While a lot is known about the factors causing low FHW performance (Kalyango et al., 2012; Mæstad, Torsvik, & Aakvik, 2010; Stekelenburg, Kyanamina, Wolffers, 2003a; Willis-Shattuck et al., 2008 &Alhassan et al., 2013), very little is known about the effectiveness of m-health interventions aimed at improving the performance of frontline health workers (Braun, Catalani, Wimbush, & Israelski, 2013b; Kimaro & Nhampossa, 2005; "MHealth in low-resource settings," n.d.; Rucks, n.d.).

According to World Health Organization (2012), there has been a general interest in m-Health initiatives by governments in low- and middle-income countries. Moreover, both the United Nations and World Health Organization has recognized the potential of m-Health as an alternative means of creating a strong base for health systems and for improving the way health services are delivered (Borus-Rotheram et al. 2012 & Freifield et al 2010). Governments need evidence of these m-health interventions to take action.

The findings of this study would contribute to the existing knowledge on effectiveness of m-health programmes especially in rural districts in Ghana. The results will also provide further evidence of the effectiveness of the MOTECH project on frontline health worker performance.

1.5 Objectives

1.5.1 General objective

To assess the effectiveness of MOTECH alert and reminder messages on improving frontline health worker performance in 5 MOTECH Districts from February to April 2014.

1.5.2 Specific objectives

1. To assess total number of defaulter alert messages sent to frontline health workers at MOTECH implementation facilities.
2. To assess how MOTECH alert messages encourage frontline health workers to trace and provide care to defaulters in the selected districts.
3. To assess whether MOTECH messages improve home visit activities by frontline health workers in the selected districts.
4. To assess which category of frontline health workers frequently used the messages from MOTECH in the conduct of work.

1.5.3 Hypothesis

Pearson's Chi-square of association was used to test two main hypothesis at 5% level of significance:

1. H_O: There is no significant association between the use of MOTECH defaulter alert messages for defaulter tracing and the explanatory variables.
2. H_O: There is no significant association between the use of query messages and alerts to plan and conduct home visits and the explanatory variables.

At the 5% level of significance, if $p<0.05$, the null hypothesis is rejected. However, we fail to reject the null hypothesis if $p>0.05$.

CHAPTER TWO: LITERATURE REVIEW

2.1 Health workforce, supervision and performance

Frontline health workers have been shown to be an effective and powerful intervention for improving community health. The conduct of routine home visits can lower maternal and neonatal mortality rates. Despite these benefits, many challenges exist. These include inadequate logistics and resources, inadequate supervisory support, making it difficult to maintain these programmes (Bhattacharji et al., 1986).

In Ghana, the quality of service within primary healthcare facilities remain problematic, and is considered to be partly responsible for the persistent high national average maternal and child mortality rates. Decisions on management as well as information given to woman were some of the gaps identified in the quality of care given to pregnant women by frontline providers in studies conducted by Oduro-Mensah et al (2013). As these providers interact with clients, they continually make decisions about client's needs and the appropriate services to provide. Potentially important supports for this process are available. The use of evidence based decision making guidelines and tools to make performance more consistent, by reducing guesswork and promoting compliance with standards have been explored (Oduro-Mensah et al., 2013).

Though an increasing number of mhealth programmes are providing frontline health staff with mobile phones and other mobile devices to support their work, low health workforce in developing countries is still a huge barrier.

Health workforce is an essential input for strengthening health systems in developing countries (Dussault & Dubois 2003; Narasimhan et al. 2004; Fritzen 2007; Willis-Shattuck et al. 2008; Witt 2009). However, several factors have been found to affect

the performance of health workers. Health worker shortages present one major barrier to performance in many developing countries (Rowe et al. 2005, 2009; Haines et al. 2007; Kurowski et al. 2007; Naicker et al. 2009). Inefficiencies in the utilization of available but scarce health workforce has been reported to adversely impact health system functioning and population health (Chen et al. 2004; Dovlo 2007). Other factors like inadequate community support and inadequate supervision have been cited as factors that affect the performance of community health workers in Zambia (Stekelenburg, Kyanamina, & Wolffers, 2003b).

According to the World Health Organization (WHO), supervision of primary health care workers is one process through which such inefficiencies may be alleviated – (World Health Organization, 2010). Supervision generally happens during personal interactions rather than during formal meetings or workshops in the workplace and includes both clinical guidance and managerial ⁄ administrative support (Bosch-Capblanch & Garner 2008). The importance of supervision has been demonstrated to be most important in peripheral primary health care facilities (Valadez & Diprete 1990; Mills et al. 2000; Marquez 2002).

Frimpong et al, (2013) reported that supportive supervision was associated with increased productivity and could maximize the output of scarce human resources in primary health care facilities such as the CHPS facilities. Several other studies reported similar results (Ahmed et al. 1993; Willis-Shattuck et al. 2008; (DeRenzi et al., 2012a; Dovlo, 2005; Mutale, Ayles, Bond, Mwanamwenge, & Balabanova, 2013). Majority of

these studies also found that if implemented effectively, technology interventions can improve the performance of health workers.

2.2 Mobile health initiatives in Africa

More than three-quarters of the world's 5.3 billion mobile phones are located in the developing world. This provides an increasingly powerful opportunity for mobile phones to be used in public health ("The Benefits of Mobile Health, on Hold," n.d.). M-health capitalizes on the mobile phone's core utility of voice and SMS as well as more complex functionalities and applications including General Packet Radio Service (GPRS), third and fourth generation mobile telecommunications (3G and 4G systems), Global Positioning System (GPS), and bluetooth technology to improve public health outcomes.

Africa is utilizing m-health interventions rapidly. The United States Agency for International Development (USAID) reported in their mhealth compendium (2012) that while South East Asia reported most m-health initiatives, Africa reported the fewest initiatives (Marshall, Lewis, & Whittaker, 2013). However, it is important to note that though fewer Africa countries reported m-health initiatives, it is possible that there could be smaller implementations by non-governmental organizations and individuals that have not yet received global recognition. In this literature, these initiatives have been reviewed according to their specialized functions.

Mhealth initiatives in education and awareness

Mobile phones have been used to increase awareness and education on public health issues in Africa. Five m-health initiatives were identified, with majority being

implemented in South Africa. These initiatives include the Learning About Living initiative implemented in Nigeria which provides useful health information about HIV/AIDS to the youth ("LaL - Nigeria (South) - HIV and AIDS," n.d.); the HIV Confidant initiative and the Masiluleke Text to Change initiatives implemented in South Africa aimed at creating awareness and stopping the transmission of HIV/AIDS (Déglise, Suggs, & Odermatt, 2012). Another important example used globally is Text4baby, which provides free health tips to expectant mothers via text messages (Whittaker et al., 2012) and the Mobile 4 Good Health Tips initiative in Kenya which provide inspirational health messages to subscribers.

Mhealth initiatives in remote data collection

Six initiatives were found to be used in remote data collection in Africa. These initiatives included the Dokoza system which uses SMS to fast-track and improve critical services to HIV/AIDS and Tuberculosis patients through efficient data collection systems in South Africa (Lagerwerf & Boer, 2009). The rest are the EpiHandy initiative which is used to collect epidemiologic data in Uganda, Mozambique and Burkina Faso. Outcomes of the EpiHandy initiative revealed significant reduction in data entry errors, broad user acceptance, and cost effectiveness relative to traditional paper-based data collection techniques (Engebretsen, 2005). Integrated Healthcare Information Service through Mobile Telephony (IHISM) is an initiative implemented in Botswana which remotely collect data and also provides useful health information on HIV/AIDs via SMS (G. Anderson et al., 2007); while the TRACnet initiative in Rwanda is a comprehensive data entry, storage, access, and sharing system used to manage critical information on HIV/AIDS patients and

monitoring anti-retroviral treatment (ART) programs nationally (Binagwaho et al., 2013). The rest of the initiatives reported are the Pocket Digital Assistant (PDAs) for Malaria Monitoring initiative in Mozambique; and EpiSurveyor used in Kenya, Uganda and Zambia (Smertnik, 2012).

Mhealth initiatives in remote monitoring

Only three initiatives were reported to be used for remote patient monitoring in Africa. These were the Cell-Life Project in South Africa where service providers entered client data into a Cell Life database from which HIV/AIDS patient' treatment progress is monitored (Skinner, Rivette, & Bloomberg, 2007). Also, the Networked Health Solutions for the Developing World initiative in Mashavu (Tanzania) allows the remote monitoring of anthropometric and health data of children by professional doctors to see the progress of health; and the SIMpill Solution for Tuberculosis treatment adherence in South Africa which basically reminds patients to take their medications (Sandnes, 2010).

Mhealth initiatives in communication and training for healthcare workers

In this category, only two initiatives were reported, both implemented in Uganda. The Mobile HIV/AIDS Support initiative provides high-quality medical information and advice to healthcare workers; while the Uganda Health Information Network uses PDAs to provide continuing medical education services to physicians (Abaasa et al., 2008).

Mhealth initiatives in disease and epidemic outbreak tracking

The only initiative found was various applications of Frontline SMS in Africa. Frontline SMS has been used to report and monitor avian flu outbreaks; coordinate blood donation programmes in Botswana; coordinate healthcare workers and field data collection in Malawi; provide HIV/AIDS information services to teachers in South Africa; and used to trace clients who missed clinic appointments in Tanzania and Uganda (Mahmud, Rodriguez, & Nesbit, 2010).

Mhealth initiatives in diagnostic and treatment support

Three initiatives were found in this category. Therapeutic and Public Health use by Front Line Healthcare Workers was implemented in Mozambique to provide Mozambican health workers with diagnostic and analytical tools including reference material in the mobile phone's memory, a calculator for determining drug dosage, and a program for analyzing inputs from medical sensors (e.g., low-cost pulse oximeter probes or a simple electrocardiogram). Another initiative reported is the HIV Mobile Decision Support programme in South Africa which helps field health workers screen HIV/AIDS patients and determine their medical needs. Finally Mobile E-IMCI was implemented in Tanzania to provide guide to health workers through the IMCI process with step-by-step instructions (DeRenzi et al., 2008; Swendeman & Rotheram-Borus, 2010).

2.3 Evidence of m-health interventions

Though mhealth initiatives are spreading at a faster rate globally and domestically, very few studies have been conducted to show evidence of improved health outcomes.

In the later part of 2010, two notable randomized controlled studies (one in Africa) of text and mobile phone initiatives showed significant improvements in outcomes. The first was the WelTel system in Kenya which was designed to help HIV patients adhere to their medications. Results of this study showed significant improvements in drug adherence and rates of viral suppression among those who used the service (Lester et al., 2010). The second study focused on WellDoc in the United States, and examined a more comprehensive mobile phone-based diabetes management system for type 2 diabetics. The study showed statistically significant improvements in blood glucose control levels among users of the WellDoc system (Quinn et al., 2008).

Since then, many smaller and larger evaluations are beginning to emerge but very few are focused on the effects of m-health initiatives on health worker performance. Three researches relating to the proposed study are highlighted here.

A cluster Randomized Control Trial (RCT) was conducted in Kenya to assess whether text-message reminders sent to health workers' mobile phones could improve and maintain their adherence to treatment guidelines for outpatient paediatric malaria. This study found that correct artemether-lumantrine management improved by 23.7 percentage points. The researchers concluded that text-messaging can improve health worker's case management in resource-limited settings (Zurovac et al., 2011).

Another RCT that was conducted in India assessed whether sending ideology messages to health workers improved quality of counselling. The researchers found that dialogic messages delivered over the mobile phone to health workers significantly improve the quality of counseling sessions and increased discussions between the health workers and the clients (Ramachandran, Goswami, & Canny, 2010).

DeRenzi et al, 2012 also showed in their research that reminder SMS sent to community health workers in Dar es Salaam, Tanzania, resulted in 89% reduction in the average number of days clients who missed their appointments received care.

Theoretically, the best source of evidence of effectiveness for clinical interventions is randomized-controlled trials. RCTs are essential for evaluating the efficacy of clinical interventions, where the causal chain between the agent and the outcome is relatively short and simple, and where results may be safely extrapolated to other settings. However, causal chains in public health interventions such as most of the m-health interventions are complex, making RCT results subject to effect modification in different populations (Victora, Habicht, & Bryce, 2004).

Other study designs such as observational designs, although inherently more susceptible to some types of bias than RCTs, can show what happens in real-life, and might be the only feasible choice in these settings. Nonetheless, both the internal and external validity of RCT findings can be greatly enhanced by observational studies using adequacy or plausibility designs (Black, 1996).

Qualitative methods are useful for describing contextual factors and latent influences such as motivation, and understanding which aspects of an intervention work well and which do not. Understanding contextual factors is particularly important because they can limit the applicability of results from one setting to another (Rowe, de Savigny, Lanata, & Victora, 2005b).

For example, a qualitative study nested within a larger quantitative study was conducted in Kenya to evaluate the impact of the Electronic Integrated Management of Childhood Illness (eIMCI) initiative on service provider adherence to Integrated Management of Childhood Illness (IMCI) protocols. The design allowed the authors to confidently

conclude that eIMCI represents a promising method for improving health care delivery because it improves healthcare provider and caretaker perception of clinical encounters (Mitchell, Hedt-Gauthier, Msellemu, Nkaka, & Lesh, 2013).

Mixed methods research is common in Health Service Research in the United Kingdom and its use has been driven by pragmatism rather than principle, motivated by the perceived deficit of quantitative methods alone to address the complexity of research in health care (O'Cathain, Murphy, & Nicholl, 2007). For example, Appleton et al, 2013 used a mixed methods study design to examine the processes by which health visitors identify problems in mother–infant relationships in the post-natal period. The design contributed to the understanding of how health visitors make assessments of mother–infant interactions (Appleton, Harris, Oates, & Kelly, 2013).

Another example of a mixed-methods approach was used in Burkina Faso to investigate how health workers working in facilities contracted by the Community-Based Health Insurance (CBHI) view the methods of provider payment used by the CBHI. Combining both the qualitative interview and quantitative survey data, this study identified that the declining quality of care due to the CBHI provider payment method was a source of significant professional stress and role strain for health workers (Robyn et al., n.d.).

2.4 Conclusion

Limited studies have been conducted to assess whether text-messaging reminders sent to healthcare providers influenced them to move out of their comfort zones to provide care to clients. Since most mhealth initiatives in Africa have multiple functions that affect both the clients/patients as well as the service providers, the need for complimentary literature is critical.

In Ghana, such literature is limited though several m-health initiatives are springing up. The need for more literature on effectiveness is critical for policy making and decision taking by the Government and other key stakeholders in health. This study proposes to add more knowledge to the existing literature, particularly in terms of the MOTECH initiative in Ghana.

CHAPTER THREE: METHODS

3.1 Study Design

A mixed method cross-sectional study of frontline health workers comprising community health nurses, community health officers and other staff working at CHPS facilities and health centers in 5 MOTECH districts was carried out between February and April 2014. Figure 2 shows a diagram of the study design.

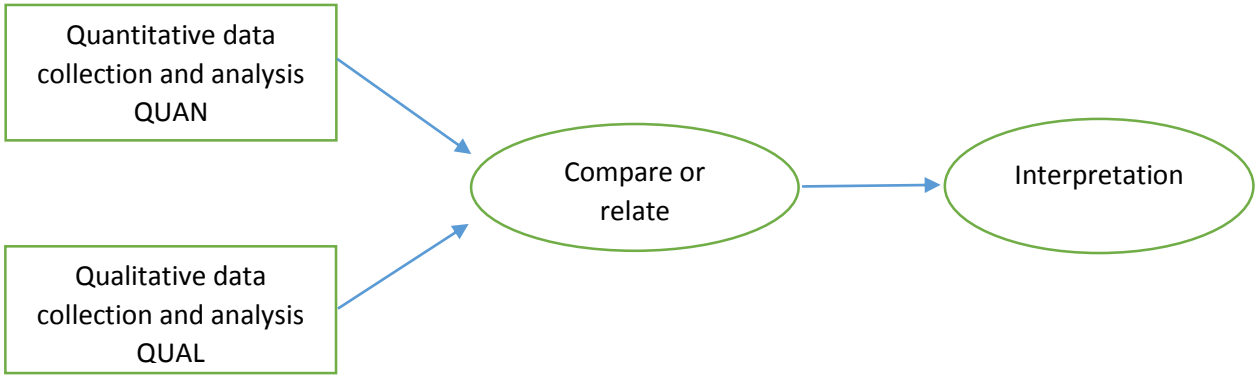


Figure 2: Convergent Mixed Methods Design

3.1.1 Description of the intervention under study

The intervention under study was a one-way communication of SMS defaulter alert messages and a two-way communication of query messages delivered to frontline health workers from the MOTECH system. These messages were delivered to low-cost java-supported mobile phones placed at all CHPS facilities and health centers. The defaulter alert messages were automatically delivered every Monday at 8am when data for care that was due for clients who were registered into MOTECH was not entered into the MOTECH system. The content of the defaulter alert message included the word "overdue", type of care missed, name of client, age of client, and community of client. The query messages were delivered immediately a FHW completed and uploaded into

the MOTECH system a query form requesting for specific information about a client or group of clients. Specific information FHWs could request from the MOTECH system included list of ANC defaulters, CWC defaulters, PNC (baby) defaulters, PNC (mother) defaulters, upcoming deliveries, recent deliveries, pregnant women with past estimated due dates, tetanus vaccine defaulters, and upcoming care for a client. All these messages were delivered as SMS text to the mobile phones provided by the MOTECH project.

Table 1 shows an example of a defaulter alert message for a client who missed Antenatal Care (ANC) appointments. “ANC overdue” is the scheduled care missed, “15/1/214” was the date the care was supposed to be received, “4012131” was the unique identification number assigned to the client, “Francisa Okrah” was the name of the client, “22” was the age of client, and “Mankomida” was the community the client lived.

Table 1: Example of ANC defaulter alert message received on a facility mobile phone

ANC overdue, 15/1/2014 4012131 Francisca Okrah, 22, Mankomida

Table 2 is a list of the different type of defaulter alert messages that were considered in this study.

Table 2: Type of MOTECH defaulter alert messages sent to FHWs

Child Welfare Clinic (Immunization) Alerts	**Antenatal Care Alerts**
1. Oral Polio (OPV) vaccine 2. Penta vaccine (DPT/Hib/HepB)	1. Antenatal care 2. Tetanus Toxoid **3.** Intermittent Preventive Treatment (IPT)

3.2 Study Area

MOTECH was implemented in seven districts across four Regions in Ghana. These included Kassena-Nankana West, Awutu Senya East, Awutu Senya West, Gomoa West, Ada East, Ada West and South Tongu Districts.

The study was conducted in five districts: South Tongu District in the Volta Region; Ada East and West District in Greater Accra Region; Awutu Senya East and Awutu Senya West District in the Central Region. These districts were selected because there was no MOTECH related research work involving FHWs going on at the time of data collection. Figure 2 shows the various location of these Districts in Ghana.

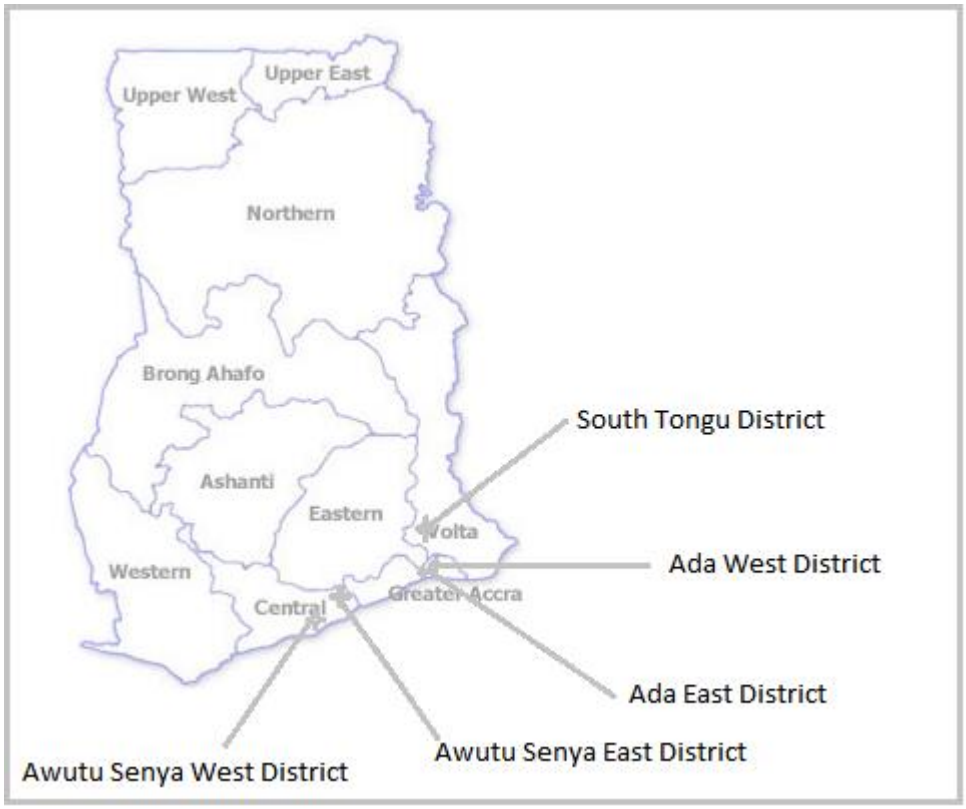


Figure 3: Map of Ghana showing study areas

3.3 Study population

The study population were Community Health Nurses (CHNs), Community Health Officers (CHOs) and other staff including enrolled nurses and health extension workers in all CHPS facilities and health centers using MOTECH. Some of these health workers stayed within the communities where they work while others lived outside and commuted to their post daily.

Community health Nurses (CHNs) were a group of nurses who received a two year training in community health and primary health care. They were stationed at peripheral health facilities to provide preventive healthcare services including immunizations and the treatment of minor illnesses. CHOs were a group of CHNs who received additional

training on the CHPS concept. CHOs are senior to CHNs and are often facility in-charges. In addition to these category of staff found at the CHPS facilities and health centers, clinical Enrolled Nurses and Health Extension Workers were also listed once they met the inclusion criteria.

1.3.1 Inclusion / Exclusion

Two set of inclusion/exclusion criteria were used to select participants for the study.

Quantitative survey:

Inclusion criteria: A health worker was included in the study if

1. He/she was using MOTECH for at least 2 months by February 1, 2014.
2. He/she was working at a CHPS or health center where MOTECH was implemented.
3. He/she was present at the facility and gave consent to participate in the study.

Exclusion criteria: A health worker was excluded from the study if

1. He/she has not used MOTECH for at least 2 months by February 1, 2014
2. He/she does not use MOTECH in the conduct of routine work.
3. He/she was not present at the facility to participate at the time of interviews.

In-depth Interviews:

Inclusion criteria: A CHO was included in the In-depth Interviews if

1. He/she was using MOTECH for at least 2 months by February 1, 2014
2. He/she was working at a CHPS where MOTECH was implemented

3. He/she was present at the facility and gave consent to participate in the study.
4. He/she had supervisory roles in addition to her normal responsibilities and may be the head of a CHPS facility.

Exclusion criteria: A CHO was excluded from the In-depth Interviews if

1. He/she has not used MOTECH for at least 2 months by February 1, 2014.
2. He/she does not use MOTECH in the conduct of routine work.
3. He/she was not present at the facility and gave consent to participate in the study.
4. He/she had no supervisory roles in addition to her normal responsibilities and was not a head or assistant head of a CHPS facility.

3.4 Sampling

3.4.1 Sample size

Using Cochran's single proportion population sample size formula, the minimum sample size was calculated as shown below:

$$N.min = deff \times \frac{Z^2 \hat{p}\hat{q}}{d^2}$$

Where;

N.min	=	Minimum sample size required
Deff	=	design effect

z	=	desired confidence level (α)
P	=	expected coverage
q	=	1 – expected coverage
p	=	precision (desired width of confidence interval)

Using a confidence level of 95% (*z* = 1.96), expected proportion of FHWs to use MOTECH in providing care of 80% (0.80), precision of 10% (d=0.10), and assuming a design effect of 2, the minimum number of FHWs required was calculated as follows:

$$N.\ min = 2 \times \frac{1.96^2 \times 0.80\ (0.20)}{0.10^2}$$

$$= 2 \times 61.46$$

$$\approx 122.9$$

Assuming 5% non-response rate (6 persons), the estimated sample size for the study was approximately 129 participants.

Census

Census was conducted for all staff present and working at the CHPS facilities and health centers. The census was done at 51 CHPS facilities and 11 health centers. An enumeration checklist was used to count staff present at the facility (see Appendix 8). The enumeration checklist collected data such as name, duration of work at the facility and use of MOTECH. A Research Assistant was accompanied by an officer from the District Health Directorate to visit each CHPS facility and health center to list all staff

present and working. This was done a week before the distribution of the survey questionnaires and conduct of in-depth interviews.

3.4.2 Sampling procedure

Survey questionnaire

Every staff working in the facilities who met the inclusion criteria were invited to participate in the study. A total of 133 health workers were counted in the census. Since the calculated sample size was approximately 129 participants, all the 133 health workers counted were invited to participate in the study.

In-depth Interviews

Purposive sampling as described by Dahlgren et al. (2007) was used to select 16 CHOs working at CHPS facilities for the in-depth interviews. These selected CHOs were not included in the quantitative survey. To maintain even representation across the study districts, at least 2 participants who met the inclusion criteria were selected from each district to participate in the in-depth interviews. The interviews were held at the facilities of study participants and took a maximum of 50 minutes.

3.5 Study Variables

Table 3: Study variables

Study variables	**Operational definition**	**Measurement scale**	**Data collection tool**
District	District in which the participant worked	Categorical	Survey questionnaire In-depth interview guide
Facility	The health facility within which a participant worked	Categorical	Survey questionnaire In-depth interview guide

Study variables	Operational definition	Measurement scale	Data collection tool
Rank	The official position of the participant	Categorical	Survey questionnaire In-depth interview guide
Age	Age in years at last birth day	Continuous	Survey questionnaire In-depth interview guide
Sex	The biological sex orientation of participant	Binary	Survey questionnaire In-depth interview guide
Duration of work in district	Number of months participant has been working the district	Continuous	Survey questionnaire
Number of supervisory visits	The number of times a supervisor from the district health directorate visits a study facility in the last quarter before study was started.	Categorical	Survey questionnaire
Number of defaulter alert messages	Total number of defaulter alert messages sent from the MOTECH system to FHWs	Continuous	MOTECH database
Received defaulter alert messages	Participant receiving and reading defaulter alert message on the facility mobile phone	Binary	Survey questionnaire
Understand defaulter alert messages	Participant understanding the content of the messages.	Binary	Survey questionnaire
*Use MOTECH defaulter alert messages	Participants using defaulter alert messages to trace defaulters	Binary	Survey questionnaire In-depth interview guide
Frequency of queries	Number of times query messages are sent to the MOTECH system by participants in a month	Categorical / qualitative	Survey questionnaire In-depth interview guide
* Use of MOTECH query messages	Participants using the feedback received from queries to plan	Categorical / qualitative	Survey questionnaire In-depth interview guide

Study variables	Operational definition	Measurement scale	Data collection tool
	and conduct home visits		

*Dependent variable

3.6 Data Collection Techniques

3.6.1 Data Sources

Primary data were collected using In-depth Interviews and self-administered survey questionnaires. The secondary data were collected electronically from the MOTECH database in a Microsoft Excel csv file.

3.6.2 Data collection

Both quantitative and qualitative data were collected on a single visit to the health facilities. The survey questionnaires were distributed to 117 participants while 16 CHOs participated in the In-depth Interviews at the facilities. The survey questionnaire was designed specifically for this study and contained self-explanatory 22-point questions. Data were collected on demographic characteristics (district, facility, rank, age, gender, duration of work in the district); defaulter tracing activities (conduct defaulter tracing, number of defaulters traced per month, received defaulter alert messages, understand defaulter alert messages, how defaulters were identified, use of alert messages for defaulter tracing, transport); home visiting activities (conduct home visits, number of home visits per month, source of information to plan home visits, frequency of making queries to MOTECH, use of query messages); and supervision from the DHMT (frequency of supervisory visits, frequent areas of supervision, and whether supervisors asked about defaulters). Secondary data on the number and type of defaulter alert messages sent out from the MOTECH system, the date these defaulter

messages were sent out, and the date FHWs entered data into the MOTECH system was received electronically from Grameen Foundation, the programme implementers. This data were extracted from the MOTECH database.

An interview guide containing 4 thematic question areas was specially designed and used to collect the qualitative data. Data were collected on the participant's understanding of messages from the MOTECH system, defaulter tracing activities, home visiting activities, utilization of the messages from MOTECH, and the benefits and challenges faced by the FHWs. All interviews took about 50 minutes and ended with a concluding statement and a final 'thank you message'. All interviews were digitally recorded using a digital Voice Recorder and notes were taken on Notepads.

3.6.3 Training of interviewers

The fieldwork was conducted by 2 Research Assistants who operated under the direct supervision of the Researcher. The Research Assistants were recruited based on having completed a University degree, having adequate experiences in conducting surveys and in-depth interviews and having sufficient knowledge of the local area. The Research Assistants received a one day training on the proper administration of the In-Depth Interview Guide and survey questionnaires. Role playing was used to ensure adequate understanding in the conduct of the surveys.

3.6.4 Pre- testing

The survey questionnaire and In-Depth Interview guide were tested for content validity (whether the instruments measured accurately the content they were intended to measure), and for clarity and understanding by respondents. About 10 Community

Health Nurses in the Gomoa West District in the Central Region of Ghana were involved in the pre-testing of the quantitative survey questionnaire while 5 CHOs were involved in the pre-testing of the In-depth Interview guide. After reviewing and modification, the final instruments were printed out.

3.7 Quality Control

To ensure quality control, the completed questionnaires were verified for completeness by the Research Assistants before departing from the CHPS facility and health centers. The uncompleted or wrongly completed questionnaires were excluded from the final data analysis. Double data entry was employed to eliminate data entry errors. The secondary data was reviewed by the Researcher for consistency and accuracy before final data export into statistical software for analysis. The survey questionnaire and in-depth interview guide were informed by the research objectives and reviewed literature. Triangulation and reliability methods were employed to ensure validity for the qualitative data. Reliability was checked using Nvivo 10 qualitative software, ensuring that coding consistency is at least 80% at all times.

During all the field work, the Researcher made random and unannounced supervisory visits to designated study sites to ensure that Research Assistants were conforming to the study procedures.

3.8 Data Processing and Analysis

3.8.1 Data processing and management

The quantitative data were cleaned and validated for completeness and consistency before entering into data screens on EpiData. The final entered data were exported to Stata Statistical software version 12 for analysis. The qualitative data were transcribed verbatim into text and imported into Nvivo Qualitative Software Version 10 for analysis.

3.8.2 Data analysis

Side-by-side comparison analysis strategy was used in the data analysis as described by Creswell (2013). The quantitative and qualitative data were analyzed separately along common variables and themes and then related. The unit of analysis was the FHW (community health nurse (CHN), community health officer (CHO), other staff at the facilities).

Wave analysis was also used to examine response bias as described by Leslie (1972). In wave analysis, the assumption is that study participants who returned survey questionnaires on the last day (in this case an hour after 5pm on the interview day was used) are nearly all non-respondents. Thus, if the responses from these participants begun to change, then there was a potential for response bias.

Quantitative data analysis

Two main outcomes of interest were considered in this study. These were Use of MOTECH defaulter alert messages to trace defaulters; and Use of MOTECH query messages to plan and conduct home visits. Both outcomes had a binary response. The explanatory variables of interest were facility, rank, age, gender, duration of work in the district, participant receiving defaulter alert messages, participant understanding

defaulter alert messages, participant conducting defaulter tracing, source of identifying defaulters, use of defaulter alert messages, means of transport, participant feeling defaulter alert messages improved defaulter tracing, participant conducting home visits, source of information for planning home visits, frequency of making queries to the MOTECH system, use of query messages from MOTECH, use of queries to conduct home visits, participant feeling query messages improved home visits, frequency of supervision, frequent areas of supervision, and supervisors asking about defaulters.

Variables such as age, duration of work in the district, number of defaulters traced and number of home visits were categorized appropriately and presented as proportions. These variables were categorized to allow a better understanding of the relationships with the outcome variables. These variables were also presented as means with the minimum, maximum values and standard deviations. All other explanatory variables that were binary and categorically ordered were presented as proportions in tables and charts.

Data on the type of defaulter alert messages sent out from the MOTECH system was presented as proportions while the duration it took for care to be provided presented as means with minimum, maximum values and standard deviation.

Since Pearson's Chi-square of association is asymptomatically equivalent to the likelihood ratio test, it was used to identify variables that were associated with the use MOTECH defaulter alert messages to trace defaulters; and use of MOTECH query messages to plan and conduct home visits at 5% level of significance. Variables found to be significantly associated with the outcome variables were put in a univariate logistic

model to determine the crude associations. Odds ratios at 95% confidence intervals were used to assess the measure of effect.

As recommended by Hosmer et al (2013), all variables resulting in p-values <0.25 in the bivariate analysis were included in a multivariate logistic regression model in order not to miss any potential confounders. Odds ratios at 95% confidence intervals were used to assess the measure of effect. P-values, calculated by Wald test, was considered significant at <0.05. Pearson goodness-of-fit was used to test the hypothesis that the data fits the model.

Qualitative data analysis

The transcribed in-depth interviews were analyzed through a systematic process of thematic content analysis, coding by writing appropriate words to represent categories as described by Rollins & Rallis (2012). Primary and secondary coding was used to represent categories. The data were presented along common themes and quotations using file name, age and gender of the participant. The real names of participants were not used to ensure confidentiality.

3.9 Ethical Issues

3.9.1 Permission to proceed

Ethical clearance for this study was obtained from the Ghana Health Service Ethical Review Committee. Written permission was received from the Regional and District Health Directorates and Grameen Foundation before the commencement of the study. Informed written consent were obtained from all individual respondents in the study.

The respondents were adequately informed about all aspects of the study (objectives, interview procedures and potential benefits and risk) before the interviews were conducted. The Research Assistants informed the respondents about the scope of the interview and its approximate duration prior to the start of the interviews. Respondents were informed that their participation was voluntary and their privacy and confidentiality will be maintained. Respondents were made to know that they had the right to discontinue an interview at any time. No compensation was given to respondents as interviews took place at their work places. However, respondents benefited by receiving advise on how to address and troubleshoot technical issues relating to the use of the MOTECH system after each interview. There was no risk to respondents as far as the study was concerned.

The completed survey questionnaires, password-protected voice files on CD ROMs and notes were locked in a safe cabinet after data entry. These will be saved for a period of 3 years after which they will be destroyed. The survey questionnaires will be shredded into pieces while the CD ROMs will be broken into pieces and discarded in a bin.

3.9.2 Declaration of no conflict of interest

Since the Researcher was an employee of Grameen Foundation, the Researcher declared that there was no conflict of interest in this study. The data collected, analyzed, interpreted was used solely for the purposes of this study.

CHAPTER FOUR: RESULTS

4.0 Demographic Characteristics

A total of 133 frontline health workers were directly using MOTECH and met the inclusion criteria. About 16 CHOs at the CHPS facilities participated in the In-depth interviews, while the remaining 117 participants completed the quantitative surveys. A 100% response rate was recorded as all the 133 participants responded favorably. About 4 survey questionnaires were incomplete and excluded, giving a final analysis of 129: 13 participants in the quantitative analysis and 16 participants in the qualitative analysis.

Out of the 16 CHOs in the in-depth interviews, 13 (81.3%) participants were heads of facilities while 3 (18.7%) were assistant heads of facilities.

About 90 (69.8%) participants were working at CHPS facilities and 39 (30.2%) were working at health centers. Majority of participants were females with a total of 120 (90.0%) while 9 (7.0%) participants were males. About 77 (59.7%) participants were Community Health Nurses (CHNs), 40 (31.0%) participants were Community Health Officers (CHOs) and 12 (9.3%) participants were other staff including Enrolled Nurses and Health Extension Workers. Majority of participants were from South Tongu District while the least number of participants were from Awutu Senya West District. Figure 4 shows the distribution of study participants across the 5 districts. The mean age of study participants was 27.6 years (min = 19, max = 48, SD = 4.1) while the mean duration of work in the district was 32.1 months (min = 2, max = 180, SD = 24.3). Table 4 shows the socio-demographic characteristics of the study participants.

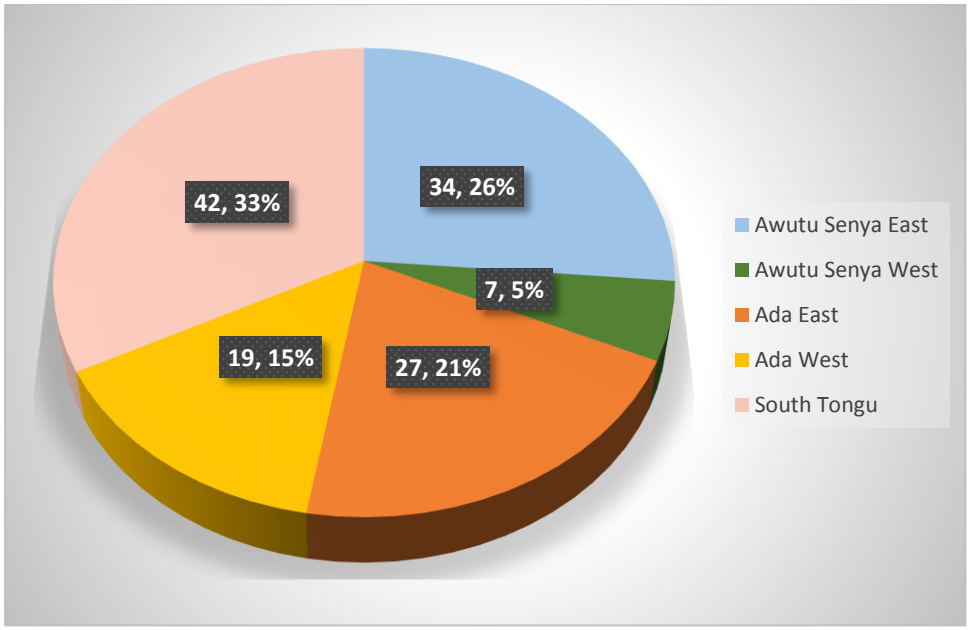


Figure 4: Distribution of study participants by district

Table 4: Socio-demographic characteristics of study participants

Characteristic	CHO n(%)	CHN n(%)	Other n(%)	Total n(%)
Facility				
Health Center	2 (5.0)	33 (42.9)	4 (33.3)	39 (30.2)
CHPS	38 (95.0)	44 (57.1)	8 (66.7)	90 (69.8)
Age (years)				
15 – 25	8 (20.0)	21 (27.3)	6 (50.0)	35 (29.2)
26 – 30	29 (72.5)	44 (57.1)	3 (25.0)	76 (55.8)
31+	3 (7.5)	12 (15.6)	3 (25.0)	18 (15.0)
Gender				
Male	1 (2.5)	7 (9.1)	1 (8.3)	9 (7.0)
Female	39 (97.5)	70 (90.9)	11 (91.7)	120 (93.0)
Duration of service in district (months)				
2 – 24	19 (47.5)	37 (48.0)	9 (75.0)	65 (50.4)
25 – 48	17 (42.5)	29 (37.7)	1 (8.3)	47 (36.4)
48+	4 (10.0)	11 (14.3)	2 (16.7)	17 (13.2)

4.1 Understanding of MOTECH

All the 16 respondents in the in-depth interviews demonstrated clear understanding of the MOTECH system. Respondents indicated that the aim of MOTECH was to reduce maternal and child mortality by sending messages to pregnant women and mothers of infants. These messages taught parents and pregnant women about pregnancy and reminded clients of scheduled appointments. Respondents also said MOTECH provided alert messages to health workers to help them provide care to their clients.

> *"I think it's just to reduce maternal health, sorry, maternal mortality and infant mortality rate" (IDI 4, 31 years, female)*

> *"MOTECH is mobile midwife that provide information to pregnant women and children under five years and those who want to be on MOTECH …" (IDI 2, 29 years, female)*

Though 11 respondents in the in-depth interviews did not know how the defaulter alert messages were technically generated, these 11 respondents said all the messages from MOTECH were based on data entered into the MOTECH system by frontline health workers using mobile phones.

Participants were asked about the frequency of receiving supervision from the district Public Health Nurses, Health Information Officer, and Disease Control Officer; the primary areas these supervisors focus on during these visits; and whether supervisors asked about defaulters. A total of 108 (95.6%) participants in the quantitative surveys received supervisory visits within the quarter preceding the commencement of the study while 5 (4.4%) participants never received any supervisory visit in the last quarter. Out of the 108 participants who received supervisory visits, 42 (37.2%) participants

received one supervisory visit, 27 (23.9%) participants received two supervisory visits, 39 (34.5%) participants received more than two supervisory visits, and 5 (4.4%) never received any supervisory visit in the last quarter. The most frequent areas of supervision were defaulters and home visits 70 (64.8%), while the least frequent area was MOTECH, 4 (3.7%). About 23 (21.3%) participants said supervision was on data accuracy, 11 (10.2%) said supervision was on clinical care while 3 (2.8%) said supervision was on ANC, CWC and PNC. A total of 100 (88.5%) participants said supervisors have specifically asked them about defaulters traced, while 13 (11.5%) indicated that supervisors did not ask about defaulters traced. Though some participants reported being asked about defaulters traced, participants in the qualitative interviews said they were not required to report defaulter tracing activities to their supervisors.

> *"... we don't report anything (to our supervisors). We just follow the alert messages ... trace our defaulters and fill any forms that we're supposed to fill and submit it monthly ..." (IDI 8, 28 years, female)*

4.2 Defaulter tracing activities

A total of 6,311 defaulter alert messages were sent out from the MOTECH system to frontline health workers from February 2014 to April 2014. Majority of these messages were CWC visits with a total of 6119 (97.0%) while ANC visits were only 192 (3.0%). The mean time it took to enter data into the MOTECH system following the receipt of an alert was 5.3 days (min=1 max 132.6 days, SD = 18.5).

Out of 113 participants in the quantitative surveys, 105 (92.9%) participants indicated conducting defaulter tracing while 8 (7.1%) participants did not conduct defaulter

tracing. Among participants who conducted defaulter tracing, 73 (94.8%) participants were CHNs, 21 (87.5%) participants were CHOs and 11 (91.7%) participants were other staff including Enrolled Nurses and Health extension Workers. Averagely, 6.7 defaulters were traced in a month (min = 1, max = 40, SD = 6.7).

Out of the 113 participants in the quantitative surveys, 103 (91.2%) participants received the MOTECH defaulter alert messages while 10 (8.8%) did not receive the defaulter alert messages. Out of the 103 participants who received the MOTECH defaulter alerts, only 2 (1.9%) participants did not understand the content of the defaulter alert messages. Table 5 shows the univariate analysis of variables related to defaulter tracing.

About 52 (49.5%) participants identified defaulters using the MOTECH alert messages while 40 (30.1%) relied on the paper registers and 13 (12.6%) identified defaulters during home visits. Out of a total of 52 participants who used the MOTECH defaulter alerts to identify defaulters, 13 (25.0%) participants were CHOs, 34 (65.4%) were CHNs and 5 (9.6%) were other staff.

Participants in the in-depth interviews said it was easier using the defaulter alert messages to identify defaulters as compared to using the paper registers.

> *"..... if this person doesn't come this month, you will immediately get the defaulter alert so you will know and you have to go back and see to them" (IDI 1, 27 years, Female)*

When study participants were asked why they used the defaulter alert messages to identify defaulters instead of the paper registers, this was what some participants said:

> *"It is easier …… with the alert messages, you get to know that this particular child or this group of children are supposed to receive care. That is easier than the simplified registers because you flip ad flip and sometimes the names are so many that you can't see them"(IDI 8, 28 years, Female).*

> *"…… it helps us too, it helps our work to be accurate. Because if it had not been this alerts, maybe I won't be able to trace this woman. So it help us to trace our defaulters. That is the main purpose of the alerts, for tracing defaulters" (IDI 7, 26 years, Female)*

Nonetheless, some of the participants said some of the defaulter alert messages were not accurate. In such cases, participants relied on their paper registers or identified defaulters during home visits.

> *"When the information is accurate, we don't have any problem with that but the situation whereby they will be giving us inaccurate information, sometimes you get bored" (IDI 5, 26 years, Female)*

Of the 52 participants who use the MOTECH alerts to identify defaulters, 22 (42.3%) participants will simply call the defaulters on a mobile phone to come to the facility for care. Only 8 (15.4%) participants traced defaulters immediately to provide care when a defaulter alert message is delivered. Another 17 (32.7%) participants will provide care to defaulters on the next scheduled visit while 5 (9.6%) will provide care during home visits.

> *"… no. we don't (trace defaulters) … immediately because we have been going for home visits daily …. (add defaulter tracing to that)" (IDI 3, 29 years, female)*

> *"We wait till we are going there to provide a service, like maybe we are going for outreach then we go and look for the person" (IDI6, 26 years, female)*

About 61 (58.1%) participants traced defaulters by walking while 21 (20.0%) used motorbikes.

> *"…it was tiring. We … will be walking and get tired with that big bag, when you come back you're tired" (IDI 14, 24 years, female)*

Though most participants do not directly use the MOTECH alert messages to immediately trace defaulters and provide care, 75 (72.8%) participants feel that the MOTECH defaulter alert messages have improved their performance. Participants said the MOTECH messages have helped increase the number of facility attendance and has reduced the number of defaulters since clients also receive reminder alerts for upcoming care.

> *"…help increase our coverage in the CWC attendance" (IDI 6, 28 years, female)*

Table 5: Univariate analysis of variables related to defaulter tracing

Variable	CHO n(%)	CHN n(%)	Other n(%)	Total N(%)
Receive MOTECH defaulter alert messages				
Conduct defaulter tracing				
No	3 (12.5)	4 (5.2)	1 (8.3)	8 (7.1)
Yes	21 (97.5)	73 (94.8)	11 (91.7)	105 (92.9)
Receive MOTECH defaulter alert messages				
No	1 (4.2)	8 (10.4)	1 (8.3)	10 (8.9)
Yes	23 (95.8)	69 (89.6)	11 (91.7)	103 (91.2)
Understand MOTECH defaulter alert messages				
No	0 (0.0)	1 (1.5)	1 (9.1)	2 (1.9)
Yes	23 (100.0)	68 (98.6)	10 (90.9)	101 (98.1)
How defaulters are identified				
Registers	7 (33.3)	28 (38.4)	5 (45.5)	40 (38.1)
MOTECH alerts	13 (61.9)	34 (46.6)	5 (45.5)	52 (49.5)
Home visits	1 (4.8)	11 (15.1)	1 (9.1)	13 (12.4)
Use of MOTECH defaulter alert messages				
Next visit	6 (46.2)	9 (26.5)	2 (40.0)	17 (32.7)
Trace immediately	1 (7.7)	6 (17.7)	1 (20.0)	8 (15.4)
Call clients on phone	6 (46.2)	15 (44.1)	1 (20.0)	22 (42.3)
Give care during home visits	0 (0.0)	4 (11.8)	1 (20.0)	5 (9.6)
Use of MOTECH defaulter alert messages to trace defaulters				
No	11 (45.8)	43 (55.8)	7 (58.3)	61 (54.0)
Yes	13 (54.2)	34 (44.2)	5 (41.7)	52 (46.0)
Means of transport to trace defaulters				
Walk	10 (47.6)	45 (61.6)	6 (54.5)	61 (58.1)
Use motorbike	4 (19.1)	14 (19.2)	3 (27.3)	21 (20.0)
Use public transport	0 (0.0)	3 (4.1)	1 (9.1)	4 (3.8)
Use facility car	7 (33.3)	11 (15.1)	1 (9.1)	19 (18.1)
Participant feel MOTECH defaulter alert messages improved defaulter tracing				
No	4 (16.7)	28 (36.4)	4(33.3)	36(31.9)
Yes	20 (83.3)	49 (63.6)	8(66.7)	77(68.1)

From Table 6, 4 variables were variables such received MOTECH defaulter alert messages, personally conduct defaulter tracing, how defaulters are identified, and participant feel defaulter alert messages improved defaulter tracing were significantly associated with the use of MOTECH defaulter alert messages to trace defaulters ($p < 0.05$).

Table 6: Bivariate analysis of variables associated with use of MOTECH defaulter alert messages

Variable	**Use of MOTECH defaulter alerts messages**			
	n	**No (%)**	**Yes (%)**	**Chi square (*P* value)**
Facility				
Health Center	39	23 (59.0)	16 (41.0)	0.597; (p=0.440)
CHPS	74	38 (51.3)	36 (48.7)	
Rank				
CHO	24	11 (45.8)	13 (54.2)	0.841; (p=0.657)
CHN	77	43 (55.8)	34 (44.1)	
Other	12	7 (58.3)	5 (41.7)	
Age group (years)				
15 – 25	33	19 (57.8)	14 (42.4)	1.537; (p=0.464)
26 – 30	63	31 (49.2)	32 (50.8)	
31 – 45	17	11 (64.7)	6 (35.3)	
Duration of work in the district (months)				
2 - 24	60	34 (56.7)	26 (43.3)	1.062; (p=0.588)
25 – 48	38	18 (47.4)	20 (52.6)	
48+	15	9 (60.0)	6 (40.0)	
Gender				
Male	9	3 (33.3)	6 (66.7)	1.678; (p=0.195)
Female	104	58 (55.8)	46 (48.9)	
Conduct defaulter tracing				
No	8	8 (100.0)	0 (0.0)	7.339; (p=0.007)
Yes	105	53 (50.5)	52 (49.5)	
Received MOTECH defaulter alert messages				
No	10	10 (00.0)	0 (0.0)	9.352; (p=0.002)
Yes	103	51 (49.5)	52 (50.5)	
Understand MOTECH defaulter alert messages				

Variable	Use of MOTECH defaulter alerts messages			
	n	No (%)	Yes (%)	Chi square (*P* value)
No	2	0 (0.0)	2 (100.0))	2.000; (*p*=0.157)
Yes	101	51 (50.5)	50 (49.5)	
How defaulters are identified				
Use the Registers	40	40 (100.0)	0 (0.0)	105.000; (*p*<0.000)
Use MOTECH alerts	52	0 (0.0)	52 (100.0)	
Home visits	13	13 (100.0)	0 (0.0)	
Means of transport to trace defaulters				
Walk	61	30 (49.2)	31 (50.8)	0.575; (*p*=0.902)
Use motorbike	22	12 (54.6)	10 (54.5)	
Use public transport	3	1 (33.3)	2 (66.7)	
Use facility car	19	10 (52.6)	9 (47.4)	
Frequency of supervisory visits in last quarter				
Never	5	3 (60.0)	2 (40.0)	6.857; (*p*=0.077)
Once	42	17 (40.5)	25 (59.5)	
Twice	27	14 (51.9)	13 (48.2)	
More than twice	39	27 (69.2)	12 (30.8)	
Area of supervisory visits				
Defaulters and home visits	70	37 (52.9)	33 (47.1)	4.872; (*p*=0.301)
Data accuracy	23	10 (43.5)	13 (56.5)	
Clinical care	11	7 (63.6)	4 (36.4)	
MOTECH	1	1 (100.0)	0 (0.0)	
ANC, CWC, PNC	3	3 (100.0)	0 (0.0)	
Supervisor ask about defaulter tracing				
No	13	8 (61.5)	5 (38.5)	0.338; (*p*=0.561)
Yes	100	53 (53.0)	47 (47.0)	
Participant feel defaulter alert messages improved defaulter tracing				
No	36	33 (91.7)	3 (8.3)	30.202; (*p*<0.000)
Yes	77	28 (36.4)	49 (63.6)	

Variables that were significantly associated were further explored using a univariate logistic model. Participants who felt the MOTECH defaulter alert messages improved

defaulter tracing were 15.7 times more likely to use the MOTECH defaulter alert messages to trace defaulters as compared to participants who feel the MOTECH defaulter alert messages has not improved defaulter tracing OR= 15.7 (95% CI: 4.330 – 56.970, $p < 0.000$). Table 7 shows the adjusted associations between use of MOTECH defaulter alert messages and the explanatory variables.

After adjusting for all other variables with $p < 0.250$, how participants identified defaulters was significantly associated with use of defaulter alert messages to trace defaulters (AOR = 5.5, $p = 0.003$, 95% confidence interval: 1.807 – 16.782). Also, participants who feel the defaulter alert messages improved defaulter tracing was also significantly associated with use of MOTECH defaulter alert messages to trace defaulters (AOR = 1225.0, $p = 0.001$ 95% confidence interval: 22.101 – 67896.160).

Table **7**: Multivariate logistic analysis of variables associated with use of MOTECH defaulter alert messages

Variable	**Use of queries messages and alerts**		
	AOR	***P* value**	**95% Conf. Interval**
Gender	0.3	0.319	0.033 - 3.034
Conduct defaulter tracing	1	-	
Received MOTECH defaulter alert messages	1	-	
Understand MOTECH defaulter alert messages	1	-	
How defaulters are identified	5.5	0.003	1.807 - 16.782
Frequency of supervisory visits in last quarter	0.8	0.311	0.443 - 1.296
Participant feel defaulter alert messages improved defaulter tracing	1225.0	0.001	22.101 - 67896.160

LR Chi2(4) = 45.6
Prob>chi2 = 0.000

4.3 Conducting home visits

A total of 111 (98.2%) participants reported conducting regular home visits while 2 (1.8%) do not conduct home visits. Among participants who conducted home visits, 77 (69.4%) were CHNs, 24 (21.6%) were CHOs, and 10 (9.0%) were other staff. Participants conducted an average of 11 home visits in a month (min = 1, max = 30 visits, SD =9.9). Participants conducted home visits by mostly walking as the common means of transport. Table 8 shows the univariate analysis of variables related to home visits.

> *"…. home visiting you have to walk because you can't pick a car you can't pick a motor" (IDI 14, 24 years, female)*

Out of the 111 participants who conducted home visits, majority 47 (42.3%) relied on the paper registers for information to plan and conduct home visits, 25 (22.5%) used itinerary developed at the beginning of the year, 22 (19.8%) participants used MOTECH defaulter alert messages, 2 (1.8%) relied on supervisor's direction while 15 (13.5%) participants do not use any specific information to plan and conduct home visits. A total of 95 (84.1%) participants sent query messages to the MOTECH system for information to plan and conduct community outreach activities. Out of the 95 participants who sent query messages, 9 (8.0%) sent the query messages daily, 51 (53.7%) participants sent the query messages weekly, 35 (31.0%) sent the query messages monthly, and 18 (15.9%) never sent any query messages. Majority 61 (64.2%) participants used the feedback from the query messages to plan home visits and outreach activities. Figure 5 shows how the feedback for the query messages were utilized by participants.

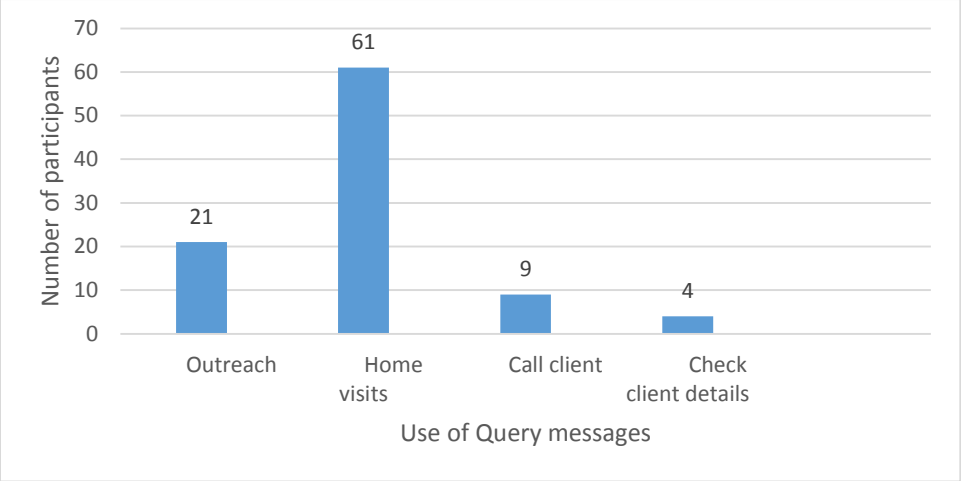


Figure 5: Use of query messages from MOTECH

"It makes (us) plan ahead like if you are supposed to request for a vaccine, you know the number you are supposed to request. And the number who will be coming for a particular immunization. So it makes work easier" (IDI 10, 27 years, female)

"..it makes home visits planning easier. So you will be able to know which house you are going to. Or when you get there, what you are supposed to talk about. Because if the person defaulted for a vaccine, when you get there, you tell talk to the person about the importance of vaccination" (IDI 10, 27 years, female)

Table 8: Univariate analysis of variables related to home visits by rank

Variable	CHO n=24	CHN n=77	Other n=12	Total N=113
Conduct home visits				
No	0 (0.0)	0 (0.0)	2 (16.7)	2 (1.8)
Yes	24 (100.0)	77 (100.0)	10 (83.3)	111 (98.2)
Receive MOTECH defaulter alert messages				
No	1 (4.2)	8 (10.4)	1 (8.3)	10 (8.9)
Yes	23 (95.8)	69 (89.6)	11 (91.7)	103 (91.2)
Source of information to plan home visits				
Registers	9 (37.5)	34 (44.2)	4 (40.0)	47 (42.3)
Itinerary	7 (29.2)	14 (18.2)	4 (40.0)	25 (22.5)
MOTECH messages	6 (25.0)	15 (19.5)	1 (10.0)	22 (19.8)
Supervisor direction	0 (0.0)	1 (1.3)	1 (10.0)	2 (1.8)
No specific information	2 (8.3)	13 (16.9)	0 (0.0)	15 (13.5)
Frequency of making queries to MOTECH				
Never	4 (16.7)	10 (13.0)	4 (33.3)	18 (15.9)
Daily	0 (0.0)	8 (10.4)	1 (8.3)	9 (8.0)
Weekly	13 (54.2)	33 (42.9)	5 (41.7)	51 (45.1)
Monthly	7 (29.2)	26 (33.8)	2 (16.7)	35 (31.0)
Use of feedback from queries				
Outreach	5 (25.0)	15 (22.4)	1 (12.5)	21 (22.1)
Home visits	11 (55.0)	43 (64.2)	7 (87.5)	61 (64.2)
Call client	4 (20.0)	5 (7.4)	0 (0.0)	9 (9.5)
Check client details	0 (0.0)	4 (6.0)	0 (0.0)	4 (4.2)
Use queries messages to plan and conduct home visits				
No	9 (37.5)	24 (31.2)	4 (33.3)	37 (32.7)
Yes	15 (62.5)	53 (68.8)	8 (66.7)	76 (67.3)
Participant feel queries messages improved planning and conducting home visits				
Yes	6 (25.0)	20 (26.0)	4 (33.3)	30 (26.6)
No	18 (75.0)	57 (74.0)	8 (66.7)	83 (73.4)

From Table 9, conduct home visits, received MOTECH defaulter alert messages, frequency of queries, use of query messages, means of transport, participant feel query messages improved home visits, area of supervision, supervisors asked about defaulters were all significantly associated with the use of query messages and alerts to plan and conduct home visits ($p < 0.05$). Facility, rank, age group, duration of work in the district, gender, source of information to plan home visits, frequency of queries made to MOTECH system, means of transport, frequency of supervisory visits were not associated with use of query messages to plan home visits ($p > 0.05$).

> *"We identify our defaulters by querying the system ..... it's so easy that on Monday you will just query the system and the system will give it to us" (IDI 11, 27 years, Female)*

Table 9: Bivariate analysis of variables associated with use of query messages

Variable		Use feedback from queries to plan and conduct home visits		
	N	No (%)	Yes (%)	P value
Facility				
Health Center	39	15 (38.5)	24 (61.5)	0.884; (*p*=0.347)
CHPS	74	22 (29.7)	52 (70.3)	
Rank				
CHO	24	9 (37.5)	15 (62.5)	0.335; (*p*=0.846)
CHN	77	24 (31.2)	53 (68.8)	
Other	12	4 (33.3)	8 (66.7)	
Age (years)				
15 – 25	33	13 (39.4)	20 (60.6)	0.940; (*p*=0.625)
26 – 30	63	19 (30.2)	44 (69.8)	
31 – 45	17	5 (29.4)	12 (70.6)	
Duration of work in the district (months)				
2 - 24	60	18 (30.0)	42 (70.0)	0.601; (*p*=0.740)
25 – 48	38	13 (34.2)	25 (65.8)	
48+	15	6 (40.0)	9 (60.0)	
Gender				
Male	9	2 (22.2)	7 (77.8)	0.492; (*p*=0.483)
Female	104	35 (30.7)	69 (66.3)	
Conduct home visits				
No	2	2 (100.0)	0 (0.0)	4.182; (*p*=0.041)
Yes	111	35 (31.5)	76 (68.5)	
Source of information to plan home visits				
Registers	47	17 (36.2)	30 (63.8)	6.794; (*p*=0.147)
Itinerary	25	3 (12.0)	22 (88.0)	
MOTECH messages	22	7 (31.8)	15 (68.2)	
Supervisor direction	2	1 (50.0)	1 (50.0)	
No specific information	15	7 (46.7)	8 (53.3)	
Received defaulter alert messages				
No	10	6 (60.0)	4 (40.0)	3.701; (*p*=0.054)
Yes	103	31 (30.1)	72 (69.9)	
Frequency of making queries to MOTECH				
Never	18	16 (88.9)	2 (11.1)	32.900;(*p*<0.000)
Daily	9	0 (0.0)	9 (100.0)	
Weekly	51	12 (23.5)	39 (76.5)	

Variable	Use feedback from queries to plan and conduct home visits			
	N	No (%)	Yes (%)	P value
Monthly	35	9 (25.7)	26 (74.3)	
Use of queries messages				
Outreach	21	21 (100.0)	0 (0.00	95.000; (p<0.000)
Home visits	61	0 (0.0)	61 (100.0)	
Call client	9	0 (0.00	9 (100.0)	
Check client details	4	0 (0.0)	4 (100.0)	
Transport to trace defaulters				
Walk	61	19 (31.2)	42 (68.9)	8.779; (p=0.032)
Motorbike	22	2 (9.1)	20 (90.9)	
Public transport	3	0 (0.0)	3 (100.0)	
Facility care	19	9 (47.4)	10 (52.6)	
Frequency of supervisory visits in last quarter				
Never	5	3 (60.0)	2 (40.0)	3.168;(p=0.366)
Once	42	12 (28.6)	30 (71.4)	
Twice	27	11 (40.7)	16 (59.3)	
More than twice	39	11 (28.2)	28 (71.8)	
Area of supervisory visits				
Defaulters and home visits	70	19 (27.1)	51 (72.9)	9.450; (p=0.051)
Data accuracy	23	7 (30.4)	16 (69.6)	
Clinical care	11	4 (36.4)	7 (63.6)	
MOTECH	1	1 (100.0)	0 (0.0)	
ANC, CWC, PNC	3	3 (100.0)	0 (0.0)	
Supervisor asked about defaulters				
No	13	9 (24.3)	4 (5.3)	8.881; (p=0.003)
Yes	100	28 (75.7)	72 (94.7)	
Feedback from queries improved home visit performance				
No	30	22 (73.3)	8 (26.7)	30.556; (p=0.000)
Yes	83	15 (18.1)	68 (81.9)	

Variables that were significantly associated with the use of query messages to plan and conducted home visits were explored further using a univariate logistic model. From Table 10, participants who send query messages to the MOTECH system weekly were 26 times more likely to use the query messages and alerts to plan and conduct home visits as compared to those who never sent query messages to the MOTECH system (OR=26.0, $p < 0.000$, 95% confidence interval: 5.278 – 129.562).

Similarly, participants who sent query messages to the MOTECH system monthly were 23.1 times more likely to use the query messages and alerts to plan and conduct home visits as compared to participants who never sent query messages to the MOTECH system (OR = 23.1, $p < 0.000$, 95% confidence interval: 4.44 – 120.810). Participants who feel the query messages and alerts have improved home visits were 12.5 times more likely to use the query messages and alerts to plan and conduct home visits as compared to participants who do not feel the query messages and alerts have improved home visits (OR=12.5, $p < 0.000$, 95% confidence interval: 4.662 – 38.335).

Also, participants whose supervisors asked about defaulters were found to be 5.8 times more likely to use the query messages and alerts to plan and conduct home visits compared to participants who supervisors do not ask about defaulters (OR=5.8, $p = 0.006$, 95% confidence interval: 1.648 – 20.317). Participants who used an already prepared itinerary were found to be 4.2 times more likely to use the query messages and alerts to plan and conduct home visits as compared to participants who used information from the paper registers (OR = 4.2, $p = 0.038$, 95% confidence interval: 1.083 – 15.950). All other explanatory variables were not found to be significantly associated with the use of query messages and alerts to plan home visits ($p > 0.05$).

Table 10: Univariate logistic regression analysis of variables associated with use of query messages

Variable	Use of query messages and alerts		
	OR	*P* value	95% Conf. Interval
Source of information to plan home visits			
Registers	1		
Itinerary	4.2	0.038	1.083 - 15.950
MOTECH messages	1.2	0.724	0.414 - 3.563
Supervisor direction	0.6	0.695	0.033 - 9.650
No specific information	0.6	0.469	0.120 – 2.099
Frequency of making queries to MOTECH			
Never	1		
Daily	1	-	
Weekly	26.0	0.000	5.278 – 129.562
Monthly	23.1	0.000	4.421 – 120.810
Means of transport to trace defaulters			
Walk	1		
Use motorbike	4.5	0.057	0.959 - 21.341
Use public transport	1	-	
Use facility car	0.5	0.200	0.176 - 1.438
Area of supervisory visits			
Defaulters and home visits	1		
Data accuracy	0.9	0.760	0.303 - 2.392
Clinical care	0.7	0.530	0.171 - 2.482
MOTECH	1	-	
ANC, CWC, PNC	1	-	
Supervisor ask about defaulters			
No	1		
Yes	5.8	0.006	1.648 – 20.317
Participant feel feedback from queries improved home visits			
No	1		
Yes	12.5	0.000	4.662 - 38.335

Variables that were significantly associated with use of query messages to plan and conduct home visits and had a $p < 0.250$ were fit into a multivariate logistic model in

order to assess the associations after adjusting for all other variables. This is presented in table 11 below. Participants who feel the query messages have improved planning and conducting home visits were 6.9 times more likely to use the query messages and alerts to plan and conduct home visits compared to those participants who do not feel the query messages have improved planning and conduct of home visits (AOR=6.9, *p*=0.001, 95% Confidence interval: 2.194 - 21.984). All the other variables were not significantly associated with use of query messages to plan and conduct home visits after adjusting for all other factors.

Table 11: Multivariate logistic regression analysis of variables associate with use of query messages

Variable	**Use of queries messages and alerts**		
	AOR	***P* value**	**95% Conf. Interval**
Source of information to plan home visits			
Registers	1		
Itinerary	1.8	0.416	0.428 - 7.767
MOTECH messages	1.2	0.797	0.323 - 4.357
Supervisor direction	0.3	0.355	0.014 - 4.592
No specific information	0.9	0.879	0.203 - 3.914
Frequency of making queries to MOTECH	1.5	0.147	0.874 - 2.476
Supervisor ask about defaulters	1.9	0.468	0.338 - 10.622
Participant feel feedback from queries improved home visits	6.9	0.001	2.194 - 21.984

CHAPTER FIVE: DISCUSSION

This study was to assess the effectiveness of MOTECH alerts and reminders on improving frontline health worker performance in 5 MOTECH districts. MacLeod et al (2012) reported in their study that frontline health workers were reluctant to carry out their traditional duties of tracing clients who missed their appointments but rather stayed at the facility level for clients to come to them. In addition, frontline health workers did not prioritize community outreach activities including home visits. All these were mainly due to the difficulties frontline health workers faced in identifying defaulters from the paper registers. Also FHWs were either demoralized to carry out these roles or there was lack of adequate supervision to ensure these roles were carried out.

Defaulter tracing

The MOTECH project was implemented to address some of these challenges by helping frontline health workers track care that was provided to clients as well as provide defaulter alert messages to frontline health workers to track defaulters and provide care. In addition, MOTECH also allowed frontline health workers to request for specific information about defaulters using the query messages to track and provide care (MacLeod, Phillips, Stone, Walji, & Awoonor-Williams, 2012c).

From the results, about 49.5% of participants used the MOTECH defaulter alert messages to identify defaulters while 30.1% relied on the paper registers to identify defaulters. This suggests that the defaulter alert messages were found to be useful and addressed the difficulty with which FHWs identified defaulters, as has been reported by MacLeod et al (2012). The results also showed that majority of frontline health workers who used these defaulter alert messages were community health nurses.

Though the number of community health nurses participating in this study was high, the critical role community health nurses played in primary health care makes motivates them to easily rely on this support. The CHPS concept was designed such that CHNs will spend about 80% of their time in the community, providing preventive services such as vaccinations, health education/promotion and family planning. In order to be effective, CHNs readily need information to ensure these community activities are targeted and effective. It is consistent therefore to observe that majority of users of the defaulter alerts were CHNs unlike the CHOs are play a supervisory role. Enrolled Nurses at peripheral facilities mainly provided clinical care than preventive care. Very few of this cadre of staff utilized the MOTECH system.

It was easier for a CHN to simply send a text message to the MOTECH system to get a list of defaulters or simply wait for the MOTECH system to automatically send a list of defaulters instead of flipping through several pages in the paper registers to identify these defaulters. This finding conforms to other studies which demonstrated that health workers were more likely to utilize easier support tools to provide care (DeRenzi et al., 2012b).

The MOTECH initiative was to also facilitate process improvement and compliance with standard guidelines especially with regards providing care to clients who missed their appointments in a timely manner. Defaulters were clients who missed scheduled appointments, usually resulting in the break in the continuum of care if the care was not provided on time. The study found that only 15.4% of frontline health workers will immediately trace and provide care to defaulters. Majority of the participants rather will either call the clients on mobile phones to come to the facility for the missed care or will provide the care during the next visit instead of immediately tracing defaulters to

provide care. This observation was consistent with baseline studies conducted by Frimpong et al (2010) prior to MOTECH pilot implementation where it was found that frontline health workers will rather wait at the facility for client to come for care instead of going out to the community.

Though the study did not observe any significant associations between using the defaulter alert messages to trace and provide care to defaulters and means of transport, previous studies cited health workers being demoralized to perform these roles due to lack of basic logistics including transport. Inadequate logistics and resources such as lack of motorbikes or vehicle to conduct defaulter tracing are factors that can demoralize frontline health workers. Frontline health workers had to walk to these defaulters to provide the care and since this was a tiring role, very few of them actually trace clients immediately to provide care. For mobile health technologies to succeed and create the impact that is desired, health systems must be strengthened both in terms available logistics as well as equipment and tools to work with. These findings are consistent with studies conducted in Kenya where emphasis was laid on the provision and strengthening of health systems to make mobile health interventions successful (Free et al., 2013).

This study also found that frontline health workers were more likely to use the defaulter alert messages to trace defaulters if they had a positive feeling about the messages. It was observed that frontline health workers who felt the MOTECH defaulter alert messages improved defaulter tracing were more likely to use the alerts to trace defaulters. The use of mobile health interventions in the developing world is only growing. The full adoption and utilization of technology is still growing with the associated slow adoption and utilization as has been reported by other researchers.

Several studies have shown that the behavioral intentions to use a particular technology or support tool was largely influenced by perceived usefulness and attitude toward using this technology or support tool. Compatibility, perceived usefulness and perceived ease of use significantly affected healthcare professional behavioral intent (Engebretsen, 2005; Kreps & Neuhauser, 2010; Putzer & Park, 2010; Wu, Wang, & Lin, 2007).

Supportive supervision has been shown to improve health worker performance (Mathauer & Imhoff, 2006). However, in this study, no significant associations were found between the use of the defaulter alert messages and frequency of supervisory visit, area of focus of these visits and whether supervisors asked about defaulters. Participants revealed that it was not mandatory to report on defaulter tracing activities. This could explain the inconsistency of these results with previous studies on supportive supervision.

Several studies have demonstrated results suggesting the effectiveness of sending SMS reminders to community health workers, resulting in a reduction in the time it took for care to be provided to clients from 9.6 days to 1.4 days (DeRenzi et al., 2012b). Though the results did not suggest quantifiable improvements, the results suggested that frontline health workers found the defaulter alert messages from MOTECH to be useful.

Home visits

Home visits is a primary role of frontline health workers in rural communities. This involved visiting the homes of clients and providing preventive healthcare service such as family planning, immunizations, health talks/promotion and treatment of minor illnesses. As part of these activities, frontline health workers are expected to prioritize

these home visits to ensure that clients who are most in need are serve first. Identification of clients most in need and appropriate planning and conducting home visits can be an effective way to provide primary health care. In baseline studies prior to MOTECH pilot implementation by Frimpong et al (2010), the researchers reported that community health workers do not priorities community activities including home visits such that these visits are not targeted and are not effective. Critical challenges exist that impede the effective conduct of these home visits. For example, inadequate logistics such as transport, long travel distances, community factors and inadequate information to plan and conduct these community outreach activities are critical challenges.

MOTECH provided some information to frontline health workers through the query messages to help them plan and conduct home visits. In this study, it was found that about 22% participants who received defaulter alert messages used this information to plan and conduct home visits while 47% of the participants used information the simplified paper registers. Also, majority of frontline health workers (84.1%) request information from the MOTECH system and used these information to plan and conduct home visits (64.2%). This was attributed to the ease with which frontline health workers received this information, conforming to previous studies that suggested that the of ease of use of smart phones applications increased the chances of use (Putzer & Park, 2010). Frontline health workers simply completed a four-point form on their mobile phone and uploaded this form onto the MOTECH system. Feedback is automatically generated and delivered to the staff within a minute.

The study also observed a significant association between the use of the query messages to plan and conduct home visits and the frequency of sending query request messages

to the MOTECH system. Ideally, frontline health workers are to conduct daily home visits within the community. The study found strong associations with participants who made queries weekly and monthly. This finding is interesting as it suggest that there could be other reasons why nurses will need such information at such times. In addition to home visits, FHWs organize static and community outreach clinics where clients meet for services such as child welfare clinics. Most of these activities usually happen in the first two weeks of the month. The remaining two weeks are usually dedicated to home visits and client follow up. This associations are therefore consistent with the routine work plans of community health workers and suggest that the feedback received is also used during these community activities. The query messages were also used to request for vaccines for outreach activities as FHWs queried the system to determine number of clients coming for certain immunizations in the next visit.

This study also demonstrated the importance of supportive supervision. Participants who were asked about defaulters by their supervisors were more likely to use messages from MOTECH to plan home visits compared to those who were not ask. These findings conforms to other studies where supportive supervision has been shown to increase health worker productivity (Frimpong et al., 2011).

Overall there has been positive outcomes in how frontline health workers used the defaulter alert messages and the query messages from MOTECH. Messages from MOTECH has reportedly improved the performance of frontline health workers in conducting defaulter tracing and home visits. However, technical and logistical challenges still remain. More than just pushing out messages to frontline health workers, strengthening health systems such as providing means of transport, and

logistics are key factors that influence how frontline health workers utilized messages from the MOTECH system.

5.1 Limitations

The following were limitations of the study:

1. In this study, the scope was limited to only how the defaulter alert messages influenced the frontline health worker.
2. Data was not available for clients who were traced and care provided as a result of receiving the defaulter alert messages.

CHAPTER SIX: CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Defaulter alert messages from MOTECH supported frontline health workers to trace and provide care to clients missing scheduled appointments. Though the intervention did not ensure immediate client follow up, it made tracking of care and identification of defaulters easier. The perceptions and feelings of frontline health workers were key factors associated with using defaulter alert messages to trace and provide care to clients who missed their appointments.

Messages from MOTECH were found to be very useful in conducting home visits and other community outreach activities. There was a higher likelihood that frontline health workers will use messages from MOTECH to plan and conduct home visits if supportive supervision was strengthened and health workers had a positive perception about the messages.

6.2 Recommendation

1. Further research should be done to understand the relationship between sending reminder messages to clients and sending defaulter alert messages to frontline health workers to determine the impacts of MOTECH on health worker performance.
2. Implementation of mhealth programmes require continuous supportive supervision to make them effective.
3. Further studies could be conducted to assess the influences of the reminder messages on both clients and the frontline health workers.

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APPENDIX 1: FHW SURVEY QUESTIONNAIRE

Demographic characteristics				
District		Facility	[ ] HC [ ] CHPS	
Gender	Male [ ] Female [ ]	Age		
How many months have you been working in the District?		Rank		
No.	**Question**	**Response**		**Comment**
Please respond to the following question and select the most appropriate answer (**only one answer**) by ticking (√) or writing at the appropriate place. **Defaulter tracing activities**				
Q1	Do you receive defaulter alert messages from MOTECH?	[ ] Yes [ ] No		
Q2	Do you understand the alert messages you receive from MOTECH?	[ ] Yes [ ] No		
Q3	Do you personally conduct defaulter tracing?	[ ] Yes [ ] No		
Q4	How many defaulters do you trace and provide care in a month?	__ __		
Q5	How do you identify your defaulters? Select the most frequent source you rely on.	[ ] Use the Registers [ ] Use MOTECH alerts [ ] My colleagues tell me [ ] I get to know when the client come for care [ ] Other specify		If No to Q3, skip to Q9
Q6	If you selected MOTECH defaulter alerts in Q5, how do you use these defaulter alert messages? (Only answer this question if answer to Q5 was use MOTECH alerts)	[ ] Immediately trace defaulters [ ] Call defaulters on phone [ ] Go to clients homes to provide care [ ] Take note and provide care in next visit [ ] Do not use the messages		
Q7	Do you use the MOTECH defaulter alert messages to trace defaulters?	[ ] Yes [ ] No		
Q8	How many days does it take for you to trace a defaulter?	__ __		
Q9	What means of transport do you use to trace your defaulters? Select your common means of transport.	[ ] Walk [ ] Use motorbike [ ] Use facility car [ ] Use public transport [ ] Other, specify		

Q10	Do you feel the alert messages has improved your performance?	[ ] Yes [ ] No	
Home visiting activities outcomes			
Q11	Do you personally conduct home visits?	[ ] Yes [ ] No	If No to Q9, skip to Q12
Q12	How many times did you conduct home visits in the last month?		
Q13	Where did you get the information to plan those home visits? Select only one, the most frequent and reliable source.	[ ] I used the Registers [ ] I continued from where I ended last time [ ] My supervisor directed me [ ] I used MOTECH messages [ ] I don't use any specific info [ ] Other specify	
Q14	How often do you make queries to the MOTECH system?	[ ] Daily [ ] Weekly [ ] Monthly [ ] Never	
Q15	How do you use the information you receive from the queries you make? Select the most frequent way you use the information.	[ ] Plan home visits [ ] Plan outreach [ ] Call clients to come for care [ ] Other specify	
Q16	Do you use the information you received from your queries to conduct home visits?	[ ] Yes [ ] No	
Q17	Has the information from the queries improved your performance in terms of home visiting?	[ ] Yes [ ] No	
Supervision and Monitoring activities			
Q18	How many times did the PHN, HIO, and DCO come to your facility for a supervisory visit in the last quarter?	[ ] Once [ ] Twice [ ] more than twice [ ] Never	

Q19	What are the areas that are of interest to your supervisor? (Select **only two** most frequent areas)	[ ] ANC, CWC and PNC [ ] Defaulters, home visits [ ] Data accuracy [ ] Clinical care [ ] MOTECH	
Q20	When your supervisors visit you, do they ask whether you have traced your defaulters of not?	[ ] Yes they do ask [ ] No they do not ask	
Q21	Why do you think they ask whether you have traced your defaulters? Select **only one** most important reason.	[ ] Meet our coverage targets [ ] Provide full care to clients [ ] Have complete data [ ] Other, specify	
Q22	**Has MOTECH improved your overall performance?**	**[ ] Yes** **[ ] No**	
Thank you for participating			

APPENDIX 2: MOTECH DATA SHEET

No.	District	Facility	Defaulter type	Time to provide care (days)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				

APPENDIX 3: IN-DEPTH INTERVIEW GUIDE

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

District: ……

Age of participant: …… Gender: Male [ ] Female [ ]

Duration of work in the District: ……

Thank you very much for accepting to participate in this study. I will be asking you questions about how you conduct you work using MOTECH. To begin with, I will ask you questions about how you understand MOTECH.

1. **Understanding of MOTECH**
    a. Do you use MOTECH at your facility?
    b. How does MOTECH work? (Probe: what is MOTECH about, how are the messages sent to pregnant women generated, how are the defaulter alert messages generated?)
        i. Why do you think it is important to upload all your data in the simplified registers? (Probe: should nurses even upload this data? What will happen if they do not upload all this data?)

Now I will ask you questions about how you utilize MOTECH in everyday work.

2. **Utilization of MOTECH**
    1. Defaulter Tracing
        a. How do you identify your defaulters? (Probe: what are the challenges? How do you overcome these challenges? What do you do when you cannot get the information you need?).
        b. Why do you use the defaulter alerts MOTECH send? How useful are these alerts? What do these alerts add to your work? Why do you say this?
        c. How do you trace to provide care to these defaulters? What are the challenges that you face?

d. If you follow up and provide care to your defaulters, do you report to your supervisors? Why?
e. How do you plan your defaulter tracing? Do you use a list, or you trace them immediately you receive the defaulter alert? Why do you trace them using this plan?
f. What are your challenges with timely data uploads? Do you discuss these challenges with your supervisors? How can these challenges be improved?

2. Home Visits
    a. How do you plan your home visits? (Probe: What kind of information do you need to plan your home visits? Where do you get this information from? How useful is this information? If MOTECH is mentioned, why do you use these messages?)
    b. Do you know how to retrieve information from the MOTECH system? How do you use this information? Why do you use this information?
    c. What are the challenges you face conducting home visits? How do you overcome these challenges?

I will now ask you questions about how MOTECH benefits you and the challenges you face.

3. Benefits of MOTECH and challenges

a. In what ways does MOTECH benefit your facility? Do you think MOTECH has improve the performance of you and your colleagues? Why do you say this?

Finally I will be asking you questions about how your supervisors support you to conduct your work.

4. Supervision

a. What do your supervisors look for whenever they visit?
b. Are your supervisors interested in whether you have defaulters or not? What are the things they do to show they are interested or not

interested? Do you think this has improved your performance? How?

Thank you for your time. If I need further information, who should I contact?

APPENDIX 4: SURVEY QUESTIONNAIRE CONSENT FORM

Welcome! The purpose of this interview is to gain a deeper understanding of how you use MOTECH in the conduct of your work. All Community Health Nurses and selected Community Health Officers are participating in this survey. This is a student research work which is a requirement for the award of a Master of Public Health degree from the University of Ghana.

This interview will take about 10 minutes of your time. You will be required to independently complete the survey by answer the question on the survey questionnaire. Feel free to skip questions you are not comfortable answering. You will not be paid any money for the interview.

This interview is not expected to cause any harm but if you feel uncomfortable with some of the questions, you can choose not to answer them. You can continue to answer the rest of the questions even if you decide not to answer some questions you are not comfortable with.

All the information that will collect from you will be treated confidentially and solely for the purpose of this study. No particular response will be associated with you or your facility. Your participation is voluntary and you have the right to decline participation.

If you have any further questions or concerns, or you feel you have been treated unfairly, contact Mr. Williams Kwarah on 0544100039 who is the Researcher or Madam Hannah Frimpong on 0243235225 who is the Administrator of the GHS Ethical Review Committee.

If you agree to participate please sign your name below. Thank you.

Study Participant Signature: ……

Research Assistant Signature: ……

Date: ……

APPENDIX 5: IN-DEPTH INTERVIEWS CONSENT FORM

Welcome! My name is …… and I am a member of the research team conducting this study. The purpose of this interview is to gain a deeper understanding of how you use MOTECH in the conduct of your work. Selected Community Health Officers have been invited to participate in this study. This is a student research work which is a requirement for the award of a Master of Public Health degree from the University of Ghana.

This interview will take about 60 minutes of your time. Feel free to interrupt me anytime with something you feel is important. I do not want to trust my memory, so I will ask for your permission to record our conversation using a portable digital recorder. If you feel uncomfortable having any portion of the interview recorded, please feel free to inform me to switch it off. You will not be paid any money for the interview.

This interview is not expected to cause any harm but if you feel uncomfortable with some of the questions, you can choose not to answer them. You can continue with the interview even if you decide not to answer some questions you are not comfortable with.

All the information that I will collect from you will be treated confidentially and solely for the purpose of this study. No particular response will be associated with you or your facility. Your participation is voluntary and at any point during the interview, you can decide to end the interview if you are not comfortable with the interview.

If you have any further questions or concerns, or you feel you have been treated unfairly, contact Mr. Williams Kwarah on 0544100039 who is the Researcher or Madam Hannah Frimpong on 0243235225 who is the Administrator of the GHS Ethical Review Committee.

If you agree to participate please sign your name below. Thank you.

Study Participant Signature: ……

Witness Signature: ……

Date: ……

APPENDIX 6: IDI PARTICIPANT CHARACTERISTICS

Table 4.1 Participant characteristics for the in-depth interviews

No.	Gender	Age	Duration of work (Months)	Role	Work with MOTECH
IDI 1	Female	27	36	In-charge	Yes
IDI 2	F	29	24	In-charge	Yes
IDI 3	F	29	24	Assistant	Yes
IDI 4	F	31	48	In-charge	Yes
IDI 5	F	26	36	In-charge	Yes
IDI 6	F	26	36	In-charge	Yes
IDI 7	F	26	48	In-charge	Yes
IDI 8	F	28	24	Assistant	Yes
IDI 9	F	24	36	In charge	Yes
IDI 10	F	27	60	In-charge	Yes
IDI 11	F	27	60	In-charge	Yes
IDI 12	F		36	In-charge	Yes
IDI 13	F	30	36	In-charge	Yes
IDI 16	F	28	37	In-charge	Yes
IDI 15	F	28	6.5	Assistant	Yes
IDI 14	F	24	12	In-charge	Yes
IDI 17	F	28	48	Assistant	Yes

Mean age = 27.38

APPENDIX 7: ENUMERATION CHECKLIST (CENSUS)

No.	District	Name of Facility	Name of Respondent	Duration of work at the facility	Do you use MOTECH in your work? (Y /N)	Comments